SINCLAIR KNIGHT MERZ
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Pluto LNG Development

REVISED PLUTO LNG DEVELOPMENT DREDGING SIMULATION AND IMPACT ASSESSMENT

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- 02 May 2007

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1. Introduction

Quantitative modelling has been applied to assess the consequences of dredging and sediment disposal operations associated with construction of the shipping channel and trunkline proposed for the Woodside Pluto LNG Development.

2. Phase 1 Modelling

Previously presented studies undertaken by APASA focussed upon the cumulative plumes of suspended sediments, and associated sedimentation rates, generated by the operations. Simulations examined the progressive evolution of a relatively complex operation involving multiple types of dredging equipment. The cumulative outcomes of multiple simultaneous operations were investigated for a conceptual dredging program spanning two years. The source location and rates of movement (of the source) and production (hence sediment flux to the environment) were dictated by the conceptual plan. Among other factors, the simulations tested for the interaction of seasonal influences on circulation and the proposed location of the operations during different seasons.

Specifications for the discharge were based on the best available information from comparable operations – either from the international literature or from documentation of previous dredging operations in Western Australian waters, and to understand the potential influence of errors in this information, the study examined the sensitivity of the model outcomes to uncertainties. Sensitivity testing was undertaken to test the influence of sediment loss rates, size-distributions of sediments, vertical distribution of sediments set up by the discharges, the duration of daily operations (15 hr per day versus 24 hr per day) and the location of discharges. The model accounted for cohesion of the finer sediments to calculate realistic rates of sinking, due to clumping. The relevant background information can be found in sections 5,6 and 7 of the Draft PER, and reference should also be made to the PER Supplement and Response to Submissions.

The focus of the previous modelling was on the initial fate of sediments suspended by the various operations and followed multiple size-classes until first settlement to the seabed. The model accounted for cohesion of the finer sediments to calculate realistic rates of sinking due to clumping. Transport was calculated using modelled currents based on wind and tide forcing. Model currents were validated against measured currents in Mermaid Sound and Dampier Archipelago. In calculating settling from the lower layer of the water column to the seafloor, the model used estimates of current shear at the seabed to determine the probability that sediment of a given size-class would settle once they sank to the benthic layer. This approach, which is based on empirical evidence from previous comparisons to ADCP measurements of sediment distributions from similar dredging operations, was to account for the spread of fine sediments in the benthic layer if currents at the seabed exceed critical levels. Model results indicated that a high proportion of fines would remain suspended, given the current velocities predicted for the dredging and disposal locations. The model did not account for subsequent resuspension of settled material, leaving uncertainties about the additional contribution by such material.

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3. Phase 2 Modelling

3.1 Scope

Further modelling was undertaken to explore sensitivity of predictions made during Phase 1. The work specifically sought to:

- Examine the influence of resuspension of suspended sediments including the influence of waves.
- Place the model results in context with field measurements from within Mermaid Sound during and outside of other dredging operations.

In addition, the dredging programme has been altered from the original concept plan and the consequences of the new plan were tested for selected operations. Operations were selected on the basis that they were closest, or otherwise were likely to constitute the highest risk, to areas of concern.

Refer to **Table 1** and **Table 2** for changes in design to the proposed dredging programme that have occurred since the Draft PER was published.

- **Table 1 Changes in Design to the Proposed Dredging Programme since the PER was Published**

Item	Draft PER	Current position	Comment
Dredged channel length	10 km	Same	Bulk of dredging is over inner 8.5km; overall ship route is approximately 16km
Width of channel	250-275m	230-250m	-
Water depth in channel	12.5–13.5m	Same	-
Water depth in turning basin	Up to 13m	Up to 12.5m	-
Water depth in berth pocket	Up to 13.5m	Same	-
Dredging operations	24 hr basis	Same	-
Types of dredging vessels proposed	TSHD CSD	Same	-
Dredging approach	Use of a medium sized TSHD to remove unconsolidated material via suction pipe or drag arms; dredged materials pumped to hoppers; solids settle, overflow discharged at keel level; full hoppers move to	CSD initially works inshore berth pocket area with direct disposal of material to an interim rehandling pit located within the proposed turning basin; inshore dredged material removed directly via surface pipe to pit; TSHD removes material from pit to disposal grounds. Current proposal to use two TSHDs which are expected to reduce	Refer to Draft PER Section 4.6.5 and this report for further detail. Further changes to proposed approach may occur.

Item	Draft PER	Current position	Comment
	spoil disposal site; CSD cuts harder material, which is deposited in situ and picked up later by TSHD for disposal to spoil ground.	overall operational time.	
Dredge spoil disposal	Coarse material from turning basin and berth pocket to spoil ground A/B and to offshore spoil ground 2B; finer material to spoil ground A/B; coarse and fine material from navigation channel to the offshore spoil ground 2B	Bulk of unconsolidated and fine material from navigation channel works to an extended offshore spoil ground 2B. Coarse and crushed materials from navigation channel works to northern section of spoil ground A/B and to northern section of offshore spoil ground 2B; some of the coarse material earmarked for possible re-use as fill for post lay trunkline stabilisation.	Refer to Draft PER Table 4-9 and this report for further detail.
Dredging duration	24 months	Same	Design, methods and operations continue to be investigated with the aim of optimising the programme and reducing works duration
Dredging start date	Q3 2007	Same	

- **Table 2: Summary of specifications and key changes to trunkline works**

Item	Draft PER	Current base case position	Comment
Trunkline length	~180 km	Unchanged	-
Trunkline route	Four route options, Options A,B,C and D, were presented from the offshore field to shore,	Revised – one option from the offshore field to a landing at Holden Point (or alternative landing at Karratha Gas Plant)	Refer to Figure 3-6 in Draft PER. The route has been selected to achieve shortest length between landfall and platform; lowest level of environmental impact; lowest risk for outside impact on trunkline and avoidance of existing permit blocks and oil & gas
Preferred landfall	Four landfall options considered – West Intercourse Island, and locations on the Burrup (Holden Point, Karratha Gas Plant, Cowrie Cove	Preferred option is Burrup Option A with landfall at Holden Point; Also still carrying second option of possible landfall to Karratha Gas Plant	Refer to Draft PER Section 3.4, Option B to West Intercourse Island was discounted earlier due to factors such as larger

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Item	Draft PER	Current base case position	Comment
	and Conzinc South)		footprint; see Draft PER Supplement Section 2.2
Trunkline corridor with - inshore	1500 m	Unchanged	width required to accommodate anchor spread
Trunkline corridor width - offshore	1500 m out to 20 m depth; 3000 m beyond 20m and out to platform to accommodate pipelay vessel	Unchanged	Refer to Draft PER Figure 4-7 for drawings of trunkline corridor widths and Draft PER Section 4.5.3.2
Shore crossing construction	Backhoe dredge excavates trench; short section of onshore-offshore interface may require blasting; land-based excavators excavate trench between LAT to onshore end of near shore trench; a temporary groyne may be required for land-based excavators; rock backfilled	Unchanged	
Pre-lay construction	Pre-lay dredging of a trench using a TSHD, CSD and Back Hoe Dredge (BHD).	Pre-lay works scope amended to include new requirement beyond KP 50 for pre-lay sweeping or “pre-sweeping” to prevent scouring effects of unconsolidated material (if the layer thickness is proven to be more than 0.3 m). This will be removed with a TSHD and placed in spoil ground 5A.	Current proposal is similar to that in Draft PER up to Kilometre Point (KP) 50; current proposal indicates additional dredging and pre-sweeping requirement beyond KP50
Post-lay trunkline stabilisation at shore crossing	Quarry rock backfill and armour	Unchanged	
Post-lay trunkline stabilisation – offshore	From 8 m depth out to DPA port limits mix of no cover rock berm and use of backfill using coarse material such as sand, gravel or crushed calcarenite sourced from a suitable borrow site or from dredging	Similar to approach indicated in Draft PER; mix of no cover rock berm for areas where protection not an issue and coarse sand or crushed calcarenite rock as backfill for areas requiring protection; backfill sand to be sourced from pre-existing TSEP sand borrow area and coarse calcarenite from dredge spoil disposed in spoil ground A/B and in spoil ground	Refer to Draft PER Figures 4-8 and 4-9 for schematic drawings of no rock fill and no cover rock berm methods

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Item	Draft PER	Current base case position	Comment
		2B	
Rock dumping volume requirements	Maximum of order of 660 KM^3 sourced from onshore quarry (Draft PER Section 4.5.3.1)	Current base case is for 330 KM^3 (550kT)	
Spoil disposal	inside DPA port limits - to spoil ground A/B, northern extension and deepwater spoil ground 2B beyond DPA port limits – to deep water spoil ground 5A	inside DPA port limits – bulk of unconsolidated material and fines from work north of KP 18 up to boundary of DPA limit to spoil ground 2B rather than to spoil ground A/B beyond DPA port limits – same plan as before – into spoil ground 5A, running parallel with trunkline Extension proposed to spoil ground 2B to accommodate anticipated volumes	Refer to Draft PER Table 4-9
Estimated dredge spoil quantities	2.0 MM^3 inside DPA port limits 1.5 MM^3 beyond DPA port limits	1.1 MM^3 inside DPA port limits 1.9 MM^3 beyond DPA port limits 0.5 MM^3 provisional scope for CSD rock dredging in Mermaid Sound	Refer to Table 4-6 in Draft PER
Estimated sand and CCR quantities for backfill	No detail available; however, the need for sourcing suitable fill from a borrow area or from dredging material indicated in Draft PER; refer to Draft PER Section 4.5.3 and Table 4-9	1.4 MM^3 from spoil ground A/B and 2B inside DPA port limits 0.8 MM^3 from borrow ground outside DPA limits and spoil ground 2B	

3.2 Model Description

In contrast to the earlier modelling, the simulations took account of the non-cyclonic wave climate within Mermaid Sound to represent resuspension. The general methods were as follows:

- Circulation patterns due to wind and tide were modelled for a period of two years (2005 and 2006) using the existing hydrodynamic model (HYDROMAP).

- Wave patterns due to swells (originating from outside Mermaid Sound) and local winds were modelled for the same two year period using a widely recognised surface wave model (SWAN), based on archived swell data from the WaveWatchIII archive (source: NOAA), archived wind fields for the same times from the NCEP atmospheric hindcast (source: NOAA) and current and sea-level information from the hydrodynamic model (to account for influences of currents and local sea-level on wave propagation and magnitude).
- Wave predictions from the SWAN model were validated against wave measurements from within Mermaid Sound for a 19-month period of measurement, to confirm they were representative.
- The previously applied sediment model (SSFATE) was extended to include calculation of combined seabed stress as a time and space-varying field from the current and wave field supplied by the HYDROMAP and SWAN models and to apply bottom stress to calculate resuspension in response to seabed stress from the combined effect of waves and currents, using resuspension algorithms developed and tested by the US Army Corps of Engineers and other sources. The algorithms use a two-stage approach to account for the lower stress required to resuspend particles that have only recently settled (i.e. within hours). Thresholds are grain-size specific. A description of the model algorithms and supporting references can be supplied.
- SSFATE was applied to model specific operations, based on the updated dredge plan. As for previous modelling, deposition predictions were based on a probability function, responding to local seabed stress and the local sediment concentration. In contrast to previous modeling, dredged material was followed through ongoing deposition and resuspension cycles In response to seabed stress. Resuspended material was transported by the prevailing current field and followed through sinking and settlement.

The modelling investigated three key dredging related operations, located in different parts of Mermaid Sound:

- dredging of the turning basin/ship berth off Holden Point (multiple operations)
- dredging of the trunkline (Trailer Suction Hopper Dredge (TSHD) work only)
- disposal of sediments to the offshore disposal ground (area 2B).

Each operation was characterised by a unique pattern of discharge:

- rate and pattern of movement (of the suspension source)
- production rate
- % of production rate lost
- size distribution of discharged sediments
- vertical distribution (due to discharge)

- timing and duration of discharge.

Specifications were based on the most recently developed dredging programme, and used previously tested (conservative) settings for sediment grain-size distributions associated with each operation. Allowance for propeller-wash was included for all operations involving vessel movement over shallow ground. For example, the regular transit of TSHD vessels along the channel leading from the turning circle.

3.3 Outcomes

Wave model predictions closely represented the trends, magnitude and timing of waves measured by Metocean Engineers at the centre of Mermaid Sound in 2005–2006. Statistical analyses indicated a high correlation between modelled and measured wave heights, wave lengths and directions (other details here) at all times of year, indicating that wave inputs were correctly scaled.

Wave modelling indicated that the proposed location of the shipping channel is exposed to wind-waves but would be sheltered to a degree from the predominant swell direction (from the south-west), due to the islands of the Dampier Archipelago. Sheltering from swells varies along the sound (least at the entrance) and over time. The dredging areas are also exposed to northerly swells during occasional storm events. The consequence of these findings are that seabed stress will vary considerably within days (due to sea breeze cycles) and between days (due to general winds and swells) and, in general, there will be increased seabed stress moving from the back of the Sound to the entrance. As a result, resuspension potential will be low in the lower reaches of Mermaid Sound and higher towards the entrance.

Analysis of seabed stress also indicated that the contribution by waves (swells and seas) would be orders of magnitude larger than by wind and tide-driven currents. Seabed current speeds around the turning circle due to winds and tides alone are predicted to exceed critical speeds purported to resuspend clay-sized particles, but only during short periods, at peak tidal flows. In contrast, seabed stress from the combined influence of swells, waves and currents was predicted to exceed thresholds for resuspension of fines for a greater percentage of the time, and for coarser grain sizes at times.

Variations in seabed stress follow similar patterns to concentrations of suspended sediments reported by MScience, when no dredging was occurring in Mermaid Sound – consistent with the theory that wave resuspension of sediments is a primary driver of background suspended sediment loads.

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3.4 Scenarios

3.4.1 Dredging of the Turning Basin

As previously predicted, suspended sediment plumes generated by the various operations, inclusive of propeller-wash, are expected to be relatively high within 1–2 km of the operations and to decrease exponentially with distance along the tidal axis. Dredging of the turning basin will take up to 5 months beginning at the start of October, and simulation with October–November wind and waves resulted in a net northward trend in the extent of the plume and sedimentation footprint.

As previously predicted, the heavier sediments (down to fine sands and coarse silts) will settle locally but a proportion of the finer sediments (fine-silt and clay-size) drifted northward in the simulations to generate a plume ‘tail’ that extended along the eastern coast of Mermaid Sound. After the first few days of discharge, there was a notable contribution to the plume at the far northern extent due to resuspended clay and fine silt (recalling that seabed stress due to wave action is expected to be larger in this direction). Concentrations as high as 20–30 mg/l above-background suspended sediments were predicted for the near-seabed layer as far north as flying foam passage, on occasions. More frequently, concentrations were predicted to reach 10–20 mg/l above background in this area.

The distribution of the TSS plume due to dredging around Holden Point was similar to previously predicted but extended further north at times. The extension beyond the previous distribution was contributed by relatively low concentrations of clay.

The extent and concentration of the northward plume was predicted to vary with the prevailing wave conditions, rather than the duration of the discharge. A greater plume extent is expected during higher wave stress, because of resuspension of fines that have previously settled. This observation has two implications:

- Discharging for longer will not tend to raise background turbidity throughout the wider sound (outside the plume footprint) in the immediate term.
- Higher turbidity due to dredged fines is likely to occur at times when ‘back-ground’ turbidity is also higher (due to wave resuspension of fines that are already in the system).

The latter point suggests a synergistic relationship between the dredge plume TSS and background TSS (as opposed to background TSS being random relative to dredge TSS).

It also follows that, if the dredging contributes increased quantities of fine sediments to the seabed of Mermaid Sound, the long-term influence of this dredging program (and previous dredging undertaken by Woodside and others) could be increased turbidity response to wave action.

Habitats aligning the eastern coast are expected to be exposed at times to elevated TSS and sedimentation rates. The frequency and magnitude is expected to be greater for close sites, and chronically above background within 1 and 2 km. As previously predicted, exposure to more distant coral habitats was indicated to be as a series of short-lived episodes. Median concentrations at sites more than 2 km away remain low (<5 mg/l above background) but over time there are extreme events of the order of 25-50 mg/l above background expected. The more extreme events are very short-lived (~ one hour) but more moderate increases (~ 10 mg/l) are expected to last for 1–2 days.

These predictions are consistent with the field monitoring by MScience. Continuous monitoring of TSS, turbidity and sedimentation rates over months before and during the most recent dredging for Hamersley Iron indicated that median concentrations do not appreciably change, even at relatively close sites(~ 200 m from discharge sources) to the dredging and disposal. However, there is an increase in the magnitude of unusually high concentrations. Short-lived peak concentrations are raised by up to 50 mg/l. Analysis of the duration of the observed peaks indicates that 10 mg/l rises last up to 1 day and 50 mg/l rises last up to an hour.

3.4.2 Spoil Disposal into Spoil Ground 2B

The simulation of disposal to area 2B under the influence of wave energy and currents specified discharge for four weeks but the simulation was extended to two months to examine the stability of the spoil ground.

Results indicated that there would be sufficient wave energy to resuspend the finer sediments – clays to coarse silts. Heavier sediments were not resuspended, indicating stability of this material. Some capping of fines would be expected, once fines that are at the surface are winnowed off.

The fine sediments that either escape the disposal area during the initial disposal, or are subsequently resuspended were predicted to migrate through a series of suspension and resuspension cycles into Mermaid Sound and Dampier Archipelago where they will be subject to resuspension over time. The simulation was undertaken during late autumn to winter conditions, and there was a tendency for this material to be constantly resuspended due to the higher wave energy around the entrance of Mermaid Sound. There was a tendency for a net migration southwards, with dispersal onto the coral habitats on the east and west side of the entrance under these conditions. Lighter concentrations also migrated through the channel south of Rosemary Island and further south into Mermaid Sound.

Predicted TSS concentrations near seabed at coral habitats around the entrance indicated an elevated median concentration (10–30 mg/l) and short-lived extremes to 100 mg/l. Net sedimentation rates by contrast were relatively low, due to predicted instability of the sediments (resuspension rates close to sedimentation rates). MScience report a similar finding from

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monitoring at these sites using a sedimentation pan that allows for resuspension (in contrast to sediment traps).

There is some potential for resuspension of fine sediments on the sediment mound at the dump site as fine sediments dumped on the spoil grounds may be gradually reworked (resuspended) by northerly swells and some of this material may be moved from the spoil grounds into Mermaid Sound. .The current dredging programme for Dampier Port Upgrade has also indicated there may be some reworking of the material dumped on the spoil ground, and once that programme is complete and the data fully analysed, the information would be available for input into the dredge management plan for the dredging proposed here. If a substantive effect is considered to be likely through sediment resuspension of fines on the spoil ground then there are number of options that could be considered to mitigate any potential impact.

3.4.3 Trailer Suction Hopper Dredging of the Turning Basin

Simulation of plumes generated by TSHD overflow and propeller-wash during dredging of the trunkline indicated localised and short-lived extents. The median concentration calculated for each location over 6 weeks were low (<5 mg/l at any location), partly because the dredging operation will move quickly and therefore affect any one location for a small part of the time. Short-term extremes (any one hour) were of the order of 90–100 mg/l in the immediate area of the discharge (~ 1 km).

Predictions for TSS concentrations at coral habitats along the east coast of Mermaid Sound indicated plumes would effectively disperse before reaching these locations – extreme concentrations were low relative to the MScience monitoring values for these sites.

Likewise sedimentation along the adjacent reefs was predicted to be small, although there was an indication that fines deposited from the operation would migrate shoreward. – expected net sedimentation was predicted to be low (> 5 mg/cm2/d).

4. Coral Impact Assessment

4.1 Model Interrogation

For comparison with the Draft PER coral impact assessment the revised model outputs were interrogated using the same thresholds as were used in the submission to responses. These were slightly modified from those used in the Draft PER predictions to introduce an added degree of conservativeness (**Table 3**). Sensitivity analysis was also undertaken by halving the absolute sedimentation thresholds (that is, before background rate was subtracted), before interrogating the model to provide an indication of the loss footprint with a conservative threshold level. Levels for sensitivity analysis are provided in **Table 3.**

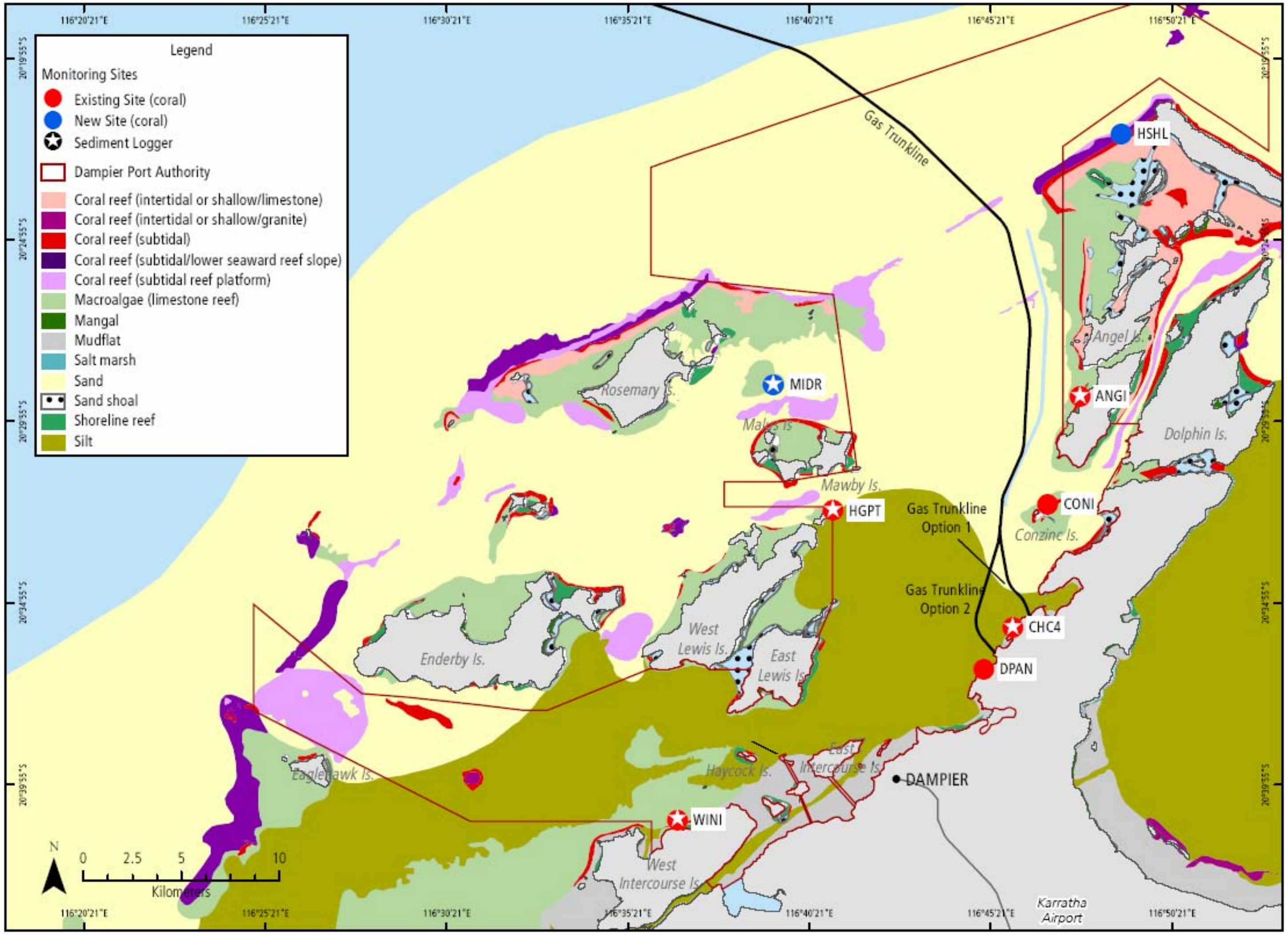
- **Table 3 Sedimentation Thresholds Used in Model Interrogation**

	Thresholds*		Sensitivity analysis	
Description	**Level**	**Duration**	**Level**	**Duration**
Acute for resilient species	445 mg/cm^2/d	Any 1 day	195 mg/cm^2/d	Any 1 day
Medium-term for resilient species	245 mg/cm^2/d	Any 5 days of any 15 day period	95 mg/cm^2/d	Any 5 days of any 15 day period
Chronic for resilient species	145 mg/cm^2/d	Any 15 days in a 30 day period	45 mg/cm^2/d	Any 15 days in a 30 day period

The coral sedimentation threshold levels were developed using existing data on sedimentation rates recorded in Mermaid Sound, in conjunction with observations on coral health. This review provided an indication of sedimentation rates and associated level of impact. An extensive literature review was undertaken to compare sedimentation rates with experimental data obtained for relevant species.

Data collected by MScience as part of a pre-dredging baseline study (that is, during periods of no anthropogenic influence such as dredging) reflects only sublethal and most likely sub-stress levels of sedimentation and turbidity and was therefore not used to develop coral sedimentation threshold levels. Monitoring sites used for this baseline study are shown in **Figure 1**.

A preliminary analysis of data collected as part of the on-going Dampier Port Upgrade dredging programme shows no evidence of substantive coral mortality as a consequence of that dredging programme. There is some implication there may be an effect at on coral health at the Tidepole site, but that is confounded by considerable variation in the levels of mortality recorded at reference sites. A full analysis of the data collected from both the Pluto baseline corals monitoring programme and the Dampier Port Upgrade programme will not be possible until those programmes have been completed. When a full analysis of the data collected by each of these programmes is available it will be assessed with respect to the information that could be relevant to fine tuning of the respective thresholds proposed within the Draft PER for the Pluto corals monitoring programmes. At this stage it is premature to include any reference to the partial results from those studies.



■ **Figure 1 Sedimentation and Coral Health Site Locations for the Baseline Study**

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4.1.1 Zone 1 – Holden Point

The model outputs for Holden Point were interrogated using the sedimentation thresholds for resilient species, as defined in the Draft PER.

Model interrogation of the turning basin simulation with the acute sedimentation threshold yielded a footprint very similar to that in the Draft PER impact assessment. However, interrogation with the medium-term and chronic thresholds yielded slightly larger footprints than in the Draft PER assessment, reflecting the effects of resuspension in the revised model simulation.

The reason for the increased loss footprint could be attributed to various factors:

- As described in **Section 3.3** settled particles resuspend when the seabed energy exceeds a certain threshold. The main contributor is wave energy, with tide and current causing resuspension to a lesser degree. The increase in the medium-term and chronic loss footprints were caused by the cycles of settlement and resuspension in close proximity to the dredging operation, with particles migrating outwards from the dredging operation over time.
- The increase in the loss footprint may also partly be attributed to the reposition of the turning basin closer to land than was the case in the Draft PER assessment.
- Also, the methodology was modified for the revised simulation, with operations increased from 15 to 24 hours a day.

Despite these changes, the revised loss footprint does not differ significantly from the Draft PER predictions. The Draft PER predicted cumulative impact was 42% (historical loss plus Pluto direct and indirect impact) in Management Zone 1 (Figure 2). Using the same baseline coral distribution data for the revised model output interrogation, the revised loss estimate for the same management zone is 43% (**Figure 3**).

Sensitivity analysis of the sedimentation thresholds was undertaken as described in **Section 4.1**. This caused the loss footprint to increase from 43 to 46% (**Figure 3**). The relatively small increase in the loss footprint shows that halving the thresholds does not yield a significantly larger footprint. As described in **Section 3.4.1** the sedimentation rates drop off exponentially along the tidal axis, and thus decrease quickly with distance away from operations. Using thresholds for impact assessment purposes is therefore relatively robust in that halving the thresholds will not cause the loss footprint to double in size, as might intuitively be expected.

The duration of the model simulation was six weeks; however, the dredging of the turning basin is estimated to take three months. As described in **Section 3.4.1** the model indicates that dredging for longer will probably not increase the level of sedimentation further than what is predicted during

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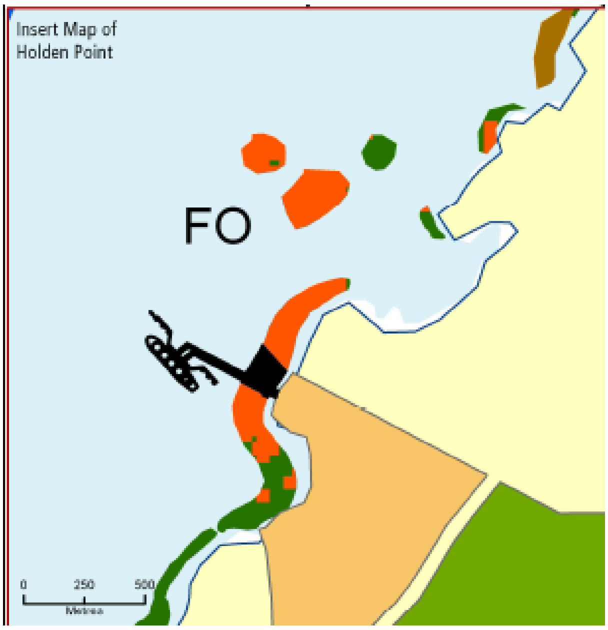
the six week simulation. Sedimentation and resuspension will tend to balance each other out over time. Simulating the construction of the turning basin for all three months may therefore not yield a larger loss footprint. However, chronic impacts from increased frequency of exposure to increased levels of TSS may cause impact outside the footprint of loss, but the exact level of impact is difficult to predict with any degree of certainty. The model output shows that a northward 'tail' will influence the eastern coast of the Burrup Peninsula, and impacts to coral communities here may occur; the influence could be chronic due to the extent of the dredging programme.



- **Figure 2 Draft PER Loss Predictions**

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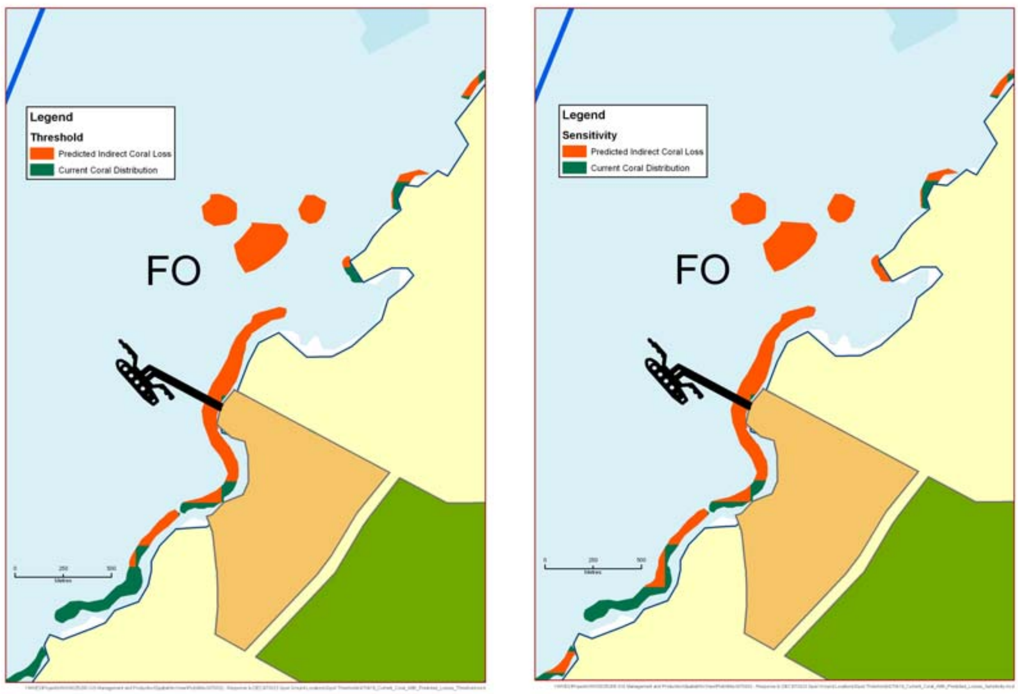

- **Figure 3 Revised Loss Predictions (left) and Loss Predictions from Sensitivity Analysis (right)**

4.2 Trunkline Installation

The model outputs for the TSHD for trunkline installation along Angel Island were interrogated using the sedimentation thresholds for resilient species, as defined in the Draft PER. Sensitivity analysis was also undertaken. The acute sensitivity threshold is equivalent to the acute threshold for sensitive species, and defined in the Draft PER.

Interrogation of the trunkline installation simulation indicated that predicted sedimentation rates were relatively low and confined to the area of operation. No losses were predicted when using the Draft PER sedimentation thresholds for resilient species.

Sensitivity analysis using halved thresholds, as described in **Section 4.1**, resulted in a small loss prediction at the south end of Angel Island. This is the same area in which losses were predicted in the Draft PER assessment from spoil disposal into spoil ground A/B. There is thus a potential for cumulative effects from trunkline installation and reuse/spoil disposal in spoil ground A/B.

The modelled trunkline installation scenario simulated the TSHD removing the upper layer of unconsolidated material prior to dredging the consolidated layer with a CSD. The period of time between these two activities is at present uncertain, but it is unlikely that the CSD will operate immediately after the cessation of the TSHD. Cumulative impacts due to chronic impacts over many weeks are therefore unlikely. However, as only the TSHD operation has been modelled the predictions of sediment flux from CSD operation may need to be considered to assess the possible cumulative effects of concurrent CSD operation and reuse/spoil disposal in spoil ground A/B.

4.3 Spoil Ground 2B

Modelling disposal of spoil into offshore spoil ground 2B during a four week period showed an increase in the sediment dispersion compared to the Draft PER model simulation. Resuspension and sediment transport into Mermaid Sound were shown to be particularly predominant during north-westerlies and high swell.

Interrogation of the simulated spoil disposal with the acute threshold for sensitive species did not yield any coral losses, neither did the sensitivity analysis where the threshold was halved. There may be a need to do further assessment on chronic impacts as the water quality in the outer harbour is generally high, and even low levels of suspended solids and sedimentation may have an impact over time.

As described in **Section 3.4.2** disposal into spoil ground 2B may cause sediments to disperse into Mermaid Sound. Though the levels of suspended solids are predicted to be low, the sediment plume of this resuspended material is predicted to reach the coral communities around Hamersley Shoal and along Gidley and Angel Island when wave and swell conditions move resuspended material in that direction. Given that spoil disposal is proposed over a duration of up to two years there is some potential for chronic impacts at some of these sensitive habitats. The level of resuspended sediments is predicted to be low and the consequent level of impact from this material is also expected to be low, and will also be influenced by the intensity and frequency of prevailing weather conditions in the Sound during the periods of release of dredge spoil over the spoil grounds.

There may also be a potential for cumulative impacts from disposal into spoil ground 2B, reuse/spoil disposal in spoil ground A/B, trunkline installation, and dredging of the turning basin. This will all depend on the timing of the operations, and the predominant weather patterns at the time.

5. General Conclusions

5.1 Holden Point

- Incorporating resuspension due to wave stress into predictions has indicated a relatively minor change in the near-field sedimentation rates at Holden Point.
- The loss footprint due to sedimentation has not increased significantly.
- The cumulative loss estimation in Zone 1 (Holden Point) has increased from 42% to 43%.
- The increase is mostly caused by an increase in the footprint due to medium-term and chronic sedimentation, reflecting the incorporation of resuspension into the model.
- The increase may also be a result of the minor relocation of the turning basin closer to Holden Point, and the increase in operations from 15 to 24 hours a day.
- The loss predictions did not increase significantly by halving the sedimentation thresholds, with cumulative loss estimates increasing only slightly from 43% to 46%.
- The model outputs show a tendency of the fines to disperse widely along the east shore of the Burrup Peninsula, and the coral communities here may therefore be at risk of impacts from light attenuation.

5.2 Spoil Ground 2B

- No losses due to sedimentation were predicted from the simulation of spoil disposal into 2B.
- The incorporation of resuspension in the model has indicated that the offshore spoil ground 2B may be unstable with finer sediments being washed out of the area. The model predicts this material will migrate into Mermaid Sound and disperse into the wider Dampier Archipelago.
- Though no losses were predicted due to sedimentation, the wide dispersion of fines from spoil disposal into 2B may cause impacts due to light attenuation, however the extent of this is unknown.

5.3 Trunkline

- The TSHD simulations along Angel Island did not predict any losses when interrogated with the thresholds for resilient species.
- A small area of loss at the south of Angel Island was predicted from interrogation with the acute threshold for sensitive species.
- This area is in the same general area where losses were predicted from spoil disposal into A/B in the Draft PER impact assessment.
- There may be a risk of cumulative effects from spoil disposal into A/B and dredging for trunkline installation, as a result of these activities occurring concurrently.