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BHPBIO

Pilbara Rail Network

Production Capacity Modelling

December 2005

Evans & Peck Assignment 60299

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EXECUTIVE SUMMARY

Scope of Study

The aim of this study was to assess the *total production capacity* of BHPBIO's Pilbara Rail Network, assuming a dual tracked rail network and utilising actual BHPBIO operating data. Throughout this report the term 'production capacity' refers to the maximum achievable level of production for a system.

Methodology

A spreadsheet-based 'static model' was provided to E&P by BHPBIO at the start of this study. BHPBIO demonstrated their estimate of a dual tracked system capacity using this model.

E&P set out to verify the accuracy of BHPBIO's estimate by firstly calibrating the model to historical data, then applying a logical series of changes to the model to reach an estimated dual track capacity for BHPBIO's system.

Results

BHPBIO's estimated dual track production capacity was 206Mtpa.

E&P's estimate of maximum dual track production capacity is between 234 and 247Mtpa. This estimate includes the impact of loading and unloading constraints. Advice from BHPBIO on the ultimate harbour capacity at Port Hedland further limits this range to between 200 and 230Mtpa.

E&P's conclusion is that the addition of unloading and loading constraints to a rail system limits production capacity to that of the 'weakest link' in the system (in this case the harbour) and that the overall system capacity is limited to the range of 200Mtpa to 230Mtpa.

In addition, E&P's dynamic modelling demonstrated that system efficiencies decrease as production approaches the maximum capacity.

1 INTRODUCTION

In August 2004 Evans & Peck (E&P) submitted a report to the Western Australian Department of Industry and Resources (DOIR), which contained an estimate of more than 400Mtpa production capacity for a dual tracked rail system transporting iron ore.

This estimate was made using publicly available data and the assumption that only the rail system's '*trunk line*' capacity was under consideration. Loading and unloading constraints were not considered.

In November 2005 BHPBIO engaged E&P to carry out a review of the 400Mtpa estimate in relation to BHPBIO's iron ore operations. In particular an estimate of *total production capacity* based on historical data and realistic assessments of future unloading and mine constraints was required.

For this study E&P assumed that a double tracked rail system would incorporate double tracking for the full length of the rail system between BHPBIO's mines and Port Hedland (including the Yandi / Area C spur line).

The estimates made in this report are primarily based on static (ie spreadsheet-based) models. Throughout this study E&P has applied a logical approach to the calibration and use of its static model so that a reasonably accurate estimate of production capacity could be made. A more accurate estimate could be achieved using a detailed 'dynamic model', however this would require more time than was available for this study.

It should be noted that static models can lead to very inaccurate estimates if a consistent set of input parameters is not used. A static model is by necessity a simplification of the real system and can ignore the 'flow-on' effects that changing one parameter can have on another (for example, reducing the spacing between trains will always increase production capacity in the static model but may actually decrease capacity in a real system if the loading/unloading facilities are unable to keep up with the extra trains).

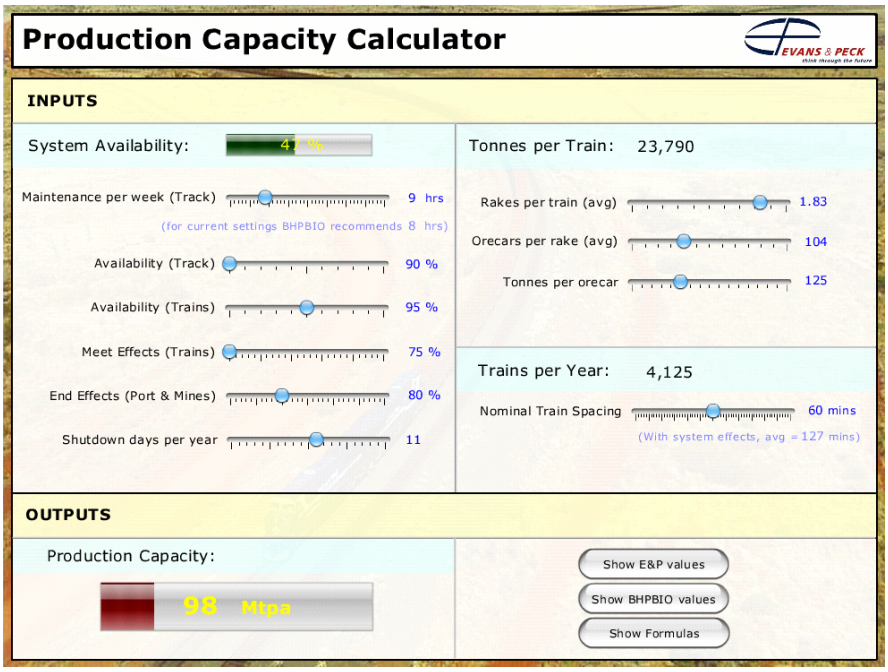
2 BHPBIO'S STATIC MODEL

BHPBIO's spreadsheet-based 'static model' was presented to E&P in November 2005. This model was used by BHPBIO to demonstrate the critical issues in arriving at an estimate of a dual tracked system capacity. E&P created its own version of this model and used it for the purpose of this study (see screenshots on the next page).

2.1 CALIBRATION TO SINGLE TRACK

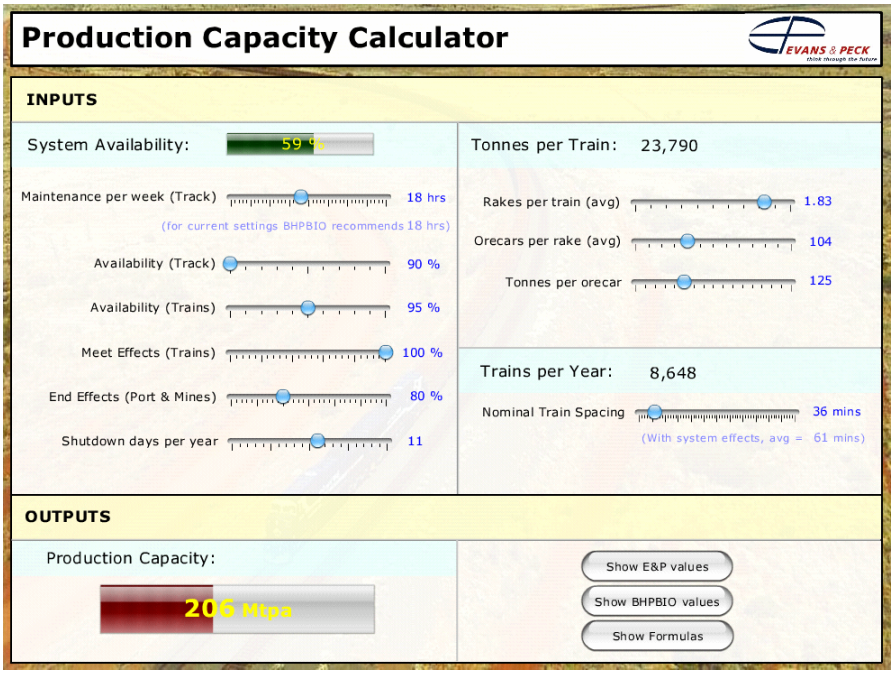
BHPBIO initially calibrated its static model to actual data from the year ending June 2005, showing a production capacity of 98Mtpa for the Mt Newman rail system (see E&P's reconstruction of this model below). The delays to trains on a single track are represented as Meet Effects in the model and set at 75%. The nominal Train Spacing in 2005 is set at 60 mins. Note that future production

gains are achievable by reducing Train Spacing, though this would require upgrades such as additional sidings to maintain system efficiencies – at some point a limit is reached and a dual track is required.



2.2 EXTRAPOLATION TO DUAL TRACK

With the static model calibrated, BHPBIO estimated a dual tracked system's capacity by setting Meet Effects to 100% (ie, no delays from trains meeting on the track) and Train Spacing to 36 mins (a minimum based on actual track gradients). The resulting estimate was 206Mtpa, as shown in the screenshot below.



3 E&P'S STATIC MODEL

E&P's static model is functionally identical to the model presented by BHPBIO in November 2005. This approach was taken so that the causes of any differences between E&P and BHPBIO's estimates of production capacity could separately be identified and addressed in this report.

3.1 CALIBRATION TO SINGLE TRACK

E&P found that 3 areas of the static model could be directly observed from BHPBIO's historical production data. These areas were Tonnes per Train, End Effects (incl. shutdowns), and Rail Efficiency (incl. track & train availability factors).

The main data source used was the spreadsheet "Rake Summary June-04 to June-05 Inclusive.xls" (for the year 1/7/04 to 30/6/05, with Yarri, Nimingarra & Recycled shipments excluded).

3.1.1 Tonnes per Train

The average quantity of ore in each train is an important parameter in the static model, as it directly affects the estimated production capacity. Tonnes per Train is also quite simple to obtain from historical data.

E&P and BHPBIO's calibrations of Tonnes per Train in 2004/05 agree closely in their totals but contain some differences in their build-up. These differences do not alter the results of the static model. The calculations used to generate E&P's figures are presented below, along with a comparison between E&P and BHPBIO's Tonnes per Train estimates.

Total Tonnes = 98Mt *(BHPBIO statement)*
Total Cars Loaded = 799,772 *(from data source)*
Total Rakes = 7,951 *(from data source)*
Total Trains = 4,123 *(from data source: rakes with identical start times)*

	E&P Derived value	BHPBIO value
Rakes per train (avg)	1.93	1.83
Orecars per rake (avg)	101	104
Tonnes per orecar	122	125
Tonnes per Train	23,781	23,790

3.1.2 End Effects

End Effects can be defined as the reduction in the efficiency of a rail system due to random delays arising from the loading and unloading operations. Normal activity times

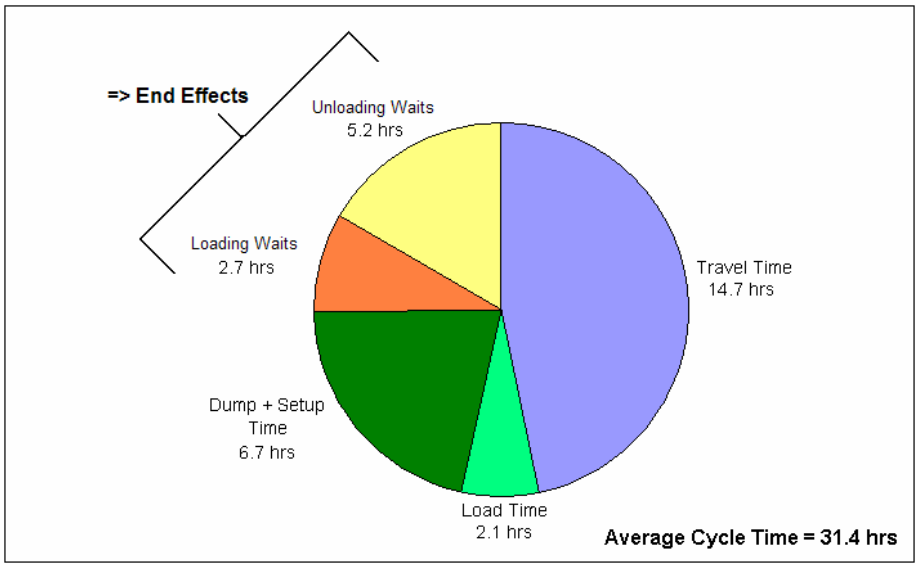
(eg dumping & loading times) are not classed as End Effects because such activities must occur in every cycle and do not normally involve waiting time.

E&P estimated the impact of End Effects on BHPBIO in 2004/05 by comparing the times spent in different activities during a typical train cycle. Activity durations were identified from the time between recorded times in the data source. The table below shows a summary of the 2004/05 rake data. In this table E&P has marked activities that contribute to End Effects with an asterisk (*).

	Rake Hrs	Hrs per Cycle	% of Total
Unloaded Travel	56,580	7.1	22.7%
Mine Load Wait *	8,652	1.1	3.5%
Load Time	16,622	2.1	6.7%
Mine Depart Wait *	12,941	1.6	5.2%
Loaded Travel	60,153	7.6	24.1%
Port Arrive Wait *	3,614	0.5	1.4%
Dump Wait *	37,820	4.8	15.1%
Dump Time	18,808	2.4	7.5%
Shunt Time	12,478	1.6	5.0%
Recouple Time	22,048	2.8	8.8%
Total	249,717	31.4	100.0%

End Effects (incl. shutdowns) = 100% - (*Mine & Unloading Waits* *)/(Total hrs) = 75%
(in the static model a value of 100% corresponds to no effect, ie End Effects = 100-25 = 75%)

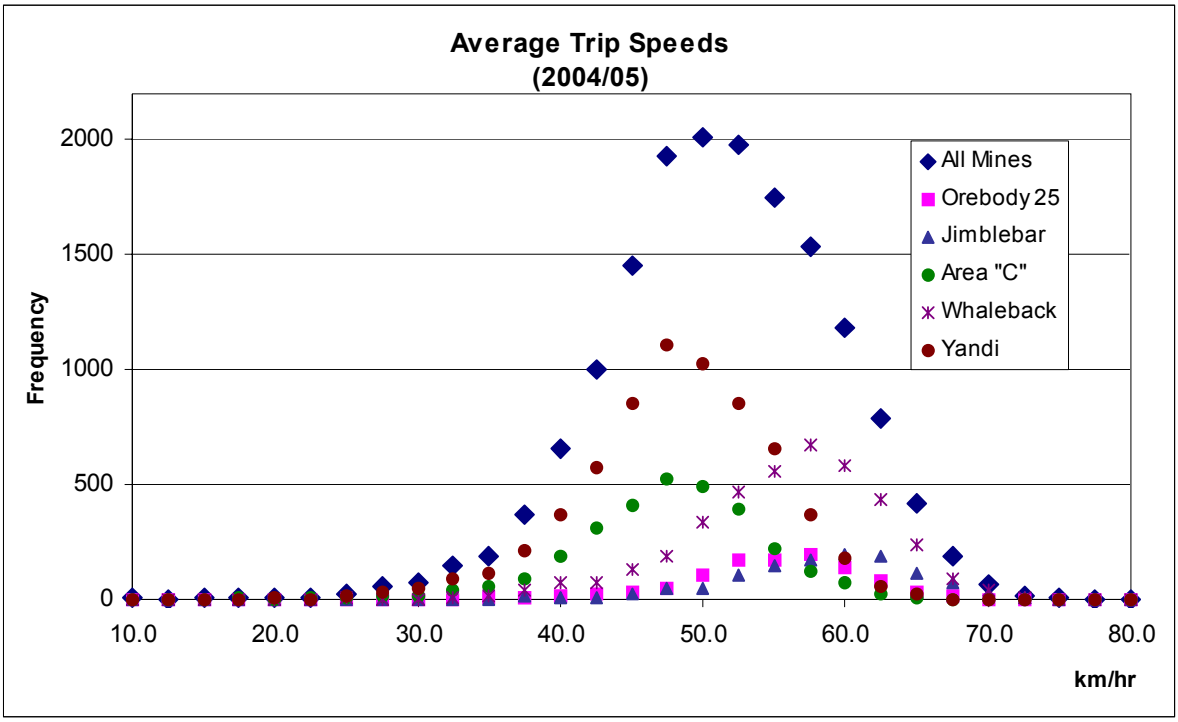
	E&P value	Comments	BHPBIO value
End effects (excl shutdowns)	77%	Calculated value	80%
Shutdown days per year	11	Assumed value	11
End effects (incl shutdowns)	75%	From data source	78%



3.1.3 Meet Effects

Meet Effects are defined as the reduced system efficiency due to trains being delayed by 'meets' on a single track. When a 'meet' occurs one of the trains must divert to a siding and wait for the other train to pass. The combined impact of all of these 'meets' is represented in the static model as Meet Effects (%).

E&P was not provided with reliable data on Meet Effects but was able to deduce the combined impact of Meet Effects and Track/Train Availabilities by comparing average versus best train trip speeds from BHPBIO's 2004/05 data. See the chart and table below for the results of this analysis.



	Best Avg. Speed (best runs, weighted avg from mine production)	Avg. Speed (all runs)	Rail Efficiency
Orebody 25	70.86	53.45	75%
Jimblebar	74.60	56.58	76%
Area "C"	66.20	46.20	70%
Whaleback	73.22	54.44	74%
Yandi	65.20	46.88	72%
Total	68.50	49.83	73%

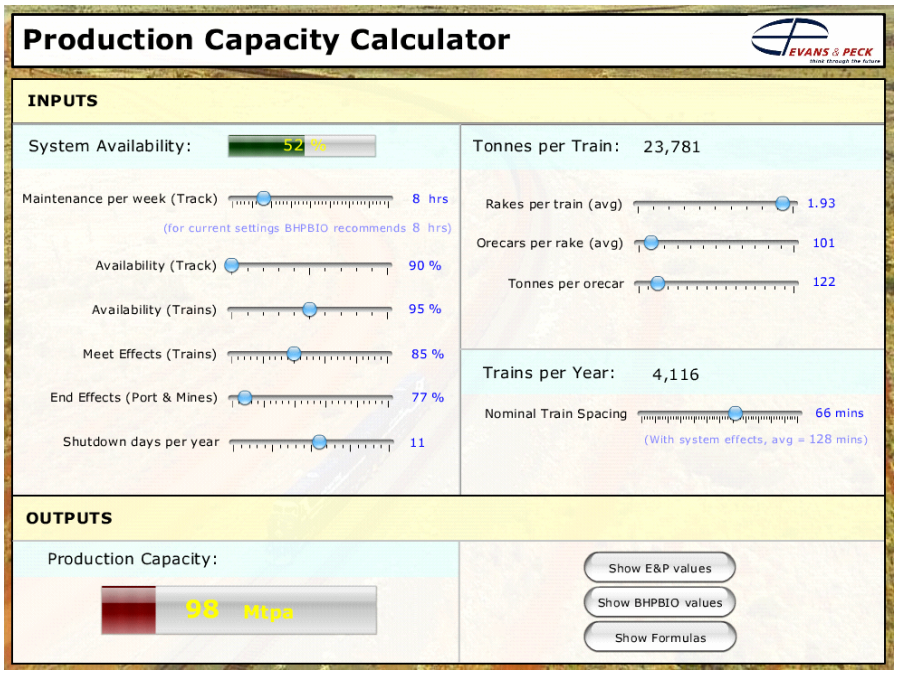
In order to estimate the Meet Effects component within the calibrated Rail Efficiency, E&P developed a simple calculation, shown in the table below.

	E&P Derived value	Comments
Number of meets	2,977	From "Delays Summary.xls"
Average delay per meet (mins)	38	From "Delays Summary.xls"
Meets per cycle	3.46	Calculated from total meets and total trains.
Meet delays per cycle (hours)	2.19	Calculated from meets per cycle.
Lost time due to Meet Effects	15%	Calculated from delays per cycle relative to the total travel time.
=> Meet Effects (2004/05)	85%	

The result of the entire Meet Effects calibration is summarised in the table below, alongside BHPBIO calibration values.

	E&P value	Comments	BHPBIO value
Maintenance per week (Track)	8 hrs	Calculated tamping hours required for production capacity	8 hrs
Availability (Track)	90%	# Estimated to calibrate to Rail Efficiency %	90%
Availability (Trains)	95%	# Estimated to calibrate to Rail Efficiency %	95%
Meet Effects (Trains)	85%	# Estimated & combined with Track/Train Availabilities to calibrate the system to Rail Efficiency %	75%
Rail Efficiency %	73%	From data source	61%

A screenshot of E&P's static single track model is shown below.



3.2 EXTRAPOLATION TO DUAL TRACK

E&P initially followed the same method as BHPBIO in its estimate of a dual tracked system's capacity, by setting Meet Effects to 100% and Train Spacing to 36 mins. It was decided however that further changes needed to be made to more accurately estimate the system's capacity. These changes and the resulting capacity estimates are described below.

3.2.1 E&P track logic

BHPBIO's assumption in moving from a single tracked to a dual tracked system is that impacts due to track & train maintenance and availabilities would be unchanged.

E&P considers this to be a conservative view, as in fact a dual track provides the operator with flexibility to continue running trains when one of the tracks is out of service. A loss in capacity will still occur because the track in these periods effectively becomes a single track (ie Meet Effects will be incurred), but this loss will not be as great as that due to a completely blocked line.

Changes made to the static model to incorporate E&P's track logic are as follows:

a) Track & Train Maintenance & Availabilities

As a first approximation, these parameters were set to 100%, ie:

- Maintenance per week = 0 hrs
- Track availability = 100%
- Train availability = 100%

Next, some allowance needed to be made for the continued effect of 'Go Slow' track sections (where maintenance is due but not yet started) and lost production from delayed trains in a dual tracked system. E&P did not have access to detailed data on these effects but estimated them to be minor, hence the assumed parameters became:

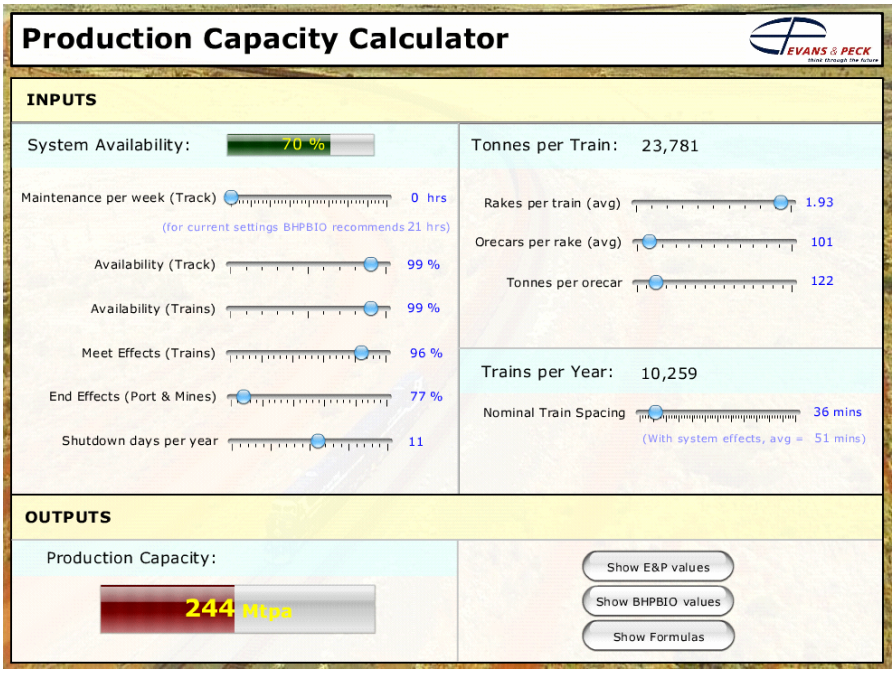
- Maintenance per week = 0 hrs
- Track availability = 99%
- Train availability = 99%

b) Meet Effects

To estimate the lost production capacity due to maintenance and availabilities on a dual tracked system, an estimate of Meet Effects was made. This calculation can be summarised as follows:

Percentage of time operating as a single track:
= 100% - (Track Availability)x(Train Availability)x(Maintenance per week impact)
= 100% - (90%)x(95%)x(168-21)/168
= 25%
Meet Effects incurred during 'single track' time:
= (100%-85%)x(25%)
= 4%
ie, Meet Effects parameter should be 100% - 4% = 96%.

Incorporating E&P's track logic into the static model yields an estimate of 244Mtpa, as shown in the screenshot below.



3.2.2 E&P track logic + Best/Worst End Effects

In addition to the revised track logic discussed previously, E&P considered that assumptions relating to the End Effects on a dual tracked system should be investigated.

In preparing its estimate of a dual tracked system's production capacity, BHPBIO assumed that End Effects would have the same relative impact that they had in 2004/05.

E&P considers that when major capital upgrades are made to a system there is typically an opportunity to improve system efficiencies (with new technologies, improved layouts etc). When considered in the context of BHPBIO's operations the following was found:

a) Unloading Waits

As BHPBIO's production out of Port Hedland approaches 150Mtpa it is likely that 1 to 2 new berths at Finucane Island will be constructed. Constraints of geography and proximity to the town of South Hedland will prevent the construction of train marshalling yards and it is likely that the efficiency of the additional capacity will be lower than that currently achieved at Nelson Point.

E&P estimated the likely range of Unloading Waits in the future to be between +0% and +10% of today's levels.

b) Loading (Mine) Waits

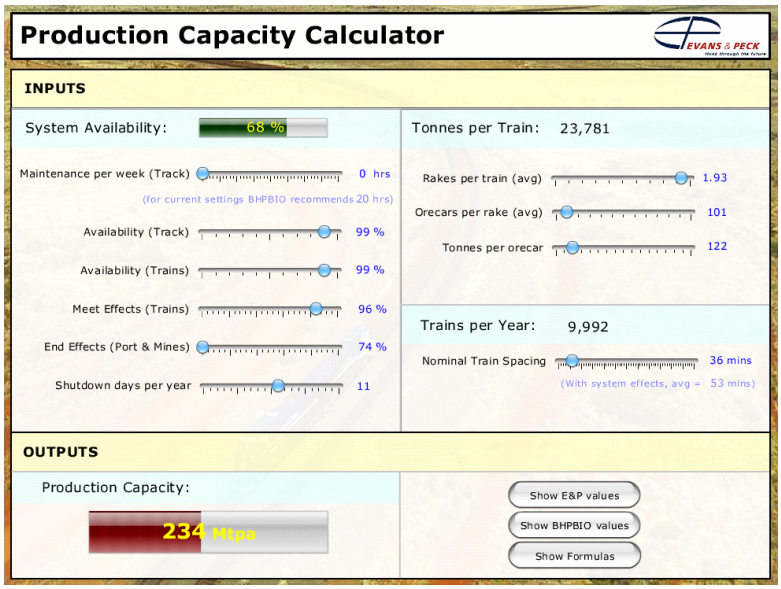
It is not known at this stage where or how large BHPBIO's future iron ore mines will be, however it is possible that the new mines will be smaller than the existing ones. The size of these mines will determine the efficiencies that can economically be achieved.

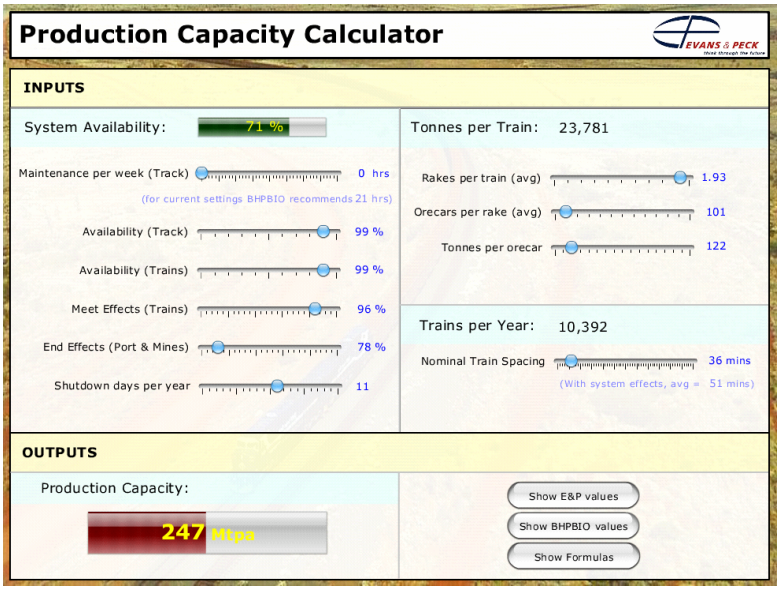
E&P therefore estimated the likely range of Loading (Mine) Waits to be between +10% and -10% of today's levels.

The combined impact of these best and worst case scenarios on End Effects is presented in the table below.

	2004/05	Worst +10%	Best -10%	Comments
Unloading Waits	16.6%	18.3%	*16.6%*	*No gains expected at Finucane Island facility*
Loading (Mine) Waits	8.6%	9.5%	7.8%	
Total Waits	25.2%	27.8%	24.4%	Range of expected impacts
End Effects (excl shutdowns)	77%	74%	78%	Used in static model

Incorporating these scenarios into the static model yields a range of 234 to 247Mtpa, as shown in the screenshots below.





3.2.3 Harbour Constraints on Production Capacity

E&P's estimate of a dual tracked system's production capacity assumed the impact of ship movements in the Port Hedland harbour on the End Effects would remain constant as production increases into the future (ie the E&P estimate allows for Unloading Waits at the same or slightly [10%] higher levels to those currently experienced).

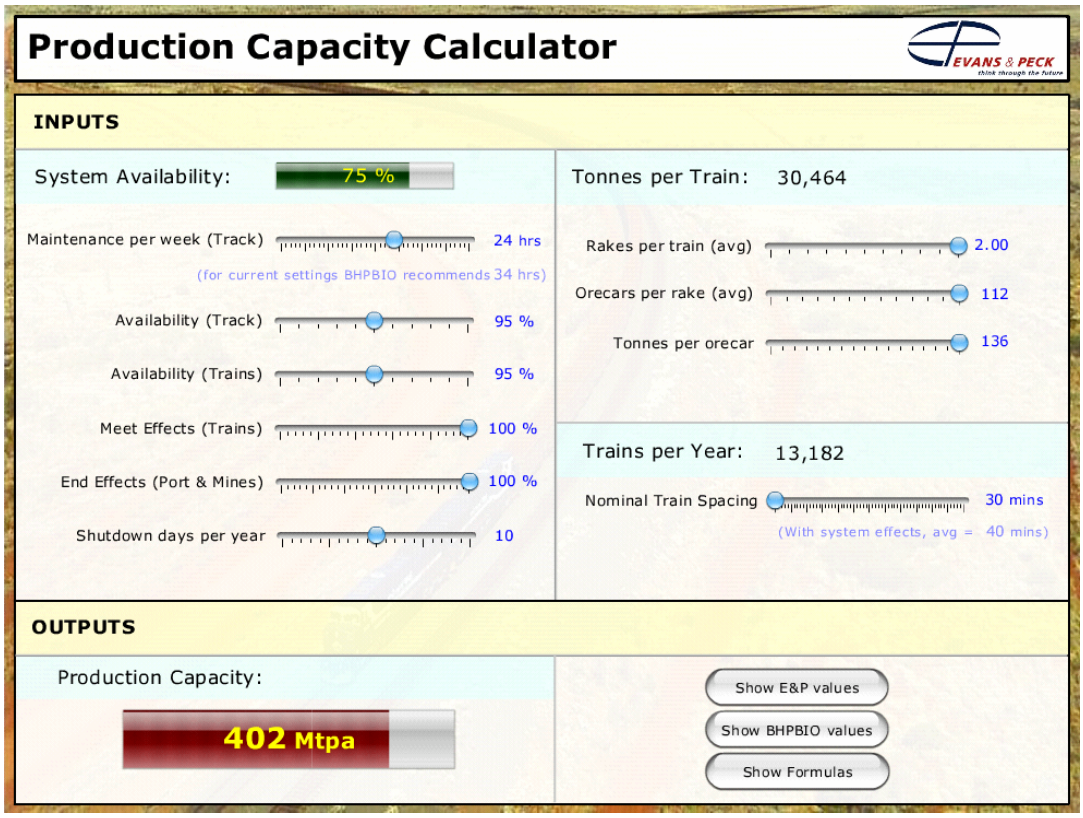
BHPIO has advised E&P that this is not the case, and that the ultimate production capacity of the harbour lies in the range of 200 to 230Mtpa. Therefore this range should be seen as a ceiling on E&P's estimates, as the rail system can only transport as much ore as the harbour can ship out.

The dual tracked system capacity is therefore constrained by the harbour capacity to between 200 and 230Mtpa.

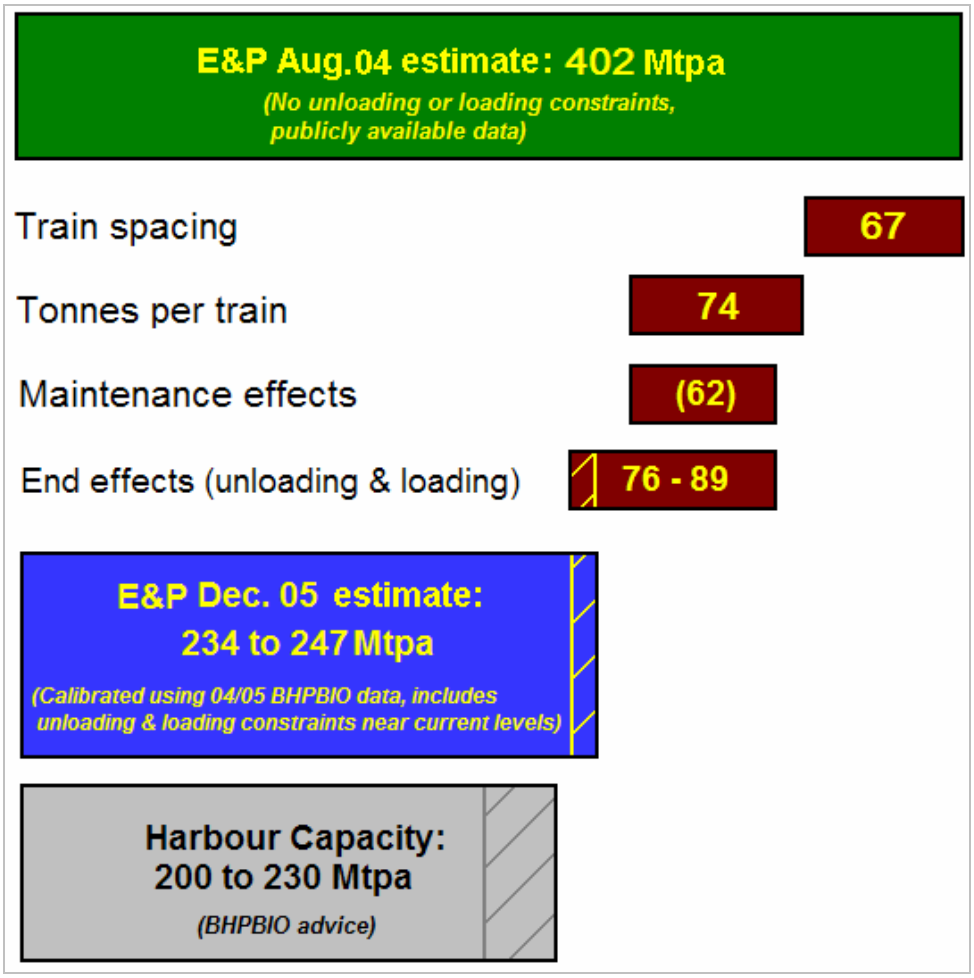
4 COMPARISON OF E&P'S 2005 AND 2004 ESTIMATES

In previous sections of this report E&P estimated between 234 to 247Mtpa production capacity for BHPBIO's system operating with dual tracks (with the constraint of the ultimate harbour capacity this is reduced to between 200 and 230Mtpa). The following section will reconcile these estimates with E&P's 2004 estimate of >400 Mtpa for a dual tracked 'trunk line', and identify the important areas of difference.

E&P's 2004 estimate expressed in terms of the static model is shown below.



Changing parameters in the model of the 2004 estimate until it agreed with E&P's 2005 estimate yielded the following table.



Train spacing: 67 Mtpa

E&P Aug.04 position: 30 mins
E&P Dec.05 position: 36 mins

Production capacity on a rail system is highly sensitive to the minimum spacing of trains. E&P had assumed a nominal 30 minute spacing and BHPBIO states that 36 minutes is a realistic minimum on BHPBIO's rail network. The 36 minutes was based on actual train speeds on BHPBIO's track through the Chichester Ranges (BHPBIO's track has the greatest gradient variability of any track in the Pilbara, hence speed variability and therefore necessary separation time is greater than for the other rail systems in the region).

E&P's opinion is that 36 minutes should be accepted as the safe minimum train spacing on BHPBIO's track (and therefore 67Mtpa should be taken from E&P's estimated production capacity). Closer train spacings may be possible in the future but not without significant cost to BHPBIO.

Tonnes per train: 74 Mtpa

E&P Aug.04 position: 30,464 tonnes

E&P Dec.05 position: 23,781 tonnes

In its 2004 report to DOIR E&P assumed that each train would consist of 2 rakes, where each rake has 112 cars carrying 136 tonnes of ore per car. BHPBIO's use of lightweight cars and long trains (up to 3 rakes) is publicly available information.

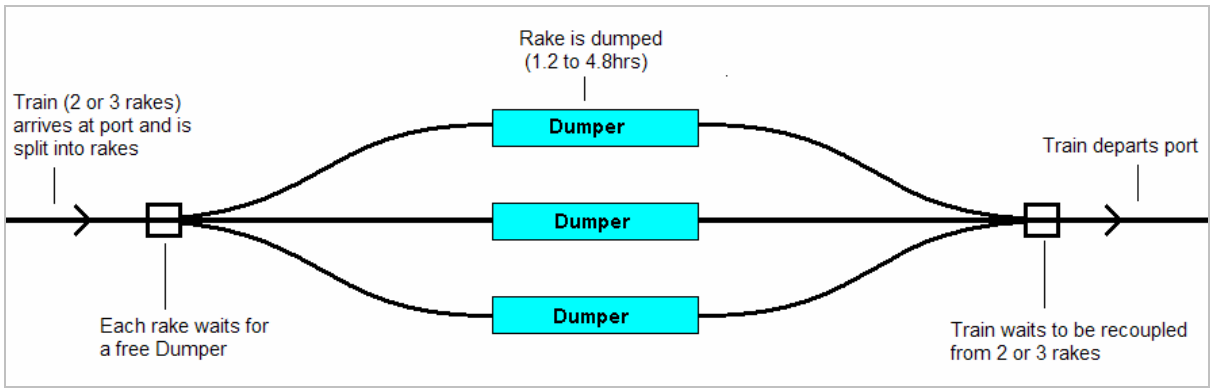
BHPBIO's historical data shows an average of less than 24,000 tonnes per train was transported in 2004/05. BHPBIO's position is that the Tonnes per Train parameter is an *output* of the system rather than an *input*. This is due to the constraints at the port and mines: increasing train lengths causes delays to unloading and loading operations and can reduce the efficiency of the system. A range of Tonnes per Train is feasible in an operational system, though the impact on system efficiency may in some cases outweigh the gains in production capacity.

E&P developed a simple dynamic model in order to test BHPBIO's claim regarding Tonnes per Train (see the following discussion). The model demonstrated that although production gains can be made by increasing Tonnes per Train the system remains constrained by the capacities of each of its parts. It is likely in fact that once the system becomes double tracked the Tonnes per Train will initially decrease in order to balance the operation of the rail with the unloading and loading facilities. Without detailed information on the layout and operation of BHPBIO's future system it is not possible to determine the optimal Tonnes per Train on the system at maximum capacity, therefore E&P deems it reasonable to assume future BHPBIO Tonnes per Train would be the same as 2004/05 levels.

Dynamic Model

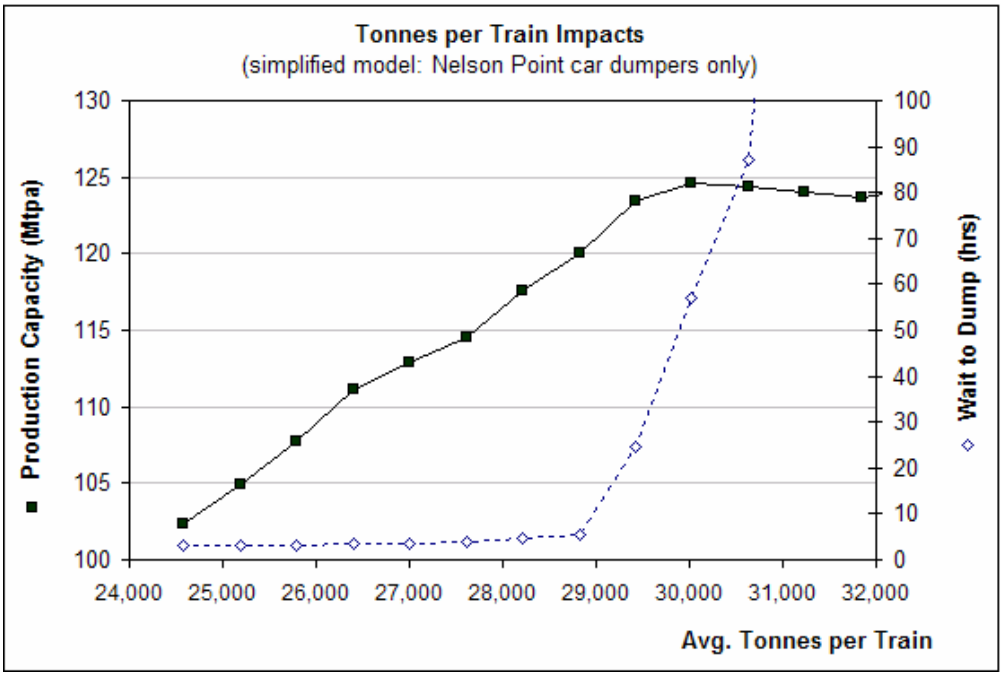
E&P developed a simple dynamic model of the Nelson Point car dumping facility in order to test the impact of Tonnes per Train on system efficiency.

A diagram of the model layout is shown below.



In this model Tonnes per Train is controlled by varying the percentage of 3 rake vs 2 rake trains that arrive at the unloading facility. Dump times were calibrated to BHPBIO's 2004/05 data. 2 rake 3 rake trains were assumed to carry 24,580 and 36,688 tonnes of ore respectively.

Dump waiting times were taken as an indicator of system efficiency and plotted against Tonnes per Train on a chart along with the system's production capacity, as shown below.



The chart shows that up to a certain point production gains can be made by increasing Tonnes per Train. There is a cost however in that average waiting times increase, and eventually a limiting capacity is reached and no further gains can be made. Note that this model does not allow for effects upstream or downstream of the dumpers at higher production rates, therefore only the trends in the results of this model should be relied on as accurate.

Maintenance effects: (62) Mtpa

E&P Aug.04 position:	Track & Train Availabilities as per single track
E&P Dec.05 position:	Most impacts can be avoided on a double track

During this study E&P has identified that a significant reduction in maintenance delays can be gained on a double track, because trains or track sections that are out of service can be bypassed by other trains in the system. This benefit was not included in the 2004 estimate, therefore it is shown as a negative difference.

End effects (unloading & loading): 76-89 Mtpa

E&P Aug.04 position:	100%
E&P Dec.05 position:	74-78%

In E&P's 2004 report it was stated that the rail system's *trunk line capacity* was being estimated (ie: End Effects were not considered).

The End Effects used in E&P's 2005 estimate were based on actual BHPBIO data and an E&P estimate of likely gains/losses in future (see the Section 3.2.2 of this report for further discussion).

5 CONCLUSIONS

The main conclusion to be drawn from this study is that if BHPBIO operates a dual tracked rail system out of Port Hedland its production capacity will be limited by the harbour capacity to between 200 and 230Mtpa. In addition, E&P's dynamic modelling demonstrated that system efficiencies decrease as production approaches maximum capacity.

The dual track rail line in itself has a higher than 230Mtpa capacity (E&P's estimate of maximum dual track production capacity is between 234 and 247Mtpa), however an operational system cannot produce more than the capacity of its elements, and therefore the system will be constrained by the harbour capacity.

It should be noted that this conclusion is based on the data provided to E&P and on the analysis that was possible in the time available in preparing the report.