MINEMAKERS LIMITED

WONARAH PROJECT

REPORT ON LOGISTICS REQUIREMENTS AND COSTS

29 May 2013

BEYOND RAIL SOLUTIONS
LEADING AUSTRALIAN SUPPLY CHAIN MANAGEMENT

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APPENDICES

1 EXECUTIVE SUMMARY

BRS was requested to assess the relative costs for two process options under consideration for the Wonarah Project based on the aim of exporting the equivalent of 1,000,000 tpa P_2O_5. The two process options were the conventional Wet Acid Process (WAP) and the Improved Hard Process (IHP).

The assessment concludes that the capital and operating costs for the land based logistics for the IHP process are lower than the WAP process. The IPH process also showed up as lower cost than the WAP process in sensitivity testing.

As some of the costs have been obtained from limited data, the figures shown are indicative only. However adjustments to specific costs are not expected to affect the overall relative cost for each of the two options. A number of sensitivity tests have been conducted to test this assessment.

Aspects requiring further consideration include concept development, plus issues raised during preparation of this report.

2 BACKGROUND

In August 2011, Minemakers Limited (Minemakers) completed an Enabling Feasibility Study for its Wonarah Phosphate Project, which examined the two potential process options - the conventional Wet Acid Process (WAP) and the Improved Hard Process (IHP). The study also included assessment of the associated logistics.

The Wonarah Phosphate Project mine is located at Wonarah, NT, Australia, 240 km east of Tennant Creek and connected to Tennant Creek by the Barkly Highway. Tennant Creek is on the Tarcoola to Darwin Railway that runs 1,000 km north from Tennant Creek to the port of Darwin.

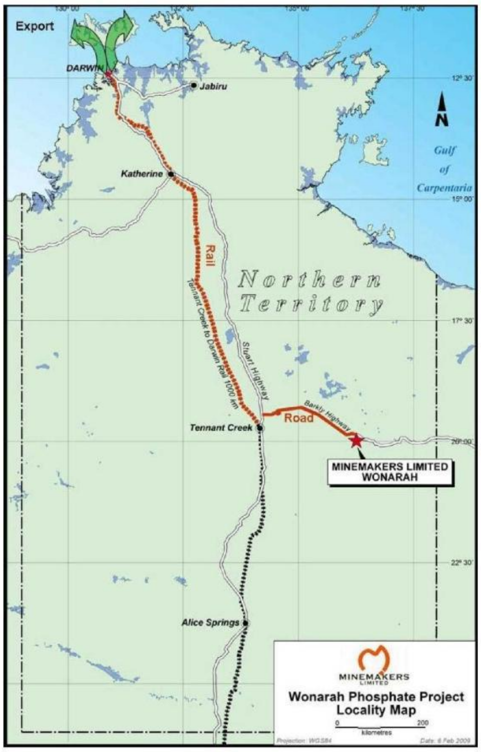

Figure 1 - Project Location

Each process option requires the transport of consumables from Darwin to the processing plant/site and the export of finished product through the port at Darwin.

For the WAP process the processing plant is intended to be located at Tennant Creek with phosphate rock slurry being transported to Tennant Creek by pipeline. Rail transport would be used for transport requirements between Tennant Creek and Darwin.

For the IHP process it is intended to locate the processing plant at the mine site. All consumables and the finished product would be transported between Darwin and the mine site by a combination of rail and road transport with an intermodal facility located at Tennant Creek.

3 REVIEW OF LOGISTICS

Minemakers favours the IHP process as the development option, but is seeking to review the land based logistics for the two identified process options. This review has been undertaken at a high level but in sufficient detail to allow a comparative assessment of both the capital and operating costs associated with the two options.

The report draws on material from the Enabling Feasibility Study and the Export Transport Logistics Study prepared by WorleyParsons in October 2009.

The rail company Genesee & Wyoming Australia Ltd (GWA) - rail network owner and rail operator on the Darwin to Alice Springs railway - has provided significant input to assist with preparation of the report.

The following aspects have been given considerations in preparing the report:

- Consumable and finished product specifications including any temperature requirements for transport
- Assessment of product specification implications for transport resources (wagons/containers), and temporary storage at intermodal transfer points e.g. Darwin and Tennant Creek
- Shipping parcel sizes for consumables and finished products, and shipping frequency
- Definition of road and rail transport specifications e.g. axle loads, truck configurations and Dangerous Goods requirements
- Development of indicative rail and road transport schedules, and of related resource requirements
- Assessment of requirements for both intermodal terminal infrastructure and equipment for temporary storage and handling
- Assessment of pathway capacity on the existing railway and identification of upgrade options and costs
- Assessment of costs in the following areas:
    - Container and rail wagon costs
    - Rail (above and below rail) transport costs
    - Road transport costs
    - Intermodal terminal infrastructure and operating costs
    - Port charges

4 PRODUCT SPECIFICATIONS

Relevant product specifications are identified in Table 1 Product Specifications.

WAP Process (Export DAP/MAP)

Product	Quantity	Bulk Density	Temperature	Pressure	Pump Rates (t/hr)		Corrosive Properties
	t/a	kg/m3	Degrees C	Bars	Load	Unload	
DAP	2,300,000	950	N/A	N/A			
Sulphur	1,000,000	960	N/A	N/A			
Ammonia	500,000	682	-33	Ambient			
		610 605	20 25	7.5 8	200-300	100-200	

IHP Process (Export SPA)

Product	Quantity	Bulk Density	Temperature	Pressure	Pump Rates (t/hr)		Corrosive Properties
	t/a	kg/m3	Degrees C	Bars	Load	Unload	
SPA	1,500,000	1800	45	Ambient	750	750	Tanks to either be lined with Chlorobutyl rubber or be 316L SS
Pet Coke	750,000	880	N/A	N/A			

Table 1 Product Specifications

A critical requirement for SPA is that the product temperature is to be maintained near the optimal temperature 45 degrees Celsius while the product is being transported between temperature controlled storage facilities. KEMWorks Technology, Inc (KEMWorks) has indicated that transporting the product in well insulated tankers should be sufficient to maintain temperature at acceptable levels during a 48 hour period.

All these assumptions, and in particular the SPA temperature control assumption, will require clarification during the BFS stage.

5 RAIL TRANSPORT OPTIONS

5.1 PRODUCT CHARACTERISTICS & INTERMODAL CONSIDERATIONS

When identifying potential rail transport options, a number of product characteristics and intermodal considerations were taken into account, as follows as follows:

- Sulphur is not a free running material and is typically not suited bottom discharge rail wagons.
- If DAP and sulphur were transported in containers then a common container handling wagon could be used for both products.
- If DAP and sulphur were transported in containers, the containers could be used for both the process input (sulphur) and the process output (DAP)
- The possibility of double stacking containers on wagons
- Ammonia and SPA could be transported in either purpose built rail wagons or in ISO containers.
- For the IHP process the use of containers for rail transport for both SPA and pet coke would provide a better synergy with road transport and would eliminate the need for purpose built storage facilities at Tennant Creek.

For the Scoping Study comparative review the following rail possibilities s (and hence road possibilities for the IHP process) were identified for both process options:

- An all container option
- Purpose built rail wagons for ammonia and SPA and containers for other products.

5.2 NETWORK CHARATERISITCS

Genesee Wyoming Australia Network (GWAN) the rail network owner/manager offers two train operating scenarios for trains travelling between Tennant Creek and Darwin as follows:

- 23t axle loads travelling at a maximum speed of 80 km/hr
- 21t axle loads travelling at a maximum speed of 110 km/hr

From a network capacity perspective GWAN would prefer trains to be operating at the higher maximum speed as this would mean a greater number of train movements over a given time period. However, for bulk haul operations it is typically better to maximise axle loads although this results in a lower maximum train speed.

The other aspects defined by the network characterises are:

- Maximum length of trains: crossing loops (locations which allow trains to pass when travelling in opposite direction) are currently suitable for 1800m trains.
- Ruling grade for the railway (i.e. the steepest grade in the loaded direction): for trains travelling from Tennant Creek to Darwin the ruling grade is currently 1 in 65.

5.3 TRAIN SIZING

To assess the train size and number of trains, it was necessary to firstly assess the likely train cycle times for the return journey between Darwin and Tennant Creek. Preliminary assessment indicated that a 48 hours cycle is appropriate.

Initial train sizing was based on the use of the higher axle loads. The table at Appendix 1 shows the indicative train sizes for the rail tanker and container possibility, and also the all container possibilities for both process options.

The initial train sizing has been provided to GWA to assist with developing operable train configurations. GWA provided a number of alternatives for consideration based around both the high and low axle load options. Double stacking of containers was considered to be an option and was included in the initial list of train options. Subsequent enquires have indicated that double stacking ISO containers of ammonia and SPA may not be allowable under the Australian Code for the Transport of Dangerous Goods by Road and Rail.

GWA's initial train scenarios are shown at Appendix 2

6 INTERMODAL FACILITIES

A number of terminal configurations have been considered. Preliminary concepts were developed using aerial photography, prior to discussion with GWA. The current concept for Berrimah was prepared after a site visit and discussions with GWA.

6.1 PRELIMINARY CONCEPTS

Conceptual terminal configurations were prepared for both the WAP and IHP processes, and both transport possibilities i.e. all container, and rail tanker and container. In these configurations it was assumed that sufficient space was available on the existing hardstand area to accommodate current operations and the operations that would be required to support the Wonarah project.

The conceptual layouts and aerial photo overlays are shown at Appendix 3

6.2 CURRENT TRACK & HARDSTAND CONCEPT AT BERRIMAH

Site investigation and GWA discussion determined that the limited capacity of the existing hardstand area makes it unsuitable for the Wonarah project requirements and an alternative conceptual plan has been prepared. This plan envisages widening the existing hardstand to the north and adding an additional track to allow access to the bottom discharge facility and the port area.

Figures 2, 3 and 4 shown below outline the concept plan for Berrimah. The aerial photo overlays are also shown at Appendix 4

Figure 2 Proposed Berrimah Terminal Extension – General Arrangement

Figure 3 Proposed Berrimah Terminal Extension - Track Layout

Figure 4 Proposed Berrimah Terminal Extension - Detail

This concept has been prepared primarily to cater for the all container options but could be modified to suit a rail tanker and container option.

GWA has indicated that the concept has merit but will require detailed discussion with GWAN who are the terminal owner before being confirmed as a development option at Berrimah.

6.3 STORAGE OPTIONS ADJACENT TO THE PORT

Site inspection and discussions with the Darwin Port Corporation (DPC) and Land Development Corporation (LDC) have identified two areas available for consideration as storage areas for bulk products. The Vopak facility is a potential site for bulk liquid storage.

The following aerial photo overlays show the sites.

Figure 5 Overview of Potential Storage Sites

Figure 5 shows an overview East Arm area and shows the two potential sites for storage of bulk products and the Vopak facility which is considered to be a potential site for storing liquid products.

Figure 6 Potential Site for Liquid Storage Facilities

Preliminary discussion with Vopak has confirmed its interest in providing facilities for the project. Vopak would have the capacity to expand into the land immediately to the north-east of the existing facility. Alternatively the land could be available for an alternate bulk liquid facility. Road access between the site and the GWAN rail terminal could be via the road that provides access to the passenger terminal. Another option would be for Minemakers is to include storage facilities within a development on Lot 6296 shown in Figure 8.

This is the site on which GWA has based its proposals outlined in Section 9.1.

The DPC have identified the land shown on Figure 7 as a potential site for bulk storage of sulphur, pet coke and DAP. This site is close to the berth and is approximately 4 kms from the rail terminal and not well suited for a container based bulk product option. The site would also require considerable development efforts to make it suitable for storage facilities.

Figure 7 DPC Land Available for Bulk Storage

The LDC has identified Lot 6296 shown on Figure 8 as land available for bulk storage.

Figure 8 LDC Land Available for Bulk Storage

This site is next to the GWAN rail terminal and offers the possibility of direct access between the site and the rail terminal. A storage facility of approximately 240m could be accommodated. Access from the Port would be via the public road on the southern boundary of the lot. This is the site on which GWA has based its proposals outline in Section 9.1.

Initial feedback from GWA which is based on current terminal operations indicate that it is unlikely that direct access between lot 6296 would be acceptable, and the proposals here are based on using the public road network. This issue requires further consideration in the BFS stage of the project.

7 POTENTIAL RAIL, ROAD AND LIFTING EQUIPMENT

Some sample images relating to potential rail, road and lifting equipment can be found at Appendix 5. Although not an exhaustive list, it provides an indication of the type of equipment being contemplated.

8 RAIL NETWORK CAPACITY

GWA has received advice from GWAN that a number of new export projects are under consideration. Future network capacity will depend on whether these projects proceed and the timing of the projects.

It is unclear at this time what network capacity upgrading would be required to support the Wonarah project and what resulting contributions may be sought by GWAN for network pathway capacity upgrading. Consequently, the following has been prepared to provide an indication of the likely network capacity upgrading that would be required to support only the Wonarah project (i.e. there were no other projects requiring additional capacity).

8.1 EXISTING CAPACITY

As identified in Section 5.2 there are two potential train operating scenarios relating to train speed and axle loads. The most relevant option for increasing network capacity is to introduce additional crossing loops along the railway. Other options include lengthening crossing loops to support longer trains, and increasing the track capacity by increasing allowable axle loads and/or train speeds. These options are not considered relevant for the Wonarah project.

Tables 2 and 3 show the network capacity impact of the maximum train speeds of 80 km/hr and 110 km/hr.

Crossing Loop	Location (kms from Adelaide)	Section	Length (kms)	Section Running Times (mins) 23t @ 80km/hr	Pathway Capacity - Freighter (pathways/day)		Proposed Pathways Used/Day	
					Theoretical	Practical 80%	Number	%
Roe Creek	1318.0	Roe Creek to Illoquara	246.3	202	6.9	5.6	2.3	33%
Illoquara	1564.3	Illoquara to Tennant Creek	238.2	208	6.7	5.4	2.3	34%
Tennant Creek	1802.5	Tennant Creek to Muckaty	129.5	109	12.5	10.0	6.6	53%
Muckaty	1932.0	Muckaty to Newcastle Waters	161.0	137	10.1	8.1	6.6	66%
Newcastle Waters	2093.0	Newcastle Waters to Katherine	353.5	293	4.8	3.9	6.6	137%
Katherine	2446.5	Katherine to Union Reef	102.2	100	13.6	10.9	6.6	49%
Union Reef	2548.7	Union Reef to Berrimah	201.3	200	7.0	5.6	8.6	123%
Berrimah	2750.0							

Table 2 Existing Crossing Loops - 80 km/hr Train Speed

Crossing Loop	Location (kms from Adelaide)	Section	Length (kms)	Section Running Times (mins) 21t @ 110km/hr	Pathway Capacity - Freighter (pathways/day)		Proposed Pathways Used/Day	
					Theoretical	Practical 80%	Number	%
Roe Creek	1318.0	Roe Creek to Illoquara	246.3	155	8.9	7.2	2.3	26%
Illoquara	1564.3	Illoquara to Tennant Creek	238.2	160	8.7	6.9	2.3	27%
Tennant Creek	1802.5	Tennant Creek to Muckaty	129.5	88	15.3	12.3	6.6	43%
Muckaty	1932.0	Muckaty to Newcastle Waters	161.0	117	11.7	9.4	6.6	56%
Newcastle Waters	2093.0	Newcastle Waters to Katherine	353.5	203	6.9	5.5	6.6	96%
Katherine	2446.5	Katherine to Union Reef	102.2	88	15.3	12.3	6.6	43%
Union Reef	2548.7	Union Reef to Berrimah	201.3	155	8.9	7.2	8.6	96%
Berrimah	2750.0							

Table 3 Existing Crossing Loops - 110 km/hr Train Speeds

The information shown on each table is as follows:

- **Crossing Loop**: name of the loop
- **Location**: running kilometreage based on Adelaide as the zero point
- **Section and Length**: details the section and the length between the crossing loops
- **Section Running Time**: indicative running times for train operating up to the maximum allowable speed
- **Pathway Capacity – Theoretical**: calculation of the theoretical number of opposing trains that can pass through a section in a 24 hour period. The calculation is time based.
- **Pathway Capacity – Practical**: assessment of the sustainable capacity based on 80% of the Theoretical Capacity
- **Proposed Pathways Used – Number**: proposed number of train based on an understanding of the existing train operations and the Wonarah Project
- **Proposed Pathways Used – Percentage**: comparison of the theoretical capacity and the proposed usage.

The sections where the proposed usage exceeds the assessed Practical Capacity between Tennant Creek and Berrimah (Darwin) are identified in orange in both Table 2 and Table 3. These sections would each require an additional crossing loop to increase the practical capacity beyond the proposed usage levels.

Table 2 identifies the Practical Capacity for the two highlighted sections as 3.9 for the Newcastle Waters to Katherine Section and 5.6 for the Union Reef to Berrimah section, with the proposed usage well above the that Practical Capacity. In Table 3 the respective capacities are higher at 5.5 and 7.2 and this illustrates the influence of the different train speeds.

It could be expected that with a mix of train speeds, the Practical Capacity lies somewhere between the figures shown in the two tables.

8.2 CAPACITY UPGRADE

Upgrading options to cater for the Wonarah Project are shown in Tables 4 and 5 below. Each table has four parts. Part 1 (top) relates to the existing crossing loop configurations as shown in Tables 2 and 3. Parts 2-4 examine three options for adding crossing loops. The scenarios are as follows:

- Part 2 assesses the capacity when new crossing loops are located at the mid-point between existing crossing loops
- Part 3 is based on locating crossing loops addressing the long term aim of locating a crossing loop at no more than 100km spacing
- Part 4 is based on locating crossing loops addressing the long term aim of locating a crossing loop at no more than 100km spacing while using the existing signalling locations (block points)

As the shortest existing section length is 102 kms, it would be desirable to use this length as a basis for locating future crossing loops.

The Union Reef to Berrimah section is 201.3 kms long so installing a new loop at the midpoint would result in spacing's of 100.7 kms. However, the section length for Newcastle Waters to Katherine section is 353.5 kms and locating a new crossing loop at the midpoint would leave each section 176.8 km long. For this section, a more strategic approach would be to install a new loop at the 1/3rd point with the option of installing a second loop at the 2/3ths point at a future time.

Two options for locating a crossing loop at a nominal 1/3rd point have been considered:

- option one - locate the new crossing loop by dividing the section into three
- option two - locate the new crossing loop at one of the existing signalling points (Block Points) which are approximately at the 1/3rd locations.

Parts 2-4 in Tables 4 and 5 show the results of the assessment. For the 80 km/hr scenario in Table 4 it is apparent that locating a crossing loop at the midpoint between Newcastle Waters and Katherine would satisfy the requirements for the Wonarah project while the other approaches result in the potential usage being above the Practical Capacity.

For the 110 km/hr scenario in Table 5 it is apparent that all options would satisfy the requirements for the Wonarah project. If the majority of the train speeds are closer to the 110 km/hr maximum speed then the more strategic approach would be appropriate.

This assessment is based on the requirement for the network to accommodate the existing train operations plus the Wonarah project. Should other projects also commence then the analysis would need to redone to comprehend the additional trains.

Crossing Loop	Location (kms from Adelaide)	Section	Length (kms)	Section Running Times (mins) 23t @ 80km/hr	Pathway Capacity - Freighter (pathways/day) Theoretical	Practical 80%	Proposed Pathways Used/Day Number	%
Roe Creek	1318.0	Roe Creek to Illoquara	246.3	202	6.9	5.6	2.3	33%
Illoquara	1564.3	Illoquara to Tennant Creek	238.2	208	6.7	5.4	2.3	34%
Tennant Creek	1802.5	Tennant Creek to Muckaty	129.5	109	12.5	10.0	6.6	53%
Muckaty	1932.0	Muckaty to Newcastle Waters	161.0	137	10.1	8.1	6.6	66%
Newcastle Waters	2093.0	Newcastle Waters to Katherine	353.5	293	4.8	3.9	6.6	137%
Katherine	2446.5	Katherine to Union Reef	102.2	100	13.6	10.9	6.6	49%
Union Reef	2548.7	Union Reef to Berrimah	201.3	200	7.0	5.6	8.6	123%
Berrimah	2750.0							

Crossing Loop	Location (kms from Adelaide)	Section	Length (kms)	Section Running Times (mins) 23t @ 80km/hr	Pathway Capacity - Freighter (pathways/day) Theoretical	Practical 80%	Proposed Pathways Used/Day Number	%
Roe Creek	1318.0	Roe Creek to Illoquara	246.3	202	6.9	5.6	2.3	33%
Illoquara	1564.3	Illoquara to Tennant Creek	238.2	208	6.7	5.4	2.3	34%
Tennant Creek	1802.5	Tennant Creek to Muckaty	129.5	109	12.5	10.0	6.6	53%
Muckaty	1932.0	Muckaty to Newcastle Waters	161.0	137	10.1	8.1	6.6	66%
Newcastle Waters	2093.0	Newcastle Waters to New Loop	176.8	147	9.4	7.5	6.6	70%
New Loop	2269.8	New Loop to Katherine	176.8	147	9.4	7.5	6.6	70%
Katherine	2446.5	Katherine to Union Reef	102.2	100	13.6	10.9	6.6	49%
Union Reef	2548.7	Union Reef to New Loop	100.7	100	13.6	10.9	8.6	63%
New Loop	2649.4	New Loop to Berrimah	100.7	100	13.6	10.9	8.6	63%
Berrimah	2750.0							

Crossing Loop	Location (kms from Adelaide)	Section	Length (kms)	Section Running Times (mins) 23t @ 80km/hr	Pathway Capacity - Freighter (pathways/day) Theoretical	Practical 80%	Proposed Pathways Used/Day Number	%
Roe Creek	1318.0	Roe Creek to Illoquara	246.3	202	6.9	5.6	2.3	33%
Illoquara	1564.3	Illoquara to Tennant Creek	238.2	208	6.7	5.4	2.3	34%
Tennant Creek	1802.5	Tennant Creek to Muckaty	129.5	109	12.5	10.0	5.4	43%
Muckaty	1932.0	Muckaty to Newcastle Waters	161.0	137	10.1	8.1	6.6	66%
Newcastle Waters	2093.0	Newcastle Waters to New Loop	235.8	195	7.1	5.7	6.6	92%
New Loop	2328.8	New Loop to Katherine	117.7	98	13.9	11.1	6.6	47%
Katherine	2446.5	Katherine to Union Reef	102.2	100	13.6	10.9	6.6	49%
Union Reef	2548.7	Union Reef to New Loop	100.7	100	13.6	10.9	8.6	63%
New Loop	2649.4	New Loop to Berrimah	100.7	100	13.6	10.9	8.6	63%
Berrimah	2750.0							

Crossing Loop	Location (kms from Adelaide)	Section	Length (kms)	Section Running Times (mins) 23t @ 80km/hr	Pathway Capacity - Freighter (pathways/day) Theoretical	Practical 80%	Proposed Pathways Used/Day Number	%
Roe Creek	1318.0	Roe Creek to Illoquara	246.3	233	6.0	4.8	2.3	38%
Illoquara	1564.3	Illoquara to Tennant Creek	238.2	240	5.9	4.7	2.3	39%
Tennant Creek	1802.5	Tennant Creek to Muckaty	129.5	147	9.4	7.5	5.4	57%
Muckaty	1932.0	Muckaty to Newcastle Waters	161.0	146	9.5	7.6	6.6	69%
Newcastle Waters	2093.0	Newcastle Waters to New Loop (2343 BP)	250.0	207	6.8	5.4	6.6	98%
New Loop (2343 BP)	2343.0	New Loop (2343 BP) to Katherine	103.5	86	15.7	12.6	6.6	42%
Katherine	2446.5	Katherine to Union Reef	102.2	132	10.4	8.3	6.6	63%
Union Reef	2548.7	Union Reef to New Loop (2662 BP)	113.3	113	12.1	9.7	8.6	71%
New Loop (2662 BP)	2662.0	New Loop (2662 BP) to Berrimah	88.0	87	15.4	12.3	8.6	56%
Berrimah	2750.0							

Table 4 Potential Capacity Increase - 80 km/hr Train Speed

Crossing Loop	Location (kms from Adelaide)	Section	Length (kms)	Section Running Times (mins) 21t @ 110km/hr	Pathway Capacity - Freighter (pathways/day)		Proposed Pathways Used/Day	
					Theoretical	Practical 80%	Number	%
Roe Creek	1318.0	Roe Creek to Illoquara	246.3	155	8.9	7.2	2.3	26%
Illoquara	1564.3	Illoquara to Tennant Creek	238.2	160	8.7	6.9	2.3	27%
Tennant Creek	1802.5	Tennant Creek to Muckaty	129.5	88	15.3	12.3	6.6	43%
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Muckaty	1932.0	Muckaty to Newcastle Waters	161.0	97	14.0	11.2	6.6	47%
Newcastle Waters	2093.0	Newcastle Waters to New Loop	176.8	102	13.3	10.7	6.6	50%
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Katherine	2446.5	Katherine to Union Reef	102.2	88	15.3	12.3	6.6	43%
Union Reef	2548.7	Union Reef to New Loop	100.7	78	17.1	13.7	8.6	50%
New Loop	2649.4	New Loop to Berrimah	100.7	77	17.3	13.9	8.6	50%
Berrimah	2750.0							

Crossing Loop	Location (kms from Adelaide)	Section	Length (kms)	Section Running Times (mins) 21t @ 110km/hr	Pathway Capacity - Freighter (pathways/day)		Proposed Pathways Used/Day	
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Newcastle Waters	2093.0	Newcastle Waters to New Loop	235.8	135	10.2	8.1	6.6	65%
New Loop	2328.8	New Loop to Katherine	117.7	68	19.6	15.7	6.6	34%
Katherine	2446.5	Katherine to Union Reef	102.2	88	15.3	12.3	6.6	43%
Union Reef	2548.7	Union Reef to New Loop	100.7	78	17.2	13.8	8.6	50%
New Loop	2649.4	New Loop to Berrimah	100.7	78	17.2	13.8	8.6	50%
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Crossing Loop	Location (kms from Adelaide)	Section	Length (kms)	Section Running Times (mins) 21t @ 110km/hr	Pathway Capacity - Freighter (pathways/day)		Proposed Pathways Used/Day	
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Tennant Creek	1802.5	Tennant Creek to Muckaty	129.5	98	13.8	11.1	5.4	39%
Muckaty	1932.0	Muckaty to Newcastle Waters	161.0	97	14.0	11.2	6.6	47%
Newcastle Waters	2093.0	Newcastle Waters to New Loop (2343 BP)	250.0	144	9.6	7.7	6.6	69%
New Loop (2343 BP)	2343.0	New Loop (2343 BP) to Katherine	103.5	59	22.0	17.6	6.6	30%
Katherine	2446.5	Katherine to Union Reef	102.2	88	15.3	12.3	6.6	43%
Union Reef	2548.7	Union Reef to New Loop (2662 BP)	113.3	87	15.4	12.4	8.6	56%
New Loop (2662 BP)	2662.0	New Loop (2662 BP) to Berrimah	88.0	68	19.5	15.6	8.6	44%
Berrimah	2750.0							

Table 5 - Potential Capacity Increase - 110 Km/hr Train Speed

8.3 SUMMARY

The network pathway capacity can be readily upgraded by adding crossing loop at appropriate locations.

To meet the train pathway requirements when the Wonarah project requirements are added to the existing usage, two new crossing loops would be required, located between the existing crossing loops at Newcastle Waters and Katherine, and between Union Reef and Berrimah.

If rail transport requirements for other projects need to be comprehended then the pathway capacity would need to be re-assessed. The existing railway has relatively very few crossing loops and the addition of other projects at the same or similar time frame to the Wonarah Project commencement can easily be accommodated by adding crossing loops at appropriate locations.

9 COSTS

Although Minemakers favours the IHP process as the development option, the land based logistics for both of the two identified process options are reviewed. The costs developed in this report are for the purposes of making an assessment of whether from a land based logistics perspective the IHP process is cheaper or more expensive than the WAP process.

The assessment has been made using a battery limit at the load/unload point at the process plant interface. Any capital costs and operating costs for infrastructure to load/unload and store products at the process plant are assumed to be part of the plant costs. At the port end the assumed battery limit is the ship at berth. Costs to load/ unload ships are included in the assessment.

Although a number of potential service providers were identified and approached to provide input, only rail operator GWA responded. Some potential providers declined on the basis that it was too early in the project development phase, while others were not prepared to participate without remuneration from Minemakers.

Sources of pricing and costs are as follows:

- Indicative pricing for a complete mine to port solutions for the Wonarah Project has been provided by Rail operator GWA in the form of three reports.

- Some additional capital costs have been taken from material provided by KEMWorks Technology Inc and also from the Export Transport Logistics Study prepared by WorleyParsons in October 2009.

- The cost for transporting phosphate rock in a slurry pipeline has been taken from Minemakers material.

9.1 GWA PROPOSALS

GWA's three reports and a supplementary note cover the following:

- Rail transport costs for the four scenarios outlined in Section 5 namely:
  - IHP
    - all container
    - purpose built rail wagons for ammonia and SPA and containers for other products.
  - WAP
    - all container
    - purpose built rail wagons for ammonia and SPA and containers for other products.
- Door to door costs for the IHP process including rail, road and terminal activities between Wonarah and Darwin Port for the full task requirements
- Door to door costs for the WAP process including rail and terminal activities between Tennant Creek and Darwin Port for a task below the full task requirement but one that optimised the rail transport resources
- A supplementary cost to provide the full WAP task requirement.

All costs have been expressed as operating costs and have not included terminal infrastructure capital costs

Despite a number of minor gaps in the data provided, the information has been sufficient to assess the comparative costs of the two process options.

The reports and supplementary note from GWA can be found at Appendix 6

The costing information from GWA is based on a number of exclusion and assumptions that are included within each report. These will need to be reviewed, and as necessary, dealt with during the BFS stage.

9.2 TOTAL COSTS (INCL CAPITAL)

The cost tables for the costs are at Appendix 7 and are summarised in Table 6

Option	Operating			Capital
	Total Cost ($M)	Cost/tonne Product ($/t)	Cost/tonne P_2O_5 ($/t)	Total Cost ($M)
IHP	228.13	152.09	228.13	118.7
WAP – below task	220.99	116.29	267.46	128.0
WAP – full task	266.77	115.99	266.77	128.0

Table 6 Summary of Capital and Operating Costs for Logistics

The assessment indicates that both capital and operating costs would be lower for the IHP process.

The capital costs do not include any provision for contributions to the rail network upgrading. Any costs in this area are likely to be common to both process options however they will need to be considered for the BFS.

A number of assumptions have been made to formulate overall costs shown in this report:

- WAP process
  - The cost to transport phosphate slurry is reflected in the Minemaker cost of $0.0655 per net tonne km.
  - Ammonia storage tanks capital costs per KEMWorks estimate based on 2 20,000t tanks
  - Bulk storage sheds capital costs using WorleyParsons estimate information
  - Cost assumptions for terminals are detailed in the tables at Appendix EE
  - Assumed operating costs for storage, transport by pipeline and unloading ammonia
  - The required shed storage would be 50% larger than the typical ship size which has been assumed at 50,000t
- IHP process
  - SPA storage tanks capital costs per KEMWorks estimate based on 3 20,000t tanks
  - Bulk storage sheds capital costs using WorleyParsons estimate information
  - Cost assumptions for terminals are detailed in the tables at Appendix 7
  - Assumed operating costs for storage, transport by pipeline and loading SPA
  - The required shed storage would be 50% larger than the typical ship size which has been assumed at 50,000t

- J Rox has not specifically been dealt with in the GWA proposals

To test the impact of cost changes on the relativities of operating costs for the two processes the following cost changes were assessed:

- Base case
- GWA costs @ 80%
- Port charges @ 80%
- SPA/ammonia transport & storage @ 75%
- Pipeline @ 110% for WAP process
- Combined case

Table 7 shows a summary and ranking for this cost sensitivity testing.

Process	Task	Sensitivity Options	Transport Cost/ tonne product ($/t)	Transport Cost/ tonne P_2O_5	Ranking
IHP	Full	Base	152.09	228.13	6
		GWA @ 80%	122.92	184.38	2
		Port Charges @ 80%	151.54	227.30	4
		SPA transport & storage @ 75%	151.21	226.82	3
		All	121.49	182.24	1
WAP	Below Task	Base	116.29	267.46	15
		GWA @ 80%	101.56	233.59	7
		Pipeline @ 110%	119.48	274.80	17
		Port Charges @ 80%	112.51	258.78	11
		Ammonia transport & storage @ 75%	116.13	267.10	14
		All	108.74	250.10	9
WAP	Full	Base	115.99	266.77	13
		GWA @ 80%	99.15	228.05	5
		Pipeline @ 110%	118.62	272.83	16
		Port Charges @ 80%	112.18	258.00	10
		Ammonia transport & storage @ 75%	115.82	266.39	12
		All	105.39	242.40	8

Table 7 Summary of Cost Sensitivity Tests

For all cases the testing indicates that the IHP process operating cost would be lowering than the equivalent WAP process operating cost.

The complete set of test information is included in Appendix 7.

9.3 COMPARATIVE COSTS AND COMPLETENESS OF COSTS

The cost assessments are based on the GWA costing and are without any significant testing. To provide some guidance, some comparative information is provided in Section 9.3.1 below.

A high level assessment to check the completeness of costs is provided at Section 9.3.2.

9.3.1 Comparative Costs

Table 8 has been prepared to provide a high level comparative assessment of some aspects of the GWA proposed costs.

Activity	Costs		
	WorleyParsons Export Logistics Study (2009) (esclated by 3% over 4 yrs)	CRONOS	GWA Costs
Port Charges	$3.57/t		$3.00/t
Port to Storage	$2.78/t		$2.50/t
Storage to Rail	Capital Item		$5.33/t
Rail	$29.75/t		$24.59/t - $46.86/t
Tennant Creek	$3.31/t		$3.15/t
Road	$32.76/t		$37.37/t
Container Hire - Bulk		$3.96/day	$12.95/day
Container Hire - ISO		$15.36/day	$19.75/day

Table 8 Comparative Costs

The costs extracted from the 2009 WorleyParsons report have been escalated by 3% over 4 years to reflect 2013 dollars. The costs detailed in that report were for a higher tonnage/one product scenario so are not directly comparable, but provide a useful comparison to the GWA costs. With the exception of the road transport cost there is reasonably close correlation between the WorsleyParsons cost and the GWA costs.

The other area of comparison is container hire costs. The indicative CRONOS costs were obtained in response to an email enquiry. The costs are significantly lower than the costs obtained by GWA and are for a shorter term (5yrs vs 10yrs) than the GWA quotes.

BRS has prepared cost assessments for rail transport under a number of scenarios and in general the costs assessments are less than the equivalent GWA costs. The rail transport costs will require further refinement during the BFS stage. Also a number of terminal activities and the number of required containers appear to be very conservative.

9.3.2 Completeness of Costs

The capital cost tables at Appendix 7 include operating cost items and the cost data relevant to the items. Also listed are a number of items that may be a cost to the project.

Data included in the table can be used as a checklist during the BFS stage to assist in ensuring that all project costs are captured.

10 SUMMARY

Based on the assessments carried out, and the assumptions made, it is concluded that the IHP process should incur lower capital and operating costs than the WAP process for the land based logistics activities to export the equivalent of 1,000,000t P_2O_5.

There are some costs not included in the assessments such as potential capital contributions to rail network pathway capacity upgrading, and a number of capital and operating costs that may be a cost to the project but as these are essentially common to each process, they should not affect the relative costs.

A number of cost sensitivities have been undertaken and in each case the IHP process remains the lowest cost process option.

The assessment is based on the ultimate project objective of exporting the equivalent of 1,000,000t P_2O_5. GWA has provided costs for rail transport based on increments of

300,000t of SPA. The incremental operating costs on a cost/tonne basis of all product transported are higher than the costs used for the assessment.

11 NEXT STEPS

A number of aspects of the land based logistics supply chain are conceptual at this stage and will require further development during the BFS. As well, a number of issues have arisen during the course of developing the report that will require further consideration during the BFS.

11.1 DEVELOPMENT REQUIREMENTS

The following areas require further development:

- Use of containers to transport all products between Wonarah and Darwin
- Rail terminal configurations and operation at both Darwin and Tennant Creek
- Location and sizing of bulk storage requirements at Darwin
- Securing tenure over land for storage facilities
- Use of Vopak facilities at Darwin
- Rail and road transport proposals to cover all consumable products (incl J Rox, fuel etc.)
- Conveyor/pipe transport vs road transport for products at Darwin
- Impact of other potential projects on the Wonarah project

11.2 ISSUES

Issues that have arisen during the study which require further consideration are:

- Use of double stacking ISO containers on rail wagons and any dangerous goods transport limitations
- Ability to control the SPA temperature close to the desired temperature of 45 degrees Celsius during transport.
- Labour availability at Tennant Creek
- Whether the rail passenger terminal at Berrimah can be relocated
- Limited suitable land available for storage at Darwin

Appendix 1 Indicative Train Configurations

Appendix 2 GWA train Scenarios

Appendix 3 Conceptual Terminal Layouts

Appendix 4 Latest Concept for Berrimah Terminal

Appendix 5 Potential rail, Road & Lifting Equipment

Appendix 6 GWA Reports

Appendix 7 Costs