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MINEMAKERS LIMITED

Wonarah Rock Phosphate Project

Export Transport Logistics Study

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Infrastructure & Environment
Level 7, QV1 Building
250 St Georges Terrace
Perth WA 6000 Australia
Tel: +61 8 9278 8111
Fax: +61 8 9278 8110
www.worleyparsons.com
WorleyParsons Services Pty Ltd
ABN 61 001 279 812

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PROJECT 301012-00970 – WONARAH ROCK PHOSPHATE PROJECT

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
A	Issued for Internal Review	B Kartuz	J McLeod	N/A	01-Jun-09	N/A	
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1. EXECUTIVE SUMMARY

WorleyParsons was requested by Minemakers to develop and examine logistics options for the mine-to-port part of the phosphate supply chain at initial (1 Mtpa) and ultimate (3 Mtpa) stages of production and throughput.

The study has identified the feasible modes and methods of storing, handing and transporting the phosphate product from the mine to the Port (Figure 1). Viable options have been developed and evaluated. In accordance with the philosophy of greatest operational reliability at minimum cost, the preferred configuration for the logistic chain involves:

- An open storage facility at Wonarah mine with a 3 day operational reserve capacity using Front End Loaders (FELs) around the storage area for simultaneous (but alternating over shifts) outloading and inloading at two ends of the stockpile.
- Use of tri-axle road trains operated by third party to transport the product from Wonarah storage facility to the Tennant Creek rail transfer facility, generally using the existing roads but requiring outlays for upgrades. 17 road trains shall be required for 1 Mtpa throughput and 49 for 3 Mtpa throughput. The crew camp is proposed at Tennant Creek with an estimated 110 person accommodation capacity.
- A covered Hyparspace type storage at Tennant Creek located close to a new, purpose built rail siding at Bulk Minerals Terminal for phosphate loading either along a shared multi user open access track or along the main line of the Adelaide Darwin Railway.
- Transfer of product onto leased rail trains operated by third party at Tennant Creek with material handling (inloading and outloading) by FELs. The rail train loaded 'in motion' with possible loco indexing using FEL operating at specified location.
- Rail transport to the Port of Darwin, in alliance/agreement with a third party rail operator using covered bottom discharge hopper wagons (62 t payload) in progressively enlarging train configuration and fleet as the tonnages grow from 1 Mtpa (1 train-set of 3L+92W.) to 3 Mtpa (3 train-sets of 3L+92W).
- Using existing bottom discharge dumper facility at Port of Darwin to unload rail trains and road transfer to the port storage facility).
- Conveyance of product from the port storage to ship loaders using road trains and FELs.
- The above logistic arrangements translate to an overall transportation cost from the mine to the port shiploader at an estimated $93.31 to $73.80 per tonne for 1 Mtpa and 3 Mpta correspondingly.
- The associated estimated upfront capital expenditure required is AUD$89.6 million and AUD$115.8 to support 1 Mtpa and 3 Mtpa throughput respectively. A part of the capital investment differential can be progressively made in certain infrastructure (e.g., accommodation) components as the operations grow towards the ultimate task of 3 Mtpa.

- The annual transportation cost from the mine to the Port only is estimated to be $74.3 to $64.49 per tonne for 1 Mtpa and 3 Mpta correspondingly. The anaylised capital expenditure portion is within the range of 14 % to 25 %.

Figure -1 Process Flow Diagram

2. PROJECT OVERVIEW

2.1 Introduction

Minemakers Australia Pty Ltd. ('Minemakers') is developing a rock phosphate mine at Wonarah in the Northern Territory. The mine is intended to commence operation in mid 2010 at 1 Mtpa, ramping up to 3 Mtpa by 2011 over a period of eighteen months.

As the transport logistics cost significantly impact the landed cost in export markets, WorleyParsons has been engaged by Minemakers to undertake a feasibility level export transport logistics study, analyse major elements of the supply chain logistics and identify a preferred solution, taking into account key risks and constraints.

2.2 Purpose

This document aims to capture the evaluations and recommendations resulting from the Export Transport Logistics Study undertaken by WorleyParsons.

2.3 Scope

The scope of the study was to identify, analyse and evaluate the options available for handing, storing and transporting the rock phosphate product from Wonarah mine to Port of Darwin and provide an assessment of anticipated cost.

The options developed propose to minimise the capital and operational costs, while delivering the planned ultimate annual capacity of 3 Mtpa with a suitable ramp up strategy plan from initial 1 Mtpa.

The study was to consider the key elements of the phosphate logistics chain, methods available for stockpiling and transport, availability and potential augmentation of infrastructure and acquisition of assets and facilities involved. Identification for third parties to interface and potential constraints and risks associated with the supply chain.

The scope of the study includes estimate of capital and operational costs for transporting the product from the mine to the port.

The battery limits of the study are described in section 2.7.

2.4 Exclusions and Limitations

The following tasks or activities are explicitly excluded from the scope of this study:

- Road access constraints for road train operations on Barkly Highway, Stuart Highway and Wareggo road.
- Land use requirements at Tennant Creek Bulk Minerals Terminal (BMT) and integration of phosphate handling facilities and rail loading siding into overall BMT development plan. Land use requirements at Tennant Creek in the vicinity of the Adelaide Darwin Railway should the multi-user shared BMT facility, does not materialise.
- Negotiating any agreement with FreightLink for the integration of planned rail operations e.g., travel times, additional crossing loops requirements, access fees etc and associated costs, except initial discussions for assessment of anticipated core elements of rail operations.
- Negotiating any agreement with Port of Darwin for integration of Port operations, e.g., use of Bottom Discharge Dumper, cycle times, conveyor capacity expansion, unloading siding expansion, access fees and associated costs etc.
- Phosphate trains unloading, stockpiling and storage structure and equipment conceptual planning and estimate at Port of Darwin (provided by GHD).
- Assessment of environmental, social and heritage impacts and mitigations.
- Evaluation and recommendation of vendor specific products is limited to conceptual and functional level and budgetary proposals.

2.5 Assumptions

The main assumptions related to the sub-elements such as storage, material handling and transport in specific areas have been included in relevant parts of this report where such sub-element is discussed.

- The following properties of the phosphate product have been adopted for this study:

Bulk density	1.6 t/ m^3
Particle size distribution	max lump size 6.5 mm
Moisture content	3%

- Rail transportation is the only viable option for transportation of the phosphate product from Tennant Creek to the Port of Darwin.
- A reserve storage/inventory equivalent to three days operations (at 3 Mtpa level) is necessary at Wonarah mine site and Tennant Creek transfer facility to avoid operational disruptions including those by any third party.
- A reserve storage/inventory equivalent to eighteen days operations (at 3 Mtpa level or 150,000 t) is necessary at the Port of Darwin to avoid operational disruptions including those by any third party. This is based on consultations with Minemakers representatives.

- Either the shared multi-user rail facility at Tennant Creek BMT will be operational and available when the phosphate operations is required or will not be available at all in the future.
- The cost analysis and economic evaluation has assumed that all capital expenditures occurs in year 0, all operating costs occur in the years thereafter and has been based on the following:
  - Project Life Ten years
  - Discount rate 15%

2.6 Basis of Design

The following are key criteria used as the basis for this study and conceptual design of the elements of the logistic chain.

Table 2-1

Annual Transportation Volumes	1 M to 3 M tonnes per year
Daily Transportation	2849 to 8547 tonnes
Number of Fully Operational Days	Three hundred and fifty one days for mine, road and rail, Three hundred and forty five days per annum for port
Wonarah Mine to Tennant Creek Transport	By road trains via existing road network, loading by Front End Loader. Covered transportation is required
Tennant Creek to Port of Darwin Transport	By freight train-sets of bottom discharge wagons (maximum 1,800 m long) via existing standard gauge railway (maximum 23 tal) Loading by Front End Loader at new rail siding. Covered transportation is required
Phosphate storage (Wonarah Mine, Tennant Creek, Port of Darwin)	An open storage facility at Wonarah Mine. Covered storage at Tennant Creek to prevent loses and adjacent area contamination Three days operation storage at Wonarah and Tennant Creek Eighteen days operation storage at Port in covered facility. Building envelope is to accommodate required level of reserves (three ship bunching)
Planned operations concept (road, rail, port and storage facilities)	Third party operations
Port of Darwin - train unloading and phosphate storage	Bottom discharge wagons utilising existing BDD facility and new conveyor transportation to covered storage facility
- Shiploading operations	By road trains, loading by FELs

2.7 Battery Limits

Specifically identified battery limits for this logistics study are as follows:

Table 2-2

Process	Battery Limit
Storage and loading at Wonarah Mine	Storage facility conceptual planning and estimate Phosphate stockpiling and loading onto triple tri axle road side tippers
Road transport -Wonarah Mine to Tennant Creek	Phosphate transport from Wonarah mine storage to Tennant Creek transfer facility using triple tri axle road side tippers Road train requirements
Unloading, storage and train loading task at Tennant Creek	Phosphate unloading from triple tri axle road side tippers onto storage building at Tennant Creek Storage building conceptual planning and estimate Bulk material/ loading from storage onto train
Rail transport task - Tennant Creek to Port of Darwin	Phosphate transport from Tennant Creek storage to Port of Darwin using bulk material train-sets New rail siding at Tennant Creek Rolling stock requirements, based on current operations practice and operations cost estimate Additional passing siding requirements based on current operations practice and future expansion plans Rail siding at Port of Darwin
Phosphate unloading, storage and loading onto ship task at Port of Darwin	Phosphate unloading from bulk material trains by existing Bottom Discharge Dumper onto storage building at Port of Darwin Phosphate transport from storage onto shiploader using existing practice (triple tri axle road side tippers)

3. WONARAH MINE TO PORT OF DARWIN PHOSPATE LOGISITCS

3.1 Wonarah Mine

3.1.1 Storage

3.1.1.1. Storage Building Concept

Following were the objectives to determine the options for product storage at Wonarah Mine site:

- Optimum storage volume for an estimated 3 Mtpa production.
- Minimum footprint for facility.
- Minimum handling of product, both inloading and outloading.
- Maximum inloading and outloading rates.
- Minimal use of fuel / energy in managing stockpile and moving product.
- Future capacity expansion.

3.1.1.2. Daily Operation Volumes

Incoming

The incoming volume at the proposed storage facility is 8,547 t /day or 356 t /hour, delivered by run of mine (ROM) trucks 193 t capacity for 24 hour/ seven day operation.

Outgoing

The outgoing volume is the same as the incoming volume and is delivered by the road trains. The estimated frequency of road trains (94.6 t capacity) is approximately 16 minutes for ultimately 3 Mtpa.

3.1.1.3. Reserve Storage Requirements

The Wonarah mine stockpile will require an open storage facility for a minimum of a three day reserve corresponding to 3 Mtpa production. This translates to a stockpile capacity of 26,000 t to act as a buffer against operational contingencies interrupting the supply chain.

3.1.1.4. Storage Facility

For bulk material storage, covered storage options were initially investigated on the basis similar to the storage requirements at Tennant Creek (refer section 3.4.1). However, covered storage was not considered a preferred approach based on discussions with Minemakers. The capital cost of the open stockpile facility envisaged is the lowest compared to the covered alternatives. Therefore, an open stockpile of approximately 86 m x 45 m base and 6 m height is recommended for the Wonarah Mine site.

Operation

One of the two short ends of the rectangular plan stockpile will be used for loading operations from ROM trucks while the other short end is simultaneously used for outloading operations to the road trains using the FELs. Both ends will be suitable for inloading as well as outloading operations to allow switching of the two ends over consecutive periods (for example shifts) to maintain the boundaries and operational safety of the stockpile on depletion-recoup cycles.

The footprint of the storage facility will also allow adequate spaces for:

- Access and inloading operations of ROM trucks at both ends for streamlined flow, this includes space for manoeuvring of ROM trucks.
- Access and outloading operations of road trains at both ends for streamlined flow, this includes a space for manoeuvring of road trains.
- Access and manoeuvring of FELs at both ends in order to load the road trains and clear the dumped product to the stockpile.

The conceptual dimensions of the open storage facility and associated material handling process and capital-operational cost factors have been arrived at accordingly. Refer drawings at Appendix A - 301012-00970-MH-DSK-0006. The summary of the features and related costs are as below.

Estimated minimum stockpile size	86 m x 45 m x 6 m
Inloading process	FEL (1)
Outloading process	FEL (2)

Control of Dust and Contamination of Adjacent Area

No specific dust and adjacent area contamination control measures are envisaged at this stage due to the unconfined nature of the storage facility.

3.1.2 Road Train Loading by Front End Loader

FEL Requirements

Phosphate from the Wonarah mine storage facility will be loaded by a FEL into triple road trains, each having a total payload of 94.6 t.

The daily transport requirement of 8,457 tonnes has been defined in section 2.6 and will therefore involve the loading of 90.35 road trains (rounded to 91) over the twenty four hour period. This corresponds to one road train every 15.94 minutes.

Hence, the model of FEL to be selected for road train loading will need to be able to complete the operation in less than sixteen minutes.

The FEL cycle time is based on the hydraulic activation time as well as the forward and reverse travel time. This has been estimated to be in the range of 0.55 to 0.90 minutes per bucket.

FEL Analysis

The rated pay loads and operating parameters of six different models of CAT FELs are summarised in Table 3-1.

CAT 972 FEL: For a 0.588 minute loading cycle time the CAT 972 FEL with a rated bucket capacity of 8.15 t would load a 94.6 t payload triple road train in twelve cycles or 7.1 minutes. As calculated above, road train frequency at 3 Mtpa is one road train every 15.94 minutes which implies on FEL duty cycle of: 7.1 min. / 15.94 min. = 45 %.

CAT 980 FEL: For a 0.588 minute loading cycle time CAT 980 FEL with a rated bucket capacity of 9.57 t could potentially load the 94.6 tonnes for the triple road train in the same twelve cycles or 7.1 minutes.

Whilst the loading time would be the same for both FELs, the larger bucket capacity of the CAT 980 would not be utilised.

However, considering the clearance of the loaders, the CAT 980 FEL (or equivalent) is therefore recommended for this application.

An additional CAT 980 FEL will be required for product inloading at 3 mtpa.

A third CAT 980 FEL will be required as standby at 3Mtpa

Two CAT 980 FEL will be required at 1 Mtpa stage including one as standby.

Figure 3-1 CAT 980 FEL

Table 3-1 Front End Loader model comparison for road trains outloading

		CAT					
		972	**980**	**988**	**990**	**992**	**994**
Wheel Loader							
Bucket Rated Payload	t	8.15	9.57	11.34	14.97	21.77	34.47
Dump Clearance at full lift and 45 de discharge	m	3.10	3.31	3.44	4.22	4.63	5.70
Production required							
Road train frequency	train/hr	3.76	3.76	3.76	3.76	3.76	3.76
Road train loading time	min	15.94	15.94	15.94	15.94	15.94	15.94
Trailer loading time	min	5.31	5.31	5.31	5.31	5.31	5.31
Road train load	t	94.60	94.60	94.60	94.60	94.60	94.60
Trailer load	t	31.53	31.53	31.53	31.53	31.53	31.53
No. of buckets per trailer							
Estimated	ea	3.87	3.30	2.78	2.11	1.45	0.91
Rounded	ea	4.00	4.00	3.00	3.00	2.00	1.00
Loader Cycle Times							
Basic cycle times	min.	0.55	0.55	0.55	0.6	0.6	0.7
road trains (owned)	min.	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
Material (3 mm to 20 mm)	min.	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Stockpile (dumped by road train)	min.	0.02	0.02	0.02	0.02	0.02	0.02
Constant operations	min.	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Travel time		0	0	0	0	0	0
Subtotal (cycle time)	**min.**	**0.49**	**0.49**	**0.49**	**0.54**	**0.54**	**0.64**
Efficiency							
50 minutes per 60 minutes	min.	50	50	50	50	50	50
%	%	83.3%	83.3%	83.3%	83.3%	83.3%	83.3%
Total FEL cycle time		**0.588**	**0.588**	**0.588**	**0.648**	**0.648**	**0.768**
Loading time							
Single trailer loading time	min.	2.4	2.4	1.8	1.9	1.3	0.8
Road train loading time	min.	7.1	7.1	5.3	5.8	3.9	2.3

3.1.3 Manpower Requirements

The manpower requirements are based on FEL operators being double rostered on 12 hour shifts working 14 days on and 7 days off over 24 hours a day 7 days per week.

Table 3-2 Manpower requirements for Wonarah Mines

Annual tonnage	1 Mtpa	3 Mtpa
FEL operators per shift	1	2
FEL operators including relief	4	8

An Indicative Costing per tonne has been provided by a third party FEL operator-contractor (refer Appendix D).

An allowance has also been made for the following FEL operator's costs:

- relocation costs.
- accommodation of FEL operators and meals at Wonarah Mine permanent camp.

3.2 Road Transport Logistics : Wonarah Mine to Tennant Creek Bulk Minerals Terminal

The product will be transported by a third party bulk material moving contractor from Wonarah Mine to a bulk minerals terminal proposed to be developed 17 km north west of Tennant Creek.

It is proposed to use side tripper triple road trains with a payload of 94.6 tonnes per unit.

Haulage of phosphate by road train from the Wonarah Mine to Tennant Creek (refer Appendix B – 301012-00970-GIS-SKT-002) involves:

- 8.5 km of new access road from the mine stockpile to the Barkly Highway.
- 260 km on the Barkly Highway to the Stuart Highway.
- 22 km on the Stuart Highway to Warrego Road.
- 16 km on the Warrego Road to a new siding constructed on the Adelaide to Darwin railway for the proposed bulk minerals terminal.

All roads are bitumen sealed. The total haul distance from Wonarah Mine to Tennant Creek is 306.5 km (one way).

The road trains will operate 24 hours per day, 7 days per week for 351 days of the year. They will be able to achieve a 12 hour Wonarah Mine-Tennant Creek-Wonarah Mine cycle time which will include:

- Refuelling.
- Shift change.
- Loading and unloading.
- Inspections, and
- Scheduled driver breaks: two for 15 minutes and one for 60 minutes.

The estimated size of required fleet of triple road side tipper trains for 1 Mtpa and 3 Mtpa, transportation volumes are calculated as follows:

- 1 Mtpa / (351 days x 2 trips per day x 94.6 t) = 15 road trains, or 17 including spares. and
- 3 Mtpa / (351 days x 2 trips per day x 94.6 t) = 45 road trains, or 49 including spares.

The above fleets of road trains will haul 2,838 and 8,514 tonnes of phosphate per day for the 1 Mtpa and the 3 Mtpa haulage tasks respectively.

A total 35 personnel growing to 106 personnel consisting of truck drivers and supervisors will need to be accommodated at a permanent camp near Tennant Creek to maintain the required delivery schedule. Truck drivers will be rostered on 12 hour shifts working 8 days on and 4 days off.

An Indicative Costing per tonne has been provided by a third party bulk moving contractor (see Appendix D) for the following operations separately:

- product stockpiling at Wonarah storage.
- Product loading onto road train at Wonarah storage.
- Wonarah mine to Tennant Creek transport by road trains.
- Product stockpiling at Tennant Creek storage.
- Product loading onto rail train at Tennant Creek.

The above includes fuel, (GST and Excise exclusive). Estimated fuel consumption for triple road trains is assumed to be 70 litres per 100 km.

An allowance has also been made for the following road haul operator's costs:

- Relocation costs, and
- Accommodation for truck drivers and meals at Barkly roadhouse.

The Wonarah stockpile has been assumed to carry three days reserve in order to permit continued road operations in the event of a disruption to production from the mine.

An Indicative Costing per tonne has been provided by a third party fleet of a road train operator operator-worker (refer Appendix D).

3.3 Wonarah Mine to Tennant Creek Road Traffic Initial Assessment

3.3.1 Existing Traffic

Info pending from NT Government

3.3.2 Project Traffic and Impacts

Info pending from NT Government

3.3.3 National Highways and Local Road Maintenance

The haulage will be carried over 306 km from Wonarah Mine to Tennant Creek (one way). All roads along this route are bitumen sealed and therefore a road maintenance cost will be associated with hauling phosphate over this distance.

A maintenance cost of 0.25 cents /NTK for heavy vehicle has been imposed along this route. Using this figure, the road maintenance cost (see below for details) will be 76.5 cents/tonne or $765,000 and $2,295,000 for the 1 Mtpa and 3 Mtpa scenarios respectively:

- $0.0025 x 306 km x 1 Mtpa = $0.765per tonne x 1 Mtpa = $765,000 pa.
- $0.0025 x 306 km x 3 Mtpa = $0.765per tonne x 3 Mtpa = $2,295,000 pa.

It is envisaged that the Northern Territory Government will impose road geometry, signage, structure and pavement upgrade costs along the route to offset the impact of additional traffic and to maintain the safety of operations on the existing road network.

The scale of the aforementioned road access and maintenance costs is subject to field investigation and assessment of traffic (refer sections 3.3.1 and 3.3.2 “Existing Traffic Initial Assessment”) and the condition of Barkly Highway, Stuart Highway and Wareggo road and further negotiations with Northern Territory Government.

3.4 Tennant Creek Phosphate Transfer Station

3.4.1 Tennant Creek Phosphate Storage Facility

3.4.1.1. Storage Building Conceptual Solution

Following were the objectives to determine the options for product storage at Tennant Creek site:

- Optimum storage volume for an estimated 3 Mtpa production.
- Minimum footprint for facility.
- Minimum handling of product, both inloading and outloading.
- Maximum inloading and outloading rates.
- Minimal use of fuel / energy in managing stockpile and moving product.
- Dust site contamination and material losses control.
- Future capacity expansion.

The following known bulk material storage options were investigated:

- Conventional concrete column and girder structure (without material handling options).
- Silo (with material handling options (refer Appendix C 1).
- Conical and dome structures (with material handling options refer Appendix C 2).
- Lightweight structures (without material handling options). This includes the concept designs of:
  - Hyparspace (refer Appendix C 3), and
  - All shelter (refer Appendix C 4).

On consideration of comparative merits of the above alternatives, Hyparspace was selected as a preferred storage solution. Hyparspace structure allows for the construction of long span, column-free building suitable for storage situations and allow future capacity expansion including, for example, towers and conveyor structure.

3.4.1.2. Hyparspace Structures

The main advantages of Hyparspace (refer Appendix C 3) are efficiency of design, significantly reduced construction / installation time, cost effective maintenance in a corrosive environment and cost competitiveness with conventional buildings. Construction is based around an on-site roll-forming technology that creates roof and wall panels that are structural and can be curved or flat. The panels are formed on-site, seamed together and lifted into place in sections. The flat panels can be applied to roll continuous lengths with spans of the semi-arch roof panels up to 60 m clear span.

It is recommended that Hyparspace type structures be considered in view of the specific storage requirements of the phosphate product for Tennant Creek transfer facilities.

3.4.1.3. Daily Operation Volumes

Incoming

The incoming volume at the proposed storage facility is 8,547 tonnes/day 3 Mtpa or 59,800 tonnes/week delivered by road trains. The frequency of road trains will be every 16 minutes. This frequency corresponds to 3 Mtpa throughputs for 24 hour/7 day, 351 day/year operation.

Outgoing

The frequency of outgoing rail trains is 10.5 rail trains per week to achieve the transport task of 59,800 tonnes/week. The trip time of trains is 48 hours with 8 hours dwell time for approach loading inspection and departure per trip.

3.4.1.4. Reserve Storage requirements

The Tennant Creek mine stockpile will require a covered storage facility for a minimum of 3 days reserve or 26,000 tonnes to act as buffer against operational contingencies interrupting the supply chain.

3.4.1.5. Storage Facility Options

Three storage options were examined from considerations of building envelope dimensions, material handling solutions and capital-operational cost factors (refer Appendix B - 301012-00970-MH-DSK-0012). The distinguishing features of operations for each of the options, impacting the storage solutions are as follows:

Option 1

The discharge product from road trains and its outloading the trains shall be on opposite sides of the stockpile inside the shed. As the road trains travel to the other end of the covered shed while exiting, a clearway of 8 m along each side shall be required allowing for requisite clearances and workspace.

The FELs will inload the dumped product to the stockpile and outload the trains.

There would be a minimum 20 m manoeuvring space for FELs at both ends between the stockpile and the shed structure.

The stockpile would be 137 m long, 29 m wide and 6 m high to accommodate the required capacity of 26,000 tonnes.

Allowing for the stockpile, the road train passage, the rail passage and FEL workspace requirements, the proposed storage building envelope is 175 m long and 45 m wide.

Option 2

This option consists of:

- An in-ground feeder hopper (capacity 100 t) for receiving material from road trains.
- An inclined conveyor from hopper to transfer tower. Transfer tower, Tripper.
- Inloading conveyor inside shed.
- An in-ground feeder hopper (capacity 100 t) at each end of the shed for receiving product from FELs for loading trains.
- An outloading inclined conveyor from each in-ground retrieval hopper to a central hopper built over the railway line for loading wagons.

The product brought by the road trains into the shed will be dumped into the underground receival hopper. An inclined covered conveyor would carry the product from the in ground hopper to transfer towers where it would be transferred to the inloading conveyor inside the shed. The inloading product can be directly transported from the in-ground hoppers to the outloading conveyor when trains are loading so avoid double handling.

The road train discharge hopper and the rail loading facility are both located outside the shed thereby not requiring dust suppression measures.

There would be a minimum 12 m manoeuvring space for FELs at both ends between the stockpile and the end structure. Therefore, the stockpile would be 71 m long, 45 m wide and 15 m high for the required capacity of 26,000 t. The building footprint shall be 95 m long and 45 m wide.

Option 3

There would be a minimum 6 m manoeuvring space for FELs at both ends between the stockpile and the shed structure for outloading of rail trains. This space would open onto an outside, unsealed area where dumped product would be cleared to the stockpile by an FEL. Rail wagons would also be loaded by an FEL.

At a given time, the inloading and outloading operations will take place at opposite ends of the shed. The inloading and outloading activities could alternate each day.

The stockpile would be 86 m long, 45 m wide and 6 m high for the required capacity of 26000 tonne. The resultant building footprint will be 98 m long and 45 m wide.

3.4.1.6. Evaluation of Storage Options

Option 1: Provides full undercover inloading and outloading operations for road and rail trains but requires the 20 m extension at each end of the stockpile for FEL manoeuvrability and the 8 m clearway on each side of the stockpile for road train and rail train access. This reduces the available width for the stockpile to 29 m and increases the length to137 m, requiring an overall shed length of 175 m. The floor area is 7,875m^2.

Option 2: Envisages material inloading and outloading by conveyors partially, thereby minimising the stockpile and shed footprints due to greater heights (15 m compared to 6 m in options 1 and 4) feasible. The stockpile area is smaller (4,275m^2 compared to next best 4,410m^2 for option 3).

This is a capital intensive option but minimises material handling and significantly improves train loading duration and consequent train cycle time.

This option does not provide for dust site contamination suppression.

Option 3: This option allows for the second smallest shed size amongst the 3 options. Like option 2, this option does not allow for undercover inloading or outloading or dust site contamination suppression.

Material handling by conveyors is not included in this option. This reduces the height of the stockpile to 6 m (from 15 m in option 2), and a corresponding increase in the stockpile footprint to 86 m long and 45 m wide.

The Table 3-3 summarises evaluation of phosphate storage and material handling options at Tennant Creek.

Table 3-3 – Evaluation of Phoshpate Storage

	Option 1	Option 2	Option 3
Shed size	175 m x 45 m	95 m x 45 m	98 m x 45 m
Stockpile size	137 m x 29 m x 6 m	71 m x 45 m x 15 m	86 m x 45 m x 6 m
Inloading process	FEL (1)	Conveyor	FEL(1)
Outloading process	FEL(2)	FEL(2)/ Conveyor	FEL(2)
Building costs @$970 per m2	7,638,750		
Building costs @$1080 per m2		4,617,000	4,762,800
Material handling Inloading conveyor costs Outloading conveyor (train loading) costs		 4,462,500 5,801,250	
Total	**7,638,750**	**14,880,750**	**4,762,800**

Option-3 is recommended for the storage of phosphate at the Tennant Creek considering that it achieves the requisite material handling and operational requirements at the lowest cost. However, there will also be an ongoing cost associated with dust contamination control (air and adjacent area) applicable to the selected option.

3.4.2 Train Loading By Front End Loader

FEL Requirements

Trains will be loaded by a Front End Loader (FEL) from the stockpile at the new storage facility at Tennant Creek. Each train will consist of 90 to 100 wagons each with a payload of 62 tonnes giving a total maximum train payload of 6,200 tonnes.

The primary requirement from the FEL is so it will be able to load the train in as short a time as possible in order to allow the train to achieve a 48 hour Tennant Creek – Darwin turnaround time.

The FEL cycle time is based on the hydraulic activation time as well as the forward and reverse travel time. This has been estimated to be in the range of 0.80 to 1.10 minutes per bucket.

FEL Analysis

The rated payloads and operating parameters six different models of CAT FELs are summarised in Table 3-4.

The CAT 992 FEL with a rated bucket capacity of 21.77 t would be able to load a railway wagon in 3 bucket cycles or 3.0 minutes. The train would be loaded in an estimated 5.0 hours.

The 3 Mtpa scenario implies a FEL utilisation of:

10.53 payloads per week x 5.0 hrs /(7days x 24 hrs) = 31 %

The smaller CAT 990 FEL with a rated bucket capacity of 14.97 t could load a railway wagon in 5 cycles or 4.7 minutes, and a train within 7.9 hours only.

The CAT 992 FEL (or equivalent) is therefore recommended for this application.

An additional CAT 992 FEL will be required on inloading of road trains at 16 minutes frequency and to build up the stockpile.

A third CAT 992 FEL will be required as standby during loading of 10.5 trains per week at 3 Mtpa.

Figure 3-2 CAT 992

Table 3-4 Front End Loader model comparison for rail trains outloading

		CAT					
		972	**980**	**988**	**990**	**992**	**994**
Wheel Loader							
Bucket Rated Payload	t	8.15	9.57	11.34	14.97	21.77	34.47
Dump Clearance at full lift and 45 de discharge	m	3.10	3.31	3.44	4.22	4.63	5.70
Production required							
Wagon loading time (62 t)	min	3.60	3.60	3.60	3.60	3.60	3.60
Train loading time (100 w.)	hrs	6.00	6.00	6.00	6.00	6.00	6.00
Wagon load	**t**	**62.00**	**62.00**	**62.00**	**62.00**	**62.00**	**62.00**
Number of buckets per wagon							
Estimated	ea	7.61	6.48	5.47	4.14	2.85	1.80
Rounded	ea	8.00	7.00	6.00	5.00	3.00	2.00
Loader Cycle Times							
Basic cycle times	min.	0.55	0.55	0.55	0.6	0.65	0.7
road trains (owned)	min.	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
Material (3mm to 20 mm)	min.	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Stockpile (dumped by road train)	min.	0.02	0.02	0.02	0.02	0.02	0.02
Constant operations	min.	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Travel time (add. distance)	min.	0.25	0.25	0.25	0.25	0.25	0.25
Subtotal (cycle time)	**min.**	**0.74**	**0.74**	**0.74**	**0.79**	**0.84**	**0.89**
Efficiency							
50 minutes per 60min.	min.	50	50	50	50	50	50
%	%	83.3%	83.3%	83.3%	83.3%	83.3%	83.3%
Total FEL cycle time		**0.888**	**0.888**	**0.888**	**0.948**	**1.008**	**1.068**
Loading time							
Wagon loading time (62 t)	min	7.1	6.2	5.3	4.7	3.0	2.1
Train loading time (100 w.)	hrs	11.8	10.4	8.9	7.9	5.0	3.6

3.4.3 Manpower Requirements

The manpower requirements are based on FEL operators being rostered on 12 hour shifts working 14 days on and 7 days off over 24 hours a day 7 days per week.

Table 3-5 Manpower requirements for Tennant Creek storage facility

Annual tonnage (inloading and outloading)	1 Mtpa	3 Mtpa
FEL operators per shift	2	2
FEL operators, including relief	8	8

An Indicative Costing per tonne has been provided by a third party FEL operator-contractor (refer Appendix D).

An allowance has also been made for the relocation of FEL operators.

It is proposed that personnel for the Tennant Creek facility be either recruited from or relocated to the town.

3.5 Rail Transport – Tennant Creek to Port of Darwin

3.5.1 Rail and Port Operations Providers

The storage facility and rail infrastructure for this project will be located about 17 km north west of Tennant Creek on the existing Adelaide - Darwin Railway (ADR), 936km from Darwin.

Owned and operated by third party, the ADR is a standard gauge, single track open access railway.

The access to the ADR is supplied by FreightLink Pty Ltd (FreightLink), the owner and operator of the railway infrastructure. It is assumed that the locomotives and wagons will be leased by Chicago Freight Car Leasing Australia Pty Ltd (CFCLA) and the train crews will be supplied by Genesee and Wyoming Australia Pty Ltd (GWA). The terminal services at the Port of Darwin will be provided by P&O Ports.

These key parties have their respective suppliers for services such as locomotive and wagon maintenance (Downer EDI), infrastructure maintenance (BJB Joint Venture), crew car maintenance (Bluebird Rail) etc with whom, Minemakers are not anticipated to have direct dealings.

3.5.2 Existing Traffic

The current weekly rail traffic on the line is made up of 34 trains (refer Figure 3-3) consisting of:

- Intermodal freight.
- Bulk freight.
- Passenger trains.

Current bulk freight operations include the following:

- Bootu Creek to Port of Darwin
  – 800 km haul of 0.6 Mtpa of manganese using 4 loaded trains and 4 empty return trains per week using 2 x 3,000 hp locomotives for 48 hopper wagons.
- Frances Creek to Port of Darwin
  – 210 km haul of 1.5 Mtpa of iron ore, 7 loaded trains and 7 empty return trains, using 3 VL locomotives with 76 hoppers (38 CHAY pairs)
- Prominent Hill to Port of Darwin
  – 2000 km haul of 0.25 Mtpa of copper ore using 5 loaded trains using “kibble containers” and 5 empty return trains per week.

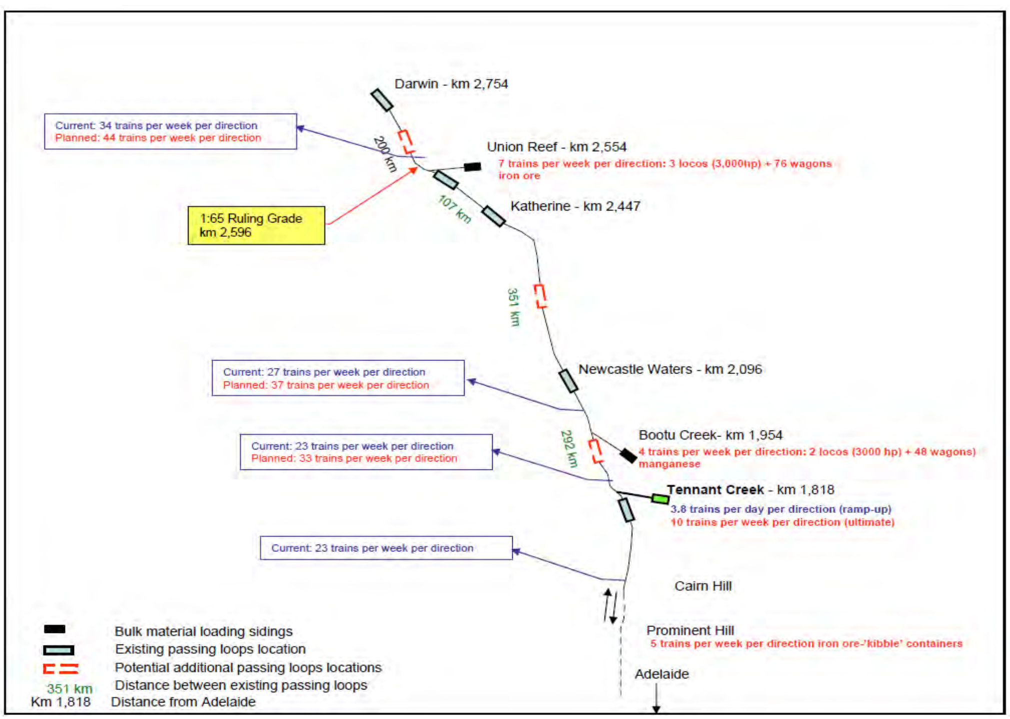

Figure 3-3 Alice Springs to Port of Darwin Railway

3.5.3 Phosphate Train Operations

3.5.3.1. Operating Parameters

Based on the initial discussions and inputs provided by FreightLink and CFCLA for specific requirements of rail operations for the phosphate project, the following operating parameters are anticipated for the phosphate train logistics:

1. Passing Loops

There are 3 existing crossing loops between Tennant Creek and Darwin. The length of passing loops is 1800m and this governs the maximum train length.

2. Axle load and speed

The current operation paradigm allows either 23 tal rolling stock with 80 km/h operational speed or a lower (by approximately 2 t) with 110 km/hr speed.

For the phosphate logistics, lower axle load and 110 km/h speed combination is considered preferable based on FreightLinks advice due to favourable impact of higher speed on cycle time without significantly trading off the payload. Thus, the payload of each wagon shall be 62t.

3. Train Maximum Trailing Load

The ruling gradient of 1 in 65 on this section (between Union Reef and Darwin) governs the maximum trailing loads for the prevailing drawbar capacity of 2 MN. On this basis and based on advise from Freightlink, a nominal 100 hopper consist is operationally permissible, to achieve the ultimate traffic task of 3 Mtpa. However, the actual train composition shall differ in the initial and ramp-up stages as detailed in section 3.5.5.

4. Locomotives

The current operations on the ADR generally utilise 3,000 and 4,000 hp locomotives are planned in the near future. Based on inputs from providers a 3x4000 hp consist pattern is considered the most efficient for the specific phosphate traffic task.

5. Wagons

Currently there are two types of wagons are in use for bulk transport on ADR:

- CHSY
- CHAY

Main performance parameters of these wagons are illustrated in Table 3-6.

Table 3-6 Wagon Main Performance Parameters

Wagon parameters	CHSY	CHAY
Type	Open Hoper	2-Pack Open Hoper
Axle load, tonne	23	25
Volume, m3	54	53 to 64
Unit length, m	11.6	12.8
Tare weight, tonnes	21	23
Gross mass, tonnes	92	100
Capacity, tonnes	71	77
Draw capacity, Mn	1.8	1.8
Maximum speed, kmh	110	115
Bogie type	70 t Barber	70 t Barber S2
Loading	Top	Top
Unloading/Discharge Chutes	Pneumatic bottom discharge / BRO Design	Pneumatic bottom discharge / BRO Design

5. Crew Car

Provision of a crew car is essential as per operational regulations for the length of haul involved for phosphate (936 km). As such, crew car shall be an integral part of the train consists and have been incorporated in the costing of rail logistics.

6. Maximum Train length

The 3x4000 hp locos, a maximum 100 hoppers and a crew car shall be the standard composition of phosphate trains and is within the limits allowed by the passing loop capacity.

3.5.3.2. Train Turnaround Cycles

Based on information and analysis of existing turnaround cycles experienced by other customers (e.g., Manganese from Bootu Creek) and advice from FreightLink and CFCLA, the following estimated range of train operating times have been established:

- At Port of Darwin – for shunting, unloading, train assembly, inspection, wagon replacements for scheduled maintenance, service locomotives 8 to 11 hours.
- Empties run from Port Darwin to Tennant Creek - 14 hours.
- Loading at Tennant Creek using FEL– 6 to 8 hours
- Loaded train run from Tennant Creek to Port of Darwin- 14 hours

Estimated Total = 42 to 47 Hours

However, to maintain consistency for departure schedules, crew and resource rostering and to absorb contingent disruptions to planned throughput, a 1 to 6 hour port layover is proposed as a buffer. This will allow the trains to be scheduled to a 48 hour turnaround cycle, which also has the advantage of synchronous scheduling of related activity operational cycles at Tennant Creek and Port. Based on these considerations a 48 hour schedule is proposed.

3.5.4 Tennant Creek Bulk Minerals Terminal Infrastructure

3.5.4.1. Rail Siding

Mining companies working in the Barkly region have inferred that a designated BMT in the vicinity of Tennant Creek would allow them to ramp up their operations. As a result a proposal to build a shared-user terminal in or near the town has been given major project status by the Northern Territory Government.

The loading of phosphate requires either such a common-user terminal or the provision of an independent facility with the capability to transfer phosphate from road trains to a storage facility and from the storage facility into rail wagons for the journey to Port of Darwin.

However, owing to external uncertainties of such multi-user shared facility/hub materialising and synchronising with the phosphate requirements, the two scenarios have been considered with and without availability of such facility.

Scenario-1 : With Shared Multi-user Facility

A new shared siding adjacent to the existing main line would consist of an estimated 3.5 km of track with 2 turnouts connecting it to the main line. The siding would pass through a load-out area within the enclosed stock pile facility. Refer to Figure 3-4 for the general arrangement.

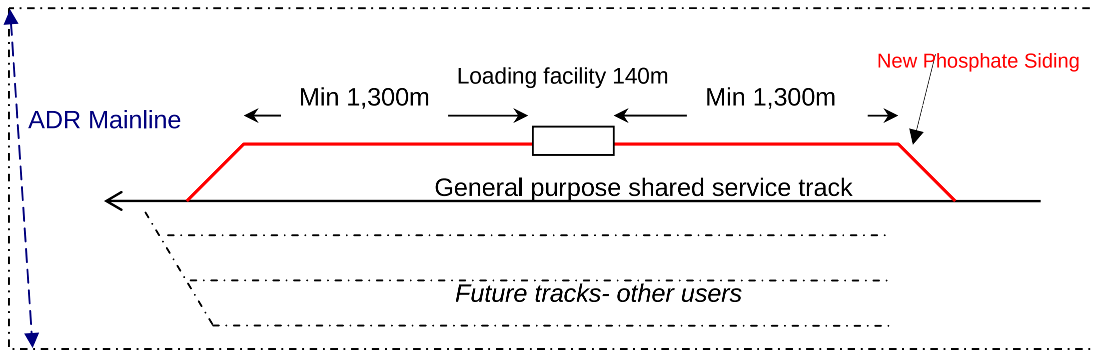

Figure 3-4: Tennant Creek Rail Siding for Phosphate Transfer to Rail Trains at BMT

In this scenario, the operational risks of delays to the phosphate trains is minimal and is not anticipated to involve extensive interfacing and signalling integration works with the mainline and associated upfront capital costs. The locomotive reversal requirement is expected to be achieved without interference or conflict with the ADR main line traffic. Furthermore, the mandatory safeworking requirements shall be less stringent, impacting design, construction and operation of the facility. However, a capital cost contribution and/or user charges may be anticipated by the proponents.

Scenario-2: Without Shared Multi-user Facility

In the event of unavailability of potential multi-user shared facility not materialising, the preferred alternative consists of building the phosphate siding along and parallel to the existing ADR main line with an objective to use the mainline for the locomotive reversal. The length of the siding and the quantum of associated infrastructure shall therefore be the same as that for the Scenario-1.

The general arrangement of the siding facility in this scenario is depicted below.

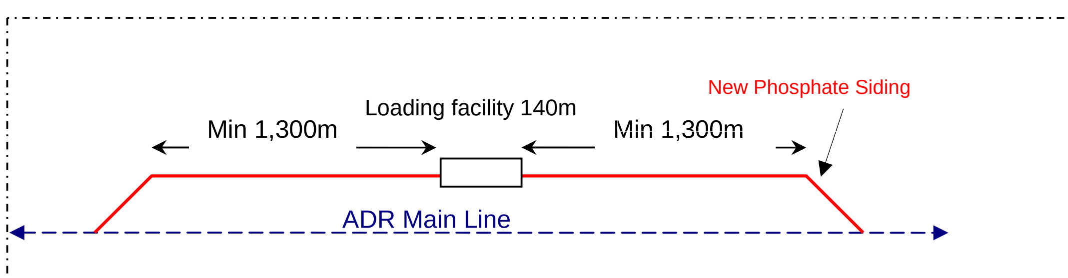

Figure 3-5: General Arrangement Siding Facility (Scenario 2)

However, the design, construction and operation of the facility in this scenario is expected to involve extensive coordination and approval issues with the infrastructure owners of the ADR for operational and signaling integration. Also, the design, construction and operation parameters are expected to be more stringent to comply with the requirement of ADR and other standards. The coordination shall also be necessary on an ongoing basis during all stages of the phosphate operation.

However, this option avoids the construction of approx. 3 km of additional track for achieving the locomotive turnaround. Furthermore, the facility in this scenario is expected to have relatively greater residual value as (a) passing loop(s) to the ADR should phosphate operations are discontinued at any stage and decommissioned.

Potential Hybrid Option

A plausible hybrid option may involve Minemakers to build the facility as per general arrangement for the Scenario-1 with a view to market it as an open access facility for the other potential/future users. However, this option is to be evaluated from a pure strategic perspective addressing issues such as the nature and analysis of potential business involved and has not been considered within the scope of this study.

3.5.4.2. Train Loading Operations and Manoeuvring

The loading operations essentially involve loading by FEL at the stockpile while the train moves at specified creep speed to the other end. On completion of loading as the train reaches far end of the proposed siding, the locomotives are run around the train using the common use service tracks, for departure. An in-motion weighbridge is proposed downstream of the farthest loading point. All train related operations for complete cycle of train loading from arrival to departure is proposed to be carried out by the same train crew.

3.5.5 Requirement of Rolling Stock and Crew

3.5.5.1. Phosphate Trains

Based on the annual tonnage movements and operational constraints, the rolling stock and crew requirements have been assessed for each annual scenario. These are summarised in Table 3.7 and Table 3-8.

Table 3-7 Table Cycle Time

Summary of Movement Requirement		
Operational weeks per year	50	weeks
Operational days per year	351	days
Wagon capacity @ 22tal	62	t
Max train size (hoppers) for 1:65 ruling grade	100	wagons
Train cycle time (Port of Darwin-Tennant Creek-Port of Darwin)	48	hrs
Train Per Year	175.5	Round trips per year for each train set

Table 3-8 Fleet and Crew Requirements

Annual transport volume	T	**1,000,000**	**1,500,000**	**2,000,000**	**2,500,000**	**3,000,000**
Average weekly transport vol.	T	20,000	30,000	40,000	50,000	60,000
Required wagon-loads per year (62 tonne payload)	ea	16,129	24,194	32,258	40,323	48,387
Required train loads per year (175.5 trips per year)	ea	175.5	263.3	351	438.8	526.5
Required train loads per week	ea	3.51	5.27	7.02	8.78	10.53
Required number of train sets (100 wagons per train-set)	ea	1.0	1.5	2.0	2.5	3.0
Fleet Requirements						
- Train-sets required		1	2	2	3	3
Proposed Train Consist Configuration						
- Train consist # 1		3 L.+ 92 W.	2 L.+ 66 W.	3 L.+ 92 W.	2 L.+ 66 W.	3 L.+ 92 W.
- Train consist # 2			2 L.+ 66 W.	3 L.+ 92 W.	2 L.+ 66 W.	3 L.+ 92 W.
- Train consist # 3					3 L.+ 98 W.	3 L.+ 92 W.
- Locomotives (4,000hp) required	ea	3	4	6	7	9
- Locomotives (4,000hp) required including spares	ea	4	5	8	9	11
- Wagons required	ea	92	132	184	230	276
- Wagons req. incl spares (8%)	ea	99	143	199	248	298
Phosphate train crews required (third party)						
- on-duty	ea	2	4	4	6	6
- off-duty	ea	2	4	4	6	6
- Total	ea	**4**	**8**	**8**	**12**	**12**
Manpower required: (third party)						
- Phosphate train locomotive crew (2 per loco)		**8**	**16**	**16**	**24**	**24**
-Port of Darwin shunting		**3**	**3**	**3**	**3**	**3**
		11	**19**	**19**	**27**	**27**

*(*a crew car applies in addition)*

The above analysis envisages a progressive increase in rolling stock holding and corresponding optimum train configuration for increasing traffic task. For example, while ramping up from 1.5 Mtpa to 2 Mtpa task, the locos as well as wagons are increased in the train consist while in case of 2 Mtpa to 2.5 Mtpa, the optimum configuration is two short (2L+66w) and one long train (3L+98w).

3.5.5.2. Locomotives

Main performance parameters of proposed locomotive are as follows:

Model	C43aci
Gauge	1435 mm
Maximum Speed	115 km/h
Tractive Power	3184 kW
Draw Capacity	2.2 MN
Coupling Length	22.0 m
Base Mass	127.0 t
Road Mass	134.0 t
Axle Load	18.0 t
Fuel Capacity	9500 L
Wheel Arrangement	Co-Co
Builder	United Group
Date of Build	2009
Load Category	L1 / L2
Outline RoA	Plate A

3.5.5.3. Wagons

For a bulk cargo characterised by comparatively lower specific gravity of 1.6 t/m^3, the volumetric requirement is a critical consideration in wagon design. In addition, bottom discharge hopper type is essential to ensure efficient in-motion unloading performance. In addition to these functional parameters, there are considerations of a technical nature e.g., drawbar forces, braking performance and maintainability.

Accordingly, adoption of CHAY type (or similar) bottom discharge hopper wagons is recommended for this project. The CHAY wagons operate in permanently coupled pairs with a solid drawbar between each pair of wagons. The specific features of the proposed wagons are listed in Table 3-9.

Table 3-9 Bottom Discharge Wagon Requirements

Bogie type and designation	70t Barber S2, AAR Class 2E
Volumetric capacity	Variable 32 to 53
Wagon Tare	23 t
Gross mass	100 t
Capacity	77 t
Length	25.6 m
Draw capacity	2 Mn

The expected design life of the recommended wagons is 30 years with re-sheeting requirement at half of the design life.

The wagons and other rolling stock (crew cars and locomotives) are proposed to be leased rather than purchased outright and this is reflected in the cost analysis in Table 4-1based on prevailing lease prices.

3.5.5.4. Requirement of Additional Crossing Loops between Tennant Creek and Darwin

On the track between Tennant Creek and Port of Darwin which will be traversed by the phosphate trains, crossing loops are currently located at Newcastle Waters (2,096km), Katherine (2,447km) and Union Reef (2,554km). The crossing loop at Union Reef is frequently occupied for bulk commodity loading. The crossing loops will be generally available for the phosphate trains. Distances between existing crossing loops are:

Table 3-10

Section	Distance (km)
Tennant Creek to Newcastle Waters	292
Newcastle Waters to Katherine	351
Katherine to Union Reef	107
Katherine to Darwin if Union Creek unavailable	307

Discussion with FreightLink suggests that there is no immediate requirement for additional crossing loop(s). However, the potential for congestion leading to excessive delays will lead to the 48 hour cycle time being exceeded. This will then lead to the phosphate trains not meeting the required annual tonnage.

Experience indicates that there could be a requirement for up to 3 additional crossing loops. However, this study has allowed one crossing loop in the overall project cost estimates at 3Mtpa.

3.5.6 Port of Darwin Rail Requirements

3.5.6.1. Train Unloading Station and Conveyors

The phosphate handling at Port of Darwin is the subject of a separate study undertaken by GHD (Ref 61/23955/89896 June-09). However, the impact of phosphate traffic on the existing rail unloader have been considered refer to section 3.6.1.

At the Port of Darwin an existing bottom discharge facility provides a nominal 1,500tph unload rate. This nominal unloading capacity equates to about 730tph for phosphate with a bulk density of 1.6 m^3.

3.5.6.2. Train Unloading Siding

Currently the dumper receives 11 trains per week, but this will increase to 21 trains per week as phosphate tonnages ramp up towards 3 Mtpa.

However, the dumper is not centrally located on the dedicated rail siding (the length of siding is approximately 450 m only). Therefore, the handling of the current 76 wagon trains involves breaking the train or occupying the multi-modal line for varying durations while discharging. This existing rail infrastructure configuration inhibits the smooth operation of discharge operations.

The major issues relating to the dumper include:

- The intermodal line will be blocked for up to approximately 2-3 hrs while the phosphate train is being inloaded. This conflict with the intermodal traffic can be significantly mitigated by extending the unloading siding or eliminated completely by constructing new siding and the dumper facility. The siding extension towards the harbour end to accommodate full train length (1300 m) is technically feasible.
- Unloading of other non-compatible bulk products at the facility (e.g., manganese and iron ore) creates a requirement for product purging and system cleaning between trains.
- The requirement to share the facility with other users will impose strict scheduling requirements on the phosphate trains.

Therefore, it is recommended to extend the siding by 900m towards the harbour end at 3 Mtpa. Additional 300 m of rail realignment is being considered at this stage (in total 1200m).

It may be worthwhile to explore the possibility of sharing of the siding extension cost by other user parties/stakeholders who are likely to make similar gains if siding extension takes place.

It is assumed that potential conflicts with other dumper users can be eliminated through negotiated scheduling.

On arrival at the Port of Darwin unloading facility, the train crews will be replaced by a shunter crew who will undertake the dumping operation. This approach is considered economical and feasible from relevant skill, cost and industry practice considerations.

3.5.6.3. Rail Transportation Cost Analysis

The total rail transportation cost expressed in $/tonne at the prevailing cost factor prices, for various levels of traffic task ramping up to 3 Mtpa. The calculations incorporate the major cost factors including the rolling stock leasing and maintenance charges, train crewing, fuel, train control and access charges to the third party railway.

The cost analysis is based on budgetary quotes from CFCLA and recent prevailing transport charges and does not take into account the price escalation over project life. The cost analysis also shows that there are potential economies of scale as the traffic volume ramps up over time.

The detailed calculations indicating the workings, cost factors and variables is available refer to Appendix E 2 – Wagons and Appendix E 3.

A summary of extract of the operational cost analysis with major cost components is presented below in Table 3-11

Table 3-11 Rail Operation Cost Analysis

Freight task (Mtpa) :	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**
Loco lease	3.54	2.95	3.54	3.19	3.25
Wagon lease	2.41	2.30	2.40	2.38	2.40
Crew	3.72	4.66	3.72	4.30	3.72
Fuel	6.36	5.86	6.36	6.52	6.36
Loco maintenance	1.85	1.64	1.85	2.22	1.85
Wagon maintenance	2.15	2.05	2.15	2.13	2.15
Train control	1.00	1.33	1.00	1.20	1.00
FreightLink access	3.51	3.49	3.51	3.56	3.51
Total, $/tonne	**24.52**	**24.29**	**24.51**	**25.49**	**24.22**

3.6 Port of Darwin Phosphate Transfer Station

3.6.1 Bottom Discharge Dumper Capacity

Refer to GHD Report for Port of Darwin Phosphate Storage Facility Feasibility Study dated June 2009 for bottom discharge dumper study.

At the Port of Darwin, the existing multi-product unloading infrastructure, the bottom discharge unloader and the rail siding is not expected to be a bottleneck upto 1 Mtpa throughput. However, as phosphate production is progressively ramped up the existing facility will be increasingly strained causing operational disruptions and inefficiencies.

Following solutions are envisaged to overcome the existing capacity limitation:

- For supporting upto 3 Mtpa throughputs, extension of existing rail siding to accommodate a standard train length will be necessary. This eliminates conflicts with port bound container traffic thus effectively increasing the throughput capacity of the unloading infrastructure.
- For achieving throughputs greater than 3 Mtpa, it is assessed that an independent phosphate unloading facility would be required consisting of a dedicated unloader and siding.

3.6.2 Phosphate Storage Facility

Refer to GHD Report for Port of Darwin Phosphate Storage Facility Feasibility Study dated June 2009 for Phosphate Storage Facility study.

3.6.3 Port of Darwin Road and Shiploading Logistics

Road Train Requirements

The product will be trucked by a third party bulk material moving contractor from storage to a truck unloading area at the Port of Darwin shiploader.

Similarly to Wonarah Mine, it is proposed to use side tripper triple road trains with a payload of 94.6 tonnes per unit.

Haulage of phosphate by road trains from the storage to the truck unloading area at shiploader involves:

- 0.75 km of facilities approach road to storage and truck unloading areas at 20km/h average speed.
- 3.25 km of service road at 40 km/h average speed.

All roads are bitumen sealed. The total return haul distance from the storage to shiploader is 8km with the road trains operating 24 hours per day, 7 days per week for 351 days of the year.

The estimated cycle time is as follow:

Travel time on approach road = 1.5km/(20km/h) =	4.5 minutes
Travel time on service road = 6.5km/(40km/h) =	9.75 minutes
Loading time by FEL CAT 988 =	6 minutes
(2 FEL would be required, with a cycle time of 0.588 min per (refer Table 3-12)	bucket or 5.3min per road train
Unloading time =	3 minutes
TOTAL =	**23.25 minutes**

To maintain a shiploader rate of 1892 tph (refer section 3.7.1.2), 20 road train payloads per 1 hr will be required or:

1892tph/94.6t = 20 road trains payloads per hour giving a frequency of 3 minutes per truck for each load.

The number of trips that can be covered by a road train in an hour is 60 min. / 23.25 min. = 2.58 trips

Hence, the number of road trains that would be required is 20/2.58 = 7.75, or 8 road trains.

FEL Requirements

The road trains will be loaded by a Front End Loader (FEL) from the stockpile at the new storage facility at Port of Darwin to be transported to the shiploading area.

The primary requirement from the FEL is to so that it is able to load 20 road trains per hour as to maintain a ship loader rate of 1892tph (refer Section 3.7), or 60/20 = 3 minutes per road train.

Using a 0.588 minute loading cycle time the CAT 988 FEL (refer table Table 3-12) with a rated bucket capacity of 11.34t would load a 94.6 tonne payload triple road train in:

3 cycles x 0.588 minutes x 3 trailers = 5.3 minutes.

To achieve the load out time of 3 minutes per road train at the stockpile, 2 CAT 988 FELs, each with a bucket capacity of 11.34 t would be required, halving the time used to load the road trains.

Hence, 2 CAT 988 FEL (or equivalent) is therefore recommended for this application at 3 Mpta.

A third CAT 988 FEL will be required as standby during ship loading operations (average 1.2 ships per week).

Two CAT 988 FELs will be required at 1 Mpta stage including one as standby.

Table 3-12 Front End Loader Model comparison for road trains outloading at Port of Darwin

		CAT					
		972	980	988	990	992	994
Wheel Loader							
Bucket Rated Payload	t	8.15	9.57	11.34	14.97	21.77	34.47
Dump Clearance at full lift and 45 de discharge	m	3.10	3.31	3.44	4.22	4.63	5.70
Production required							
Road train frequency	train/hr	20.00	20.00	20.00	20.00	20.00	20.00
Road train loading time	min	3.00	3.00	3.00	3.00	3.00	3.00
Trailer loading time	min	1.00	1.00	1.00	1.00	1.00	1.00
Road train load	t	94.60	94.60	94.60	94.60	94.60	94.60
Trailer load	t	31.53	31.53	31.53	31.53	31.53	31.53
Number of buckets per trailer							
Estimated	ea	3.87	3.30	2.78	2.11	1.45	0.91
Rounded	ea	4.00	4.00	3.00	3.00	2.00	1.00
Loader Cycle Times							
Basic cycle times	min.	0.55	0.55	0.55	0.6	0.6	0.7
road trains (owned)	min.	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
Material (3mm to 20 mm)	min.	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Stockpile (dumpted by road train)	min.	0.02	0.02	0.02	0.02	0.02	0.02
Constant operations	min.	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Travel time		0	0	0	0	0	0
Subtotal (cycle time)	**min.**	**0.49**	**0.49**	**0.49**	**0.54**	**0.54**	**0.64**
Efficiency							
50 minutes per 60min.	min.	50	50	50	50	50	50
%	%	83.3%	83.3%	83.3%	83.3%	83.3%	83.3%
Total FEL cycle time		**0.588**	**0.588**	**0.588**	**0.648**	**0.648**	**0.768**
Loading time							
Single trailer loading time	min.	2.4	2.4	1.8	1.9	1.3	0.8
Road train loading time	min.	7.1	7.1	5.3 **(2 req.)**	5.8	3.9	2.3

Figure 3-6: CAT 988

3.6.4 Manpower Requirements

The manpower requirements are based on FEL operators being rostered on 12 hour shifts during shiploading operations. The shunters and general ground staff requirement assessment is based on the premise of flexible roster arrangement synchronous with train schedules on a weekly cycle (3 to 10 trains per week).

Table 3-13 Manpower requirements for Port of Darwin storage facility

Annual tonnage	1.0 Mtpa	3.0 Mtpa
FEL operators per shift	1	2
Shunters per shift	1	1
General staff/labourers per shift	1	1
Total Manpower Requirement	9	12

An Indicative Costing per tonne has been provided by a third party FEL operator-contractor (refer Appendix D).

An allowance has also been made for the relocation of FEL operators.

It is proposed that personnel for the Port of Darwin facility be either recruited from or relocated to the town. The number is expected to be between 10 and 15, depending on the adopted operations model.

3.7 Shiploading and Export Constraints at darwin port

3.7.1 Dry Bulk Cargo Loading Constraints

3.7.1.1. Ship-Loader Throughput

Bulk cargo operations at Darwin Port are carried out through the multipurpose Common User Berth. This 600m long berth forms part of the East Arm Wharf complex and is equipped with a 2000tph Tenova-SEMF ship-loader conveyor.

The technical details of the Tenova-SEMF ship-loader include:

- Maximum designed loading rate: 2000 tonnes/hour.
- Conveyor belt speed: 2.2 m/s.
- Conveyor belt width: 1200 mm.
- Maximum luffing range: -15 to +80 degrees to horizontal.
- Ship-loader luff boom angle operating: -15 to +10 degrees to horizontal.
- Luffing speed: 7.5 deg/min fast 3.75 deg/min slow.
- Max shuttle travel extension: 8.95 metres.
- Shuttle travel at boom luff angle range: -15 to +25 degrees.
- Shuttle speed: 6 m/min.
- Tail shuttle retraction distance: 6.35 metres.
- Discharge chute luff angle: +20 to -20 degrees to vertical.
- Max operating wind speed: 20 m/s (39 Knots, 72km/h).
- Long travel distance: 340m.
- Operating travel distance: 152m.
- Long travel - fast: 20m/minute.
- Long travel - creep: 5m/minute.

The maximum designed loading rate of 2000tph reflects the “peak capacity” of the ship-loader. This is the maximum hourly unloading rate which can be achieved by the unloader when the cross traverse and hoisting distances in the unloading cycle are the absolute minimum. It is not a realistic representation of the throughput capacity of the ship-loader under operational conditions.

The “rated capacity” of the ship-loader is the unloading rate when unloading from a specific point in a vessel. This point is generally located, horizontally, at the centre of the vessel to be unloaded, and vertically, at mean low water level for the port. The “rated capacity” of the ship-loader is a more realistic estimate of peak ship-loader capacity at the port and is typically around 20 percent lower than the “peak capacity” as outlined above.

This throughput capacity is further reduced by a “through ship efficiency factor” which accounts for time lost due to lost in trimming, cleaning up, moving between holds and the requisite breaks during the working periods, but does not account for scheduled non-working periods. This factored capacity reflects the average loading rate which may be expected from the ship-loader and forms the basis of cargo loading throughput calculations.

Using an estimated rated capacity of 1600tph, and a through ship efficiency factor of 0.7, the ship loader can be expected to achieve an average loading rate of around 1120tph.

3.7.1.2. Road Train Feed Rate

The ship-loader is to be fed at by road based bulk haulage vehicles. Each of these vehicles may be assumed to be capable of a 94.6 tonne payload.

The maximum likely rate of loading by the Tenova-SEMF ship-loader will be a value between the average rate of loading for a ship (rated capacity) and the design rate of the ship-loader (peak capacity). For the purposes of this exercise this maximum likely rate of loading will be assumed to be 1800tph.

For reasons of efficiency it is preferable to ensure that the ship-loader is always running at peak capacity. It is therefore necessary to ensure that the rate of arrival of the bulk haulage vehicles is adequate to provide a supply of ore in excess of this maximum likely rate of loading. At 94.6 tonnes per vehicle a rate of around 20 vehicle loads per hour will satisfy this requirement.

3.7.2 Weather considerations

3.7.2.1. Cyclone conditions

According to Commonwealth Bureau of Meteorology (BoM) data, a cyclone will enter the Northern Territory forecasting district at a rate of 0.8 times per year, resulting in the issuing of a “Cyclone Watch” for Darwin. Under these circumstances the port will operate under the Darwin Port Corporation Cyclone Procedures, whereby activities at the port are likely to be slowed significantly, with restrictions on vessel movement and loading/unloading.

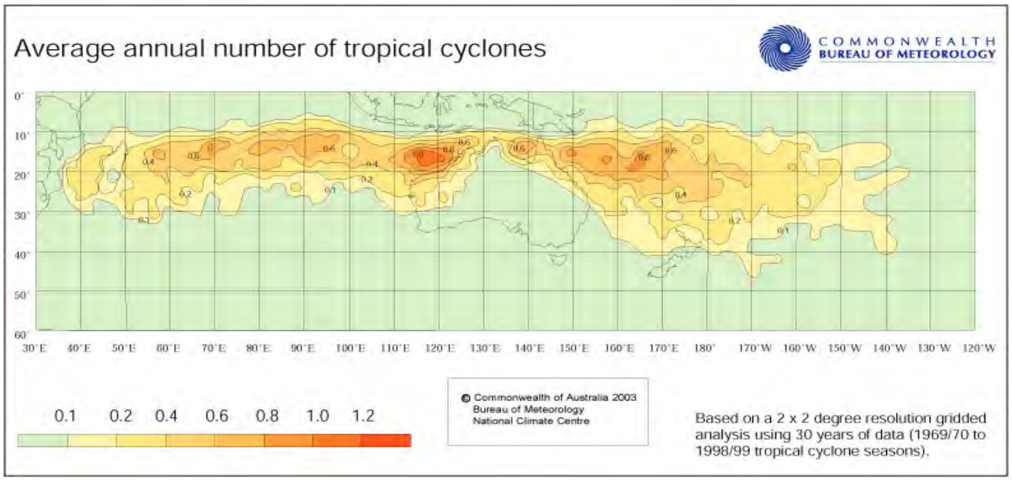

Figure 3-7: Average Annual Number of tropical cyclones

The same procedures state that Darwin Port will be closed entirely in the event that a "Cyclone Warning" is issued by the BoM. According to BoM statistics, the historical frequency of cyclones in Darwin is less than 0.4 per year, or less than one cyclone every 2 years. As a cyclone may still warrant the issuing of a Cyclone Warning for Darwin if it passes nearby and does not actually hit the city, it is reasonable to assume that a warning would be issued, on average, once per year.

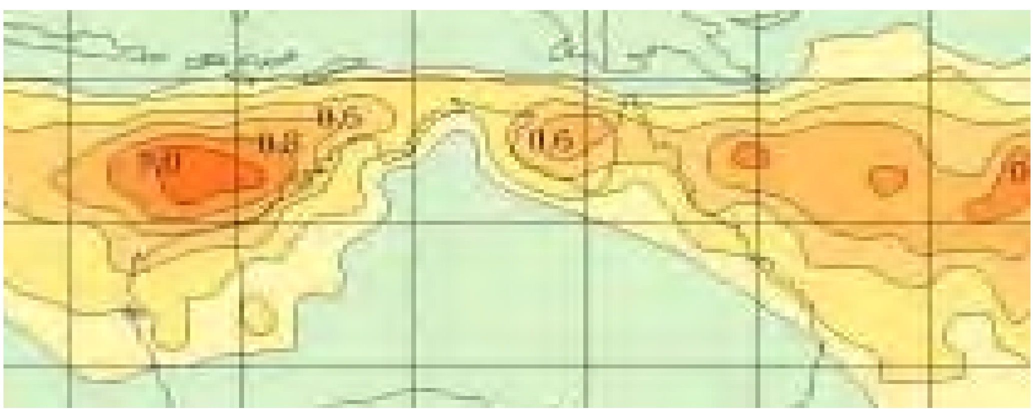

Figure 3-8:

In the experience of the Harbourmaster these cyclone conditions will typically last for around 3 or 4 days, but this time is highly dependent on the movement of the cyclone which is impossible to predict. It will be assumed that following a Cyclone Warning the port will remain closed for an average of 4 days.

A destructive cyclone has the potential to cause damage to infrastructure at the port resulting in further service disruptions. It is anticipated that cyclones of this magnitude will be very rare.

For the purposes of this exercise the following service disruptions due to cyclones will be accounted for:

- An average of 2 Cyclone Watches per year, equivalent to 2 days lost time each
- An average of 1 Cyclone Warning per year, lasting 4 days
- No lost time due to cyclone damage

3.7.2.2. Ships unable to berth in > 25 knot winds

Cargo ships are unable to berth safely at the port in winds higher than 25 knots (46km/h). This is due to practical difficulties in manoeuvring and securing the ships in adverse wind and wave conditions.

BoM data for 9am and 3pm mean wind speeds at Darwin Airport indicate that the average wind speed tends to be highest during the dry season months. However, the data also shows that the months with the highest proportion of wind speed readings above 40km/h are in the monsoonal months between November and March.

The following graph shows historical maximum wind gusts for each month alongside corresponding data for the year 2008. It is evident from the graph that the highest historical wind speeds lie in the cyclone affected months of November to April.

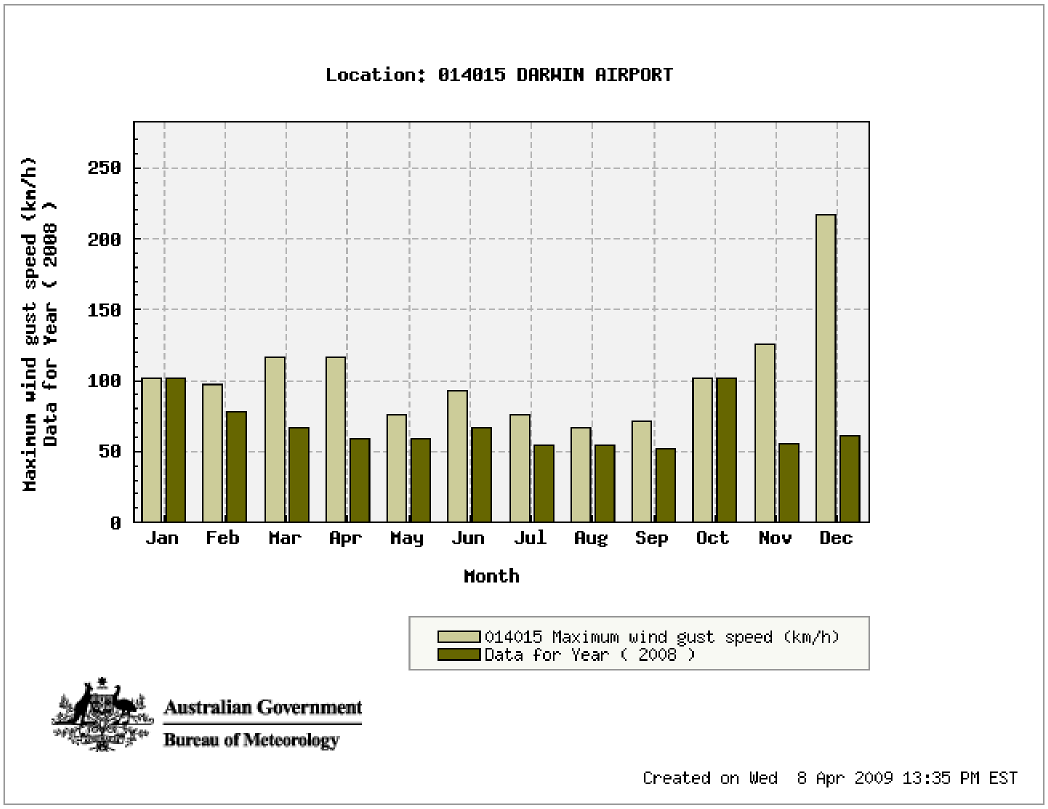

Figure 3-9: Wind Gust Speed

The BoM maximum wind gust data for the year 2008 shows that the wind gusts exceeded 50km/h on at least one occasion each month. There was only one cyclone to affect Darwin during 2008, cyclone Helen in early January, so the gust speeds during the other months can be assumed to have occurred under normal conditions.

It is reasonable to assume that winds will be unsuitable for berthing on an average of 15 times per year, but this number will be highly variable from year to year.

The difficulty in berthing will only persist for as long as the high winds are maintained. As soon as these winds ease it will be possible for the ships to berth safely again. As such, it is assumed that each high wind event only results in a loss of 6 hours.

3.7.2.3. Container cranes and ship-loader conveyor closed in > 30 knot winds

The container cranes and ship-loader conveyor facilities at the East Arm Wharf are not used during periods with wind speeds of greater than 30 knots (56km/h). In the experience of the Harbourmaster this will occur in the order of 10 times per year, however this number is highly variable.

As with the previous case it is assumed that these high wind events will tend to occur in the monsoonal months and each incident will result in a loss of 6 hours.

Table 3-14 Total Lost Time per year

Issue	Time Lost	Recurrence	Days lost per year (average)
Public Holidays	1 day	6 per year	6
Cyclone Watch	2 days	2 per year	4
Cyclone Warning	4 days	1 per year	4
> 25 knot winds	6 hours	15 per year	3.75
> 30 knot winds	6 hours	10 per year	2.5
		TOTAL	**20.25**

From the table above, Darwin Port can be expected to operate for an average of around effectively 345 days per year. This value does not include any downtime due to scheduled maintenance, breakdowns, accidents or any other unexpected disruptions to port activities.

3.7.3 Throughput Capacity

3.7.3.1. 3 Mtpa in isolation at East Arm Wharf

At an output of 3Mtpa, employing 55 kt DWT ships with an assumed load carrying capacity of 50kt, the average number of ships to be serviced annually at the port will be 60. Assuming that the phosphate exporter has guaranteed access to the dry bulk load out berth and associated facilities (i.e., they are not impacted by the operations of any other operators at the port) the following can be inferred:

Ship Loader Rated Capacity =	1600	tph
Through Ship Efficiency Factor=	0.7	(assumed)
Ship Loader Effective Capacity =	**1120**	tph
Ship Loader Berth Configuration Factor=	1	(one berth)
Through Ship Gross Loading Rate=	**1120**	tph
Standard Ship Operating Hours per Day=	24	h
Through Ship Net Loading Rate=	**1120**	tph
Average Shipment Size=	50000	t
Berthing-Deberthing Delay=	2	h (assumed)
Average Berth Time per Ship=	**46.64**	h
Number of Ships per Year=	60	ships (3Mtpa, 50kt per ship)
Berth Day Requirement=	**116.6**	days
Terminal Commission Days per Year=	345	days (20 days lost)
Berth utilization=	**0.338**	
Waiting Time Factor=	0.160	<from Table IX, Ref 1>
Time in Queue=	7.463	h
Time at Port per Ship=	**54.11**	**h**

The average queuing time for ships arriving at port will therefore be around 7 hours. Under these circumstances each ship may be expected to spend an average of 54 hours at the port.

3.7.3.2. 3 Mtpa out of a total of 6Mtpa through East Arm Wharf

The phosphate exporting operation in question does not in reality have exclusive access to the load out facility of the East Arm Wharf. A number of other operations currently use the port and can be assumed to account for at least 3Mtpa of material passing through the port.

Not all of this additional throughput will be require the ship-loader conveyor and there is ample berthing area for bulk cargo ships away from the ship-loader. If it is assumed that half of this additional cargo is loaded using the Tenova-SEMF ship-loader, and half via vessels equipped with shipboard loaders or other means, the following estimate for queuing time can be established:

Ship Loader Rated Capacity =	1600	tph
Through Ship Efficiency Factor=	0.7	(assumed)
Ship Loader Effective Capacity =	**1120**	tph
Ship Loader Berth Configuration Factor=	1	(one berth)
Through Ship Gross Loading Rate=	**1120**	tph
Standard Ship Operating Hours per Day=	24	h
Through Ship Net Loading Rate=	**1120**	tph
Average Shipment Size=	50000	t
Berthing-Deberthing Delay=	2	h (assumed)
Average Berth Time per Ship=	**46.64**	h
Number of Ships per Year=	90	ships (4.5Mtpa, 50kt per ship)
Berth Day Requirement=	**174.9**	days
Terminal Commission Days per Year=	345	days (20 days lost)
Berth utilization=	**0.507**	
Waiting Time Factor=	0.404	<from Table IX, Ref 1>
Time in Queue=	18.84	h
Time at Port per Ship=	**65.49**	h

The average queuing time for ships arriving at port will therefore be around 19 hours. Under these circumstances each ship may be expected to spend an average of 65 hours at the port.

3.7.4 Arrival Scheduling

It is expected that, each month, an average of 5 ships will arrive in the port to be loaded as part of the proposed phosphate exporting operation. This is based on a 3Mtpa output from the port using 50kt cargo ships (55kt DWT) and assumes a constant output over the year.

Using a Poisson probability distribution it is possible to calculate the chance that more, or less, than 5 ships will arrive during the course of any one month.

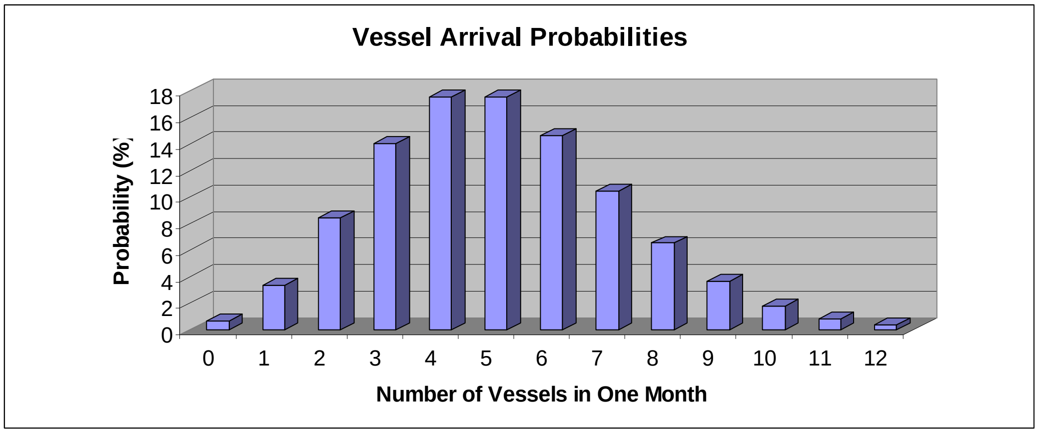

Figure 3-10

Allowing X to be the number of vessel arrivals per month, P(X=0) is the probability that for a given month the number of vessel arrivals will be equal to zero.

$$P(X) = \frac{m^X}{e^m (X!)}$$

Where m= the average number of ship arrivals in a month.

The table below shows a probability that each number of vessels, between 1 and 12 vessels, will arrive in any given month.

Table 3-15 Total Lost Time per year

No.	Probability of n Ships P(X=n)	Probability of Less than n Ships P(X<n)	Probability of More than n Ships P(X>n)
0	0.0067	*0.0000*	*0.9933*
1	0.0337	*0.0067*	*0.9596*
2	0.0842	*0.0404*	*0.8753*
3	0.1404	*0.1247*	*0.7350*
4	0.1755	*0.2650*	*0.5595*
5	0.1755	*0.4405*	*0.3840*
6	0.1462	*0.6160*	*0.2378*
7	0.1044	*0.7622*	*0.1334*
8	0.0653	*0.8666*	*0.0681*
9	0.0363	*0.9319*	*0.0318*
10	0.0181	*0.9682*	*0.0137*
11	0.0082	*0.9863*	*0.0055*
12	0.0034	*0.9945*	*0.0020*

For design and planning purposes it is necessary to define a design range for the number of vessels which will arrive in any given month. The probability that the number of vessels arriving in a given month will fall outside this range is the “probability of exceedence”.

For example, if it is deemed to be acceptable that for one month a year there will be a number of vessels arriving at the port which falls outside the design range the probability of exceedence is 1 month in 12, or 0.0833 (8.33%). The probability of less than 2 arrivals (0.0404) plus the probability of more than 9 arrivals (0.0318) is less than this probability of exceedence, thus a range of between 2 and 9 vessels may be designed for.

Similarly, if a once in 10 year probability of exceedence (0.0083) is appropriate the design range may be taken as between 0 and 11 arrivals per month. Obviously, a lower probability of exceedence will require a larger design range for monthly vessel arrivals.

This table can be used to calculate the design range for any exceedence period that is deemed appropriate for the design. It may be appropriate to use a different probability of exceedence for the cases of too many ships and of too few arriving in a given month as each case will have different associated risks. It should also be remembered that the Poisson probability calculation is only an approximation in this application.

3.7.5 Stockpile Constraints

Based on standard curves as shown below, the estimated required stockpile capacity would be 350,000 imperial tonnes, plus dead storage.

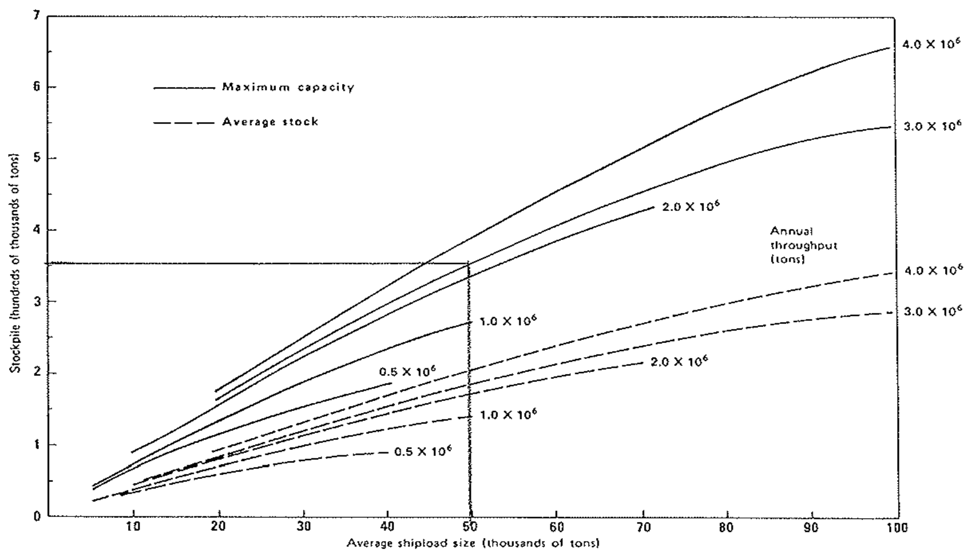

Figure 3-11: Stockpile Constraints (Imperial)

In order to test the validity of this estimate for the conditions that could be expected at the Port of Darwin, calculations of stockpile capacity were undertaken based on the following two scenarios:

- 3 Million tons per year of phosphate at a dedicated berth
- 3 Million tons per year of phosphate at a berth shared with others, with a total throughput of 4.5 Million tons per year

3.7.5.1. Stockpile Management

For the purposes of the study it was assumed that the stockpile would be replenished at an average rate of 250,000 tonnes per month (342.5 tonnes per hour), equivalent to 3 Mtpa. Also that the minimum target stockpile level would be equivalent to one and a half ship loads, or 75,000 tonnes, plus dead storage.

3.7.5.2. Stockpile Size

Based on the foregoing, the following can be concluded:

Table 3-16

Description	Unit	3 Mtpa dedicated berth	3 Mtpa shared berth
Average berth time per vessel	hrs	46.64	46.64
Average time in queue	hrs	7.46	18.84
Total time at berth	hrs	54.10	65.48
Total berth occupancy, incl. other users	%	34	50
Average number of vessels per month	No.	5	5
Max no. vessels per month, based on acceptable exceedence of once in one year	No.	9	9
Stockpile replenishment whilst loading 9 vessels*	Mt	166,763	201,842
Stockpile draw-down in 1 month	Mt	450,000	450,000
Assumed minimum stockpile level	Mt	75,000	75,000
Required stockpile capacity	Mt	358,237	323,158

*Note: stockpile replenishment assumed as 250,000 tonnes per month.

Therefore the estimate of 350,000 tonnes for required stockpile capacity based on standard curves appears to be valid for the shared facility at Darwin, on the assumption that the average vessel size and berth time for other users is similar to that assumed for loading phosphate. If other users have more, smaller vessels, then phosphate loading capacity might be reduced due to lack of sufficient berth time. This would require increased stockpile capacity, nearer to that required for a dedicated berth.

3.7.5.3. References

Data from this section has been obtained from the following references:

- Port Development: A handbook for planners in developing countries
- Port of Darwin Handbook
- Port of Darwin Corporation: Cyclone Procedures
- BoM climate statistics for Darwin Airport:

http://www.bom.gov.au/climate/averages/tables/cw_014015_All.shtml

- SEMF datasheet on East Arm Ship-loader

http://www.semf.com.au/projects.php?page=darwin-shiploader&nosub_on=1

3.7.6 Risks Associated with Capacity of Stockpile at Port of Darwin

Minemakers' proposed to keep a 150,000 tonnes stockpile, which is equivalent to the loading capacity of 3 ships.

In a year, a 3 Mtpa berth could be serviced by 3,000,000t / (50,000t/ship) = 60 ships.

This translates to 5 ships per month or 1.2 ships per week (refer Table 3-17).

However there may be a case of stockpile size critical fluctuation (refer Table 3-8) due to the following reasons:

- continuous loading of more than 1.2 ships in a week.
- ships did not show up for few weeks (cyclones).

This would deplete the stockpile quickly to a less than one ship, or exceed the capacity of a storage building.

The proposed phosphate train operations program does not have additional capacity to replenish the stockpile for the short term.

Therefore, WP proposes to reconsider the size of storage facilities as indicated in section 3.7.5:

- 150,000 t for 1 Mtpa production.
- additional 200,000 t to a total 350,000 t for an ultimate 3 Mtpa.

It is recommended to investigate this recovery mode in the next study stage using supply change discrete event simulation model.

Table 3-17 Regular Operations

	Ship Export			Port Stockpile	Train export			
Week	ea	Capacity	Vol	Reserve	train sets	capacity	loads	Volume
Initial stockpile								
1				60,063	3.0	5,704	10.53	60,063
2				120,126	3.0	5,704	10.53	60,063
3				150,158	3.0	5,704	5.27	30,032
					3.0			

	Ship Export			Port Stockpile	Train export			
Week	ea	Capacity	Vol	Reserve	train sets	capacity	loads	Volume
1	1.20	60,000	60,001	150,220	3.0	5,704	10.53	60,063
2	1.20	60,000	60,001	150,282	3.0	5,704	10.53	60,063
3	1.20	60,000	60,001	150,344	3.0	5,704	10.53	60,063
4	1.20	60,000	60,001	150,405	3.0	5,704	10.53	60,063
5	1.20	60,000	60,001	150,467	3.0	5,704	10.53	60,063
6	1.20	60,000	60,001	150,529	3.0	5,704	10.53	60,063
7	1.20	60,000	60,001	150,591	3.0	5,704	10.53	60,063
8	1.20	60,000	60,001	150,653	3.0	5,704	10.53	60,063
9	1.20	60,000	60,001	150,715	3.0	5,704	10.53	60,063
10	1.20	60,000	60,001	150,777	3.0	5,704	10.53	60,063
11	1.20	60,000	60,001	150,839	3.0	5,704	10.53	60,063
12	1.20	60,000	60,001	150,901	3.0	5,704	10.53	60,063
13	1.20	60,000	60,001	150,963	3.0	5,704	10.53	60,063
14	1.20	60,000	60,001	151,025	3.0	5,704	10.53	60,063
15	1.20	60,000	60,001	151,087	3.0	5,704	10.53	60,063
16	1.20	60,000	60,001	151,149	3.0	5,704	10.53	60,063
17	1.20	60,000	60,001	151,210	3.0	5,704	10.53	60,063
18	1.20	60,000	60,001	151,272	3.0	5,704	10.53	60,063
19	1.20	60,000	60,001	151,334	3.0	5,704	10.53	60,063
20	1.20	60,000	60,001	151,396	3.0	5,704	10.53	60,063
21	1.20	60,000	60,001	151,458	3.0	5,704	10.53	60,063
22	1.20	60,000	60,001	151,520	3.0	5,704	10.53	60,063
23	1.20	60,000	60,001	151,582	3.0	5,704	10.53	60,063
24	1.20	60,000	60,001	151,644	3.0	5,704	10.53	60,063
25	1.20	60,000	60,001	151,706	3.0	5,704	10.53	60,063
26	1.20	60,000	60,001	151,768	3.0	5,704	10.53	60,063
27	1.20	60,000	60,001	151,830	3.0	5,704	10.53	60,063
28	1.20	60,000	60,001	151,892	3.0	5,704	10.53	60,063
29	1.20	60,000	60,001	151,953	3.0	5,704	10.53	60,063
30	1.20	60,000	60,001	152,015	3.0	5,704	10.53	60,063
31	1.20	60,000	60,001	152,077	3.0	5,704	10.53	60,063
32	1.20	60,000	60,001	152,139	3.0	5,704	10.53	60,063
33	1.20	60,000	60,001	152,201	3.0	5,704	10.53	60,063
34	1.20	60,000	60,001	152,263	3.0	5,704	10.53	60,063
35	1.20	60,000	60,001	152,325	3.0	5,704	10.53	60,063
36	1.20	60,000	60,001	152,387	3.0	5,704	10.53	60,063
37	1.20	60,000	60,001	152,449	3.0	5,704	10.53	60,063
38	1.20	60,000	60,001	152,511	3.0	5,704	10.53	60,063
39	1.20	60,000	60,001	152,573	3.0	5,704	10.53	60,063
40	1.20	60,000	60,001	152,635	3.0	5,704	10.53	60,063
41	1.20	60,000	60,001	152,697	3.0	5,704	10.53	60,063
42	1.20	60,000	60,001	152,758	3.0	5,704	10.53	60,063
43	1.20	60,000	60,001	152,820	3.0	5,704	10.53	60,063
44	1.20	60,000	60,001	152,882	3.0	5,704	10.53	60,063
45	1.20	60,000	60,001	152,944	3.0	5,704	10.53	60,063
46	1.20	60,000	60,001	153,006	3.0	5,704	10.53	60,063
47	1.20	60,000	60,001	153,068	3.0	5,704	10.53	60,063

	Ship Export			Port Stockpile	Train export			
Week	**ea**	**Capacity**	**Vol**	**Reserve**	**train sets**	**capacity**	**loads**	**Volume**
48	1.20	60,000	60,001	153,130	3.0	5,704	10.53	60,063
49	1.20	60,000	60,001	153,192	3.0	5,704	10.53	60,063
50	1.20	60,000	60,001	153,254	3.0	5,704	10.53	60,063
51			-	153,254				
52			-	153,254				
Total	**60**	**3,000,000**					**526**	**3,003,156**

Table 3-18 Operational Delays

		Ship Export			Port Stockpile	Train export			
Wk	**Mth**	**ea**	**Capacity**	**Vol.**	**Reserve**	**train sets**	**capacity**	**loads**	**Vol**
Initial stockpile									
1					60,063	3.0	5,704	10.53	60,063
2					120,126	3.0	5,704	10.53	60,063
3					150,158	3.0	5,704	5.27	30,032
1	Jan	1.20	60,000	60,001	150,220	3.0	5,704	10.53	60,063
2		1.20	60,000	60,001	150,282	3.0	5,704	10.53	60,063
3		1.20	60,000	60,001	150,344	3.0	5,704	10.53	60,063
4			-	-	210,407	3.0	5,704	10.53	60,063
5			-	-	270,470	3.0	5,704	10.53	60,063
6	Feb	1.20	60,000	60,001	270,532	3.0	5,704	10.53	60,063
7		1.20	60,000	60,001	270,594	3.0	5,704	10.53	60,063
8		2.40	120,000	120,002	210,654	3.0	5,704	10.53	60,063
9		1.20	60,000	60,001	210,716	3.0	5,704	10.53	60,063
10	Mar	1.20	60,000	60,001	210,778	3.0	5,704	10.53	60,063
11		1.20	60,000	60,001	210,840	3.0	5,704	10.53	60,063
12		2.40	120,000	120,002	150,901	3.0	5,704	10.53	60,063
13		1.20	60,000	60,001	150,963	3.0	5,704	10.53	60,063
14	Apr	1.20	60,000	60,001	151,025	3.0	5,704	10.53	60,063
15		1.20	60,000	60,001	151,087	3.0	5,704	10.53	60,063
16		1.20	60,000	60,001	151,149	3.0	5,704	10.53	60,063
17		1.20	60,000	60,001	151,210	3.0	5,704	10.53	60,063
18	May	1.20	60,000	60,001	151,272	3.0	5,704	10.53	60,063
19		1.20	60,000	60,001	151,334	3.0	5,704	10.53	60,063
20		2.40	120,000	120,002	91,395	3.0	5,704	10.53	60,063
21		2.40	120,000	120,002	31,456	3.0	5,704	10.53	60,063
22		1.20	60,000	60,001	31,518	3.0	5,704	10.53	60,063
23	Jun	1.20	60,000	60,001	31,580	3.0	5,704	10.53	60,063
24		2.40	120,000	120,002	- 28,360	3.0	5,704	10.53	60,063
25		2.40	120,000	120,002	- 88,299	3.0	5,704	10.53	60,063
26		1.20	60,000	60,001	- 88,237	3.0	5,704	10.53	60,063
27	Jul	1.20	60,000	60,001	- 88,175	3.0	5,704	10.53	60,063

		Ship Export			Port Stockpile	Train export			
Wk	**Mth**	**ea**	**Capacity**	**Vol.**	**Reserve**	**train sets**	**capacity**	**loads**	**Vol**
28		1.20	60,000	60,001	- 88,113	3.0	5,704	10.53	60,063
29		1.20	60,000	60,001	- 88,051	3.0	5,704	10.53	60,063
30		1.20	60,000	60,001	- 87,989	3.0	5,704	10.53	60,063
31		1.20	60,000	60,001	- 87,927	3.0	5,704	10.53	60,063
32	Aug	1.20	60,000	60,001	- 87,866	3.0	5,704	10.53	60,063
33		1.20	60,000	60,001	- 87,804	3.0	5,704	10.53	60,063
34		1.20	60,000	60,001	- 87,742	3.0	5,704	10.53	60,063
35		1.20	60,000	60,001	- 87,680	3.0	5,704	10.53	60,063
36	Sept	1.20	60,000	60,001	- 87,618	3.0	5,704	10.53	60,063
37		1.20	60,000	60,001	- 87,556	3.0	5,704	10.53	60,063
38		1.20	60,000	60,001	- 87,494	3.0	5,704	10.53	60,063
39		1.20	60,000	60,001	- 87,432	3.0	5,704	10.53	60,063
40	Oct	1.20	60,000	60,001	- 87,370	3.0	5,704	10.53	60,063
41			-	-	- 27,307	3.0	5,704	10.53	60,063
42		1.20	60,000	60,001	- 27,245	3.0	5,704	10.53	60,063
43			-	-	32,818	3.0	5,704	10.53	60,063
44	Nov	1.20	60,000	60,001	32,880	3.0	5,704	10.53	60,063
45			-	-	92,943	3.0	5,704	10.53	60,063
46		1.20	60,000	60,001	93,005	3.0	5,704	10.53	60,063
47			-	-	153,068	3.0	5,704	10.53	60,063
48	Dec	1.20	60,000	60,001	153,130	3.0	5,704	10.53	60,063
49		1.20	60,000	60,001	153,192	3.0	5,704	10.53	60,063
50		1.20	60,000	60,001	153,254	3.0	5,704	10.53	60,063
51				-	153,254				
52				-	153,254				
	Total	**60**	**3,000,000**					**526**	**3,003,156**

4. COST ESTIMATES

4.1 Capital Cost

4.1.1 Basis of Cost Estimate

The rates used throughout the estimate were built from the 'bottom up' using first principals, however where applicable rates from recent vendors and historical in-house data were used. Given the level of detail and scope definition some work item rates were entered as an allowance only.

The quantity derivation was based on engineer material take offs, assumptions and allowances.

4.1.2 Estimate assumptions and exclusions:

- Port of Darwin and Tennant Creek personnel will have permanent residency in one of the following: residential dwelling, apartment or motel. A cost for mobilisation of these personnel has been included in the capital cost.
- A permanent accommodation village will be constructed for 110 personnel at Tennant Creek. The camp will include all facilities required for a permanent village.
- Stage 1 (1 Mtpa) has reduced accommodation village cost due to number of personnel required. Assumed village will be upgraded to 110 personnel when mine ramped up to 3 Mtpa.
- The client will lease all Front End Loaders & Road Trains. All leased equipment has been excluded from the CAPEX estimate.
- Land Acquisition will already be completed and is excluded from the estimate.
- Existing Port loadout facilities are assumed to be available and able to handle Phosphate material. No allowance has been included for shiploader and Bottom Discharge Dumper modifications and upgrades.
- There is no inclusion for road surface upgrades.
- Materials Handling equipment at Port of Darwin Inloading only. Material at Tennant Creek, Wonarah Mine and Port of Darwin will be handled by Front End Loaders and Trucks.
- Port of Darwin Storage Shed 210m x 67 m by GHD.
- Tennant Creek Storage Shed 98 m x 45 m.
- Wonarah Mine open stockpile included in the mine cost.
- All Storage Sheds will require minor dust suppression systems.
- An allowance for 200m^2 of buildings has been included for Offices, Control Room, Guardhouse, Ablutions etc at Tennant Creek.

- An inclusion of an in-motion weighbridge has been included for the Tennant Creek rail siding.
- Storage Facility, materials handling and costs provided by VDM Group.
- New Infrastructure has been assumed and included at each location, cost and quantities vary depending on the work and also what existing facilities are already available. and
- An allowance has been included in general items for weather delays which will cover the contractor's costs for downtime/delays during periods of bad weather.

4.1.3 Capital Cost Estimate Summary

The capital cost estimate for Wonarah Rock Phosphate Export has been presented as two stages of development (refer Appendix B). Stage 1 which is constructed for the export of 1Mtpa and Stage 2 which is a total cost to construct for the export of 3Mtpa.

As shown in section 4.1 Cost Estimate Summary to construct Stage 2 facilities and infrastructure for 3Mtpa export is an additional $26.2M.

This difference in cost is due to the following:

- Tennant Creek accommodation village upgrade. Extra rooms and facilities for the increased number of personnel required to achieve 3Mtpa.
- Main Rail line crossing loops only required for Stage 2 works.
- Port of Darwin Rail Unloading Siding only required for Stage 2 works.
- Additional number of personnel required for Port of Darwin operations resulting in extra costs for accommodation.

General Contract items increased as they are based on total cost of works.

Table 4-1 Wonarah Rock Phosphate Project Estimate Summary

Description	Stage 1 - 1 Mtpa	Stage 2 - 3 Mtpa
Wonarah Mine	$ -	$ -
Infrastructure	$ -	$ -
Buildings	$ -	$ -
Tennant Creek	$ 20,748,800	$ 27,748,800
Infrastructure	$ 1,640,000	$ 1,640,000
Rail Loading Siding	$ 9,716,000	$ 9,716,000
Buildings	$ 5,242,800	$ 5,242,800
Accommodation	$ 4,150,000	$ 11,150,000
Main Rail Line Crossing Loops	$ -	$ 6,300,000
Port Darwin	$ 35,376,979	$ 39,411,979
Infrastructure	$ 1,212,000	$ 1,212,000
Rail Unloading Siding	$ -	$ 3,960,000
Materials Handling	$ 20,516,979	$ 20,516,979
Buildings	$ 13,423,000	$ 13,423,000
Accommodation	$ 225,000	$ 300,000
General	$ 6,960,000	$ 8,060,000
CONTRACTOR TOTAL	$ 63,085,779	$ 81,520,779
EPCM Costs	$ 7,570,293	$ 9,782,493
Contingency	$ 18,925,734	$ 24,456,234
CAPEX TOTAL	$ 89,581,806	$ 115,759,506

4.1.4 Cost Estimate Accuracy

The current scope of study does not envisage project specific and detailed quotes from the market suppliers for different cost elements for want of adequate definition. However, the broad logistic configuration established in this study, is used for assessing the project costs to as much accuracy as achievable at this stage.

Inevitably therefore, the confidence level of estimates of various cost elements is dependent upon the relied upon basis as well as degree of their definition in the study. For example-

- The building cost estimates have 15% accuracy as tailored phosphate storage is proposed and cost estimates from the potential suppliers are available.
- In contrast, the infrastructure costs at Tennant Creek and Port Darwin are based on conceptual plans and preliminary study, without any site specific data collection and consequent engineering that invariably influences the costs.

The infrastructure costs therefore are estimated to have ±40% deviation.

- Along this continuum are costs for example, facilities studied by others (eg GHD for material handling), that have accuracy between 15% and 20%.
- The capital cost estimate provided includes an EPCM allowance of 12% and a 30% contingency allowance which is typical for a "Class 1" cost estimate. The contingency cost is an allowance for the unknowns such as goods and services which at the current state of project definition cannot be accurately quantified.

The weighted average of estimated variances of various cost elements is ±23% representing the overall degree of confidence in costs. These are summarised in Table 4.2 below.

Table 4-2 Cost Estimate Accuracy

Description	Cost $AUD	Accuracy + %	Total Maximum (Assuming + variance)	Basis of Costing
Wonarah Mine	**$ -**		**$ -**	
Infrastructure	$ -	40%	$ -	
Buildings	$ -	15%	$ -	Uncovered stockpile - included in mine costs
Tennant Creek	**27,748,800**			
Infrastructure	1,640,000	40%	$ 2,296,000	WP historical data
Rail Loading Siding	$ 9,716,000	30%	12,630,800	WP historical data
Buildings	$5,242,800	15%	6,029,220	cost from VDM estimate with 15% accuracy
Accommodation	$11,150,000	20%	13,380,000	cost from GHD estimate with 20% accuracy
Main Rail Line Crossing Loops	$6,300,000	30%	8,190,000	WP historical data
Port Darwin	**$39,411,979**			
Infrastructure	$1,212,000	40%	1,696,800	WP historical data
Rail Unloading Siding	$3,960,000	30%	5,148,000	WP historical data
Materials Handling	$20,516,979	20%	24,620,375	cost from GHD estimate with 20% accuracy
Buildings	$13,423,000	20%	16,107,600	cost from GHD estimate with 20% accuracy
Accommodation	$300,000	30%	390,000	WP historical data
General	**$8,030,000**	**20%**	**9,672,000**	WP historical data
CONTRACTOR TOTAL	**$81,150,579**		**100,160,795**	
EPCM Costs	**$9,738,069**		**12,019,295**	
Contingency	**$24,345,174**		**30,048,238**	
CAPEX TOTAL	**$115,233,822**		**142,228,329**	
Estimated Accuracy			**23%**	

The way forward to achieve greater accuracy and confidence of a low accuracy cost estimate components, will be based on the principles underlying the cost estimation guidelines, the relevant among them are extracted below:

- For a consistent <30% confidence,
- the equipment are priced from budget quotations or historical data with front end engineering designs (1-15%) and
- Basic material take-offs are prepared with auxiliary items. This requires sizing of key equipment and facilities, for example, buildings, site preparation, piling, control equipments, demolition, underground piping, water source location and depth, electrical, roads, fencing etc.
- For a consistent <15% confidence,
- Detailed estimates are derived from the engineering deliverables of a Front End Engineering Design process (10-40%),

- The scope description and execution plan is defined, and specifications and datasheets are developed,
- Specific detailed maps and surveys are used, with definition of water, power, HS&E related items.

- As such, the cost estimates associated with this study will require updating and refining progressively as the further engineering proceeds.

4.2 Operating Cost Estimate Summary

4.2.1 Annualised capital and operating cost analysis

The annual operating costs are estimated for 1 Mtpa ramp up scenario and an ultimate 3 Mtpa production scenario (refer Appendix G1) for Stage 1 and Stage 2.

A summary of the operating costs for Stage 1 and Stage 2 is presented in Table 4-3

The estimated operating costs are inclusive of all capital expenditures and have been based on the following:

- All capital expenditures occur in year 0.
- All operating costs occur in the years thereafter.
- Project Life 10 years.
- Discount rate 15%.

The following major costs factors making up the capital operating and maintenance costs have been considered in the analysis:

- Product stockpiling, road train outloading and accommodation at the mine.
- Mine site buildings, roads, utilities and support infrastructure have not been considered - see mine infrastructure capital and operating expenditures.
- Road train haulage costs and accommodation for road train crews at Tennant Creek.
- Tennant Creek transfer facility buildings, roads, utilities, site infrastructure and site personnel and their accommodation.
- Road train inloading, product stockpiling and trains outloading at Tennant Creek.
- Tenant Creek to Port of Darwin rail haulage costs including costs of lease, crew, fuel, maintenance and train control and rail access fees.
- Rail infrastructure including loading siding at Tennant Creek, unloading siding at Port of Darwin, and additional crossing loops.
- Port of Darwin buildings, material handling, road, utilities, support infrastructure, site personnel and their accommodation.
- Road train ouloading, haulage and unloading costs at Port of Darwin.

- Handling charges of third parties at Tennant Creek and Port of Dawrin.
- Service provider contract management personnel and mobilisation/demobilisation of personnel.

Table 4-3

Client	**Minemakers**						
Project	**Wonarah Rock Phosphate, NT**						
Scope	**Export Transport Logistics - Summary Cost Analysis**						
WP Project No.	**301012-00970**						
Variable Input Data							
Project Life	10						
Discount Rate	15.0%						
	Option	**Capex ($)**	**$/t for Annual Traffic Task (Mtpa)**				
			1.0	**1.5**	**2.0**	**2.5**	**3.0**
	Ramp-up Installation & Production (1-1.5 Mtpa)						
A-1 Mpta	Bulk Logistics Option A - 1 Mtpa	$89,581,806	$88.17	$79.03			
	Ultimate Installation & Staged 1 Mtpa to 3 Mtpa Production Expansion						
A-3 Mpta	Bulk Logistics Option A - 3 Mtpa	$115,759,506	$93.31	$82.98	$77.99	$79.34	$73.80

The operating cost analysis shows a high proportion of fixed operating cost and a low proportion of variable operating cost component, yet achieving economies of scale of the order of 20% on ramp up to 3 Mtpa.

4.2.2 Annualized operating cost analysis

The summary of net operating costs for Stage 1 and Stage 2 excluding all capital expenditures are presented in Table 4-4 (refer Appendix G-2).

The following major costs factors making up the operating and maintenance costs have been considered in the analysis:

- Product stockpiling, road train outloading and accommodation at the mine.
- Road train haulage costs and accommodation for road train crews at Tennnat Creek.
- Road train inloading, product stockpiling and trains outloading at Tennant Creek.
- Tennant Creek to Port of Darwin rail haulage costs including costs of lease, crew, fuel, maintenance and train control and rail access fees.
- Road train ouloading, haulage and unloading costs at Port of Darwin.
- Handling charges of third parties at Tennant Creek and Port of Dawrin.
- Service provider contract management personnel and mobilisation/demobilisation of personnel.

Table 4-4

	Option	Capex ($)	$/t for Annual Traffic Task (Mtpa)				
			1.0	**1.5**	**2.0**	**2.5**	**3.0**
	Ramp-up Installation & Production (1-1.5 Mtpa)						
A-1 Mpta	Bulk Logistics Option A - 1 Mtpa	$0	$72.28	$68.44			
	Ultimate Installation & Staged 1 Mtpa to 3 Mtpa Production Expansion						
A-3 Mpta	Bulk Logistics Option A - 3 Mtpa	$0	$74.30	$70.30	$68.49	$68.16	$64.49

The comparison of evaluation of annualized capital and operating cost vs annualized operating costs only is presented table Table 4-5.

The above evaluation reveals that annualized capital expenditure portion is within the range of 14 to 25%.

Table 4-5 Capital and Operating Cost Analysis

Cost Analysis	**$/t Annual Traffic Task (Mtpa)**				
	1.0	**1.5**	**2.0**	**2.5**	**3.0**
Annualised operating costs only	$74.30	$70.30	$68.49	$68.16	$61.49
Annualised capital and operating costs	$93.31	$82.98	$77.99	$79.34	$73.80
Capital expenditures portion	25.6%	18.0%	13.9%	16.4%	14.4%

5. SUMMARY AND RECOMMENDATIONS

The study has identified the feasible modes and methods of storing, handing and transporting the phosphate product from the mine to the Port. Viable options have been developed and evaluated. In accordance with the philosophy of greatest operational reliability at minimum cost, the preferred configuration for the logistic chain involves:

- Uncovered stockpile at Wonarah mine with facility to use FELs within the stockpile area for simultaneous (but alternating over shifts) outloading and inloading at two ends of the stockpile.
- Use of tri-axle road trains operated by third party to transport the product from Wonarah stockpile facility to the Tennant Creek rail transfer facility, generally using the existing roads but requiring outlays for upgrades.
- A covered storage infrastructure at Tennant Creek located centrally at a new, purpose built rail siding for phosphate loading.
- Transfer of product into leased rail trains operated by a third party at Tennant Creek, with material handling (inloading and outloading) organised on the same principle as at the Wonarah mine site.
- The rail train loaded ‘in motion’ with possible loco indexing, using FEL operating at specified location.
- Rail transport to the Port of Darwin, in alliance/agreement with a third party rail operator using covered bottom discharge hopper wagons in progressively enlarging train configuration and fleet as the tonnages grow from 1 Mtpa to 3 Mtpa.
- Using existing bottom discharge dumper facility at Port of Darwin to unload rail trains and road transfer to the port storage facility (details by others). and
- Conveyance of product from the port storage to ship loaders using road trains and FELs.
- The above logistic arrangements translate to an overall transportation cost from the mine to the port dumper at an estimated $93.31 to $73.80 per tonne for 1 Mtpa and 3 Mpta correspondingly.
- The associated estimated upfront capital expenditure required is AUD$89.6 million and AUD$115.8 to support 1 Mtpa and 3 Mtpa throughput respectively. A part of the capital investment differential can be progressively made in certain infrastructure (e.g., accommodation) components as the operations grow towards the ultimate task of 3 Mtpa.
- The annual transportation cost from the mine to the Port only is estimated to be $74.3 to $64.49 per tonne for 1 Mtpa and 3 Mpta correspondingly. The anaylised capital expenditure portion is within the range of 14 % to 25 %.

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5.1 Risks (In progress)

Risk is considered to be the quantifiable likelihood of loss of any kind, or a lower than expected return or outcome. Therefore, for the loss or sub optimal return to be quantified, some form of baseline must first exist to define the normal or expected state.

This section details:

- An overview of the risk management process performed during the study.
- Information on the Risk Management Plan developed during the study.
- Minemakers Critical Success Factors, i.e., the targeted normal or expected state.
- The project specific likelihood and consequence multipliers developed during the Risk Workshop.
- An overview of the top ten five project risks and their mitigation strategies.

5.1.1 WorleyParsons Approach to Risk

The process for risk identification, evaluation and mitigation used by WorleyParsons is based on the Australian and New Zealand Standard for Risk Management AS/NZS 4360:2004 (a recognised standard for risk management) and other international standards and guidelines for risk management. Currently there is no international standard for risk management. However, the International Standards Organisation is currently developing a risk management standard.

The WorleyParsons Project Management Process (WPMP) risk management approach is consistent with project-based risk management processes, such as Risk Analysis and Management for Projects (RAMP), produced jointly by the Institution of Civil Engineers and the Faculty and Institute of Actuaries in the UK.

5.1.2 Key Stakeholders

Minemakers Australia Pty Ltd

Federal Government Agencies

State Government Agencies- NT

Local Government Agencies

Port of Darwin

The highway and road authorities:

- FreightLink (The infrastructure owner and operator of Adelaide Darwin Railway).
- Other infrastructure owners and operators.

- WorleyParsons Services Pty Ltd.
- Other Minemakers Project related partners.
- Traditional Owners.
- Existing title and lease holders.
- Other exploration lease holders.
- General public.
- Trade unions.

5.1.3 Risk Rating Matrix and Live Risk Register

The risk matrix applicable to the project is based on the project specific risk document (Refer AMC Project Report 209021) and is reproduced below.

Likelihood	Consequences				
	Insignificant 1	**Minor 2**	**Moderate 3**	**Major 4**	**Catastrophic 5**
5 Chronic or Almost Certain During exposure.	**H**	**H**	**E**	**E**	**E**
4 Likely During exposure.	**M**	**H**	**H**	**E**	**E**
3 Possible During exposure.	**L**	**M**	**H**	**E**	**E**
2 Unlikely During exposure.	**L**	**L**	**M**	**H**	**E**
1 Rare During exposure.	**L**	**L**	**M**	**H**	**H**
Matrix Legend	**E** - Extreme Risk	-	Immediate Action Required in FS		
	H - High Risk	-	Attention Needed during Implementation		
	M - Moderate Risk	-	Operational Responsibility must be Specified		
	L - Low Risk	-	Manage by Routine Procedures.		

The major risks associated with the scope of this study have been identified, ranked and analysed in the project Risk Register. As the controls are implemented for existing risks and newer risks are identified, generally with increasing degree of detail, the live risk register will be progressively updated and used as a tool to manage the risks.

For the risk register developed at current stage of the study, refer to Appendix H.

5.1.4 Primary Risk Analysis

A primary level risk identification and analysis has captured currently foreseeable risks. This includes those associated with the logistic task associated with the project as well as key infrastructure risks at the:

- Construction and commissioning stage,
- Operation and maintenance stage and
- Decommissioning risks.

5.1.4.1. Key High Risks

The 'high' ranked risks are mainly associated with the ability to achieve access to land for survey and construction purposes at mine, rail transfer station at Tennant Creek and the Port of Darwin for their respective infrastructural facilities e.g., stockpiling and storage, rail siding, material handling and ship loader. This also includes achieving requisite approvals from the Government agencies, including environmental clearance.

Using the existing ADR railway, it is the only viable option for the long distance inland transport, the ability to successfully negotiate and achieve the access agreements with the rail infrastructure owner and operator, FreightLink, this represents a high ranked risk. Furthermore, the disruptive potential of the unplanned breakdown of third party facilities e.g., ship loader is ranked as a high risk. In both cases, rail and port operators, the 'high risk' classification also takes into account the asset specificity and sole provider status of the suppliers.

The over 300 km heavy haul road transport proposition from the mine to the rail transfer facility at Tennant Creek involves risks of 'high' rank as the costs of fulfilling upgrade, maintenance and licensing and associated time, may significantly impact the viability of the project.

The consequential disruptions in phosphate production or operations due to accidents or incidents on a third party controlled system e.g., ADR, the national highway and connected access roads and Port Darwin entail high risks of:

- depletion of any or all of storage stockpiles or
- any or all stockpiles filled to maximum capacity and impacting operations

These risks are to be managed through deft forecasting, intra-supply chain coordination and breakdown prevention strategies.

5.1.4.2. Other Important Risks in Key Areas

For the stockpile area of the Wonarah mine, the design adequacy, equipment (specifically FELs) performance adequacy, geotechnical uncertainty and potential conflicts with underground utilities entail medium risks associated with construction and commissioning. Other key risk areas are for road access to the Wonarah mine, geometrical, structural and flow design designs adequacy and procurement of supplies. From the operational perspective, adequacy of manpower, consumables and machinery are key risk areas, in addition to unplanned breakdown at any element of the operations.

At the Tennant Creek storage facility, the risks of engineering uncertainties, design and resources adequacy are the key risk areas, akin to those at Wonarah mine stockpile area. In addition, specific issues related to the rail siding are identified as key risks, the more important amongst them are negotiated acceptance of operational integration with ADR railway, handing over/hand back strategy, track design adequacy and lead times of construction supplies, and potential conflicts of phosphate cargo with other rail users.

From the operational perspective, the key risks associated with the planned operations at Tennant Creek are mutually impacting train or FEL delays arising out of ADR's 'on schedule' performance as well as FELs meeting predicted outputs without disruption due to resourcing issues such as operators, fuel, unplanned breakdowns etc.

At the Port of Darwin, the key construction risk is to achieve approvals and access for survey and construction. This, in turn, is dependent on adequacy and compliance of designs and fulfilling the potential conditions of the negotiated outcome with the Port operators. While the construction at the Port entails common construction risks, there are significant risks in operations. This includes disruption risks attributable to, but within, Minemakers' control such as FEL and road train operations but more significantly, attributable to and controlled by the third parties.

At the Port Darwin unloader, the path conflict or unloader delays may cascade to train schedules and related parts of supply chain and are identified to involve key risks. In addition, a major risk of 'high' classification is associated with the availability and reliability of the shiploader during operations.

5.2 Procurement of Long Lead Items

Major procurement and supplies involving long lead items or limited to a single supplier are identified as areas of high risk. Some of the key long lead procurement items likely to be on the project critical path are:

- Supply of access to rail infrastructure.
- Access to third party port facilities.
- Access to Barkly Highway for heavy road trains.
- Supply of locomotives and ore cars (wagons) and crews.
- Supply of rails, turnouts, concrete sleepers and ballast for the Tennant Creek siding infrastructure.
- Supply of covered storage facility as identified.

5.3 PROJECT EXECUTION

The delivery of the project would require coordination amongst the key components of the project. An integrated management providing single point of responsibility for the delivery of all components under the PMC concept or direct management by Minemakers (MM) are the strategic options. Project delivery architecture with PMC under overall umbrella of Minemakers is a preferred option for the next stage- DFS. The PMC's scope of services may exclude strategically critical spheres such as

- The key approvals goals involving state or Federal Governments and/or
- Negotiating with key external parties such as Freightlink and Port authorities.

The primary role of the PMC would be to design and deliver a packaging architecture of the implementation under specific WBSs as identified in their scope of work.

MM will establish a steering committee that will take an oversight role of the project, under which the integrated PMC team will report to.

The PMC framework will stipulate the roles, responsibilities and discretions of various parties and lay down a performance measurement and monitoring mechanism.

The PMC contracts are typically structured on cost reimbursable plus a fee with incentives and penalties tied to performance meeting the Mine Makers objectives.

5.3.1 Scope

The scope of the PMC may be approached on the philosophy of encompassing the full responsibility of the supply chain delivery packages, on the philosophy of 'built and operate' and factoring the costs for per unit of throughput. This principle places the onus on the PMC to deliver, in most efficient manner, the synchronised/programmed delivery of major components such as:

- Mine Facilities
- Storage infrastructure
- Utilities and services
- Accommodation infrastructure
- Rail infrastructure
- Port infrastructure
- Operational contracts

5.3.2 Work Breakdown Structure (WBS)

A well defined work breakdown structure is critical to achieve a successful delivery strategy and allow the packages to be planned tracked and controlled for cost.

It is proposed that the WBS will be based on the philosophy of 'built and operate' with further refinement to be developed within the DFS stage of the project.

The WBS definition aims to capture the costs and data in line with the requirements of a final asset accounting system that suits the customer structure for taxation and accounting, and will require further discussion to deliver the best outcomes. This will requires further articulation in the DFS.

5.3.3 Contracting Strategy

Under the PMC umbrella, all engineering, construction and supply contracts will be prepared, and packaged. The commercial relationships among the suppliers, the PMC and Minemakers and development of conditions of contract and general philosophies in contracting would be a subject of DFS level study.

5.3.4 Project Organisation

The project organisation will be based around on current best practices in the industry reflecting leaders/mangers to deliver for the key functional areas of project execution, such as the port, rail and the mine.

Construction organisation will be based on overall project management organisation along with their supervision team reflecting the common (such as HSE) and specialist areas of work, within the principle of design and build of distinct facilities.

The project organisation will be fully defined at the DFS stage on these principles.

5.3.5 Project Execution Health, Safety and Security

Particular emphasis will be placed upon the importance of the HSE function to ensure that the project goals are maintained within the organisations of the participating contractors. The PMC contractors will have the overall responsibility to develop projected health, safety and environmental plans, procedures, conducting training programs and expected emergency response policy.

5.3.6 Planning and Scheduling

Approvals will be a critical area for the planning and delivery of the project. This area of the project has previously been under customer management and it is important that under the PMC umbrella, a combined customer and PMC contractor driven team be allocated to address the approach and philosophy for the delivery of these critical approvals.

5.3.7 Engineering

The delivery of engineering packages will be based on the premise of the PMC selecting suitable organisations and firms with capacity and knowledge to deliver the associated WBS items. Where a design and construct contracting strategy is adopted the selection of the design and construct organisation will include the contractors design capability.

Engineering packages will be managed under the respective package engineering and procurement package leads and they will be responsible for the establishment of common standard across the sites and ensuring that the delivery of engineering quality and documentation meets all of the requirements to deliver a sound and robust contract package.

5.3.8 Procurement and Contracts

The key procurement goal is to minimise cost and delivery/installation time without compromising quality. Procurement can be broken down into the procurement of the equipment and the fabricated items.

The procurement strategy for the selection of equipment suppliers will adopt the following philosophy representing the basic premise of the project:

- Selecting proven technology with reliable performance
- Selection of equipment that has an existing design in place suitable for the site that allows for significantly shorter delivery timelines
- Selection of common approach to equipment across the sites to ensure inter-changeability and common approach to operations and maintenance

Each procurement package will be appraised to select the most appropriate purchasing strategy for the supply. The PMC contractor will be required to work with Minemakers objectives regarding local industry participation, and utilise the resources of the industry capability network, and the local business groups to ensure opportunities would be well communicated, expectations would be met.

Strategies for supply will include competitive bidding, approved single source, and use of existing strategic agreements where appropriate. The PMC contractor will function as an agent for MM as defined in the PMC contract.

The procurement actions will focus on the objectives of meeting the best acceptable combination of outcomes for HSE, quality, cost, schedule, environmental considerations and regulation requirements.

5.3.9 Construction

It is proposed that the MM infrastructure construction and operations at the mine, transfer facility and port will be implemented on a ‘build and operate’ principle. The objective will be to utilise the resources of local and international contractors who have proven experience in similar projects and who embrace the project objectives, particularly in the areas of safety, efficiency and leadership.

The contractors will be required to have plans and policies that interface closely with those of the Minemakers, other stakeholders and related contractors.

The contractors will be required to carry out their assigned duties in accordance with these plans and policies. They will be responsible for all construction activities associated with their work and will supply all resources necessary to complete these activities. The construction contractors will provide facilities and common services as necessary to execute the works.

5.3.10 Pre-commissioning and Commissioning

Commissioning will occur upon completion of installation and pre-commissioning tests and trials by the contractors and equipment suppliers. Commissioning will be carried out by cross organisational commissioning team(s) comprising members from, for example, the Minemakers, the Contractors and Supervisory Engineers.

It is envisaged that the approach to commissioning the Minemakers will be as follows:

- The commissioning team will develop the commissioning plan, packages and procedures.
- The contractors will undertake pre-commissioning tests and trials.
- The facilities will be commissioned for defined scale of operations.
- Minemakers, assisted by the contractors where appropriate, will ramp-up the facilities to full production.

5.3.11 Risk

Risk management processes are a significant component of the effective delivery highlighting the potential risks for HSE, technical, schedule, cost and operational efficiency requirement for the project.

Further risk workshops and associated processes will be an ongoing requirement. These processes will incorporate robust customer input, PMC contractor input, engineering inputs and also operator inputs.

5.4 Way Forward

The feasible modes and methods of storing, handling and transporting the phosphate product from the mine to the port were developed through the desktop analysis of the logistic chain components and within recognized scope limitations for this feasibility stage development.

These limitations include:

- Undefined access constraints for road trains operations on Barkly Highway, Stuart Highway and Wareggo road.
- Undefined access constraints for storage, road access and rail siding at Tennant Creek.
- Broad desktop assumptions and allowances and undefined access constraints for trains operations between Tennant Creek and Port of Darwin.
- Broad desktop assumptions and allowances and undefined access constraints for trains unloading and shiploading operations at Port of Darwin.
- Evaluation and recommendation of vendor specific products is limited to conceptual and functional level and budgetary proposals.

To better define feasible phosphate storage and transport options and associated costs it is recommended that the following studies are to be carried out in the immediate period to better define the scope and eliminate nor feasible option, prior to detailed work commencing upon the DFS:

- Investigate, negotiate and agree with Northern Territory Government on access constraints for road trains operations on Barkly Highway, Stuart Highway and Wareggo road, access/maintenance fees and associated costs, etc.
- Investigate, negotiate and agree with the Developer on land use requirements at Tennant Creek Bulk Minerals Terminal (BMT) and integration of phosphate handling facilities and rail loading siding into overall BMT staged development plan.
- Investigate, negotiate and agree with FreightLink on the integration of planned rail operations e.g., travel times, additional crossing loops requirements, access fees etc and associated costs.
- Investigate, negotiate and agree with Port of Darwin on integration of Port operations, e.g., use of Bottom Discharge Dumper, road trains and FEL, berth and shiploader, cycle times, capacity expansion, unloading siding expansion, access fees and associated costs etc.
- Assessment of environmental, social and heritage impacts and mitigations.
- Issue RFQs, evaluate and recommend final vendor specific products budgetary and financing proposals: storage facilities and material handling, road transport solutions, rail transport, rolling stock lease, manpower and accommodation requirements etc.
- Assess environmental, social and heritage impacts and recommend mitigations.

- Refine capital and operational costs.
- Undertake discreet event simulation modeling, investigate system ultimate capacity and recommend expansion strategy.
- Develop project implementation plan.

Appendix A – Definitions and Abbreviations

AAR	Association of American Railroads
ADR	Adelaide – Darwin Railway
BDD	Bottom Discharge Dumper
BoM	Bureau of Meteorology
BMT	Bulk Minerals Terminal
DIRN	Defined Interstate Rail Network
DSO	Direct Shipment Order
FOB	Free On Board
gtk	gross tonne kilometres
hp	horse power
Mtpa	Million tonnes per annum
ROM	Run Of Mine
tal	tonnes axel load
tph	tonnes per hour
WP	WorleyParsons

Appendix B – Drawings

Appendix C – Stock Pile Storage Options

Appendix C 1 – DOME SANVIK STORAGE PROPOSAL

Appendix C 2 – EUROSILO STORAGE PROPOSAL

Appendix C 3 **– VDM STORAGE PROPOSAL**

Appendix C 4 – ALL SHELTERS STORAGE

Appendix D – Road Logistics and Proposals

Appendix E – Rolling Stock Data and Proposals

Appendix E 1 – BUDGETARY PROPOSAL

Appendix E 2 – WAGONS

Appendix E 3 – LOCOMOTIVES

Appendix F – CAPEX

Table Appendix F 1 Stage 1 Cost Estimate Summary (1 Mtpa)

Table F 2 Stage 1 Cost Estimate Summary (3 Mtpa)

Table F 3 Stage 1 Cost Estimate Summary (3 Mtpa)

Appendix G – OPEX

Appendix G 1 Summary Cost Analysis

Appendix H – RISK REGISTER (Pending)

Appendix I – NORTHERN TERRITORY ROAD TRAFFIC DATA (Pending)