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Annex T

(Confidential) Worley Parsons – Optimising Locations of Maintenance Depots: for the Queensland Rail Network, 18 August 2008

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QR NETWORK

UT3 Parallel Active Comparison Exercise

Supporting Document

Optimising Locations of Maintenance Depots

for the Queensland Rail network

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WorleyParsons Rail
Transport and Urban Development
Level 9 Centenary Square
100 Wickham Street
Fortitude Valley Qld 4006 Australia
Tel: +61 7 3319 3700
Fax: +61 7 3244 9699
www.worleyparsons.com
WorleyParsons Services Pty Ltd
ABN 61 001 279 812

QR NETWORK
OPTIMISING LOCATIONS OF MAINTENANCE DEPOTS
FOR THE QUEENSLAND RAIL NETWORK

SYNOPSIS

As supporting documentation to UT3 parallel active comparison exercise Queensland Rail Network commissioned WorleyParsons to carry out a desktop logistical study of the existing depot locations in the coal network and provide a commentary based on the findings of this study.

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1. INTRODUCTION

1.1 WorleyParsons has modelled the QR rail network from a limited abstract viewpoint in order to assess the deport locations in relation to location efficiencies for the coal network, in part because the amount of information available from QR has been constrained. This report details the modelling of the existing locations of various depots on the QR system and suggests alternative locations which have been optimised to reduce the travel time from the nearest depot to an arbitrary location on the network.

1.2 This report has been prepared as a sub-task of the UT3 Parallel Active Comparison Exercise Queensland Coal Railway Networks.

1.3 An analysis of the expected improvements in travel distance that can be realized for each type of depot has been included in this report.

1.4 From a purely mathematical viewpoint – the locations of the existing depots are not optimum and significant improvements in typical travel distances can be realised by changing the locations of existing depots.

1.5 However, it should also be noted that other factors such as travel time for personnel (who would probably live close to major town centres) and access to external services have not yet been factored into account. The location of depots at Barcaldine, for example seems to have been chosen because it is a remote population centre – whereas it is a significant distance from the QR network and would not be considered optimum from a travelling time to the QR assets viewpoint.

1.6 The type of activities related to each depot type also has not been factored into account because WorleyParsons has not been given access to this information. When these factors are built into the model the optimum locations associated with each type of depot may change.

2. METHODOLOGY

2.1 The investigation by WorleyParsons has used the following methodology:

- Create a mathematical computer model of the existing Central Queensland Coal Network.
- Using the mathematical computer model, determine:
    - the distance, on each system, between each location on the rail network.
    - the distance to each existing depot location from each location on the rail network.
    - the distance of the shortest path to each existing depot location from each location on the rail network.
- Determine the optimum location for each type of depot based on the shortest distance from each location on the network to each depot.
- Compare the optimum depot locations identified with the mathematical computer model with the existing depot locations on the rail network.

Mathematical computer model

2.2 WorleyParsons has developed a computer model of the Central Queensland Coal Network using a software package called Mathematica.

The model is a mathematical representation of the rail network and represents each location on the Moura, Blackwater, Goonyella and Newlands systems, which make up the Central Queensland Coal Network, and the major roads inter-connecting the rail networks.

Distance to depot locations

2.3 Using system diagrams provided by Queensland Rail, the distance between each location on each system of the rail network was determined by the mathematical model. Figure A 1 to Figure A 8 in Appendix 1 show these distances diagrammatically for each of the four systems on the network, the interconnecting road network and the entire rail coal network.

From the distances calculated between each location, the distance to each depot from every location on the network was determined and then used to calculate the shortest path to each existing depot location from every point on the rail network.

Determination of optimum depot locations

2.4 The location of a depot was considered to be optimum when there is minimal distance to travel from the depot to any other location on the network. The mathematical model identified the optimum placement of the depots by performing iterative calculations to find the location or number of locations on the network where there is a minimal distance to travel from the depot location to any other location on the network.

The number of optimum locations identified by the model for each type of depot is based on the existing number of depots for each type of depot.

Section 3 presents the optimum locations identified by the model for each type of depot on the rail network.

3. RESULTS AND DISCUSSION

3.1 The optimum depot locations determined by the mathematical computer model of the Central Queensland Coal Network are presented below.

In the examination of depot placement on the rail network, a depot was considered to be optimally placed if there is minimal distance to travel from the depot location to any other location on the network. The model identified optimum locations for each type of depot based on this principle and limited the number of depot locations identified to the number of existing depots for that depot type.

3.2 Comparisons of the existing depot locations with the optimum locations reveal that very few of the depots are optimally placed. These differences in the placement of existing depot locations can be accounted for by the fact that the mathematical computer model is not fully representative and does not take into account the location of the workforce, major townships and population centres or the site terrain, constraints and conditions. Table 3-1 and Table 3-2 provide a summary of the existing and optimum location depots (by type) respectively.

Type of depot	***Existing depot locations***					
Track	Ayr	Biloela	Blackwater	Duringa	Dysart	
	Emerald	Gladstone	Gracemere	Jilalan	Mackay	
	Merinda	Moranbah	Mt Larcom	Sarina		
Structure	Ayr	Barcaldine	Callemondah	Emerald	Glenmore	Mackay
Operational Systems	Bowen	Emerald	Moranbah			
Trackside Systems	Blackwater	Yukan				
Network Systems	Mackay					
Network Services	Gladstone	Rockhampton				
Network Support	Rockhampton					
Wayside Support	Gladstone	Glenmore	Mackay	Rockhampton		
Traction Power	Callemondah	Gracemere	Moranbah			
Electric Repair Centre	Rockhampton					

Table 3-1 – Existing depot locations by depot type

Type of depot	***Optimum depot locations***					
Track	Baralaba Coal	Bauhinia	Blackwater	Boundary Hill	Briaba	
	Dysart	Gladstone	Gogango	Kabra	Mallawa	
	Nogoa	Pring	Raglan	Yukan		
Structure	Crew	Merinda	Mt Rainbow	Stanwell	Tootoolah	Yarwun
Operational Systems	Mt Larcom	Tolmies	Wandoo			
Trackside Systems	Gogango	Mindi				
Network Systems	Dingo					
Network Services	Gogango	Mindi				
Network Support	Dingo					
Wayside Support	Coppabella	Merinda	Sagittarius	Yarwun		
Traction Power	Burngrove	Coppabella	Rocklands			
Electric Repair Centre	Burngrove					

Table 3-2 - Optimum depot locations by depot type

3.3 Appendix 2 provides graphical representations of the distance between depot locations and other locations on the network for each depot type.

3.4 Examination of the figures in Appendix 2 illustrate some of the differences between placing depots at existing locations and optimum locations. In general, placing depots at optimum locations results in more locations being in closer proximity to a depot than in the existing case. A decrease in the furthest distance to travel to any network location is also typical but does not always occur.

3.5 Table 3-3 provides a summary of the distances from the existing and optimum depot locations to each depot types' furthest distance to travel to any network location. The difference between these distances is also included. Negative distances, in bold text, represent a *decrease* in the furthest distance travelled if a depot is placed at the identified optimum location. Positive distances represent an *increase* in the furthest distance travelled if a depot is placed at the identified optimum location.

Examination of these distances show that for more than half of the depot types, there is a decrease of greater than 29 km of the furthest distance travelled to any location if the depots are placed at the optimum locations identified by the model.

3.6 The figures in Appendix 2 show that the probability of distance travelled is typically reduced by larger amounts – depending on the number of depots deployed in the field.

For the cases where there is an increase in the furthest distance travelled from any depot to any location on the network, it has been identified that there is only one or two existing depot locations for that type of depot. Where only one depot exists for a particular depot type, the increase in the furthest distance travelled exceeds 100 km. Overall, although there is an increase in the furthest distance to the depot(s), there is a decrease in the distances to the depot from most of the other locations on the network than in the existing case. This is evident in the CDF (cumulative distribution function) plots in Appendix 2 . An example is given below.

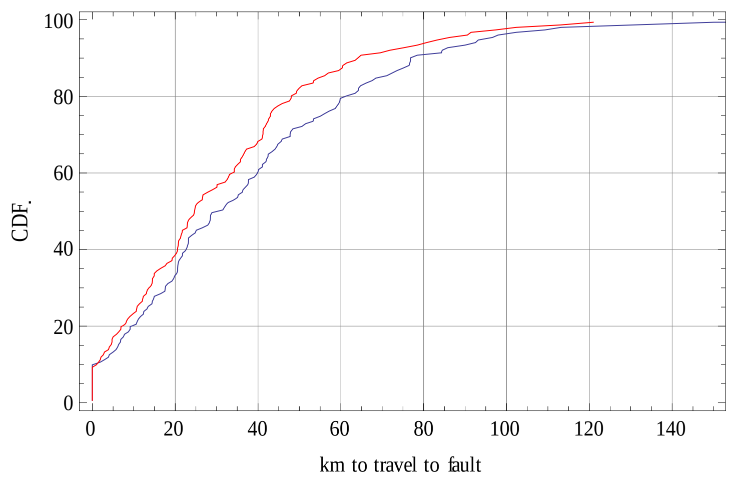

Figure B 1 - Track Depots and Optimum locations of Track Depots.

All CDF plots show the existing distances of locations to the nearest depot compared to the optimum case (shown as a red trace). Whenever the red trace is to the left of the blue trace, the optimum case has a lesser distance to travel than the existing arrangement of depots.

The CDF plots show, as a percentage, the probability of travelling a particular distance from a depot to a network location. Comparison of the CDF plots for existing and optimum depot locations show that for each depot type overall; the distance to travel from the depot to a network location has decreased.

Figure B 2 to Figure B 11 illustrate that if depots are placed at the optimum locations identified, there is a greater probability, compared to the existing case, that the distance to travel to the location is within the lower range of distances (shorter travelling distances) between depot and locations.

The travelling distances are measured along both the rail and the road networks throughout the regions associated with each system.

For the two electrical networks, (i.e. Blackwater and Goonyella systems) the associated depots were optimised with respect to only the electrical rail networks and the associated road networks.

Type of depot	Furthest distance to existing depot location(s) (km)	Furthest distance to optimum depot location(s) (km)	Difference in furthest distance to depot (km)
Track	150.06	120.94	**- 29.12**
Structure	260.22	175.75	**- 84.47**
Operational systems	551.193	482.57	**- 68.623**
Trackside systems	475.333	518.18	+42.85
Network systems	606.353	791.02	+184.667
Network services	673.77	518.18	**- 155.59**
Network support	673.77	791.02	+117.25
Wayside support	353.75	195.123	**- 158.627**
Traction power	431.95	384.22	**- 47.73**
Electric repair centre	516.9	617.98	+101.08

Table 3-3 - Summary of furthest distances to depots

4. CONCLUSIONS

4.1 WorleyParsons has examined the placement of existing depot locations of the Central Queensland Coal Network and provides the following conclusions.

4.2 From a purely mathematical viewpoint – the locations of the existing depots are not optimum and significant improvements could be realised by changing the locations of existing depots.

4.3 However, it should also be noted that other factors such as travel time for personnel (who would probably live close to major town centres) and access to external services have not been factored into account. The location of depots at Barcaldine, for example seems to have been chosen because it is a remote population centre – whereas it is a significant distance from the QR network and would not be considered optimum from a travelling time to the QR assets viewpoint.

In addition it is not appropriate to address only the distance to assets but consideration needs to be made as to the distance to assets which require the most frequent maintenance works. This information can only be gathered through analysis of the maintenance database confirmed through discussions with field staff and other relevant personnel.

The type of activities related to each depot type has also not been factored into account because WorleyParsons has not been given access to this information. When these factors are built into the model the optimum locations associated with each type of depot may change.

In addition, when considering shifting a depot location cost factors also have to be built into the model. These costs will include the many factors accounted into the cost and benefit evaluation. For example additional costs incurred will involve costs and construction of new facilities, possible loss off valuable staff resources where staff may not be prepared to travel the additional distances, connection of broadband or other IT services to the new site, etc.

5. QUALIFICATION

5.1 In preparing this report WorleyParsons has exercised the degree of skill and care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering design principles.

5.2 WorleyParsons has used all reasonable endeavours to inform itself of the parameters and requirements of the project and has taken all reasonable steps to ensure that the report estimate is as accurate and comprehensive as possible given the information upon which it is based.

5.3 It is not intended that this report represent a final assessment of the feasibility of the project.

5.4 WorleyParsons reserves the right to review and amend all calculations, cost estimates and/or opinions included or referred to in the report if:

(a) Additional sources of information not presently available (for whatever reason) are provided or become known to WorleyParsons; or

(b) WorleyParsons considers it prudent to revise the report in light of any information which becomes known to it after the date of submission.

5.5 WorleyParsons does not give any warranty nor accept any liability in relation to the completeness or accuracy of the report.

5.6 If any warranty would be implied whether by law, custom or otherwise, that warranty is to the full extent permitted by law excluded.

5.7 All limitations of liability shall apply for the benefit of the employees, agents and representatives of WorleyParsons to the same extent that they apply for the benefit of WorleyParsons.

5.8 This report is for the use of the party to whom it is addressed and for no other persons. No responsibility is accepted to any third party for the whole or part of the contents of this report and cost estimate.

5.9 If any claim or demand is made by any person against WorleyParsons on the basis of detriment sustained or alleged to have been sustained as a result of reliance upon the report and cost estimate or information therein, WorleyParsons will rely upon this provision as a defence to any such claim or demand.

Appendix 1 - Distances around the coal network

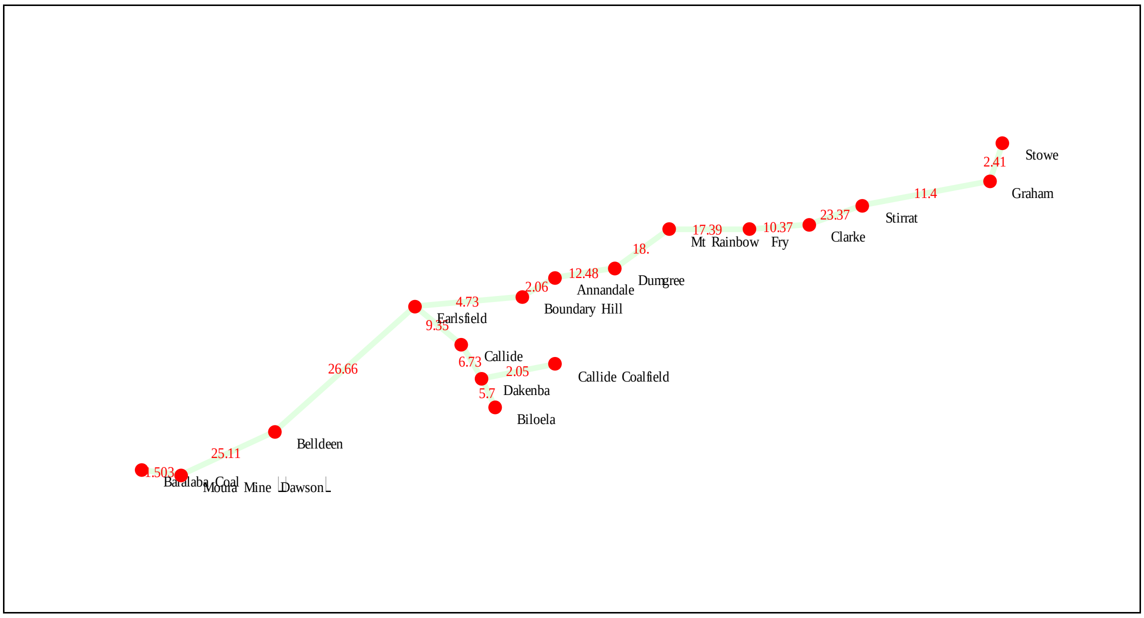

Figure A 1 - Distances around the Moura System

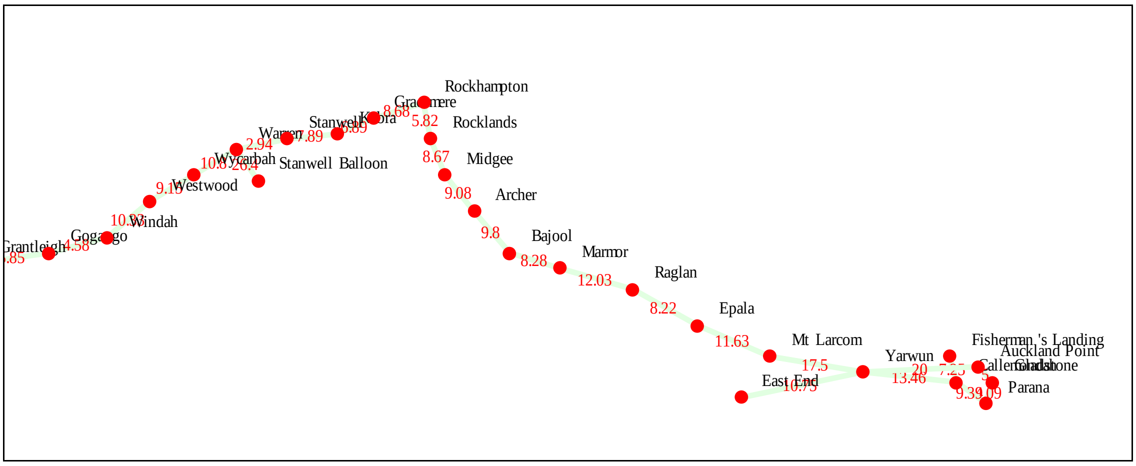

Figure A 2 - Distances around the Blackwater System (Part 1)

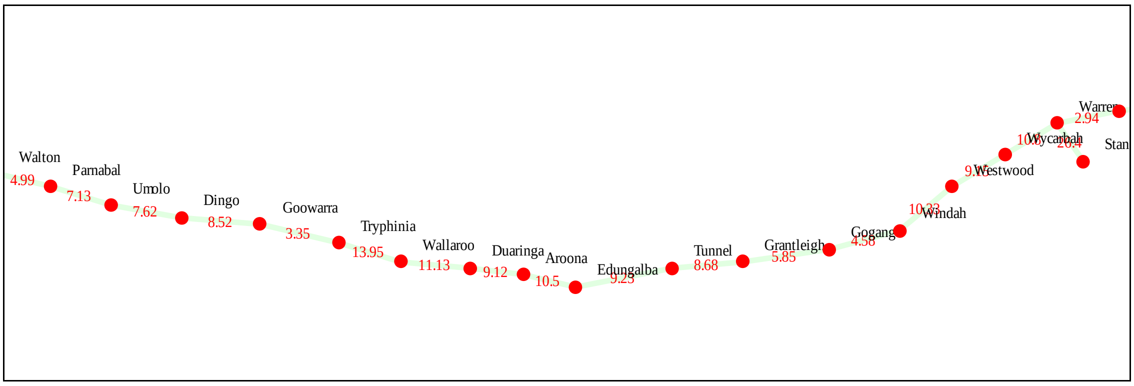

Figure A 3 - Distances around the Blackwater System (Part 2)

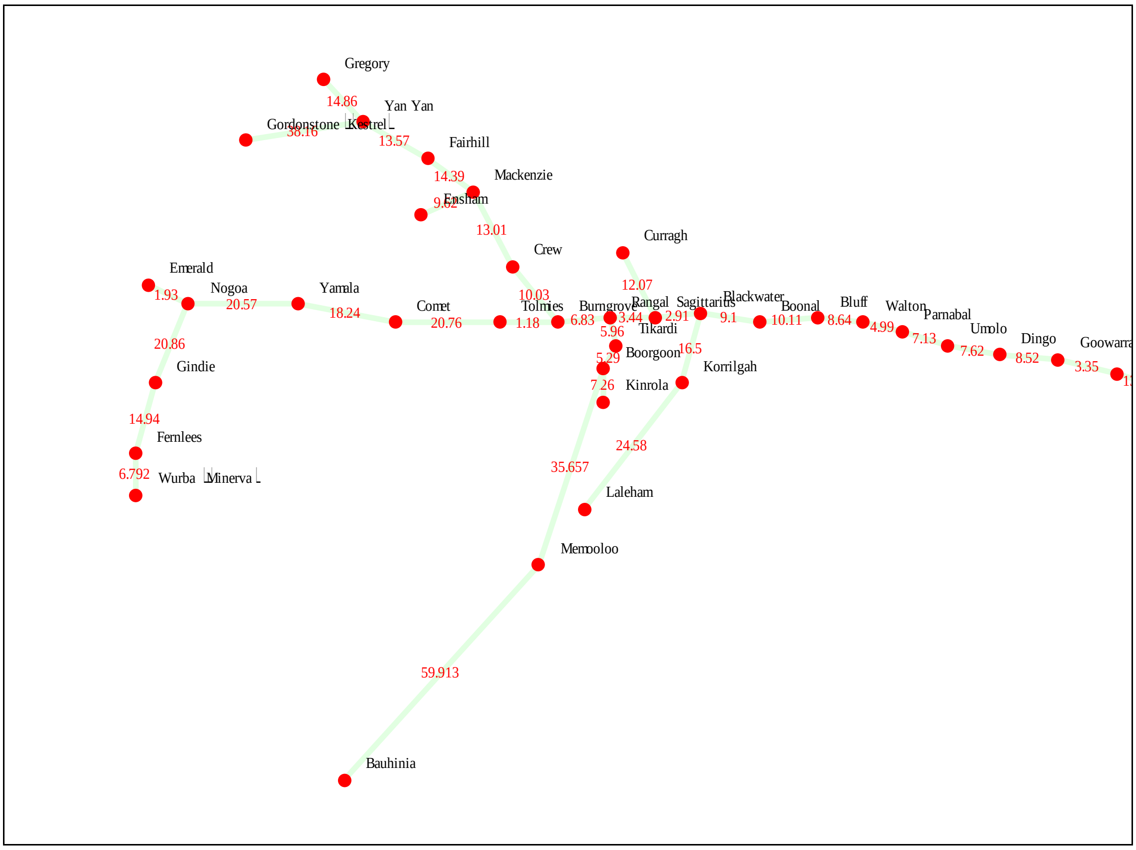

Figure A 4 - Distances around the Blackwater System (Part 3)

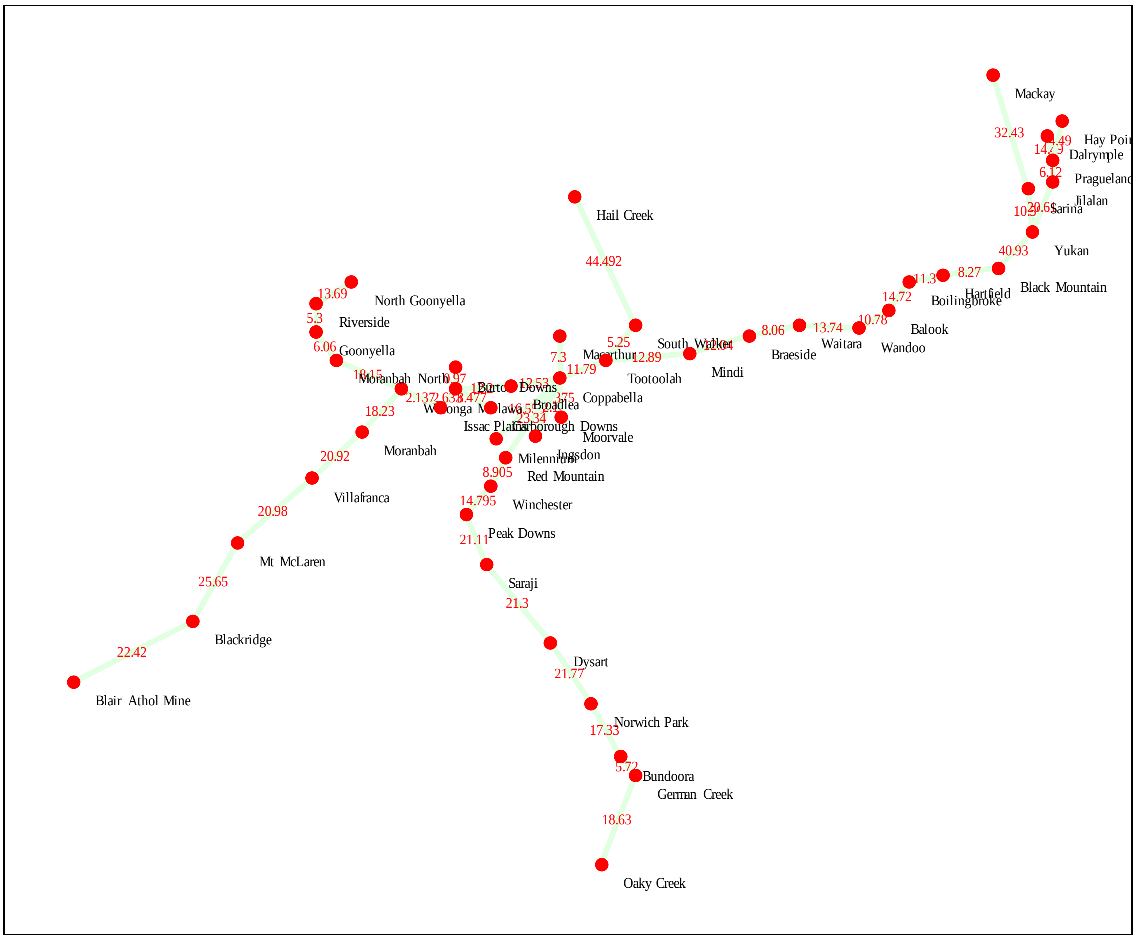

Figure A 5 - Distances around the Goonyella System

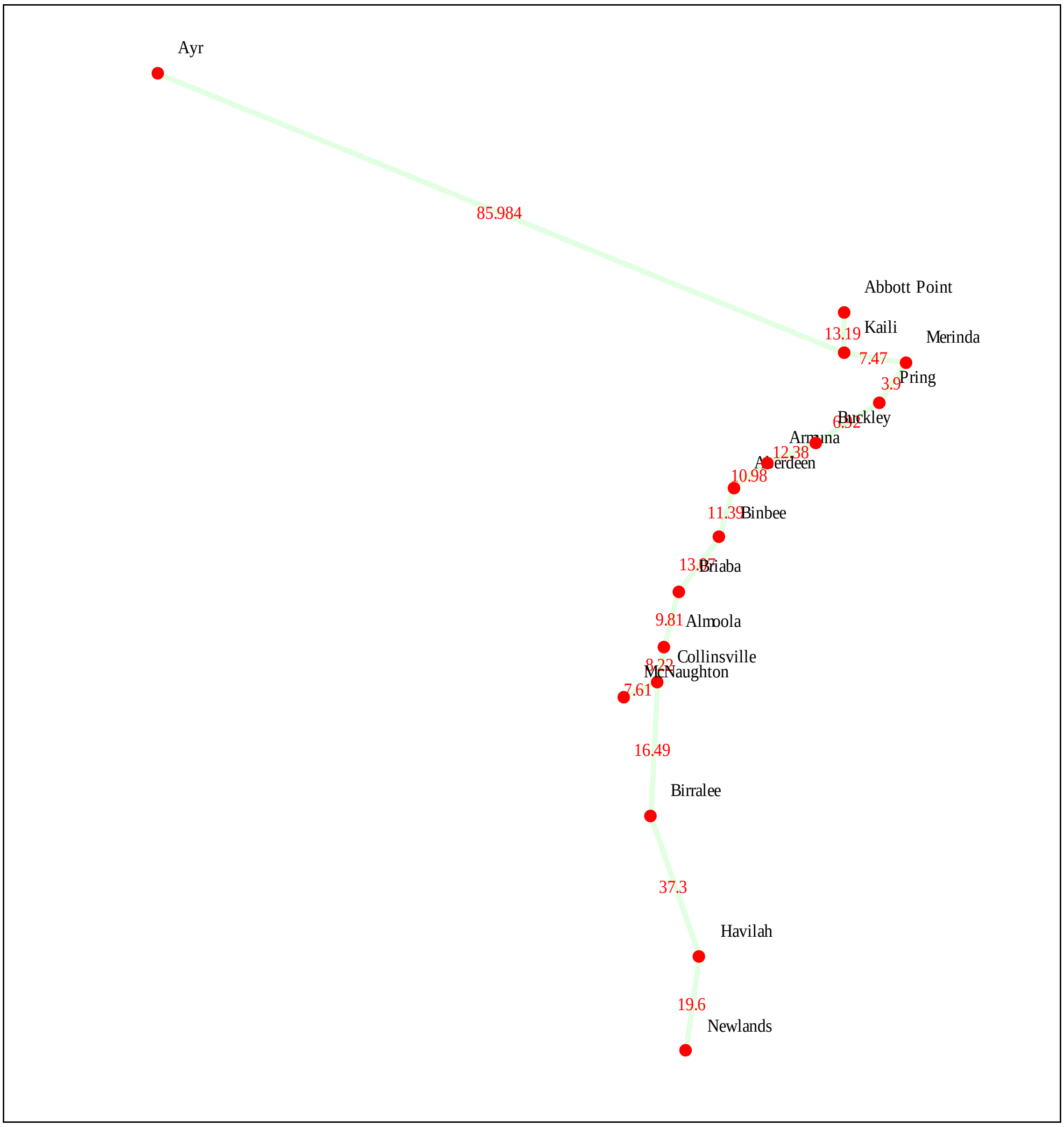

Figure A 6 - Distances around the Newlands System

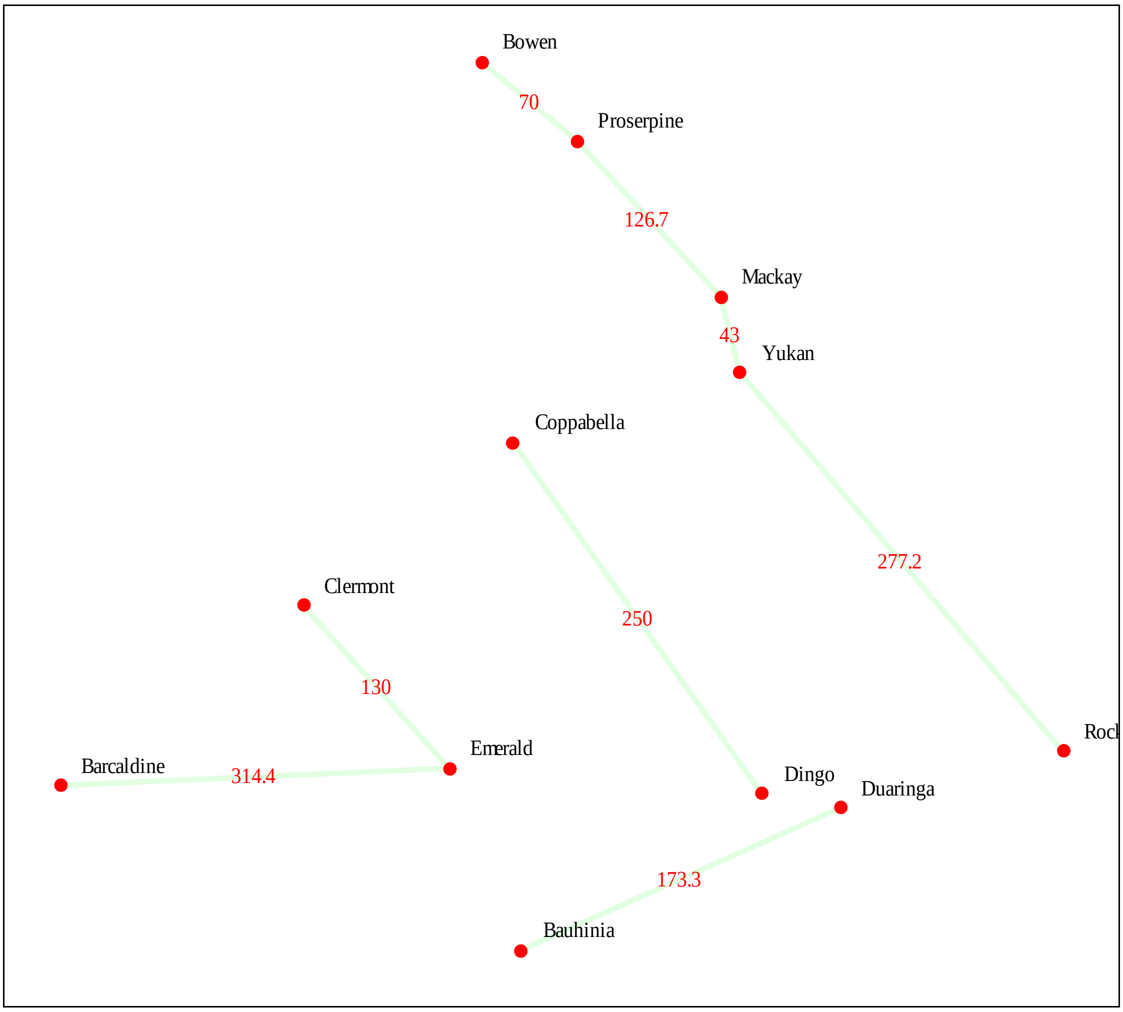

Figure A 7 - Distances around the major roads connecting the entire rail system

*NOTE: The distances shown in this figure are approximate and have been determined by measuring between points on the Central Queensland Coal Network diagrams and scaling the measurements using the scale provided.

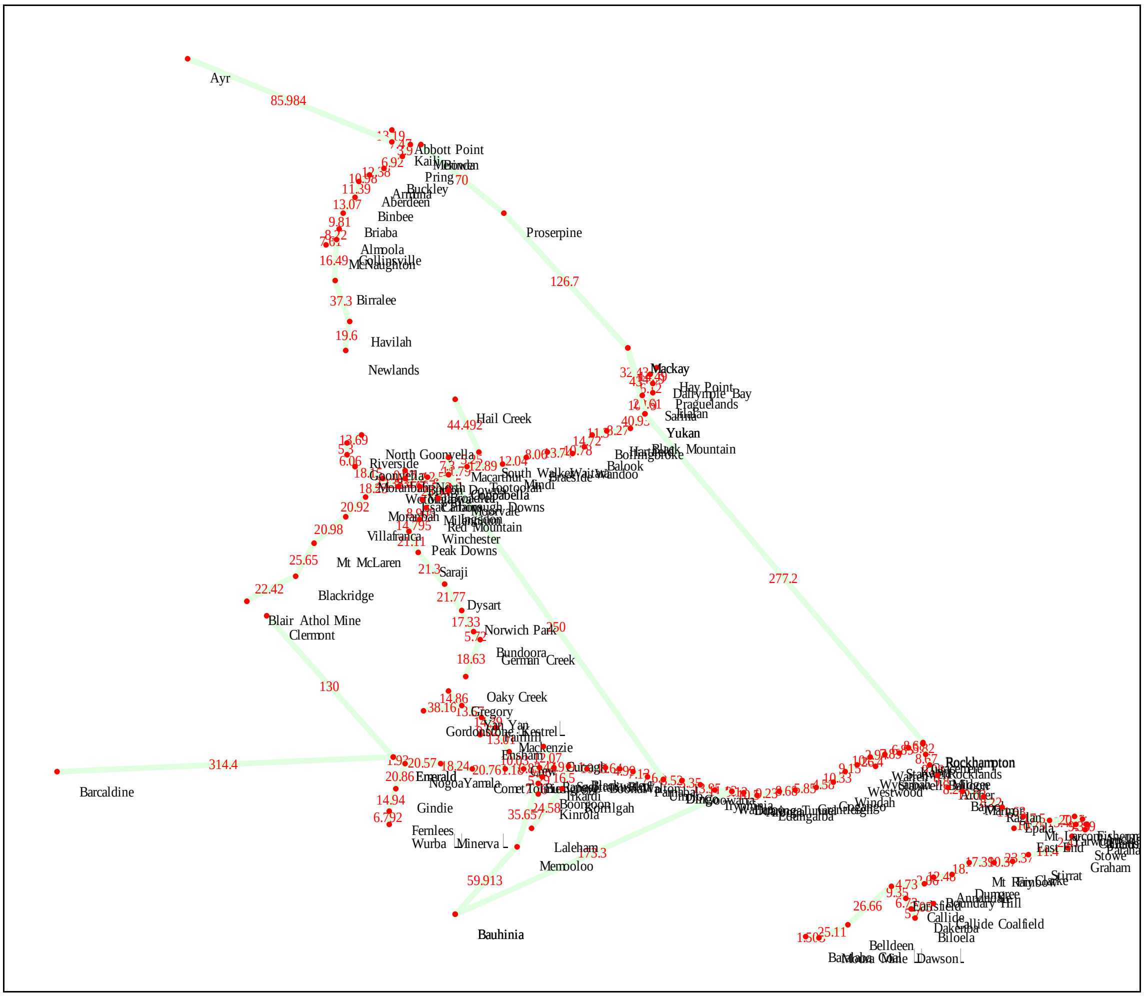

Figure A 8 - Distances around the entire coal rail network (including major roads)

Appendix 2 - Cumulative Density plots showing probability of travel distances expected for existing and proposed depot locations

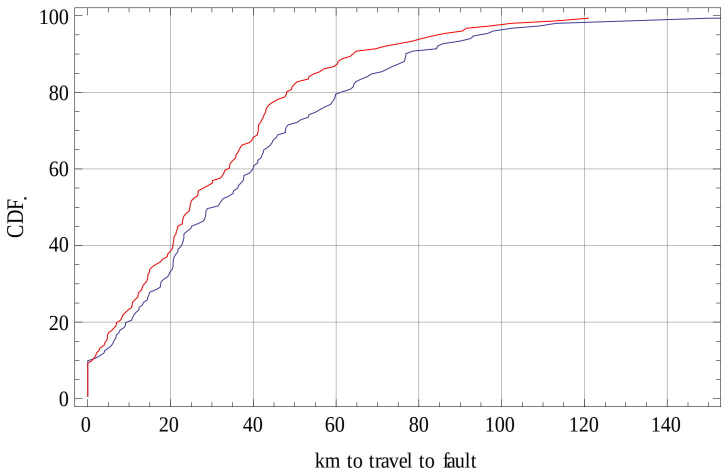

Figure B 2 - Track Depots (blue trace) and Optimum locations (red trace) of Track Depots

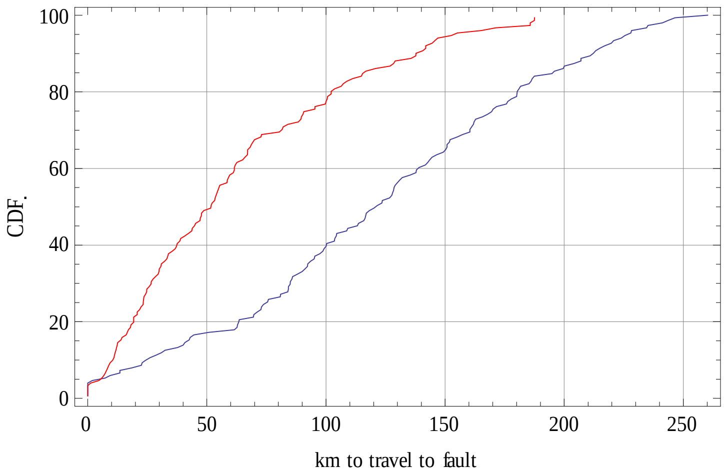

Figure B 3 - Structure Depots (blue trace) and Optimum locations (red trace) of Structure Depots

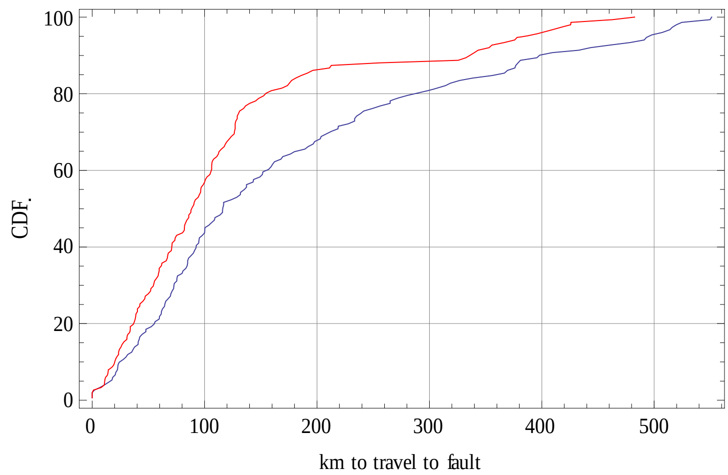

Figure B 4 - Operational Depots (blue trace) and Optimum locations (red trace) of Operational Depots

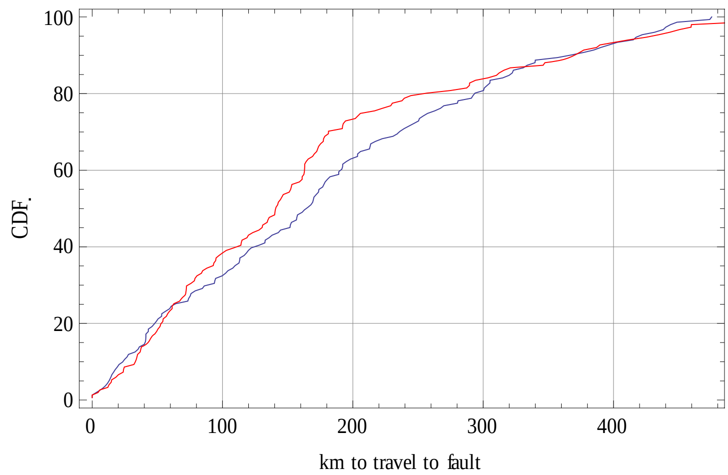

Figure B 5 - Trackside Systems Depots (blue trace) and Optimum locations (red trace) of Trackside Systems Depots

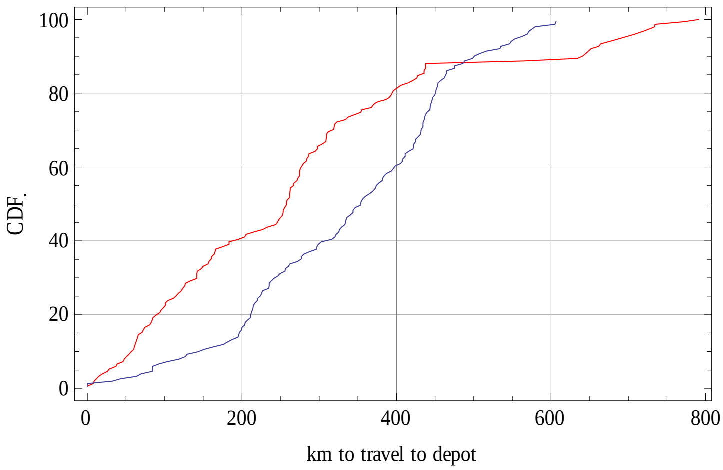

Figure B 6 - Network Systems Depot (blue trace) and Optimum Network Systems Depot (red trace)

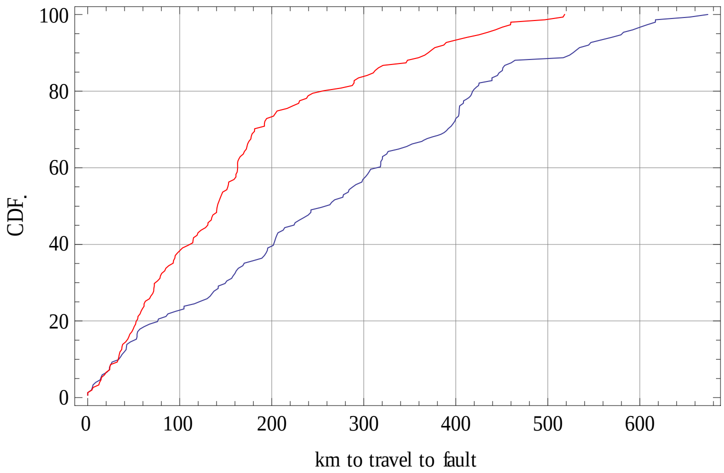

Figure B 7 - Network Services Depots (blue trace) and Optimum Network Services Depot (red trace)

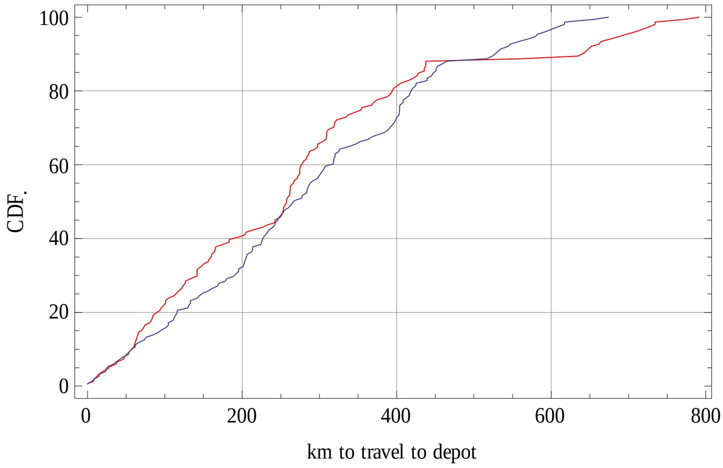

Figure B 8 - Network Support Depot (blue trace) and Optimum Network Support Depot (red trace)

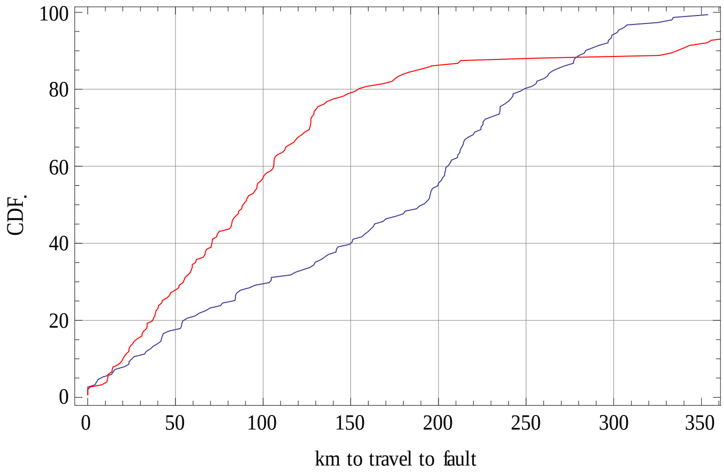

Figure B 9 - Wayside Support Depots (blue trace) and Optimum Wayside support depot (red trace)

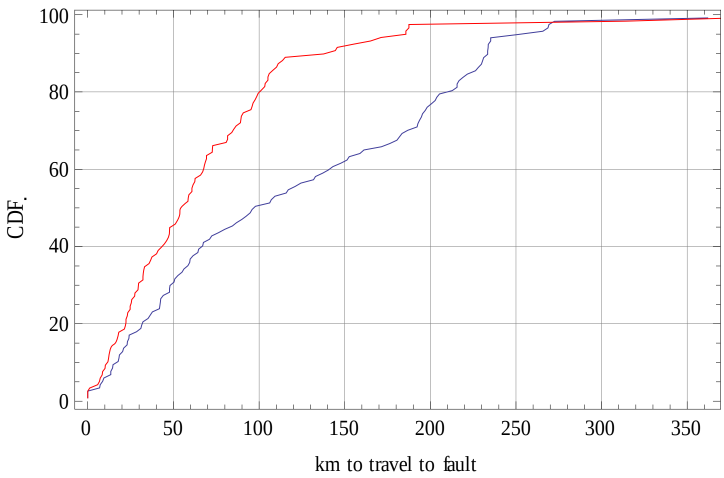

Figure B 10 - Traction Power Depots (blue trace) and optimum Traction Power depots (red trace)

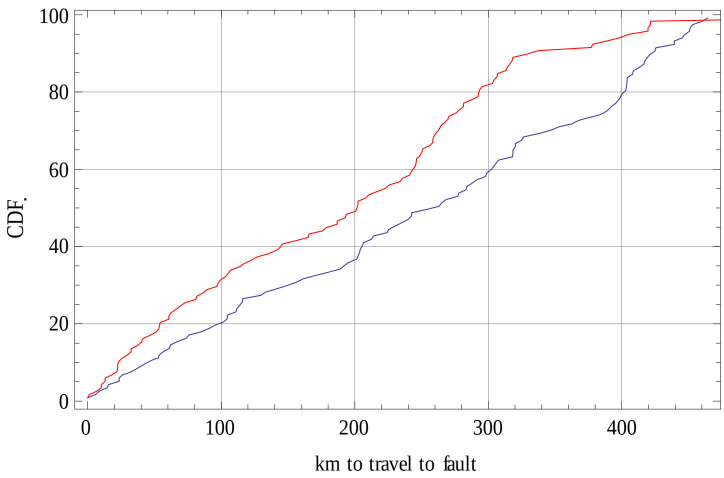

Figure B 11 - Electric Repair Centre (blue trace) and Optimum Electric Repair centre (red trace)