WestNet Rail Grain Lines

Independent Physical Review of Proposed Resleepering
Conducted on Behalf of Public Transport Authority

G J Willox (Kalswan Pty Ltd) – August 2009

CONTENTS

EXECUTIVE SUMMARY

The physical assessment concludes that the number of sleepers proposed to be replaced by WestNet Rail is acceptable and within normal variances of estimating accuracy for work of this nature.

The timing to resleeper the grain lines over the next 4 years is appropriate with some sections such as the Pingelly to Narrogin and Tambellup to Redmond requiring early priority in order to commence this financial year.

The Sectional Running Times on the more heavily used railway sections are within the times stipulated in the Lease Agreement.

The railway tracks on the more heavily used railway sections are in a “Fit for Purpose” condition.

If resleepering is deferred or not undertaken then the railways will deteriorate and eventually will be no longer “Fit for Purpose” and will not be able to operate within the required Sectional Running Times.

Sections of railway with light 30kg/m rail and mechanical joints on gravel ballast are considered substandard for modern train operations. Full life cycle costing of the sleeper replacement cycles should be conducted in considering the economics of resleepering. Additional improvements to strengthen the track including welding into continuous welded rail, rerailing with heavier rail and metal ballasting should also be considered.

For this next resleepering cycle and in order to obtain at least 20 years life it is recommended that a better quality timber sleeper be sourced and that these be treated with preservatives.

INTRODUCTION

WestNet Rail has included in its submission to Government that Western Australia's narrow gauge grain railway network ('the grain Lines") require a resleepering cycle for;

- the long term safe operation of trains, and
- in order for rail to remain competitive with road transport.

WestNet Rail submitted that the capital expenditure proposal is based on the cost of a full resleepering cycle to upgrade the grain lines from 1 in 4 to 1 in 2 steel sleeper configuration. The costs to do so were estimated on a desktop basis based on spot samples of sleeper condition and elapsed time since previous resleepering cycles.

WestNet Rail estimated that the total number of sleeper insertions would be 1,244,828. This being made up of new steel sleepers 518,760, new timber sleepers 561,008 and reinsertions of timber sleepers 165,060. The resleepering work would take 4 years to complete commencing in 2009/10 and finishing in 2012/13.

The economic assessment of WestNet Rail's submission was conducted by consultants KPMG and does not form part of this particular report. There is a slight anomaly in the submission in that the actual number of sleepers submitted by WestNet Rail does not include for any work between Yilliminning to Bruce Rock, whereas the estimated costs include capital expenditure of $16.7 million during the year 2012/13. Appropriate adjustment of sleeper numbers for this section has been made elsewhere in this report.

The Public Transport Authority of WA required an independent physical review of WestNet Rail's resleepering proposals to be undertaken. Mr Garry Willox who has 40 years experience in the maintenance and construction of railway infrastructure was selected to undertake this review. The review was undertaken in two parts being firstly a desktop review of WestNet Rail's data and secondly field inspections to check the physical condition of the railway infrastructure and the justification of WestNet Rail's proposed works.

METHODOLOGY

WestNet Rail (WNR) and the Public Transport Authority (PTA) extended their full cooperation to Mr Willox in order to undertake the review.

The Desktop review was undertaken over four days at WestNet Rail's office. It consisted of examining;

- data on Sectional Running Times for the relevant sections of railway,
- the track maintenance strategies adopted for the maintenance of the grain lines,
- completion reports on previous resleepering where railways with 1 in 4 steel sleepers had been converted to 1 in 2 steel sleepers,
- data on allowable maximum speeds and temporary speed restrictions,
- data on the line classifications,
- times of previous resleepering cycles, and
- the Narrow Gauge Code of Practice and its application where relevant to this review.

The physical review was conducted over a period of four weeks ending on the 6th August 2009. The inspections were carried out on-rail using a hi-rail inspection vehicle. Mr Willox was accompanied by senior representatives of the PTA and WestNet Rail all with significant experience in the carrying out and management of the maintenance of railway infrastructure. Approximately 2,200 kilometres of railway were inspected. In addition physical checks of the condition of the sleepers were undertaken at approximately 20 km intervals with 50 sleepers being assessed at each location.

Track recorder data was made available however for the purposes of this review a more general assessment of the track condition as observed from the hi-rail vehicle was relevant. The track recorder vehicle used on the narrow gauge railway network is old and does not produce information such as track quality indices that could have been useful in comparing track condition. The visual inspection was however adequate.

It should be noted that the inspections were undertaken in cool winter temperatures of between 8C – 18C. Under such observation the track alignment was seen at its best. If undertaken during hot summer conditions there would be more irregularities due to the build up of heat induced forces in the rail and compounded further by loose fastenings on deteriorated timber sleepers. On the other hand being undertaken in wet conditions allowed observations of the unsatisfactory load holding ability of steel sleepers combined with light rail on soft gravel ballast.

The physical inspection of fifty sleepers at approximately 20 km intervals assessed;

- the age of the sleeper. Generally indicated by a "date nail" or "date disc" imbedded in the sleeper with the date of when it was placed in the railway track stamped on it. This practice began in 1969.

- the number of sleepers that had expired, i.e. broken or split to such an extent the sleeper was no longer functional,
- the number of sleepers that were expected to fail within the next 5 years,
- those that had a life expectancy of 5 to 10 years
- those that were expected to last more than 10 years.
- those sleepers that would be replaced in resleepering to a 1 in 2 steel sleeper strategy,
- those sleepers that if taken out for the insertion of a steel sleeper were suitable for reinsertion rather than use a new timber sleeper.

Photographs of the sleeper condition were also taken at each sample location and these and the above data are included as Attachment No 1 to this Report.

In assessing the sleepers that would need to be replaced consideration had to be given to;

- when the resleepering cycle was to be carried out. It was much simpler to assess this where the cycle was to be take place in the next year than say in four years time.
- when the following resleepering cycle was to occur. If it was to be in a further 15 years, allowance had to be made for deterioration within that period. This is where judgement from persons experienced in track maintenance was critical.

The approach taken with this latter assessment was that if a sleeper was expected to fail in the first half of the period until the next cycle it should be replaced. If it was expected to last more than halfway to the next cycle it should remain. If it did fail in that latter period then it may need to be replaced under gang spot renewal maintenance rather than under the cyclic maintenance strategy.

The general principle was to obtain a balance between not replacing sleepers prematurely and the preventative maintenance strategy of cyclic resleepering.

With representatives of both PTA and WNR there was generally consensus between the parties regarding sleeper condition and replacement. In the event of non agreement Mr Willox as the independent expert made the determination.

THE STRATEGY OF CYCLIC MAINTENANCE

To understand the need to carry out resleepering of most of the grain lines over a period of the next 4 years rather than undertake continual resleepering spread over many years the strategy of cyclic maintenance needs to be taken into account.

In the late 1960's and early 1970's and with the advent of modern machinery to carryout mechanised resleepering and associated tamping and lining of the track geometry, Westrail embarked on cyclic maintenance.

Based at the time of an average sleeper life of 20 years, a cycle of sleeper replacement of an average of 25% of the sleepers were replaced every 5 years. The actual cycle times were variable with track carrying heavy train tonnages having shorter cycle times.

During the 1970's and early 1980's as sleeper life was extended to an expected 30 years through the use of sleepers treated with creosote and other preservatives, the cycle times were extended on average to 7½ years.

In the early 1980's trials were undertaken to use a steel sleeper as every 4th sleeper with the three intermediate sleepers remaining as timber. These trials were successful and this followed with most of the grain railways having every 4th sleeper replaced with steel during the 1990's. Under such a strategy as developed by Westrail it was expected that the time between cycle times could be extended to 15 years for light haul railways, i.e. the grain lines. This preventative maintenance strategy was outlined in a Westrail Report dated February 1996 "Track Maintenance Strategy for Narrow Gauge Grain Lines".

The follow-up strategy and now having been adopted by WestNet Rail was that at the time of the next cycle the centre sleeper in the cluster of 4 would also be a steel sleeper. That is a 1 in 2 steel sleeper structure with the 1st, 3rd, 5th, etc sleepers being steel. The 2nd, 4th, 6th, etc sleepers being timber. Where a steel sleeper insertion required the removal of a timber sleeper in good condition this would be re-used. Timber sleepers that had failed or expected to fail during part of the period to the next cycle time would be replaced with new timber or the re-useable sleepers.

Conversion to 1 in 2 steel was undertaken by Westrail on the sections from Avon to Goomalling and Avon to York. WNR has since resleepered with 1 in 2 steel from York to Pingelly and Redmond to Albany. WNR now propose to convert the rest of the grain network to 1 in 2 steel.

It should be noted that treatment of timber sleepers with preservatives is no longer undertaken. Also the quality of the new timber sleepers is poor. The life expectancy of timber sleepers is now expected to have reduced back to 20 years or less. Alternatives to timber are being examined by WNR. For this next resleepering cycle it is recommended that a better quality timber sleeper be sourced and that these be treated with preservatives.

SECTIONAL RUNNING TIMES

Under the Lease Agreement, WestNet Rail is required to maintain the railway in a physical condition that is “Fit for Purpose”. There are a number of key criteria for this and one being to maintain the railway to the physical standards of safety as required under the Rail Safety Act.

The other key criteria is to maintain the railway in the physical condition as necessary to meet the Initial Performance Standards (IPS) of the Lease Agreement. The IPS include for each section of railway the allowable axle loads and the allowable maximum speeds for both empty and loaded trains. Most importantly they also include Sectional Running Times (SRT) and this is considered to be the key criteria for measuring WestNet’s performance in meeting its lease obligations. Attachment 1 provides details of SRT’s, train speeds and axle loads.

There are sections of the railway where due to deteriorated condition of the track that speed restrictions have been imposed and the actual SRT can still be completed close to or within the lease SRT’s. For instance due to poor sleeper condition the section of railway from Tambellup to Redmond has 10km/hr reduced maximum speeds of 70 km/hr for empty trains and 50 km/hr for loaded trains. For Tambellup – Redmond – Albany for empty trains the lease SRT is 145 minutes where-as the actual SRT can be completed in 155 minutes; being an additional 10 minutes. For loaded trains the comparison is lease SRT 210 minutes, actual 197 minutes; being a savings of 13 minutes. For the all round journey the train can complete the travel within its lease SRT.

One of the difficulties is that actual SRT’s can be influenced by other factors than the physical condition of the railway infrastructure. In particular train management by the above rail operator can have a significant impact. To assist in determining what SRT’s can actually be achieved despite speed restrictions that may be in place due to deteriorated track conditions, WestNet Rail has had modelling undertaken by AECOM consultants. Refer to the summary on the following page.

As can be seen from the summary the sections of railway that are outside the lease times are;

- West Toodyay to Miling,
- Burakin to Beacon,
- West Merredin to Bullaring, and
- Narrogin to Yealering.

More information on these will be included further in this report.

Importantly unless the railway infrastructure is resleepered and in some cases other improvements carried out there will be more speed restrictions imposed and more sections will not meet the required Sectional Run Times

WNR Line No.	Line Section	Loaded Axleload (t)	Loading	Direction	Master Lease Sectional Running Time (mins)	Modelled Sectional Running Time (mins)	Cycle Time: Modelled vs. Master Lease (%)
Northern Railway							
34/91/3	Maya to Geraldton	16	Empty	Geraldton-Maya	461	372	82%
			Loaded	Maya-Geraldton	520	428	
3	Marchagee to Geraldton	15.5	Empty	Geraldton-Marchagee	295	279	96%
			Loaded	Marchagee-Geraldton	353	340	
3	Millendon Jct to Watheroo	16	Empty	Millendon Jct-Watheroo	205	202	96%
			Loaded	Watheroo-Millendon Jct	249	234	
Eastern Narrow Gauge Railway							
3	West Toodyay to Miling	16	Empty	West Toodyay-Miling	250	254	103%
			Loaded	Miling-West Toodyay	250	261	
34	Avon Yard to Goomalling	19	Empty	Avon Yard-Goomalling	70	60	87%
			Loaded	Goomalling-Avon Yard	75	66	
34	Goomalling to McLevie	16	Empty	Goomalling-McLevie	250	170	71%
			Loaded	McLevie-Goomalling	290	212	
38	Goomalling to Mukinbudin	19	Empty	Goomalling-Mukinbudin	240	199	76%
			Loaded	Mukinbudin-Goomalling	400	290	
36	Amery to Kalannie	19	Empty	Amery-Kalannie	140	113	77%
			Loaded	Kalannie-Amery	185	137	
37	Burakin to Beacon	16	Empty	Burakin-Beacon	110	115	106%
			Loaded	Beacon-Burakin	140	150	
35	West Merredin to Trayning	16	Empty	West Merredin-Trayning	170	144	83%
			Loaded	Trayning-West Merredin	185	151	
59	West Merredin to Bullaring	16	Empty	West Merredin-Bullaring	191	238	116%
			Loaded	Bullaring-West Merredin	265	289	
60	West Merredin to Kondinin	16	Empty	West Merredin-Kondinin	297	214	73%
			Loaded	Kondinin-West Merredin	344	256	
Southern Railway							
31	Narrogin to Avon Yard	19	Empty	Avon Yard-Narrogin	195	208	90%
			Loaded	Narrogin-Avon Yard	320	254	
59	Narrogin to Yealering	16	Empty	Narrogin-Yealering	105	120	110%
			Loaded	Yealering-Yilliminning	125	98	
			Loaded	Yilliminning-Narrogin		34	
60	Yilliminning to Kulin	16	Empty	Yilliminning-Kulin	190	153	92%
			Loaded	Kulin-Yilliminning	190	197	
33	York to Quairading	16	Empty	York-Quairading	200	114	68%
			Loaded	Quairading-York	200	156	
62	Lake Grace to Hyden	19	Empty	Lake Grace-Hyden	150	125	84%
			Loaded	Hyden-Lake Grace	180	153	
61	Wagin to Newdegate	19	Empty	Wagin-Newdegate	222	205	99%
			Loaded	Newdegate-Wagin	250	260	
31	Wagin to Tambellup	19	Empty	Tambellup-Wagin	95	101	97%
			Loaded	Wagin-Tambellup	135	123	
31	Tambellup to Albany	19	Empty	Albany-Tambellup	145	155	99%
			Loaded	Tambellup-Albany	210	197	

PHYSICAL CONDITION OF THE GRAIN RAILWAYS

There has been significant improvement of the grain railways over the past 20 – 30 years. This can be attributed to a number of factors including;

- The replacement of much light rail with heavy rail. This being the replacing of 30 kg/m rail with at least 40 kg/m rail,
- The elimination of mechanical joints by welding into continuous welded rail (CWR),
- The replacement of gravel ballast with metal ballast,
- The use of steel sleepers in a 1 in 4 pattern that holds the track together avoiding gauge widening and controls rail creep,
- The move to 1 in 2 steel sleepers where the sub-ballast is adequate to support steel sleepers,
- Preventative maintenance in the form of cyclic maintenance using mechanised equipment,
- Drainage improvements, formation strengthening and vegetation control,
- Outsourcing that permits WestNet Rail managers to concentrate on the physical and technical requirements of better railway maintenance without being distracted by the staff management issues.

It is essential that those sections of railway that have been improved by many of the above works be kept in good condition by preventative maintenance rather than reactive maintenance that was a problem of the past. All will require a resleepering cycle with associated resurfacing and ballast make-up during the next 4 years. The sections that have been improved over time include;

- Avon – Albany
- Wagin – Lake Grace - Newdegate
- Lake Grace – Hyden
- Avon – Goomalling
- Goomalling – Amery – Wyalkatchem
- Wyalkatchem – Mukinbudin,
- Amery – Kalannie, and
- Narrogin – Yilliminning

Most sections of the grain railways are in a state of “Fit for Purpose”. However, unless the next cycle of resleepering with associated works are carried out soon, then the railway will progressively deteriorate and decline into a state of “Unfit for Purpose”. An undesirable outcome of deferred maintenance is that failed sleepers place additional stress on otherwise healthy sleepers causing their premature failure. As a consequence the railway enters into a state of accelerated deterioration.

Speed restrictions have been imposed on a number of railway sections due to substandard track conditions generally due to poor sleeper condition, associated deterioration of track geometry and substandard track structure. As a result these sections are not at present meeting the lease Sectional Running Times. These include;

- Yilliminning - Yealering,
- West Merredin - Bullaring,
- Burakin - Beacon,
- West Toodyay - Miling

There are also other sections of railway that may be meeting the Sectional Running Times; however if they are to be kept operational consideration should be given to additional upgrading rather than just the proposed resleepering. These include;

- Trayning – West Merredin,
- Kondinin – West Merredin,
- McLevie – Wongan Hills,
- York – Quairading,
- Yilliminning – Kulin (parts of)
- Katanning – Nyabing,
- Tambellup – Gnowangerup.

The detailed condition of each section of track is contained in Attachment 1

RESLEEPERING ASSESSMENT

The following contains the summaries of the resleepering assessments for each section of railway and the comparison with WestNet Rail's Proposals. The detail of each sleeper assessment is shown in Attachment 1.

As mentioned previously there is a slight anomaly in the submission in that the actual number of sleepers submitted by WestNet Rail does not include for any work between Yilliminning to Bruce Rock, whereas the estimated costs include capital expenditure of $16.7 million during the year 2012/13. To correct for this an estimate was made of the number of sleepers that WestNet could place based on their cost per sleeper and the percentages they have used elsewhere for sleepers numbers.

WestNet Rail has used a broad based approach when calculating numbers of sleepers when converting from 1 in 4 steel to 1 in 2 steel. This is on average that in any cluster of 4 sleepers there will be 25% replacement with steel (1 new steel sleeper), 25% replacement with timber (1 new timber sleeper) and 30% reinsertions of the timber sleepers removed when replaced with the steel sleeper.

The overall comparison after adding the extra sleepers for the Yilliminning – Bruce Rock Section is:-

	New Steel	New Timber	Reinsertions	Total
WestNet Rail	555,766	598,015	176,065	1,329,846
Independent Assessment	517,499	649,807	148,492	1,315,798
Difference	38,267	-51,792	27,573	14,048

For the total number of sleepers this is remarkably close being a variance of 1.05%

The comparison without allowing for any resleepering from Yilliminning – Bruce Rock is:-

	New Steel	New Timber	Reinsertions	Total
WestNet Rail	518,766	561,015	165,065	1,244,846
Independent Assessment	472,023	589,509	140,071	1,201,603
Difference	46,743	-28,494	24,994	43,243

For the total number of sleepers this is a variance of 3.47%. Given the inexactness of determining the remaining life of sleepers this is a very close correlation of the quantities. Also refer to Note on Page 29 showing possible closer agreement. It is however recommended that in carrying out the economic assessment for any particular section of railway that the numbers gained from the independent assessment be used.

SUMMARY of SLEEPER REPLACEMENTS

Excluding Yilliminning - Bruce Rock

Line/ Section	WestNet Numbers				Independent Review				WestNet Totals	Independ Totals
	Steel	New Timber	Reinsertions	Total	Steel	New Timber	Reinsertions	Total		
Avon - Beverley	0	24236	4028		0	35165	0			
Pingelly - Narrogin	16703	16703	5011		16830	27129	2692			
Wagin - Redmond	69758	69758	20927		70029	39081	25023			
Total	**86461**	**110697**	**29966**	**227124**	**86859**	**101375**	**27715**	**215949**	**227124**	**215949**
Narrogin - Yilliminning	7533	7533	2260		7590	6375	4250			
Yilliminning - Bruce Rock	0	0	0		0	0	0			
Yilliminning - Kulin	31113	31113	9334		31350	31977	9334			
Total	**38646**	**38646**	**11594**	**88886**	**38940**	**38352**	**13584**	**90876**	**88886**	**90876**
Wagin - Lake Grace	38973	38973	11693		39270	41940	14137			
Lake Grace - Newdegate	20633	20633	6190		20790	13554	11642			
Lake Grace - Karlgarin	25545	25545	7664		25740	19562	9781			
Karlgarin - Hyden	5240	5240	1572		0	9293	0			
Total	**90391**	**90391**	**27119**	**207901**	**85800**	**84349**	**35560**	**205709**	**207901**	**205709**
York - Quairading	**24235**	**24235**	**7271**	**55741**	**17582**	**24419**	**1953**	**43954**	**55741**	**43954**
West Merredin - Bruce Rock	15720	15720	4716		10771	29779	2977			
West Merredin - Kondinin	46178	46178	13854		31640	65141	5211			
West Merredin - Trayning	23908	23908	7172		19021	35422	2890			
Total	**85806**	**85806**	**25742**	**197354**	**61432**	**130342**	**11078**	**202852**	**197354**	**202852**
Avon - Goomalling	0	18013	5404		0	26136	0			
Goomalling - Amery	11135	11135	3341		11220	11489	5700			
Amery - Wyalkatchem	10480	10480	3144		10560	11404	2534			
Wyalkatchem - Mukinbudin	39628	39628	11888		39930	38333	14374			
Total	**61243**	**79256**	**23777**	**164276**	**61710**	**87362**	**22608**	**171680**	**164276**	**171680**
Amery - Kalannie	32095	32095	9629		32340	42300	3751			
Burakin - Beacon	23253	23253	6976		23340	24835	7497			
Total	**55348**	**55348**	**16605**	**127301**	**55680**	**67135**	**11248**	**134063**	**127301**	**134063**
Goomalling - McLevie	58296	58296	17489		45540	39174	10929			
Maya - Perenjori	18340	18340	5502		18480	17001	5396			
Total	**76636**	**76636**	**22991**	**176263**	**64020**	**56175**	**16325**	**136520**	**176263**	**136520**
Overall Total	**518766**	**561015**	**165065**	**1244846**	**472023**	**589509**	**140071**	**1201603**	**1244846**	**1201603**

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Including Yilliminning - Bruce Rock

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Yilliminning - Bruce Rock	37000	37000	11000		45476	60298	8421			
Yilliminning - Kulin	31113	31113	9334		31350	31977	9334			
Total	**75646**	**75646**	**22594**	**173886**	**84416**	**98650**	**22005**	**205071**	**173886**	**205071**
Wagin - Lake Grace	38973	38973	11693		39270	41940	14137			
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Total	**76636**	**76636**	**22991**	**176263**	**64020**	**56175**	**16325**	**136520**	**176263**	**136520**
Overall Total	**555766**	**598015**	**176065**	**1329846**	**517499**	**649807**	**148492**	**1315798**	**1329846**	**1315798**

SLEEPER CONDITION ANALYSIS

At each location 50 sleepers were sampled
Railway Section Avon - Albany

Location	Number of Steel	Average Timber Age	Remaining Life				Replace	Re-use	Planned 1 in 2 steel
			Expired	< 5 Years	5 - 10 Years	> 10 Years			
9 km	25	1985	6	13	6	25	22	0	1 in 2 steel existing
36 km	25	1987	0	8	11	31	14	0	1 in 2 steel existing
60 km	25	1988	0	11	13	26	18	0	1 in 2 steel existing
Avon - Beverley	**Average**	**1987**	2.0	10.7	10.0	27.3	18.0	0.0	
	Percent		**4.0**	**21.3**	**20.0**	**54.7**	**36.0**	**0.0**	
91 km	25	1985	5	18	2	25	24	0	1 in 2 steel existing
120 km	25	1985	7	13	3	27	23	0	1 in 2 steel existing
Beverley - Pingelly	**Average**	**1985**	6.0	15.5	2.5	26.0	23.5	0.0	
	Percent		**12.0**	**31.0**	**5.0**	**52.0**	**47.0**	**0.0**	
138.5 km	12	1979	22	14	0	14	36	0	
153 km	12	1981	17	18	1	14	37	1	
169 km	12	1984	18	7	13	12	31	5	
Pingelly - Narrogin	**Average**	**1981**	19.0	13.0	4.7	13.3	34.7	2.0	
	Percent		**38.0**	**26.0**	**9.3**	**26.7**	**69.3**	**4.0**	
180 km	13	1988	0	20	8	22			No cycle planned
200 km	13	1983	0	17	20	13			No cycle planned
218.5 km	13	1988	0	9	13	28			No cycle planned
Narrogin - Wagin	**Average**	**1986**	0.0	15.3	13.7	21.0			
	Percent		**0.0**	**30.7**	**27.3**	**42.0**	**0.0**	**0.0**	
230 km	15	1987	9	10	6	25	23	2	
250.75 km	13	1987	8	14	6	22	24	2	
273.75 km	13	1987	8	12	8	22	21	3	
294.5 km	13	1989	8	12	14	16	23	7	
310 km	14	1983	6	4	18	23	24	2	
330 km	13	1985	8	15	11	16	24	6	
336 km	12	1986	5	21	8	16	25	7	
385.5 km	13	1988	2	16	10	22	27	4	
394 km	13	1987	12	5	6	27	24	5	
402.75 km	12	1988	4	6	10	30	24	9	
426.5 km	13	1985	4	23	8	15	24	2	
Wagin - Redmond	**Average**	**1987**	6.7	12.5	9.5	21.3	23.9	4.5	
	Percent		**13.5**	**25.1**	**19.1**	**42.5**	**47.8**	**8.9**	

Summary for Avon Albany

Avon - Beverley

Already 1 in 2 steel. Intermediate timber sleepers to be replaced as required
Distance 74 kms x 1320 sleepers/ km x 36.0% = 35165 new sleepers
WestNet estimate that 13428 + 10808 = 24236 new sleepers required
In addition WestNet have allowed for 4028 insertions of recovered sleepers.
This is not understood as there will be no recovered timber sleepers in an area where there is already 1 in 2 steel
Conclusion is that WestNet may have under-estimated the number of new timber sleepers required

Pingelly - Narrogin

Existing is 1 in 4 steel sleepers. The centre sleeper is to be replaced with steel plus timber as required
The average age of the timber sleepers is 1981 and is one of the oldest throughout the network
Distance 51 kms x 1320 sleepers/ km x 69.3% = 46652 sleepers to be inserted
Number of steel 51 km x 1320 x 25% = 16830 sleepers
Number of timber 46652 - 16830 = 29822 sleepers
Of the total sleepers 4.0% are insertions of reusable timber 51 x 1320 x .04 = 2692
Number of new timber therefore estimated to be 29822 - 2692 = 27129
WestNet estimate 16703 steel, 16703 timber, 5011 insertions of recovered timber sleepers.
Conclusion is that WestNet may have under-estimated the number of new timber sleepers required

Wagin - Redmond

Existing is 1 in 4 steel sleepers. The centre sleeper is to be replaced with steel plus timber as required
The average age of the timber sleepers is 1987
Distance 213 kms x 1320 sleepers/ km x 47.8% = 134394 sleepers to be inserted
Number of steel 213 x 1320 x 25% = 70290 sleepers
Number of timber 134394 - 70290 = 64104 sleepers
Of the total sleepers 8.90% are insertions of reusable timber 213 x 1320 x .089 = 25023
Number of new timber therefore estimated to be 64104 - 25023 = 39081
WestNet estimate 69758 steel, 69758 new timber, 20927 insertions of recovered timber sleepers.
Conclusion is that WestNet may have over-estimated the number new timber sleepers required

Summary of Avon - Albany Overall

WestNet has used an overall average approach, whilst the physical surveys are more specific to each section of railway
However there is much margin for variation considering that only 1,100 sleepers of a total of 579,480 were sampled
For the whole of the Avon to Albany Railway the sampling indicates that 216,209 sleeper insertions are required
WestNet estimate that a total of 227,124 sleeper insertions are required
This is only a variance of 4% and confirms that WestNet's overall estimate for Avon to Albany is reasonable

SLEEPER CONDITION ANALYSIS

At each location 50 sleepers were sampled

Railway Section **Wagin - Lake Grace - Hyden & Newdegate**

Location	Number of Steel	Average Timber Age	Remaining Life				Replace	Re-use	Planned 1 in 2 steel
			Expired	< 5 Years	5 - 10 Years	> 10 Years			
10 km	13	1986	5	13	8	24	27	3	
30 km	12	1985	0	0	38	12	25	0	
53 km	12	1985	6	17	8	19	34	4	
61 km	12	1980	12	23	3	12	38	0	
88 km	12	1990	5	10	3	32	24	8	
110 km	12	1985	7	12	11	20	34	12	
Wagin - Lake Grace	**Average**	**1985**	5.8	12.5	11.8	19.8	30.3	4.5	
	Percent		**11.7**	**25.0**	**23.7**	**39.7**	**60.7**	**9.0**	
10.25 km	13	1985	0	21	12	17	30	3	
30 km	13	1985	0	28	7	15	29	3	
50 km	12	1980	7	3	5	35	20	8	
60.5 km	12	1983	12	7	15	16	28	5	
Lake Grace - Karlgarin	**Average**	**1983**	4.8	14.8	9.8	20.8	26.8	4.8	
	Percent		**9.5**	**29.5**	**19.5**	**41.5**	**53.5**	**9.5**	
80 km	25	1982	3	19	3	25	25	0	Existing 1 in 2 steel
90 km	25	1986	2	13	4	31	19	0	Existing 1 in 2 steel
Karlgarin - Hyden	**Average**	**1984**	2.5	16.0	3.5	28.0	22.0	0.0	
	Percent		**5.0**	**32.0**	**7.0**	**56.0**	**44.0**	**0.0**	
134 km	12	1986	8	11	2	29	29	8	
152 km	12	1988	7	9	0	34	25	9	
175 km	12	1985	8	17	12	13	29	4	
Lake Grace - Newdegate	**Average**	**1986**	7.7	12.3	4.7	25.3	27.7	7.0	
	Percent		**15.3**	**24.7**	**9.3**	**50.7**	**55.3**	**14.0**	

Summary for Wagin Lake Grace, Lake Grace - Hyden, Lake Grace - Newdegate

Wagin Lake Grace

Existing is 1 in 4 steel sleepers. The centre sleeper is to be replaced with steel plus adjacent timber replacement as required
The average age of the timber sleepers is 1985
Distance 119 kms x 1320 sleepers/ km x 60.7% = 95347 sleepers to be inserted
Number of steel 119 km x 1320 x 25% = 39270 sleepers. Number of timber 95347 - 39270 = 56077 sleepers
Of the total sleepers 9.0% are insertions of reusable timber 119 x 1320 x .09 = 14137
Number of new timber therefore estimated to be 56077 - 14137 = 41940
WestNet estimate 38937 steel, 38937 new timber, 11692 insertions of recovered timber sleepers.

Conclusion is that WestNet may have under-estimated the number of new timber sleepers & re-insertions required

Lake Grace - Karlgarin

Existing is 1 in 4 steel sleepers. The centre sleeper is to be replaced with steel plus adjacent timber replacement as required
The average age of the timber sleepers is 1983
Distance 78 kms x 1320 sleepers/ km x 53.5% = 55083 sleepers to be inserted
Number of steel 78 km x 1320 x 25% = 25740 sleepers. Number of timber 55083 - 25740 = 29343 sleepers
Of the total sleepers 9.5% are insertions of reusable timber 78 x 1320 x .095 = 9781
Number of new timber therefore estimated to be 29343 - 9781 = 19562
WestNet estimate 25545 steel, 25545 new timber, 7664 insertions of recovered timber sleepers.
Conclusion is that WestNet may have over-estimated the number of new timber sleepers & under-estimated re-insertions

Karlgarin - Hyden

Existing is 1 in 2 steel sleepers. WestNet has shown this as 1 in 4. Their plans for this short section will need to be reconsidered
The average age of the timber sleepers is 1984
Distance 16 kms x 1320 sleepers/ km x 44% = 9293 sleepers to be inserted. All of these will be new timber
WestNet estimate 5240 steel, 5240 new timber, 1572 insertions of recovered timber sleepers.
Conclusion is that WestNet have assumed converting to 1 in 2 steel, however the section is already 1 in 2 steel
There is a requirement for nil steel and more new timber. WestNet's total number of sleepers may be overestimated

Lake Grace - Newdegate

Existing is 1 in 4 steel sleepers. The centre sleeper is to be replaced with steel plus adjacent timber replacement as required
The average age of the timber sleepers is 1986
Distance 63 kms x 1320 sleepers/ km x 55.3% = 45987 sleepers to be inserted
Number of steel 63 km x 1320 x 25% = 20790 sleepers. Number of timber 45987 - 20790 = 25197 sleepers
Of the total sleepers 14% are insertions of reusable timber 63 x 1320 x .14 = 11642
Number of new timber therefore estimated to be 25197 - 11642 = 13554
WestNet estimate 20633 steel, 20633 new timber, 6190 insertions of recovered timber sleepers.
Conclusion is that WestNet may have over-estimated the number of new timber sleepers & under-estimated re-insertions

Overall Summary of Wagin - Lake Grace, Lake Grace - Hyden & Lake Grace - Newdegate

WestNet has used an overall average approach, whilst the physical surveys are more specific to each section of railway
However there is much margin for variation considering that only 750 sleepers of a total of 364,320 were sampled
For the whole of these sections the sampling indicates that 205,710 sleeper insertions are required
WestNet estimate that a total of 207,828 sleeper insertions are required
This is only a variance of 1% and confirms that WestNet's overall estimate for the area is reasonable

SLEEPER CONDITION ANALYSIS

At each location 50 sleepers were sampled

Railway Section **Narrogin - Yilliminning, Yilliminning - Kulin, Yilliminning - Bruce Rock**

Location	Number of Steel	Average Timber Age	Remaining Life				Replace	Re-use	Planned 1 in 2 steel
			Expired	< 5 Years	5 - 10 Years	> 10 Years			
30 km	12	1989	7	10	11	22	31	4	
50 km	12	1987	10	7	21	12	24	0	
70 km	12	1988	10	8	18	14	27	6	
90 km	12	1987	10	8	20	12	32	3	
Yilliminning - Kulin	**Average**	**1988**	9.3	8.3	17.5	15.0	28.5	3.3	
	Percent		**18.5**	**16.5**	**35.0**	**30.0**	**57.0**	**6.5**	
15km	12	1991	6	12	8	24	30	7	
Narrogin - Yilliminning	**Average**	**1991**	6.0	12.0	8.0	24.0	30.0	7.0	
	Percent		**12.0**	**24.0**	**16.0**	**48.0**	**60.0**	**14.0**	
28 km	0	1986	19	6	17	8	37	1	Timber at Present
47 km	0	1986	16	9	25	0	28	3	Timber at Present
65.5 km	0	1984	16	5	12	17	31	5	Timber at Present
76 km	0	1978	19	20	11	0	46	0	Timber at Present
98 km	0	1982	17	20	8	5	33	2	Timber at Present
120 km	1	1987	15	10	17	8	29	5	Timber at Present
149.5 km	0	1985	20	14	7	9	38	3	Timber at Present
160 km	12	1985	8	20	7	15	29	1	Existing 1 in 4 steel
Yilliminning - Bruce Rock	**Average**	**1984**	16.3	13.0	13.0	7.8	33.9	2.5	
	Percent		**32.5**	**26.0**	**26.0**	**15.5**	**67.8**	**5.0**	

Summary for Narrogin - Yilliminning, Yilliminning - Kulin, Yilliminning - Bruce Rock

Yilliminning - Kulin

Existing is 1 in 4 steel sleepers. The centre sleeper is to be replaced with steel plus adjacent timber replacement as required
The average age of the timber sleepers is 1988
Distance 95 kms x 1320 sleepers/ km x 57.0% = 71478 sleepers to be inserted
Number of steel 95 km x 1320 x 25% = 31350 sleepers. Number of timber 71478 - 31350 = 40128 sleepers
Of the total sleepers 6.5% are insertions of reusable timber 95 x 1320 x .065 = 8151
Number of new timber therefore estimated to be 40128 - 8151 = 31977
WestNet estimate 31113 steel, 31113 new timber, 9334 insertions of recovered timber sleepers.
Conclusion is that WestNet's estimate of new timber sleepers is reasonable. Re-insertions estimate also reasonable

Narrogin - Yilliminning

Existing is 1 in 4 steel sleepers. The centre sleeper is to be replaced with steel plus adjacent timber replacement as required
Only one sample site was taken in this short 23 km section. The average age of the timber sleepers is 1991
Distance 23 x 1320 sleepers/ km x 60% = 18216 sleepers to be inserted

Number of steel 23 km x 1320 x 25% = 7590 sleepers. Number of timber 18216 - 7590 = 10626 sleepers
Of the total sleepers 14% are insertions of reusable timber 23 x 1320 x .14 = 4250
Number of new timber therefore estimated to be 10626 - 4250 =
6375
WestNet estimate 7533 steel, 7533 new timber, 2260 insertions of recovered timber sleepers.
Concluded that as only one sample was taken and the numbers are not far different that WestNet's estimate is not un-reasonable

Yilliminning - Bruce Rock

Existing is primarily timber sleepered track with some isolated locations with 1 in 4 steel sleepers.
Track in poor condition with 30kg/m rail and jointed. Due to joints it will not be possible to have a consistent 1 in 2 steel pattern
Sampling showed that with the jointed track and in adopting a nominal 1 in 2 steel pattern only 27% will be steel (not 50%)
The average age of the timber sleepers is 1984
Distance 145 km x 1320 sleepers/ km x 67.8% = 129769 sleepers to be inserted
Number of steel 145 km x 1320 x 27% = 51678 sleepers. Number of timber 129769 - 51678 = 78091
sleepers
Of the total sleepers 5% are insertions of reusable timber 145 x 1320 x .05 = 9570
Number of new timber therefore estimated to be 78091 - 9570 = 68521
WestNet has not provided an estimate of sleeper requirements for this section.
WestNet has indicated an estimated expenditure of $16.7m in 2012/13
If no resleepering Bullaring - Yealering then use 88% of sleeper numbers, i.e. steel 45476, new timber 60298, reinserts 8421
Cost of this based on $205 (45476 + 60298) + $60 x 8421 = $22.19 m
For WestNet estimate use $16.7m and their ratios. Estimated Steel 37000, Timber 37000, Reinsertions
11000

Overall Summary of Narrogin - Yilliminning, Yilliminning - Kulin, Yilliminning - Bruce Rock

WestNet has used an overall average approach, whilst the physical surveys are more specific to each section of railway
There is much margin for variation considering that for Narrogin - Kulin only 250 sleepers of a total of 155760 were sampled
For the Narrogin - Kulin sections the sampling indicates that 89,694 sleeper insertions are required
For the same sections WestNet estimate that a total of 88,886 sleeper insertions are required
This is only a variance of 1% and confirms that WestNet's estimate is reasonable
The Yilliminning - Bruce Rock railway needs additional track strengthening other than resleepering if it is to remain operational

SLEEPER CONDITION ANALYSIS

At each location 50 sleepers were sampled

Railway Section **West Merredin - Trayning, West Merredin - Bruce Rock, West Merredin - Kondinin**

Location	Number of Steel	Average Timber Age	Remaining Life				Replace	Re-use	Planned 1 in 2 steel
			Expired	< 5 Years	5 - 10 Years	> 10 Years			
125 km	12	1988	8	11	10	21	26	2	Jointed Track
145 km	12	1984	14	9	12	15	30	2	New Steel 17%
164 km	12	1987	15	6	5	24	26	1	Nominal 1 in 2
180 km	13	1987	14	5	6	25	21	0	
201 km	12	1988	5	18	9	18	27	3	
220 km	12	1987	15	12	5	18	28	1	
241 km	13	1984	13	22	1	14	37	1	
254 km	12	1991	7	8	16	19	24	1	
Kondinin - West Merredin	**Average**	**1987**	11.4	11.4	8.0	19.3	27.4	1.4	
	Percent		**22.8**	**22.8**	**16.0**	**38.5**	**54.8**	**2.8**	
170 km	12	1988	16	11	5	18	31	3	Jointed Track
190 km	11	1987	13	13	7	17	32	4	New Steel 17%
209.5 km	11	1987	8	19	9	14	40	0	Nominal 1 in 2
Bruce Rock - W Merredin	**Average**	**1987**	12.3	14.3	7.0	16.3	34.3	2.3	
	Percent		**24.7**	**28.7**	**14.0**	**32.7**	**68.7**	**4.7**	
121 km	12	1987	10	13	12	15	25	4	Jointed 60lb/yd
140 km	12	1990	15	13	8	14	28	0	Trayning - Nungarin
160 km	12	1983	18	16	3	13	31	0	13 % (Nom 1 in 2)
180 km	13	1985	24	8	1	17	35	2	LWR 63lb/yd
Trayning - W Merredin	**Average**	**1986**	16.8	12.5	6.0	14.8	29.8	1.5	Nungarin - W Merri
	Percent		**33.5**	**25.0**	**12.0**	**29.5**	**59.5**	**3.0**	25% (1 in 2)

Summary for Kondinin - West Merredin, Bruce Rock - West Merredin, Trayning - West Merredin

Kondinin - West Merredin

Existing is nominal 1 in 4 steel sleepers. To be converted to nominal 1 in 2 steel.
However track is jointed and 4 sleepers under and adjacent joints to remain as timber. New steel assessed to be 17% not 25%
The average age of the timber sleepers is 1987
Distance 141 kms x 1320 sleepers/ km x 54.8% = 101993 sleepers to be inserted
Number of steel 141 km x 1320 x 17% = 31640 sleepers. Number of timber 101993 - 31640 = 70353 sleepers
Of the total sleepers 2.8% are insertions of reusable timber 141 x 1320 x .028 = 5211
Number of new timber therefore estimated to be 70353 - 5211 = 65141
WestNet estimate 46178 steel, 46178 new timber, 13854 insertions of recovered timber sleepers. Total = 106210
Conclusion is that by not allowing for the joints WestNet may have under-estimated the number of new timber sleepers

& over-estimated the steel sleepers & re-insertions. Total insertions differ by 3% and is an acceptable estimating variation.
However if the viability of this railway is being checked, it is recommended the sleeper numbers from sampling be used
Track structure is substandard. Consideration should be given to eliminating joints by welding 60 AS rail (similar to 63lb/yd) and rerailing sections of 60 WA rail with heavier continuously welded rail.

Bruce Rock - West Merredin

Existing is nominal 1 in 4 steel sleepers. To be converted to nominal 1 in 2 steel.
However track is jointed and 4 sleepers under and adjacent joints to remain as timber. New steel assessed to be 17% not 25%
The average age of the timber sleepers is 1987
Distance 48 kms x 1320 sleepers/ km x 68.7% = 43528 sleepers to be inserted
Number of steel 48 km x 1320 x 17% = 10771 sleepers. Number of timber 43528 - 10771 = 32756 sleepers
Of the total sleepers 4.7% are insertions of reusable timber 48 x 1320 x .047 = 2977
Number of new timber therefore estimated to be 32756 - 2977 = 29779
WestNet estimate 15720 steel, 15720 new timber, 4716 insertions of recovered timber sleepers. Total = 36156
Conclusion is that by not allowing for the joints WestNet may have under-estimated the number of new timber sleepers & over-estimated the steel sleepers & re-insertions. Total insertions differ by 20% and is not acceptable estimating variation.
In considering the viability of this line the additional sleepers shown from sampling should be used
In addition the track is substandard with light 30kg/m rail (jointed). Consideration should be given to rerailing with heavier rail

Trayning - West Merredin

Existing is nominal 1 in 4 steel sleepers. To be converted to nominal 1 in 2 steel.
Track is jointed from Trayning to Nungarin and 4 sleepers under and adjacent joints to remain as timber.
New steel assessed to be 13% not 25% in this area. From Nungarin to West Merredin rail is long welded and 1 in 2 steel achievable
The average age of the timber sleepers is 1986
Distance 73 kms x 1320 sleepers/ km x 59.5% = 57334 sleepers to be inserted
Number of steel 32 km x 1320 x 13% = 5491 plus 41 km x 1320 x 25% = 13530. Total number of steel is 19021 sleepers.
Number of timber 57334 - 19021 = 38313 sleepers
Of the total sleepers 3% are insertions of reusable timber 73 x 1320 x .03 = 2890
Number of new timber therefore estimated to be 38313 - 2890 = 35422
WestNet estimate 23908 steel, 23908 new timber, 7172 insertions of recovered timber sleepers. Total = 54988
Conclusion is that by not allowing for the joints WestNet may have under-estimated the number of new timber sleepers & over-estimated the steel sleepers & re-insertions. Total insertions differ by only 4% and is an acceptable estimating variation.
However if the viability of this railway is being checked, it is recommended the sleeper numbers from sampling be used
In addition the track is substandard with light 30kg/m rail (jointed) from Trayning to Nungarin.
The track is also on gravel ballast and this is inadequate when combined with light rail and steel sleepers
Consideration to be given to rerailing with heavier 41kg/m rail Trayning to Nungarin and metal ballasting the complete section

Overall Summary of West Merredin - Kondinin, West Merredin - Bruce Rock, West Merredin - Trayning

WestNet has used an overall average approach, whilst the physical surveys are more specific to each section of railway
For the whole of these sections the sampling indicates that 204,855 sleeper insertions are required
WestNet estimate that a total of 197,354 sleeper insertions are required
This is a variance of 4% and confirms that WestNet's overall estimate for the area is reasonable for the purpose of budgeting
However if the viability of these lines is being considered it is recommended the numbers derived by sampling be used.

It is recommended that consideration be given to strengthening the railways by replacing light 60 lb/yd rail with heavier rail
It is recommended that gravel ballast from Trayning to Nungarin and Kondinin to Narembeen be replaced with metal ballast

SLEEPER CONDITION ANALYSIS

At each location 50 sleepers were sampled

Railway Section **Avon - Goomalling - Amery - Wyalkatchem - Mukinbudin**

Location	Number of Steel	Average Timber Age	Remaining Life				Replace	Re-use	Planned 1 in 2 steel
			Expired	< 5 Years	5 - 10 Years	> 10 Years			
14.2 km	25	1985	7	10	4	29	18	0	Existing 1 in 2 steel
34 km	25	1986	8	10	1	31	19	0	
40 km	25	1990	4	6	7	33	17	0	
Avon - Goomalling	**Average**	**1987**	6.3	8.7	4.0	31.0	18.0	0.0	
	Percent		**12.7**	**17.3**	**8.0**	**62.0**	**36.0**	**0.0**	
3 km	13	1985	13	16	6	15	31	3	
15 km	13	1989	1	17	11	21	31	5	
31 km	12	1987	3	17	5	25	33	11	
Goomalling - Amery	**Average**	**1987**	5.7	16.7	7.3	20.3	31.7	6.3	
	Percent		**11.3**	**33.3**	**14.7**	**40.7**	**63.3**	**12.7**	
40 km	12	1986	11	17	1	21	31	3	
61 km	13	1987	1	21	3	25	27	3	
Amery - Wyalkatchem	**Average**	**1987**	6.0	19.0	2.0	23.0	29.0	3.0	
	Percent		**12.0**	**38.0**	**4.0**	**46.0**	**58.0**	**6.0**	
9 km	13	1982	15	22	0	13	37	0	
20 km	12	1990	10	6	8	26	28	12	
40 km	13	1996	0	1	14	35	14	11	
58.5 km	12	1989	7	12	5	26	26	5	
60 km	13	1982	21	15	1	13	36	0	
81 km	13	1984	7	23	6	14	31	0	
99 km	12	1990	2	18	10	20	29	7	
115 km	13	1981	9	21	7	13	31	1	
Wylk - Mukinbudin	**Average**	**1987**	8.9	14.8	6.4	20.0	29.0	4.5	
	Percent		**17.8**	**29.5**	**12.8**	**40.0**	**58.0**	**9.0**	

Summary for Avon - Goomalling, Goomalling - Amery, Amery - Wyalkatchem, Wyalkatchem - Mukinbudin

Avon - Goomalling

Existing is 1 in 2 steel sleepers. Intermediate timber sleepers to be replaced as required with new timber
The average age of the timber sleepers is 1987
Distance 55 kms x 1320 sleepers/ km x 36% = 26136 sleepers to be inserted. All new timber
WestNet estimate 18013 new timber, 5404 insertions of recovered timber sleepers.
Conclusion is that WestNet has under-estimated the number of new timber sleepers.
Also only un-useable sleepers will be removed there will be no re-insertions

Goomalling - Amery

Existing is 1 in 4 steel sleepers. The centre sleeper is to be replaced with steel plus adjacent timber replacement as required
The average age of the timber sleepers is 1987
Distance 34 kms x 1320 sleepers/ km x 63.3% = 28409 sleepers to be inserted
Number of steel 34 km x 1320 x 25% = 11220 sleepers. Number of timber 28409 - 11220 = 17189 sleepers
Of the total sleepers 12.7% are insertions of reusable timber 34 x 1320 x .127 = 5700
Number of new timber therefore estimated to be 17189 - 5700 = 11489
WestNet estimate 11135 steel, 11135 new timber, 3341 insertions of recovered timber sleepers.
Conclusion is that WestNet estimate for new timber is reasonable and there may need to be more re-insertions

Amery - Wyalkatchem

Existing is 1 in 4 steel sleepers. The centre sleeper is to be replaced with steel plus adjacent timber replacement as required
The average age of the timber sleepers is 1987
Distance 32 kms x 1320 sleepers/ km x 58% = 24499 sleepers to be inserted
Number of steel 32 km x 1320 x 25% = 10560 sleepers. Number of timber 24499 - 10560 = 13939 sleepers
Of the total sleepers 6% are insertions of reusable timber 32 x 1320 x .06 = 2534
Number of new timber therefore estimated to be 13939 - 2534 = 11404
WestNet estimate 10480 steel, 10480 new timber, 3144 insertions of recovered timber sleepers.
Conclusion is that WestNet estimates are reasonable considering there are only 2 sample sites

Wyalkatchem - Mukinbudin

Existing is 1 in 4 steel sleepers. The centre sleeper is to be replaced with steel plus adjacent timber replacement as required
The average age of the timber sleepers is 1987
Distance 121 kms x 1320 sleepers/ km x 58% = 92637 sleepers to be inserted
Number of steel 121 km x 1320 x 25% = 39930 sleepers. Number of timber 92637 - 39930 = 52707 sleepers
Of the total sleepers 9% are insertions of reusable timber 121 x 1320 x .09 = 14374
Number of new timber therefore estimated to be 52707 - 14374 = 38333
WestNet estimate 39628 steel, 39628 new timber, 11888 insertions of recovered timber sleepers.
Conclusion is that WestNet estimates are reasonable

Overall Summary for Avon - Goomalling, Goomalling - Amery, Amery - Wyalkatchem, Wyalkatchem - Mukinbudin

WestNet has used an overall average approach, whilst the physical surveys are more specific to each section of railway
As expected there is agreement on the number of steel to be inserted.
After allocating the insertions shown on the Avon - Goomalling to the other sections there is agreement on the re-insertions
For new timber WestNet estimate 79256 sleepers. The sampling estimates 87362 sleepers. WestNet has not over-estimated the requirement
When tight curves that have been strengthened are taken into account this will reduce the difference in numbers

SLEEPER CONDITION ANALYSIS

At each location 50 sleepers were sampled

Railway Section **Amery - Kalannie, Burakin - Beacon**

Location	Number of Steel	Average Timber Age	Remaining Life				Replace	Re-use	Planned 1 in 2 steel
			Expired	< 5 Years	5 - 10 Years	> 10 Years			
9 km	13	1982	21	13	2	14	35	1	
30 km	13	1982	22	9	4	15	35	0	
43.25 km	12	1983	20	13	5	12	34	1	
50 km	12	1989	7	15	13	15	27	3	
61 km	12	1986	17	10	8	15	30	1	
77 km	12	1986	11	10	8	21	26	4	
90 km	12	1984	13	10	14	13	25	0	
Amery - Kalannie	**Average**	**1985**	15.9	11.4	7.7	15.0	30.3	1.4	
	Percent		**31.7**	**22.9**	**15.4**	**30.0**	**60.6**	**2.9**	
11 km	12	1989	13	13	5	19	33	5	
30 km	9	1990	7	14	12	17	27	5	
50 km	13	1986	15	15	6	14	32	1	
70 km	12	1987	11	11	10	18	27	5	
Burakin - Beacon	**Average**	**1988**	11.5	13.3	8.3	17.0	29.8	4.0	
	Percent		**23.0**	**26.5**	**16.5**	**34.0**	**59.5**	**8.0**	

Summary for Amery - Kalannie, Burakin - Beacon

Amery - Kalannie

Existing is 1 in 4 steel sleepers. The centre sleeper is to be replaced with steel plus adjacent timber replacement as required
The average age of the timber sleepers is 1985
Distance 98 kms x 1320 sleepers/ km x 60.6% = 78392 sleepers to be inserted.
Number of steel 98 km x 1320 x 25% = 32340 sleepers. Number of timber 78392 - 32340 = 46052 sleepers
Of the total sleepers 2.9% are insertions of reusable timber 98 x 1320 x .029 = 3751
Number of new timber therefore estimated to be 46052 - 3751 = 42300
WestNet estimate 32095 steel, 32095 new timber, 9629 insertions of recovered timber sleepers.
Conclusion is that WestNet has under-estimated the number of new timber sleepers by approx 31%.
Also significantly overestimated number of recoverable sleepers for re-insertions

Burakin - Beacon

Existing is nominal 1 in 4 steel sleepers. Jointed track requires 4 timber sleepers under & adjacent to joints
The average age of the timber sleepers is 1988
Distance 71 kms x 1320 sleepers/ km x 59.5% = 55763 sleepers to be inserted
Number of steel 71 km x 1320 x 25% = 23340 sleepers. Number of timber 55763 - 23340 = 32333 sleepers
Of the total sleepers 8% are insertions of reusable timber 71 x 1320 x .08 = 7497
Number of new timber therefore estimated to be 32333 - 7497 = 24835
WestNet estimate 23253 steel, 23253 new timber, 6976 insertions of recovered timber sleepers.

Conclusion is that WestNet estimates are acceptable
The rail is 31kg/m and is welded from Burakin to Kulja (12 kms). The other 59 kms to Beacon is jointed
It is recommended that prior to resleepering the rail be welded into CWR. Consideration to metal ballasting also needed

Overall Summary for Amery - Kalannie & Burakin - Beacon

More new timber sleepers may be needed in the Amery - Kalannie section than estimated by WestNet
Recommended that the Kulja - Beacon section of railway be welded into CWR prior to resleepering
Metal ballasting of the Burakin to Beacon section to also be considered

SLEEPER CONDITION ANALYSIS

At each location 50 sleepers were sampled

Railway Section **Goomalling - McLevie, Maya - Perenjori**

Location	Number of Steel	Average Timber Age	Remaining Life				Replace	Re-use	Planned 1 in 2 steel
			Expired	< 5 Years	5 - 10 Years	> 10 Years			
56 km	12	1995	4	13	15	18	23	4	
76 km	16	1990	11	10	10	19	25	2	
96 km	13	1991	13	9	5	23	25	3	
116 km	13	1997	8	8	9	25	26	3	
136 km	12	1995	8	12	7	23	28	3	
156 km	13	1986	8	20	6	16	30	2	
176 km	12	1986	14	15	4	17	31	1	
190 km	12	1993	7	8	3	32	22	6	
Goomalling - McLevie	**Average**	**1992**	9.1	11.9	7.4	21.6	26.3	3.0	
	Percent		**18.3**	**23.8**	**14.8**	**43.3**	**52.5**	**6.0**	
245 km	12	1992	4	10	14	22	23	7	
264 km	12	1990	4	20	3	23	30	3	
285 km	12	1989	7	14	12	17	30	1	
Maya - Perenjori	**Average**	**1990**	5.0	14.7	9.7	20.7	27.7	3.7	
	Percent		**10.0**	**29.3**	**19.3**	**41.3**	**55.3**	**7.3**	

Summary for Goomalling - McLevie, Maya - Perenjori

Goomalling - McLevie

Existing is 1 in 4 steel sleepers. The centre sleeper is to be replaced with steel plus adjacent timber replacement as required
The average age of the timber sleepers is 1992
Distance 138 kms x 1320 sleepers/ km x 52.5% = 95643 sleepers to be inserted
Number of steel 138 km x 1320 x 25% = 45540 sleepers. Number of timber 95643 - 45540 = 50103 sleepers
Of the total sleepers 6% are insertions of reusable timber 138 x 1320 x .06 = 10929
Number of new timber therefore estimated to be 50103 - 10929 = 39174
WestNet estimate 58296 steel, 58296 new timber, 17489 insertions of recovered timber sleepers.
WestNet estimate is in error as they have miscalculated the number of kms from Ballidu to McLevie
The numbers obtained from sampling should be used

Maya - Perenjori

Existing is 1 in 4 steel sleepers. The centre sleeper is to be replaced with steel plus adjacent timber replacement as required
The average age of the timber sleepers is 1990
Distance 56 kms x 1320 sleepers/ km x 55.3% = 40877 sleepers to be inserted
Number of steel 56 km x 1320 x 25% = 18480 sleepers. Number of timber 40877 - 18480 = 22397 sleepers
Of the total sleepers 7.3% are insertions of reusable timber 56 x 1320 x .073 = 5396
Number of new timber therefore estimated to be 22397 - 5396 = 17001
WestNet estimate 18340 steel, 18340 new timber, 5502 insertions of recovered timber sleepers.

Conclusion is that WestNet estimate for new timber may be slightly high by 7%

Overall Summary for Goomalling - McLevie and Maya - Perenjori

Goomalling to Wongan Hills has metal ballast. Wongan Hills to McLevie is gravel ballast. Recommend metal ballasting
Maya - Perenjori has gravel ballast. Track is in reasonable condition
WestNet error in calculating distance Ballidu - McLevie. Less sleepers required than estimated by WestNet
WestNet miscalculated by showing the distance from Ballidu to McLevie as 83 km whereas it is 43 km.
WestNet's numbers should be reduced by steel 13,100; new timber 13,100; reinsertions 3,930; Total 30,130.

NOTE: If this adjustment were to be taken into account the difference in the numbers shown in the summary on page 12 would be;
New Steel +33643, New Timber -41593, Reinsertions +21064, Total +13113.
The cost value of this would be (33643 x $205) – (41593 x $205) + (13113 x $60) = -$366,115.
This is remarkably close agreement between WestNet's estimates and the Independent Assessor's estimate.

SLEEPER CONDITION ANALYSIS

At each location 50 sleepers were sampled

Railway Section **Katanning - Nyabing & Tambellup - Gnowangerup**

Location	Number of Steel	Average Timber Age	Remaining Life				Replace	Re-use
			Expired	< 5 Years	5 - 10 Years	> 10 Years		
10 km	0	1986	8	23	10	9	No Planned Cycle	
30 km	0	1980	12	26	9	4	Fully timbered track	
53 km	0	1984	11	21	0	9		
Katanning - Nyabing	**Average**	**1983**	10.3	23.3	6.3	7.3		
	Percent		**20.7**	**46.7**	**12.7**	**14.7**	**0.0**	**0.0**
3 km	13	1987	4	14	7	25	No Planned Cycle	
25 km	12	1987	2	17	13	18	Nom 1 in 4 steel	
Tambellup - Gnowangerup	**Average**	**1987**	3.0	15.5	10.0	21.5		
	Percent		**6.0**	**31.0**	**20.0**	**43.0**		

Summary for Katanning - Nyabing & Tambellup - Gnowangerup

Both railways are not in use at present. Line and top varies from fair to poor.
Only suitable for operations in dry weather at 30 km/h speed restrictions
Significant resleepering and track strengthening required if brought into regular use

SLEEPER CONDITION ANALYSIS

At each location 50 sleepers were sampled
Railway Section **York - Quairading**

Location	Number of Steel	Average Timber Age	Remaining Life				Replace	Re-use	Planned 1 in 2 steel
			Expired	< 5 Years	5 - 10 Years	> 10 Years			
10 km	13	1989	14	5	11	20	20	1	Existing is
30 km	13	1989	13	11	13	13	26	2	nominal 1 in 4 steel
50 km	13	1990	9	15	13	13	23	0	
70 km	13	1992	8	9	12	21	21	1	
York - Quairading	**Average**	**1990**	11.0	10.0	12.3	16.8	22.5	1.0	
	Percent		**22.0**	**20.0**	**24.5**	**33.5**	**45.0**	**2.0**	

Summary for York - Quairading

The general condition of the alignment and top the track is poor. Timber sleepers are prematurely damaged due to lack of support
Was resleepered with nominal 1 in 4 steel pattern in 1994. The average age of the timber sleepers is 1990
Rail is 60lb/yd (30kg/m), is jointed and on gravel ballast. Such track structure is considered inadequate for modern trains
It will not be possible to obtain a consistent 1 in 2 steel sleeper pattern dur to the need to have timber under and adjacent to joints
Distance 74 kms x 1320 sleepers/ km x 45% = 43956 sleepers to be inserted
Number of steel 74 km x 1320 x 18% = 17582 sleepers. Note 25% not possible due to joints
Number of timber sleepers to be inserted is 43956 - 17582 = 26373
Of the total sleepers 2% are insertions of reusable timber 74 x 1320 x .02 = 1953
Number of new timber therefore estimated to be 26373 - 1953 = 24419
WestNet estimate 24235 steel, 24235 new timber, 7271 insertions of recovered timber sleepers.
WestNet appear to have over-estimated the number of steel by not allowing for the jointed track

SLEEPER CONDITION ANALYSIS

At each location 50 sleepers were sampled
Railway Section **Toodyay - Miling**

Location	Number of Steel	Average Timber Age	Remaining Life				Replace	Re-use	Planned 1 in 2 steel
			Expired	< 5 Years	5 - 10 Years	> 10 Years			
21km	25	1991	4	10	2	34	15	0	Existing is
42 km	23	1994	7	6	11	26	14	0	nominal 1 in2 steel
62 km	13	1983	17	6	14	13	32	1	
82 km	15	1991	7	12	5	26	20	0	
100 km	22	1985	9	14	3	24	22	0	
120 km	23	1998	4	5	2	39	10	0	
132 km	16	1984	9	15	3	23	24	1	
Toodyay - Miling	**Average**	**1989**	8.1	9.7	5.7	26.4	19.6	0.3	
	Percent		**16.3**	**19.4**	**11.4**	**52.9**	**39.1**	**0.6**	

Summary for Toodyay - Miling

This section of track is not included in the current WestNet proposal for resleepering.
It was inspected to obtain an appreciation of how light rail, jointed, gravel ballasted might perform with 1 in 2 steel sleepers
The general condition of the alignment and top of such track is poor and operates under a 30 km/h speed restriction
Toodyay - Miling was resleepered with nominal 1 in 2 steel in 2004.
Rail is a mixture of 58lb/yd, 60lb/yd, 63 lb/yd and some 80 lb/yd on curves
58 & 60 lb/yd rail is jointed track as cannot be welded & therefore a consistent 1 in 2 steel pattern not achievable
Approximately half the railway is of this light rail & consideration should be given to rerailing with heavier rail
The railway from Piawaning to Miling is gravel ballast and consideration should be given to metal ballasting

SUB- STANDARD TRACK STRUCTURE

In carrying out the inspections it was apparent that although most of the railway is of a suitable track structure there are a number of the sections that are not of the standard required to run today's modern trains. Improvements that have been carried out on many sections to bring them up to a standard necessary to operate in today's environment have been previously mentioned.

There are however sections that are little changed from when they were constructed in the early 1900's. That was an era of steam locomotives, hauling short trains and with very light axle loads. The rail itself gives an indication of the era for which it was intended and the embossed dates on the rail showed some dating back to as early 1901 and 1910.

Light rail and mechanical rail joints are inadequate for modern train operations. This refers firstly to 30kg/m rail (60 lb/yd and in some cases 58 lb/yd). This rail is mostly in 12.2 metre (40 feet) lengths and joined by a fishplate and bolts. Rail of this type cannot be welded into Continuous Welded Rail (CWR). In the past projects to glue the joints as an alternative to welding were carried out. Observations during the hi-rail inspection indicate this was not successful long term.

With the passage of a train the loaded wheels pound the joints downward causing the vertical geometry (top) to be depressed at each joint. Steel sleepers cannot be placed under the joints due to lack of support and as a consequence there are timber sleepers under the joints and in addition in an endeavour to add further support the two adjacent sleepers are also timber, being four sleepers in total at each joint.

As an outcome there cannot be a consistent 1 in 4 steel sleeper pattern and more-so no consistent 1 in 2 steel sleeper pattern. In addition the timber sleepers are overstressed and deteriorate prematurely then break. The life expectancy of such timbers is much shortened.

This problem is compounded even further when the track is on gravel ballast as then even the steel sleepers are deficient in supporting the track structure even away from the area of the joints. Only in a few places were steel sleepers when combined with 30 kg/m rail on gravel ballast seen to be adequately packed and supporting the rail. In most cases depressions were formed around the steel sleepers due to "pumping" and the adjacent timber sleepers were relied upon to support the train loads. In wet weather the depressions accumulate water and as a consequence the gravel ballast was softened further exacerbating its weakness in supporting loads. The additional stress on the adjacent timber sleepers again leading to accelerated deterioration and finally early breakage.

It is considered that the resleepering with 1 in 2 steel of track comprising 30kg/m jointed rail is economically questionable. The time between resleepering cycles will be short, 10 years at the most. A full life cycle costing should be conducted to determine the economics. Steel resleepering has the benefit of holding the rails together and therefore there should not be any derailments due to gauge widening. However, it is still only possible to operate at low speeds and the Toodyay – Miling line is an example of this where despite resleepering with a nominal 1 in 2 steel pattern in 2004 the train speeds on the light rail remain restricted to 30 km/hr.

It is recommended the minimum track structure for the carriage of 16 tonne axle load trains should be 31kg/m continuously welded rail on metal ballast. The section from Narrogin to Yilliminning is a good example of the success of this. However, 31kg/m rail is no longer produced and the next size obtainable is 41 kg/m rail. This size rail has the ability to carry 16 tonne axle loads on gravel ballast as the greater beam strength distributes the load over more sleepers and compensates for the deficiencies of steel sleepers in gravel ballast.

For 19 tonne axle loads the minimum track structure is considered to be 41 kg/m CWR on metal ballast. It is desirable that the timber sleepers have sleeper-plates between the rail and sleeper. On the Lake Grace – Newdegate section there are places where 47 kg/m CWR is carrying 19 tonne axle loads on gravel ballast with reasonable results.

SECTIONS OF RAILWAY TO BE CONSIDERED FOR ADDITIONAL IMPROVEMENT

Burakin – Beacon

The rail is 31kg/m and is connected by mechanical joints. The section from Burakin to Kulja has already been welded into long welded rail (LWR) and it would be minor work to weld this into continuous welded rail (CWR). The remainder of the section from Kulja to Beacon is completely jointed track. The Railway from Burakin to Beacon is in poor condition. Even the section from Burakin to Kulja is in poor condition despite the LWR and fewer joints, due to the poor support of steel sleepers with light rail on soft gravel ballast.

It is recommended the railway from Burakin to Beacon be welded into CWR prior to resleepering. In addition replacement of the gravel ballast with metal ballast should be considered.

Wongan Hills to McLevie

The section from Goomalling to Wongan Hills is in fair condition and is constructed of 31 kg/m CWR rail on metal ballast. With the resleepering and resurfacing cycle it is expected to be brought back to good condition. From Wongan Hills to Ballidu the track is in poorer condition despite being 31 kg/m CWR. Rather than being on metal ballast it is on gravel ballast and the steel sleepers do not provided adequate support when combined with light rail on this particular gravel ballast. Resleepering was carried out in 2004 and despite this the track is not in good condition. There are some isolated sections with metal ballast and this track is in good condition.

From Ballidu to McLevie there is gravel ballast and the railway is in even poorer condition and among the worse of any of the sections with 31kg/m CWM seen on the inspection of the network. It is under a speed restriction of 30 km/h for loaded trains. This section was resleepered in 1998 being 6 years earlier than the section from Ballidu to Wongan Hills. This is an example that a 15 year cycle for substandard track structure is not appropriate. When combined with light rail gravel ballast is not acceptable for today's trains.

It is recommended that the section of railway from McLevie to Wongan Hills be considered for metal ballasting.

Kondinin to Narembeen

Track has a combination of 30kg/m and 31kg/m rail and has mechanical joints. Formation is soft in many locations and gravel ballast is poorly drained. The section should not be operated in wet winter months. The steel sleepers are ineffective in supporting loads and adjacent timber sleepers take the load causing overstressing and premature deterioration and finally breakage. Based on a 15 year cycle, resleepering is due in 2014 however needs earlier cycle due to premature deterioration of timber sleepers.

It is recommended that consideration be given to rerailing with heavier rail and metal ballasting.

Narembeen to West Merredin

The track is 30 kg/m (60AS and similar to 63AS) rail with mechanical joints every 12.2 metres and is on metal ballast. It is in better condition than the adjoining section from Narembeen to Kondinin that is on gravel ballast. The rail could be welded into CWR and thus eliminating the high maintenance brought about by the pounding of train wheels on joints. This would also enable a consistent 1 in 2 steel resleepering pattern and extend the cycle time between resleepering. A 10 year cycle time is currently more applicable to this type of track structure and not 15 years.

Recommended that consideration be given to welding the rail into CWR prior to resleepering.

Bruce Rock to West Merredin

The track is 30 kg/m (60 WA) rail with mechanical joints every 12.2 metres. This type of rail is not suitable for joint elimination by welding. The track has metal ballast and as such is in better condition than similar light rail on gravel ballast. Due to the light track structure and sleepers in poor condition the speeds of loaded trains are restricted to 30 km/hr.

Recommended that consideration be given to rerailing with heavier CWR prior to resleepering.

Bruce Rock to Yilliminning

Track is in poor condition with 30 kg/m rail, mechanical joints and gravel ballast. From Bruce Rock to Bullaring approximately 10 kms has 1 in 4 steel sleepers whilst the other is timber sleepers. Sleepers are in poor condition. A speed restriction of 30 km/hr applies to the section. Track is barely suitable for operations in either wet or hot weather.

If this section of railway is to be kept in operation consideration needs to be given to rerailing with heavier rail and resleepering with 1 in 2 steel sleepers and possibly metal ballasting.

Trayning to West Merredin

The section of railway from Trayning to Nungarin consists of 30 kg/m rail with mechanical joints on gravel ballast. The sleepers are in poor condition. The lack of support from steel sleepers and flogging sleepers at joints places additional stress on otherwise good sleepers leading to premature failure. It is only 10 years since the last cycle and the track is in already in poor condition requiring a 30k/h speed restriction. The rail from Nungarin to West Merredin is slightly heavier being 31kg/m. It is also welded into long lengths although not CWR. With the heavier rail this section of track is in slightly better condition.

It is recommended that consideration be given to rerailing the section from Trayning to Nungarin with heavier CWR and metal ballasting the complete railway.

York to Quairading

The railway consists of 30 kg/m rail with mechanical joints every 24.4 metres on gravel ballast. Being jointed track at joints 4 sleepers are required to be timber in order to provide support. Therefore it is not possible for consistent 1 in 4 steel or as intended a 1 in 2 steel pattern. Similar to elsewhere steel sleepers in conjunction with light rail and gravel ballast are not providing adequate support due to flogging and accumulation of rain water in depressions created around the sleepers. Also the flogging of the sleepers tends to draw-up moisture from the sub-ballast and compounds the problem of soft/ inadequate support. The main advantage is the gauge holding ability of the steel sleepers.

It is recommended that consideration be given to rerailing with heavier CWR and if possible also metal ballasting.

Maya to Perenjori

The section from Maya to Perenjori is 31kg/m CWR on gravel ballast and is in a fit for purpose condition. It is one of the better sections with relatively light rail on gravel ballast. Possibly due to less rainfall than in the southern areas the gravel is providing better support to the steel sleepers. The adjoining section from Perenjori to Morawa has recently been metal ballasted. At some future time this metal ballasting may be extended south to Maya. However at this stage it is considered as low priority.

Toodyay to Miling

The Toodyay to Miling section is a mixture of rail types and ballast types. From Toodyay to Piawaning there is metal ballast and gravel ballast from Piawaning to Toodyay. There are also sections of 40 kg/ m rail, 31 kg/m rail and 30 kg/m (as light as 58 lb /yd) rail. As observed elsewhere the 30kg/m rail with mechanical joints on gravel ballast is substandard and the track is in poor condition. The railway was resleepered to a nominal 1 in 2 steel sleeper pattern in 2004 and the speed restriction of 30km/hr on the light rail sections has not been lifted as the track geometry remains in poor condition.

Consideration should be given to rerailing the light rail sections with heavier CWR. This comprises approximately half of the 135 km railway. Metal ballasting from Piawaning to Miling should also be considered.

Tambellup to Gnowangerup

Consists of light 30kg/m rail with mechanical joints on gravel ballast. It operates under a 30 km/hr speed restriction. The railway has had very little use in the last 3 years and as such the geometry is in reasonable condition. It would deteriorate quickly if regular trains were operating. It is not suitable for use in wet weather conditions. If this railway is to remain in use consideration should be given to rerailing with heavier rail and metal ballasting

Katanning to Nyabing

Is similar to the Tambellup to Gnowangerup railway although has not been resleepered with 1 in 4 steel sleepers and remains as a timber sleepered track. There are some sections of metal ballast and the other sections are gravel ballast. It consists of light 30 kg/m rail with mechanical joints. The railway has not had regular use in the last 3 years and when it operates it does so under a 30 km/hr speed restriction. It is not suitable for wet weather operations. If the railway is to remain in use consideration should be given to rerailing with heavier rail, resleepering and metal ballasting the sections that are currently gravel.