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Yunnan Integrated Road Network Development Project ROAD MAINTENANCE IN YUNNAN PROVINCE

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ABBREVIATIONS

ADB	Asian Development Bank
CPMS	China Pavement Management System
DPCB	Dehong Prefecture Communication Bureau
CB	Communication Bureau
MOF	Ministry of Finance
MOT	Ministry of Transport
NDRC	National Development and Reform Commission
RAMS	Road Asset Management System
YHAB	Yunnan Highway Administration Bureau
YHIC	Yunnan Highway Investment Company
YPDOT	Yunnan Provincial Department of Transport

In this report an exchange rate of USD1 = CNY 6.8 has been used
\$ refers to USD

INTRODUCTION

1. This report looks at the management of the road sector in Yunnan province of the People's Republic of China, focusing on road maintenance. It starts by looking at the road sector in general, the characteristics of the road network, the different road agencies responsible for its management and the existing government policies regarding road maintenance. The second chapter looks specifically at the road network managed by one of these road agencies, namely the trunk road network managed by the Yunnan Highway Administration Bureau (YHAB), paying attention to the characteristics of the trunk roads, the funding and planning of trunk road maintenance, and the implementation modalities of this maintenance. The third chapter does the same for the rural road network managed by the prefecture and county communication bureaus. The final chapter includes the main conclusions and recommendations of this study. In a separate annex, a number of recommendations are given regarding possible issues and components to be included in the proposed second ADB project on road maintenance in Yunnan.

1. THE ROAD SECTOR IN YUNNAN

2. In China roads are categorised according to technical classes (I to IV and under class) and according to administrative level (national, provincial, county, township, village and special roads). The technical classification refers to minimum standards of pavement width and thickness, design speed, horizontal and vertical alignment constraints, etc. However, many roads fail to meet the minimum requirements for class IV roads, and are thus categorised as under class roads. The administrative level refers to the function of the road in linking different administrative units¹. A third categorisation of the road network is made according to the road surface type.

3. At the end of 2008, Yunnan Province had a total of 203,753 km of roads, of which 9% are national and provincial highways, 24% are county roads, 49% are township roads, 16% are village roads and the remaining 2% are so-called special roads. Of the total network, only 9% are class III or above, 53% are class IV roads and the remaining 39% are under class. For the national and provincial highways the percentage of class III or above is 62% and under class roads only form 3%, while for the county, township and village roads only 3% is class III or above and 42% is under class. The percentage of class IV and under class roads is thus substantial, especially for lower level roads.

4. Paved roads (asphalt, cement concrete and simple paved roads) comprise only 19% of the total network. A further 8% has stone paving, whilst 37% have a gravel surface and the remaining 35% are earthen roads. For the national and provincial highways, 91% is paved (52% asphalt concrete and 37% simple pavement) and only 6% has a gravel surface (no earthen roads). Of the county, township and village roads only 10% are paved and a further 8% have stone paving, while 82% is unpaved (41% have a gravel surface and the remaining 41% are earthen roads). In the case of township and village roads, the percentage of unpaved roads increases to 93%, with 51% earthen roads. The percentage of unpaved lower level roads is substantial, especially for township and village roads.

¹ For instance, roads linking two townships are categorised as county roads, whereas roads linking a township with an administrative village are referred to as township roads.

Table 1: Road characteristics in Yunnan Province (km)

Class/ Pavement	Total	National Highway	Provincial Highway	County Road	Township Road	Village Road	Special Road
Expressway	2,512	2,367	145	-	-	-	-
Class 1	633	341	67	219	6	-	-
Class 2	4,859	1,625	1,785	1,305	87	8	49
Class 3	9,563	1,814	3,288	4,062	237	12	150
Class 4	106,959	1,655	4,713	35,640	52,643	9,682	2,626
Under Class	79,227	139	452	7,377	46,106	23,704	1,450
Total	203,753	7,941	10,451	48,603	99,080	33,406	4,274
Asphalt concrete	19,919	4,536	5,073	8,816	1,000	105	390
Cement concrete	6,030	248	66	2,304	2,455	699	258
Simple pavement	13,607	2,445	4,340	5,556	719	232	316
Cobblestone	15,867	151	345	11,240	3,363	516	253
Gravel	76,231	561	624	16,721	46,858	9,477	1,989
Earthen	72,098	-	3	3,966	44,684	22,377	1,069
Total	203,753	7,941	10,451	48,603	99,080	33,406	4,274

Source: Yunnan statistical yearbook 2009

5. The percentage of highways and lower level roads is more or less the same in the different prefectures. An extreme is Yuxi prefecture, where less than 7% of the road network consists of highways, and as much as 78% of the roads are township and village roads.

Table 2: Road administrative level by prefecture (km)

Prefecture	Total	National	Provincial	County	Township	Village	Special
Province	203,753	7,941	10,451	48,603	99,080	33,406	4,274
Kunming	16,035	783	414	3,384	6,745	4,172	537
Qujing	20,293	914	720	3,777	9,657	4,940	286
Yuxi	16,390	428	666	2,401	10,739	1,999	157
Baoshan	11,549	353	576	2,738	5,605	1,881	396
Zhaotong	14,312	424	806	4,031	7,538	1,494	19
Lijiang	5,966	50	740	1,884	2,866	417	8
Simao	19,077	757	1,245	4,796	9,763	2,244	271
Lincang	13,755	307	859	3,153	6,764	2,205	468
Chuxiong	16,644	686	375	3,721	7,414	4,114	333
Honghe	18,917	738	1,253	5,232	9,863	1,253	597
Wenshan	12,872	701	632	4,449	5,400	1,171	518
Xishuangbanna	6,270	514	362	1,282	3,983	4	124
Dali	16,783	743	747	3,761	6,284	4,874	373
Dehong	6,834	128	370	1,971	2,606	1,696	63
Nujiang	3,695	-	509	742	2,312	72	61
Diqing	4,342	413	176	1,280	1,541	868	63

Source: Yunnan statistical yearbook 2009

6. More differentiation exists between the prefectures when looking at road classes. The percentage of roads of class III and above is quite consistent, but the percentages of class IV and under class roads vary strongly. The same Yuxi prefecture only has 3% under class roads, with 88% class IV roads. At the other extreme is Zhaotong with 69% under class roads and only 26% class IV roads (also only 4% of its roads are class III or above).

Table 3: Road class by prefecture (km)

Prefecture	Total	Expressway	Class I	Class II	Class III	Class IV	Under Class
Yunnan Province	203,753	2,512	633	4,859	9,563	106,959	79,227
Kunming	16,035	359	120	712	618	9,793	4,434
Qujing	20,293	255	229	305	994	13,948	4,561
Yuxi	16,390	240	78	246	1,005	14,368	453
Baoshan	11,549	134	21	386	306	6,386	4,315
Zhaotong	14,312	135	-	282	204	3,771	9,919
Lijiang	5,966	-	15	240	475	2,398	2,839
Simao	19,077	135	-	147	835	7,461	10,498
Lincang	13,755	-	22	448	214	6,099	6,972
Chuxiong	16,644	301	-	185	713	5,915	9,530
Honghe	18,937	334	43	389	1,285	11,564	5,322

Prefecture	Total	Expressway	Class I	Class II	Class III	Class IV	Under Class
Wenshan	12,872	303	-	110	1,364	6,757	4,338
Xishuangbanna	6,270	90	27	247	26	3,664	2,216
Dali	16,783	226	77	550	1,083	7,186	7,662
Dehong	6,834	-	-	410	254	3,241	2,930
Nujiang	3,695	-	-	33	129	1,351	2,182
Diqing	4,342	-	2	170	57	3,056	1,056

Source: Yunnan statistical yearbook 2009

7. Yunnan province has plans to extend and improve the road network from the 203,753 km at the end of 2008 to an estimated 256,536 km in 2020. This includes new construction, but also the upgrading of existing roads to higher technical classes.

Table 4: Road sector plans in Yunnan Province (km)

Category	2008	2010	2020
Total	203,753	215,614	256,536
Expressway	2,512	3,000	6,000
Class I	633	550	800
Class II	4,859	6,500	12,000
Class III and below	186,186	205,564	237,736

Source: Yunnan statistical yearbook 2009

1.1 ROAD MANAGEMENT

8. The road network in Yunnan province is managed by different units. The expressways and a number of tolled national highways are managed by the Yunnan Highway Investment Company (YHIC) through the different expressway companies. The remainder of the national and provincial highway network (some of which are tolled) as well as some important county roads, are managed by the Yunnan Highway Administration Bureau (YHAB) through the general highway divisions in each prefecture (this network is referred to in this report as the trunk road network to differentiate it from the highway network, part of which is managed by other units and which does not include the county roads managed by YHAB). The rural road network including the remaining county roads together with the township, village and special roads, is managed by the prefecture communication bureaus through the county communication bureaus together with the township and village authorities. A few other roads are managed by special other units.

9. Although theoretically the management of the road network is linked to the administrative level of the roads (national and provincial highways by YHAB and county, township and village roads by the communication bureaus), this is clearly not always the case in Yunnan (and China in general), where a considerable percentage of county roads are managed by YHAB and some highways are managed by the prefecture and county communication bureaus. This means that the administrative level of a road has no other function than to refer to the type of link the road provides, and that general statistics according to road administrative level (such as table 1) give relatively little information as to the management of the different roads. It is recommended to bring the management of the road network in line with the administrative categorisation of the roads, either changing the administrative level of the road to reflect its importance and management, or transferring the management to the road agency that is responsible for the administrative level concerned.

Table 5: Road management in Yunnan Province (km)

Management Unit	National	Provincial	County	Township	Special	Village	Total
YHIC	2,733	-	-	-	-	-	2,733
YHAB	4,774	9,692	9,007	-	-	-	23,473
CB's	-	711	39,596	99,080	4,274	33,406	177,066
Other units	434	48	-	-	-	-	481
Total	7,940	10,451	48,602	99,080	4,274	33,406	203,753

Source: Yunnan Statistical Yearbook 2009

10. The management of the road network by the different management units in each prefecture is shown in the table below.

Table 6: Road management by prefecture (km)

Prefecture	Total	YHIC	YHAB	CB's	Other
Yunnan Province	203,753	2,733	23,473	177,066	481
Kunming	16,035	255	1,865	13,832	83
Qujing	20,293	316	1,758	17,924	296
Yuxi	16,390	199	1,183	15,008	-
Baoshan	11,549	134	1,253	10,162	-
Zhaotong	14,312	168	1,751	12,393	-
Lijiang	5,966	-	903	5,063	-
Simao	19,077	135	2,339	16,603	-
Lincang	13,755	140	1,368	12,247	-
Chuxiong	16,644	301	1,263	15,080	-
Honghe	18,937	187	2,861	15,791	98
Wenshan	12,872	303	1,734	10,835	-
Xishuangbanna	6,270	256	1,052	4,962	-
Dali	16,783	339	1,781	14,658	5
Dehong	6,834	-	821	6,014	-
Nujiang	3,695	-	589	3,106	-
Diqing	4,342	-	953	3,389	-

Source: Yunnan Statistical Yearbook 2009

1.2 MAINTENANCE POLICIES

11. A number of policies exist at national, provincial and prefecture level related to road maintenance and its management. Especially rural road maintenance has changed drastically over the past 5 years as a result of these policies, although these also have certain implications for trunk road maintenance.

TRUNK ROAD MAINTENANCE POLICIES

12. In 2002, the Yunnan Provincial Highway Administration Bureau issued the "**Commercialization Reform Measure of Maintenance of Roads Maintained by Highway Bureau**". This document aims to improve efficiency by downsizing, introducing market mechanisms and transparent competitive bidding procedures. It also calls for the separation of maintenance implementation from maintenance management, making the general highway divisions in the 16 prefectures responsible for management and the 111 maintenance divisions responsible for implementation. The document further sets maximum management staff levels for the general highway divisions and maintenance divisions according to the length of roads managed. The maintenance divisions should furthermore form highway maintenance companies, and based on these companies a highway maintenance corporation should be formed which is to coordinate the bids from the maintenance companies. The document also states that initially (during the internal market phase) the highway maintenance corporation and maintenance companies should not form separate legal entities but should act as "a horse with two brands", and only once the conditions are ripe they should be separated and their relationship should become a purely

contractual one. Layoffs, unemployment and retirement are then to become internal issues of the companies. The companies appear to fall under the maintenance divisions and not replace them, however, meaning that the maintenance divisions will continue to exist even after the creation of separate legal entities for the companies whereas it would be preferable to transform the maintenance divisions into companies that can compete with each other. The corporation is to be formed by the staff of the contract management division of YHAB, and is to assist the companies in the bidding process and is also to become a separate legal entity, although its future role is unclear. This policy appears to create a number of parallel structures rather than replacing the existing structure by a more commercially oriented one.

13. YHAB is to be responsible for general supervision and monitoring while the general highway divisions are to manage the highways in their prefectures and supervise the contracts. Contracts for asphalt roads more than 10 km continuous or CNY 1 million are to be handled by YHAB, contracts for asphalt roads of less than 10 km continuous and between CNY 100,000 and CNY 1 million are to be handled by the general divisions through province-wide bidding, while contracts of less than CNY 100,000 are to be handled by the general divisions through bidding at prefecture level. Routine maintenance is to be managed by the general divisions (determining the lengths for each division), while the bidding process is carried out by the respective maintenance divisions.

14. This policy has never really been put into practice, however. Although a number of issues have been implemented or partially introduced, currently the tendency is to revert to the previous system of full force-account and all the company forms have been dropped. The possibilities for open bidding and private sector involvement are thus very limited, as neither the general highway divisions nor the maintenance divisions are independent legal entities, and procurement is generally an internal process with no real competition.

RURAL ROAD MAINTENANCE POLICIES

15. In 2005 the State Council issued the “***Reform Plan of Rural Road Management and Maintenance***” aimed at introducing proper maintenance of rural roads within three years after issuance. It makes the county communication bureaus responsible for the implementation of maintenance of the rural road network with assistance from the township authorities, while the provincial authorities are made responsible for raising the required funds, issuing provincial policies and supervising the work of the county communication bureaus.

16. The policy also states that the income from the vehicle maintenance fee and from the motorcycle and farm vehicle maintenance fee (also called the tractor maintenance fee) should be used mainly for road maintenance, with a minimum of 80% of the collected fees (after deducting collection costs) to be spent on maintenance. It further defines a minimum maintenance subsidy to be provided from the vehicle maintenance fee collected by the provincial government to the prefecture and county level based on the length of county, township and village roads (CNY 7,000 per km per year for county roads, CNY 3,500 for township roads and CNY 1,000 for village roads). The tractor maintenance fee collected at prefecture level is to be wholly used for rural road maintenance. Further required funding should be allocated by local governments, and regions with specific difficulties may receive additional transfers from central government. The funding is to be used for minor, medium and major maintenance as well as maintenance management costs.

17. The policy goes further to state that road management agencies should no longer be involved in the implementation of maintenance and that for this purpose road maintenance companies should be set up. These companies are to have private contracts with their employees, making them non-public staff. Over time the contracting of maintenance is to be carried out through open bidding to stimulate the participation of the private sector and

increase competition. The subcontracting of local people is also promoted as a means of maintenance for low volume roads.

18. In 2006 this was followed by the “**Note on Perfecting the Reformation of Rural Road Management and Maintenance**” issued by the Ministry of Transport, the National Development and Reform Commission (NDRC) and the Ministry of Finance, in which they require the identification of demonstration prefectures in each province for the implementation of the State Council policy. This piloting would form the basis for subsequent scaling up at national level.

19. This policy document also indicates that the minimum 80% vehicle maintenance fee should be spent mainly on maintenance engineering and not on management costs. Additional personnel should not be hired and personnel expenditure should be decreased. It also recommends the competitive contracting of maintenance through villages to create incomes and employment for people in rural areas, with pavement repairs contracted out to professional units. It furthermore calls for the involvement of township and village governments in the maintenance management.

20. In 2007 Yunnan Provincial Government issued the “**Work Plan for Pilot Reformation of Yunnan Rural Road Management and Maintenance**” reiterating the issues of the above-mentioned policies. In addition, it states that all of the tractor maintenance fee will be applied to rural road maintenance, after deduction of the collection costs which may not form more than 40% of the collected fee. It goes on to state that the provincial subsidy (vehicle maintenance fee) is to be used for medium and major maintenance, while the minor (routine) maintenance is to be funded from the tractor maintenance fee and other maintenance funding. This restriction in the use of the subsidy is specific to Yunnan province and is likely to form a problem for the proper execution of routine and minor maintenance.

21. For the contracting of the maintenance, it stipulates that major and medium maintenance of asphalt and concrete roads should be contracted out through open bidding. For minor maintenance of technical nature (pavement repairs) professional services are to be contracted on a competitive basis while non-pavement works may be contracted out to villagers on a competitive basis, stimulating employment and incomes.

22. In Yunnan Province, Dehong Prefecture was selected as demonstration area and in 2007 Dehong Prefecture issued the “**Reformation Plan of Dehong Rural Road Management and Maintenance**”. This largely reiterates the issues of the State Council policy and subsequent MOT/NDRC/MOF policy. Additionally, however, it states that of the maintenance subsidy only 20% is to be used for minor (routine) maintenance², with the remainder to be used for medium and major maintenance according to need with the following unit rates: CNY 200,000/km for asphalt and concrete roads, CNY 80,000/km for stone paved roads and CNY 50,000/km for gravel roads. This restriction forms a further limitation to applying proper routine and minor maintenance, which are especially important for unpaved low-volume township and village roads. It is not clear why this restriction was put in place.

23. In 2008, based on the initial pilots in Dehong, Yunnan Provincial Department of Transport (YPDOT) issued the “**Guidelines for Rural Road Maintenance in Yunnan Province**”. This document builds on the general issues of previous policies, but goes on to state that the maintenance subsidy from provincial level will only be given if complementary funding is provided from prefecture and county level governments. It repeats that all of the tractor maintenance fee will be applied to rural road maintenance, after deduction of the

² CNY 1,400 per kilometre per year for county roads, CNY 700 for township roads and CNY 200 for village roads.

collection costs which may not form more than 40% of the fee. It confirms that the use of the subsidy should in principle be exclusively for medium and major maintenance, with no less than 80% of the maintenance subsidy to be spent on these maintenance types. Up to 20% may be used for routine maintenance and minor repairs. Additional routine and minor repair costs are to be covered from the prefecture and county budgets.

24. This document repeats the contracting of major and medium maintenance of asphalt and concrete roads through open bidding, competitive contracting of minor maintenance of paved surface to professional maintenance organizations and the competitive contracting of non-surface related maintenance to villagers.

25. New in these guidelines is the introduction of different management tools such as measurement and mapping of traffic and road conditions for planning purposes. It states that maintenance and road condition inspections should be carried out by the county communication bureaus every month for county roads, quarterly for township roads and six monthly for village roads. Every year the prefecture communication bureaus are to carry out a rural road maintenance quality check which is to be reported to provincial level. YPDOT is furthermore required to annually check the condition of the county road network.

2. TRUNK ROAD MAINTENANCE IN YUNNAN

26. This chapter looks in more detail at the current status of trunk road maintenance in Yunnan. The scope of this chapter includes all trunk roads managed and maintained by the Yunnan Highway Administration Bureau, thus including most of the national and provincial highway network³ as well as some important county roads.

2.1 THE TRUNK ROAD NETWORK

The trunk road network managed by YHAB totals 23,473 km, 62% of which are national and provincial highways and the remainder are important county roads. 44% are class III or above, including a very small length of expressway. Of the remaining 56%, 47% are class IV and only 9% are under class. The vast majority is paved (81%), although the majority of these only have simple pavement (Otta seal or similar). A further 5% has cobblestone paving and the remaining 14% has a gravel surface.

Table 7: Characteristics of the trunk road network administered by YHAB (km and %)

By Administrative Level						
National Roads	Provincial Roads		County Roads		Total	
4,774	9,692		9,007		23,473	
20.3%	41.3%		38.4%		100.0%	
By Technical Class						
Expressways	Class I	Class II	Class III	Class IV	Under class	Total
45	123	2,942	7,241	10,985	2,137	23,473
0.2%	0.5%	12.5%	30.8%	46.8%	9.1%	100.0%
By Pavement Type						
Asphalt concrete	Cement concrete	Simple pavement	Cobblestone		Gravel	Total
8,015	125	10,758	1,275		3,300	23,473
34.1%	0.5%	45.8%	5.4%		14.1%	100.0%

Source: Yunnan Statistical Yearbook 2009

³ Over 34% of the national highways are managed by YHIC and a further 5% by special units, while 7% of the provincial highways are managed by prefecture communication bureaus and 0.5% by special units.

2.2 TRUNK ROAD MAINTENANCE FUNDING

27. This section looks at the main sources of funding for trunk road maintenance, as well as the different types of expenditure the funding is used for.

SOURCES OF FUNDING

28. Funding for the maintenance of the trunk road network under YHAB is provided by YPDOT and traditionally came mainly from the vehicle maintenance fee and the tolls on the class I and class II highways. Of these two sources, the vehicle maintenance fee has been by far the most important, providing 90% of the trunk road maintenance budget in the past. Although the allocation from the vehicle maintenance fee has been increasing over the years, this increase has been limited (income from the vehicle maintenance fee only increased by 30% between 2001 and 2008). The collection of this fee has also been troubled by high collection costs.

29. As per the 1st of January 2009, the vehicle maintenance fee (together with other fees) was replaced by revenue from an increase to the fuel tax (CNY 0.8 per litre for gasoline and CNY 0.7 per litre for diesel). As part of this reform, tolls for class II highways were also abolished, although Western provinces were given a grace period during which the toll collection could be continued. The allocation of this fee to the provincial finance departments is based on the 2007 collection of the vehicle maintenance fee and other revenues increased by a specific annual growth rate which has been set at 10% for the period 2009-2011.

30. The benefits in terms of maintenance budget are a steady and higher annual increase in available funding. Although the 2009 allocation (the first year of application) indeed reflected an annual growth rate of 10% compared to 2007, compared to 2008 the growth was only 8.5% (growth in 2007-2008 had been 12.5%). The amounts allocated to trunk road maintenance form only 30% of the total revenue received by YPDOT (CNY 4 billion in 2008 and CNY 4.4 billion in 2009), with an additional 20% allocated as a subsidy for rural road maintenance. The remaining 50% is not used for road maintenance, even though the State Council reform plan states that at least 80% of the net collected maintenance fee (now fuel tax revenue) should be used for road maintenance. In light of the lack of sufficient maintenance funding, especially for rural roads, it is recommended to push for the allocation of a greater percentage of the fuel tax revenue to road maintenance.

Table 8: Planned maintenance funding for trunk roads in Yunnan (CNY million)

Item	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Vehicle Maintenance Fee (Fuel Tax)	912	935	935	985	985	985	1,050	1,180	1,280	1,360
Tolls	130	127	133	113	144	140				
Total	1,042	1,062	1,068	1,098	1,129	1,125	1,050	1,180	1,280	1,360

Source: YHAB

31. Apart from these planned funding sources, another important source of funding for trunk road maintenance are the fines given to overloaded and oversized trucks. This may provide as much as CNY 400 million to the actual maintenance budget. Similarly, maintenance allocations from central government special engineering funding and from vehicle purchase tax may add up to another CNY 100 million. These funding sources are currently not included in the planned maintenance budgets, and it is recommended to include these in order to facilitate more realistic maintenance planning and budgeting.

32. Another problem related to this, is the late approval of the maintenance budgets. This is currently done very late in the year, often only in the month of October, with funds received only in November or December. Although these funds can apparently be used

beyond the calendar year, this makes implementation and monitoring very complicated as the budget is booked under one calendar year and expenditure is mainly booked under the following calendar year. It is recommended to ensure a more timely approval of the budget, or otherwise to shift the financial reporting year in order that budget and expenditure better correspond.

MAINTENANCE EXPENDITURE

33. Maintenance expenditure is differentiated into maintenance engineering expenditure and maintenance operating expenditure. The maintenance engineering costs consist mainly of the actual implementation costs for minor, medium and major maintenance, including the staff costs of maintenance workers under the different maintenance divisions and stations and in the maintenance gangs. Also included are expenditure on flood damaged sections, bridge repairs, special roads, sporadic engineering and bio-engineering. Expenditure for minor maintenance forms approximately two-thirds of the total engineering expenditure, reflecting an appropriate priority for minor maintenance, although also reflecting a relatively high cost per km. A further 30% of the engineering expenditure is spent on medium and major maintenance, although very little medium maintenance is actually carried out and by far the major part of this expenditure is spent on more costly major maintenance.

34. Maintenance operating expenditure includes management staff costs, retired staff pension costs, road administration costs, traffic and road condition surveys, feasibility studies, equipment procurement, technical research and operation and maintenance of road management buildings. Operating expenditure on average makes up over half the available maintenance expenditure, which is very high. A major part of this operating expenditure is formed by the pension costs, making up as much as 65% of the operating costs and up to 30% of the overall trunk road maintenance expenditure.

35. This is the result of the fact that no pension fund has been set up for retired maintenance staff, but that these costs are paid from the maintenance budget. At present the pension costs are very high compared to the current staff levels, with 21,511 retired staff compared to 17,891 employees at the end of 2008. Over the next few years a further 1,000 staff members are expected to retire each year with pension costs rising quickly, after which the pension costs are expected to become more or less stable. The creation of a pension fund is recommended to avoid that the pensions for current staff are to be paid from future maintenance budgets.

Table 9: Expenditure on trunk road maintenance in Yunnan Province (CNY million)

Item	2001	2002	2003	2004	2005	2006	2007	2008	2009
Maintenance engineering expenditure	592	589	546	538	583	744	858		
Minor Maintenance	379	388	407	411	420	458	466		
Major and Medium Maintenance	117	114	82	66	82	252	332	300	
Other	95	87	58	61	81	34	60		
Maintenance operating expenditure	450	474	523	560	546	505	558		
Administration management cost	132	143	143	145	140	140	140		
Pensions	253	287	297	339	352	335	360		
Other	65	44	83	76	54	30	58		
Total	1,042	1,062	1,068	1,098	1,129	1,249	1,415	1,700	2,080

Source: YHAB

36. Overall, however, the maintenance funding is expected to improve significantly over the next few years as a result of the decrease in management costs (decrease in staff costs and stabilization of the pension costs) and a steady increase in funding allocation (10% annual increase compared to 2007 allocations). As such, most of the additional funding is expected to be allocated to maintenance engineering, which will therefore increase by at

least 15% per year, thus closing the funding gap between available and required maintenance funding. This could be further enhanced by improving the efficiency of maintenance engineering, especially regarding minor maintenance costs and by promoting medium maintenance. Additional measures aimed at lowering the operating costs should also be looked at.

2.3 TRUNK ROAD MAINTENANCE PLANNING

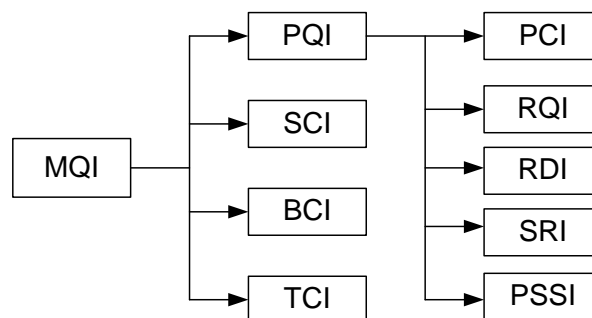
37. In the early 1990's, China created its own highway pavement assessment and maintenance system named *Chinese Pavement Management System* (CPMS). In November, 2007, the Ministry of Transport (MOT) promulgated the "Highway Performance Assessment Standards" as a substitute for the "Highway Maintenance Quality Inspection and Assessment Standards" and put forward a more systematic and scientific system of standards and indicators for highway maintenance assessment and provided a brand-new system of indicators for scientific performance assessment of all the highways in China. Together with these new standards, an updated version of the CPMS was developed, also referred to as Road Asset Management System (RAMS). Supported by MOT, the improved CPMS is being extended and applied nationwide.

38. The new standards indicate that the highway performance will be assessed by the *Maintenance Quality Indicator* (MQI), including the MQI for asphalt concrete pavement, cement concrete pavement, gravel & stone pavement, road base, bridge structure, tunnel and culvert, transportation project and its facilities. The MQI has four sub-indicators: PQI (*Pavement Quality Index*), SCI (*Sub-grade Condition Index*), BCI (*Bridge, tunnel and culvert Condition Index*) and TCI (*Traffic facility Condition Index*). Yunnan has prioritized the assessment of the pavement quality, and therefore only calculates the PQI for the different highways.

39. The PQI has five sub-indicators: PCI (*Pavement Condition Index*), RQI (*Riding Quality Index*), RDI (*Rutting Depth Index*), SRI (*Skidding Resistance Index*) and PSSI (*Pavement Structure Strength Index*). As almost all highways in Yunnan are class II or below, the PQI only depends on the PCI and RQI:

$$PQI = w_{PCI}PCI + w_{RQI}RQI \quad (\text{where } w_{PCI} = 0.6 \text{ and } w_{RQI} = 0.4 \text{ for class II and below asphalt roads})$$

Figure 1: Road condition indicators



40. PCI depends on the area of different types of defects, while RQI is calculated on the basis of the International Roughness Index (IRI). Both PCI and RQI are automatically calculated by the CPMS software based on the measurement data collected using the automatic measuring vehicles. Yunnan has purchased two such vehicles for the annual assessment of the trunk road network as well as for other measurement tasks. Based on the calculated PQI, the road condition is determined.

Table 10: Road condition according to PQI value

Excellent	Good	Fair	Poor	Very Poor
PQI≥90	90>PQI≥80	80>PQI≥70	70>PQI≥60	60>PQI

Source: YHAB

ROAD CONDITIONS

41. In the second quarter of 2009 an assessment was carried out of the trunk road network condition covering 14,009 km of the total trunk road network (one lane). A second assessment was carried out in late 2009 and is still being analyzed, and in future annual assessments are planned. Based on different measurements, the Pavement Quality Index (PQI) was determined, on the basis of which the road condition was defined.

Table 11: Trunk road conditions by administrative level based on PQI values (km)⁴

Type	Excellent	Good	Fair	Poor	Very poor	Extremely poor	Total assessed	Total existing
National	480.61 12.5%	846.38 22.0%	646.77 16.8%	523.42 13.6%	1,173.46 30.5%	181.40 4.7%	3,852.03	4,774
Provincial	678.23 10.4%	1,692.36 26.0%	1,338.56 20.6%	885.96 13.6%	1,621.31 24.9%	286.80 4.4%	6,503.23	9,692
County	314.26 8.6%	964.24 26.4%	759.84 20.8%	490.85 13.4%	842.04 23.0%	283.16 7.7%	3,654.39	9,007
Total	1,473.09 10.5%	3,502.99 25.0%	2,745.17 19.6%	1,900.23 13.6%	3,636.81 26.0%	751.36 5.4%	14,009.65	23,473

Source: Consultant's processing of YHAB data

42. The assessment data show that on average 45% of the assessed trunk roads are in poor to very poor condition and 35% in good to excellent condition (the condition of the whole trunk road network is expected to be worse, as especially a large percentage of the county roads has not been included in this assessment). According to the average PQI value for all roads assessed, the trunk road network is in "poor" condition overall. In the site visits, the defined road conditions appeared to properly reflect existing conditions. For the very poor roads, however, it is recommended to make further distinction between pavement that is cracked and potholed and needs replacement in the near future, and sections where the pavement has completely deteriorated and road conditions are extremely poor leading to significantly increased road user costs (e.g. a road condition "extremely poor" for PQI values<25). In theory this category would only be of a temporary nature while the serious backlog in maintenance still exists.

43. One important note is that the road condition data is currently not made available based on length. The average PQI is calculated for each road, for each administrative class and for each responsible general highway division, and the number of roads in different average conditions are determined. However, an average PQI of 75 for instance, may mean that the whole road is in fair condition which would be quite good, but it may also mean that some parts are in excellent condition (recently rehabilitated) while other parts are in very poor condition and urgently require major maintenance⁵. These average condition values are useful for monitoring the overall improvement/deterioration of average road conditions over

⁴ The consultant has included an additional category of "extremely poor" to indicate those roads where the asphalt pavement has completely deteriorated. In the original pavement condition assessment this category is included under the category "very poor". While road conditions in the province are very poor, it is recommended to introduce such an additional category to better differentiate existing road conditions.

⁵ For instance, for the S317 in Baoshan and the S225 in Lijiang, both with average PQI values between 70 and 80, defining the condition as fair, the percentages of the road length in very poor condition are respectively 51% and 21%. Similarly, the S220 in Lijiang has a PQI value between 60 and 70, defining the condition as poor, while the length in very poor condition is 41%, less than the S317 in Baoshan that is supposedly in fair condition. This clearly shows that average PQI values do not properly reflect variations in road conditions, and that differentiated PQI values according to road length are required to properly assess road conditions and the need for maintenance.

time, but are not very suitable for planning maintenance interventions. For planning, the exact number of kilometres in excellent, good, fair, poor and very poor condition (and possibly extremely poor condition) should be calculated, which is much more important than the average condition, and allows the user to determine the number of kilometres requiring different types of maintenance and thus the required maintenance budget. It also allows for the prioritization of maintenance based on road condition (PQI value), although this should ideally be complemented with other decision-making criteria (traffic volumes, economic importance, etc.).

44. The tables above and below were prepared by the consultant based on the PQI values for each km of assessed road that were provided by the Highway Research Institute, and provide the number of kilometres in excellent, good, fair, poor, very poor and even extremely poor condition by administrative level, by prefecture (or general highway division), and for each road. This could easily be done by the Highway Research Institute upon request of YHAB, but currently such length-based information is not readily available. It is therefore strongly recommended that YHAB include this in their future requests for data analysis.

45. The road conditions in the different prefectures vary considerably. Dehong has been a pilot prefecture for different approaches and as a result shows very good road conditions with nearly 70% in good or excellent condition. Baoshan also scores high with nearly 60% in good or excellent condition. On the other extreme are prefectures such as Yuxi, Kaiyuan and Chuxiong with respectively 68%, 65% and 64% in poor to very poor (extremely poor) condition. Note also the high percentage of roads in extremely poor condition in Yuxi (although most of these are county roads).

Table 12: Trunk road conditions by prefecture based on PQI values (%)

Prefecture	Excellent	Good	Fair	Poor	Very poor	Extremely poor	Total (km)
Baoshan	19.1%	38.3%	17.9%	10.9%	12.7%	1.0%	879.00
Chuxiong	3.2%	17.0%	16.0%	17.6%	41.9%	4.4%	778.40
Dali	6.7%	22.4%	21.2%	16.1%	29.4%	4.2%	791.15
Dehong	30.2%	38.9%	19.9%	9.2%	1.7%	0.0%	401.02
Jinghong	7.1%	26.6%	14.5%	16.2%	21.7%	13.8%	618.88
Kaiyuan	6.9%	12.8%	15.5%	13.5%	42.1%	9.2%	1,820.31
Kunming	9.4%	25.7%	20.3%	12.5%	25.4%	6.7%	1,337.60
Lijiang	18.6%	22.0%	19.5%	11.9%	24.0%	4.0%	690.03
Lincang	11.4%	29.6%	17.6%	12.3%	26.1%	2.9%	951.80
Liuku	6.3%	27.7%	42.7%	17.0%	6.3%	0.0%	540.20
Quijing	6.3%	23.3%	20.5%	17.3%	25.2%	7.4%	1,068.97
Simao	13.5%	33.8%	23.3%	8.9%	19.8%	0.7%	1,161.08
Wenshan	15.3%	33.5%	16.8%	10.6%	20.2%	3.7%	1,124.80
Xianggelila	18.3%	21.1%	24.3%	19.1%	16.2%	0.9%	621.04
Yuxi	2.1%	12.9%	17.1%	12.4%	38.1%	17.4%	764.73
Zhaotong	3.5%	27.9%	17.1%	16.8%	32.5%	2.2%	460.65
Total	10.5%	25.0%	19.6%	13.6%	26.0%	5.4%	14,009.65

Source: Consultant's processing of YHAB data

46. The assessed roads do not cover the entire trunk road network under YHAB, but it is expected that with the assessment data collected at the end of 2009, all trunk roads will have been inspected. The road assessment generally only covers one lane, but should still provide a sufficiently accurate indication of pavement conditions. The next step will be to use the collected data in the planning of maintenance interventions.

TRUNK ROAD MAINTENANCE PLANNING

47. In the new CPMS, more function modules were included compared to the old CPMS, including highway condition information management, highway performance assessment,

maintenance decision-making analysis, daily maintenance management, annual maintenance plan, and medium- and long-term maintenance plan. As such it has grown out to a full-fledged maintenance planning system.

48. In Yunnan, however, the additional modules have not yet been purchased, and they only have the basic database which allows the storing of road measurement data and the calculation of the different indicators. This module does not include any planning tools, however, and planning is currently still being carried out based on the experience and understanding of the engineers, although the engineer now can count on objective road condition data as a basis for planning. Other relevant data, such as road user costs, traffic data, costs of different maintenance types, etc. are not readily available and although the experience of the engineer is used to compensate for this, this may still result in a rather subjective basis for planning.

49. The loan provided by the ADB is intended to be used for rehabilitation in order to work away the maintenance backlog that has developed in the trunk road network. Those roads in (very) poor condition (low PQI values) will therefore be targeted, and the road assessment data forms a good basis for decision-making. Additional data has been entered into HDM-IV to ascertain the economic rate of return and impact on road condition over time. This has been done in a more project-based approach, however, as the road sections had already been selected by YHAB. For the planned second ADB project it is recommended to use a more network-based approach where the whole road network is looked at and the selection of the road sections to be maintained is based on more criteria than only road pavement condition.

50. For the use of regular maintenance budgets such a network approach is also preferable. It is therefore recommended that Yunnan province purchase the planning module for CPMS in order to be able to determine the best maintenance programme given the available funding, trunk road network, road conditions, traffic levels, road user costs, etc. (other network planning software could also be used). Especially now that trunk road maintenance funding is increasing, the proper planning of its use becomes all the more important.

51. Currently major and medium maintenance is also being planned separately from minor maintenance, focusing mainly on major rehabilitation, and as a result short isolated sections tend to be rehabilitated throughout the province. Due to this approach, road conditions vary considerably on the different roads, with some short sections having been recently rehabilitated, others being slightly deteriorated and again others being heavily deteriorated, making proper routine maintenance more complicated and providing a safety hazard for road users (as road conditions can go from excellent to very poor in a short distance, requiring significant speed adjustments). Although the heavily deteriorated sections will be rehabilitated, at the same time the other sections will deteriorate further, leading to a continuous state of widely varying road conditions.

52. In the ADB project a new approach is being introduced where a continuous road segment is selected which on average is in poor to very poor condition. Different maintenance interventions are carried out in the different road sections according to the existing road conditions and maintenance needs (rehabilitation, overlay, sealing, patching, etc.), and as a result the road condition will be good to excellent for the entire road segment after the completion of the maintenance, facilitating regular maintenance and providing better predictability of road conditions for road users. It is recommended to further promote this approach with YHAB, especially in the planned second ADB project focusing on road maintenance.

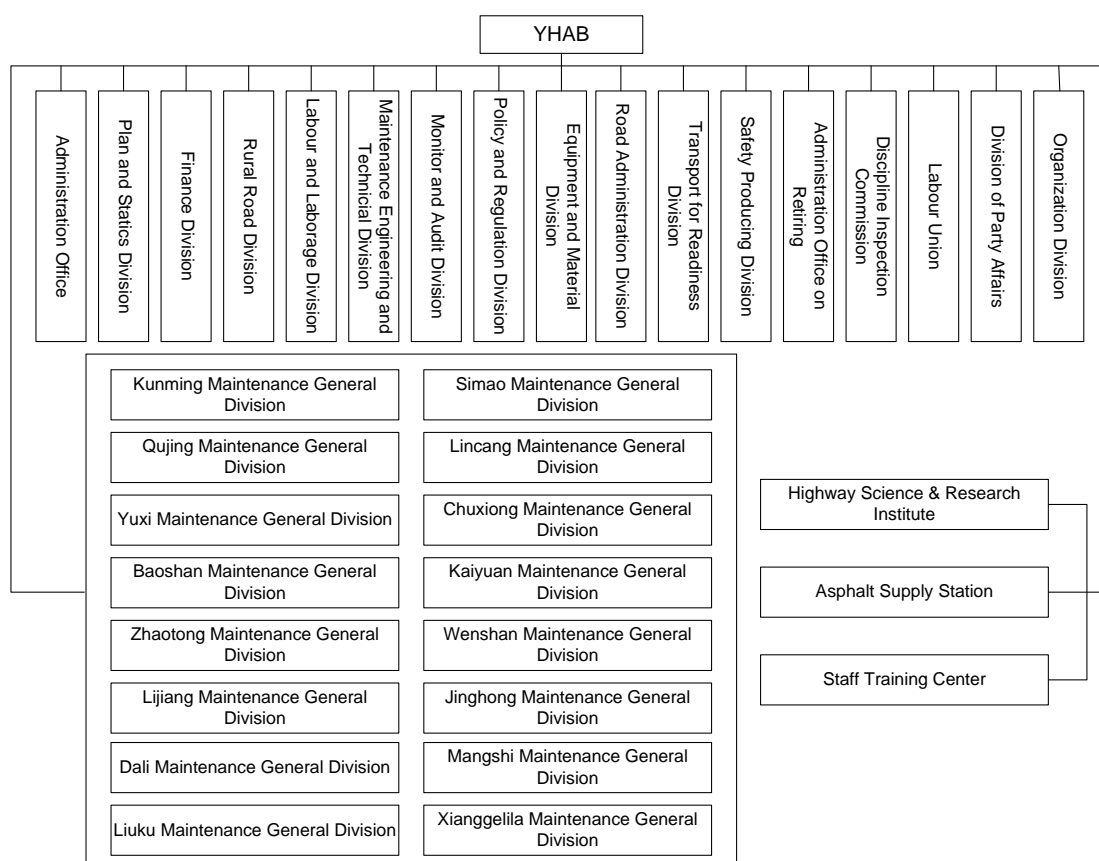
2.4 TRUNK ROAD MAINTENANCE IMPLEMENTATION

53. This section looks at the organizational structure regarding the maintenance of the trunk road network, and how the maintenance is implemented.

ORGANIZATIONAL STRUCTURE

54. The maintenance of the trunk road network under YHAB is the responsibility of the Maintenance Engineering and Technical Division, and is managed by the 16 general highway divisions (one in each prefecture). Under these 16 general highway divisions are 111 maintenance divisions in different parts of the prefectures that are responsible for implementing the trunk road maintenance activities, through their 476 maintenance stations and 70 maintenance gangs (the latter are responsible for routine maintenance). Further support to trunk road maintenance is supplied by the Highway Science & Research Institute, the Asphalt Supply Station and the Staff Training Centre.

Figure 2: YHAB organizational structure



Source: YHAB

55. Both the 16 general highway divisions that are the prefectural arms of YHAB and the 111 maintenance divisions that form part of the general highway divisions, have no independent legal status. This is at odds with YHAB's commercialization reform measure described in chapter 2, which foresees the creation of maintenance companies that would create separate legal entities after an "initial internal market" phase. It appears, however, that the Yunnan Provincial Government (YPG) is no longer in favour of commercialising the maintenance of the trunk road network. As a result, these entities are not able to enter into open bidding procedures, and procurement is carried out as an internal process that is not open to the private sector or other external participants.

MINOR MAINTENANCE PROCUREMENT

56. Minor maintenance, consisting of routine maintenance and including patching, is currently carried out by the maintenance gangs and maintenance stations under the maintenance divisions. Each maintenance division appears to be responsible for the minor maintenance of the roads within its area. The quality of this minor maintenance has not been assessed, but from the expenditure data it becomes clear that the costs are quite high. According to YHAB, the unit cost of minor maintenance is approximately CNY 30,000/km (approximately \$4,400/km). Excluding patching, the cost of routine maintenance is likely to be around CNY 20,000/km (\$2,900/km). Based on the data from YHAB, 2007 expenditure on routine maintenance (excluding patching) was CNY 383 million, giving a minimum cost per kilometre per year of CNY 16,300 (based on the total network length of 23,472 km), equivalent to US\$ 2,400 (most likely this did not cover the whole trunk road network, and costs per kilometre were thus higher).

57. Compared to average costs of routine maintenance by microenterprises for similar type roads in Latin America (\$1,400 in Colombia, \$800 in Peru, \$1,050 in Honduras, some of these including patching), this comes out quite high. Similar costs of around \$1,000 per km per year are found as average for routine maintenance in Asia (World Bank Road Costs Knowledge System - ROCKS). Although China has relatively high wage rates compared to the rest of the region, Yunnan's routine maintenance costs are in the same order of magnitude as European countries where they are around \$2,900 per km per year (ROCKS).

58. A further analysis of the routine maintenance costs is therefore justified, to see what causes these to be so high. The contracting out of minor maintenance should be looked at, possibly including the creation of maintenance microenterprises (these could initially be formed by the workers of the maintenance gangs). The introduction of performance-based contracts should also be contemplated, especially as this has led to lower costs per kilometre in many countries, as well as better overall road conditions.

59. Given the poor road conditions in Yunnan, such a performance-based system should include different maintenance service levels (target conditions)⁶. Basically, more important roads (higher traffic levels) require higher service levels (better target conditions), while poorer initial road conditions imply higher costs to obtain the same service level. The choice of service level therefore depends on the importance of the road (defining the desired service level), the initial condition of the road (determining the cost of achieving a particular service level) and the available budget (determining which service level can be achieved).

60. Based on the selected service level, bidders are invited to submit bids for keeping the condition of the roads in question at the selected service level (a unit price per kilometre per year/month). The winning bidder is responsible for determining and organising the work required to keep the road in the target condition (service level), and is paid according to the compliance with this service level in line with the agreed monthly payments (in case of non-compliance, deductions are made to the payments). The inspection of compliance is according to preset performance indicators (which vary according to the service level), indicating the required condition of different road elements. In the case of China, these performance indicators should be based on the indicators used in CPMS.

61. The required input to achieve the maintenance standard and comply with the performance indicators is not relevant for the payment (although information may be required initially to improve the system). This results in lower administration costs for the contracting agency, and allows the contractor to improve his efficiency and increase profits. At the same time overall road conditions are found to improve because damage is

⁶ The experience in Armenia is interesting in this respect, as it also suffers from very poor road conditions.

addressed earlier (as this results in lower costs for the contractor), and maintenance costs also tend to be lower than in an input-based system.

MEDIUM AND MAJOR MAINTENANCE PROCUREMENT

62. The unit costs of major and medium maintenance are respectively CNY 1,000,000/km and CNY 500,000/km. The medium and major maintenance of the trunk roads is currently implemented by the 111 maintenance divisions under the 16 general highway divisions (one in each prefecture). To improve the efficiency of road maintenance, internal competition was introduced by means of the selection of maintenance divisions through a bidding process. However, this bidding process remains an internal process as the maintenance divisions are not legally independent entities and therefore not able to participate in open bidding processes as independent companies. The efficiency of the existing bidding process is also limited as competition is only among maintenance divisions from the same prefecture, excluding maintenance divisions from other prefectures as well as bidders from the private sector.

63. The ADB project is planning to introduce open bidding processes for its local roads component. However, due to the fact that neither the maintenance divisions nor the general highway divisions are legal entities, it will be the 16 construction companies in each of the prefectures that compete for the contracts (together with the private sector and possibly companies from other provinces). These construction companies are independent legal entities (state-owned companies). However, the maintenance contracts are small and the distances between the 16 construction companies is great, making it unlikely that very competitive prices will result due to high mobility costs for other companies. Apart from opening up the bidding to the private sector and promoting open bidding with participation by independent legal entities, this approach is therefore unlikely to result in significantly increased levels of competition.

64. It would be preferable to have the 111 maintenance divisions compete, and it is therefore recommended to create legal entities for these (either the creation of fully autonomous private or state-owned companies or at least parallel legal entities that are able to participate in open bidding procedures). Such retrenching has happened in many countries and has generally resulted in better performance levels and lower costs, as well as greater efficiency and profits for the newly formed companies (in most cases neither the contracting agency nor the contractor wish to return to the old modality). This is also in line with YHAB's commercialisation reform measure (2002), although this appears to no longer be in effect. Such an approach will allow the introduction of more realistic competition and more competitive prices, whilst allowing the maintenance divisions to increase their efficiency to create a profit. As such it is recommended to further promote such an approach in the second ADB project.

OVERLOADING

65. The roads in Yunnan province currently suffer a lot of damage from overloaded freight vehicles. It is expected that with the abolishment of tolls on class II highways, this will be increased as trucks chose to avoid tolled expressways in favour of the cheaper trunk roads. Weighing stations are currently placed every 60km on average, but this does not appear to deter overloading. Although significant fines are being collected (CNY 400 million in 2009), the benefits of overloading appear to continue to outweigh these costs. In addition, there is significant local overloaded freight traffic making use of the trunk roads, especially near mines and construction sites, which is not affected by the weighing stations.

66. This damage by overloaded trucks appears to be the most significant cause of road pavement deterioration, together with high traffic levels, and most of the road sections

identified for the ADB local road rehabilitation component had overloading related damage. The general course of action currently applied by YHAB is to reinforce the subgrade and rebuild the pavement, referred to as major maintenance. However, from interviews with general highway division staff, it is clear that the newly rehabilitated roads are quickly damaged again, as witnessed by roads rehabilitated in 2006 which were included in the ADB local roads component.

67. In tackling overloading, there are two options open to YHAB. One is to lessen the benefits of overloading by increasing the chances of being fined and the size of the fines themselves, thus making the average costs of overloading higher. This could be achieved by implementing mobile weighing stations in areas known to suffer from overloading, together with an increase in fines for overloading. The income from these fines will help to pay for the required repairs, also making those responsible for the damage pay for the repairs, although it is unlikely they will cover the full costs of the damage caused.

68. A second option, and one with better chances of success in light of the high degree of overloading and the low class of roads, is to increase the pavement strength of the trunk roads. Currently most of the trunk roads are class III or below (87%), for which the pavement thickness is significantly less as can be seen in the table below.

Table 13: Technical design criteria of different class roads

Class	Subgrade Width	Lane	Surface Course (AC)	Base (cement stabilised macadam)
Class I	21.5 m	4x3.75 m	3.5+5 cm	25-35 cm
Class II	12.0 m	2x3.50 m	3.5+5 cm	25-35 cm
Class III	7.5 m	2x3.25 m	2.0+4 cm	25-30 cm
Class IV	6.5 m	2x3.00 m	2.0+4 cm	25-30 cm

Source: YHAB

69. For a number of class III roads, however, the actual traffic levels are in line with class I or II roads⁷. Nevertheless, the pavement design is still being based on the existing class and not on the required class or existing traffic levels. As a result, pavement strengths are applied that are meant for much lower traffic levels, and subsequently deteriorate very rapidly under the influence of the high traffic levels and overloading. For instance, the G320 in Kunming and Quijing is a class III road (AADT of 2,000-6,000 PCU), while actual traffic levels require a class II road (AADT of 5,000-15,000 PCU) and projected traffic levels for 2025 even require a class I road (AADT of 15,000-30,000 PCU), for which the pavement and subgrade design strength is significantly higher (see the table above). The table below compares existing road classes to required road classes based on actual and projected traffic volumes for the ADB project roads.

⁷ In terms of AADT whereby different vehicles have been converted to PCU using Chinese conversion factors that are quite low for heavier vehicles. By applying more realistic conversion factors for the heavy (overloaded) freight traffic, much higher traffic volumes would be found for most roads.

Table 14: Road classes in relation to actual and projected traffic volumes

Highway	Prefecture	Current class	Heavy traffic	PCU 2008	Required class 2008	PCU 2025	Required class 2025
G108	Kunming	II	228	5,770	II	19,424	I
G214	Lijiang	III	684	3,795	III	5,640	III
G214	Dali	III	801	6,249	II	9,987	II
G320	Qujing	III	3,007	9,929	II	20,232	I
G320	Kunming	III	1,689	8,110	II	22,086	I
G320	Chuxiong	III	955	7,423	II	23,210	I
G320	Dali	III	1,528	9,096	II	23,084	I
G320	Baoshan	III	1,272	6,704	II	21,545	I
G320	Dehong	II	244	4,193	III	7,955	II
G323	Kaiyuan	III/IV	570	4,202	III	6,265	II
G326	Qujing	III	811	4,549	III	5,823	III
G326	Kaiyuan	II	315	1,917	III	2,460	III
S221	Dali	II	446	7,697	II	21,442	I
S313	Lincang	IV	131	1,228	IV	2,879	III

Source: YHAB, Yunnan Statistical Yearbook 2009, Consultant's calculations

70. The problem of design strength for road pavement and subgrade is especially important in the case of the class III roads, many of which should be class II or even class I roads based on actual or projected traffic volumes, with significantly higher design criteria than for class III roads. Although it is not recommended to change the class of the trunk roads at this time, as this would imply significantly higher costs for realignment and widening, it is recommended to use the surface course criteria of class I/II roads for class III and below roads where traffic volumes require this. It is advisable to increase the pavement strength (thickness) even further in areas with severe overloading. In short, it is recommended to base the design strength of the pavement and subgrade on the traffic volume and especially traffic load, instead of on the road class (in those cases where road class and traffic volume/load are not in concordance). Only by doing so will premature deterioration be avoided and will the design life of the pavement be ensured.

71. This will increase the costs of rehabilitation, but will also result in less damage by overloading and longer service life of the pavement. If combined with other measures aimed at reducing overloading, it could have a significant effect on service life of the trunk roads, decreasing the need for costly major maintenance. If the same substandard surface course is rebuilt every time, damage will occur rapidly and service lives will be short.

MEDIUM MAINTENANCE

72. Medium maintenance in Yunnan includes the replacement of the asphalt layer, without any improvement of the road base and subgrade, and is budgeted at CNY 500,000 per km. It is hardly carried out in Yunnan province with an average of 30 km per year of medium maintenance being implemented according to YHAB. The major part of the maintenance engineering expenditure is spent on minor maintenance, and the remainder is spent mainly on major maintenance. The lack of priority given to this maintenance type means that roads deteriorate further, thus requiring more costly major maintenance including repairs to the road base.

73. Another issue is that this maintenance type is limited to replacement of the asphalt layer, and does not include resealing aimed at rejuvenating the existing asphalt surface, although this may have little effect given that most damage is caused by overloading and not by climate influences. It is the opinion of the consultant, however, that the application of medium maintenance (expanded to include resealing) with higher design standards for the surface course (as mentioned in the section above), would lead to better results than major maintenance with subgrade improvements but with the same weak surface course.

74. Timely medium maintenance should be promoted in Yunnan, and expanded to include resealing in those cases where damage by overloading is tackled as per the recommendations given above. Simple overlays should also be applied more.

3. RURAL ROAD MAINTENANCE IN YUNNAN

75. This chapter looks in more detail at the current status of rural road maintenance in Yunnan. The scope of this chapter includes all roads managed and maintained by the prefecture communication bureaus together with the county communication bureaus (sometimes with assistance from township and village authorities), thus including most of the county roads⁸ together with the township and village roads as well as the special roads. A lot of the information in this chapter is based on data collected from Dehong prefecture, where interviews were carried out at prefecture, county and village level.

3.1 THE RURAL ROAD NETWORK

76. The rural road network managed by the communication bureaus in Yunnan includes a total of 177,066km, 87% of the total road network in the province. County roads form 22%, township roads 56%, village roads 19% and special roads 2%. 98% are class IV or under class. For lower category roads the percentage of underclass roads is higher (14% of county roads, 47% of township roads and 71% of village roads). The vast majority is unpaved (82% with 42% gravel roads and another 42% earthen roads), 8% has stone paving and the remaining 10% has asphalt or concrete pavement. Lower category roads tend to be unpaved (46% of county roads, 92% of township roads, 95% of village roads are unpaved), nearly half of which are earthen roads (10% for county roads, 45% of township roads, 67% of village roads).

Table 15: Characteristics of the rural road network administered by CB's (km and %)

By Administrative Level						
Provincial highways	County Roads	Township Roads	Village Roads	Special Roads	Total	
711	39,596	99,080	33,406	4,274	177,066	
0.4%	22.4%	56.0%	18.9%	2.4%	100.0%	
By Technical Class						
Expressways	Class I	Class II	Class III	Class IV	Under class	Total
145	221	1,348	2,319	95,942	77,091	177,066
0.1%	0.1%	0.8%	1.3%	54.2%	43.5%	100.0%
By Pavement Type						
Asphalt concrete	Cement concrete	Simple pavement	Cobblestone	Gravel	Earth	Total
8,944	5,682	2,818	14,592	72,934	72,095	177,066
5.1%	3.2%	1.6%	8.2%	41.2%	40.7%	100.0%

Source: Yunnan Statistical Yearbook 2009

77. To further illustrate the maintenance situation for rural roads, the situation for Dehong prefecture will be highlighted in this chapter.

⁸ Of the county roads, 9,007 km are managed by YHAB.

Table 16: Characteristics of the rural road network administered by Dehong Prefecture CB (km and %)

By Administrative Level						
Provincial highways	County Roads	Township Roads	Village Roads	Special Roads	Total	
44	1,605	2,606	1,696	63	6,014	
1%	27%	43%	28%	1%	100%	
By Technical Class						
Expressways	Class I	Class II	Class III	Class IV	Under class	Total
0	0	75	43	3,012	2,884	6,014
0%	0%	1%	1%	50%	48%	100%
By Pavement Type						
Asphalt concrete	Cement concrete	Simple pavement	Unpaved	Total		
220	17	6	5,771	6,014		
4%	0%	0%	96%	100%		

Source: Yunnan Statistical Yearbook 2009

3.2 RURAL ROAD MAINTENANCE FUNDING

78. This section looks at the main sources of funding for rural road maintenance, as well as the different types of expenditure the funding is used for.

SOURCES OF FUNDING

79. Traditionally, the prefecture communication bureaus received funding from three planned budget sources:

- The regular vehicle maintenance fee collected at prefecture level and transferred to province level, where part was returned to the prefecture and county communication bureaus for rural road maintenance
- The farm vehicle and motorcycle maintenance fee (or tractor maintenance fee) collected at county level and transferred to prefecture level, where part was returned to the counties for rural road maintenance
- Tolls collected on the few class I and class II highways under the management of the prefecture CB's.

80. Of these the vehicle maintenance fee was the most important. Up to 2005 the allocation of this fee was the responsibility of YPDOT, which transferred the money through the Rural Road Division of YHAB, but after 2005 this was carried out by the Yunnan Provincial Finance Department (which is why the data available only goes to 2005).

Table 17: Planned maintenance funding for rural roads in Yunnan (CNY million)

Item	2001	2002	2003	2004	2005
Vehicle maintenance fee (Fuel Tax)	70	70	70	70	70
Tractor maintenance fee	50	50	45	43	40
Tolls	4	5	10	19	22
Total	124	125	125	132	132

Source: YHAB

81. Apart from these planned funding sources, the county communication bureaus also received funding from the vehicle and truck fines (especially the overloaded truck fines) and in the last few years some have received extra subsidies from the prefecture governments, as can be seen in the maintenance budget for Dehong prefecture. Also evident from the table below is the 10-fold increase to the maintenance subsidy received from provincial level in 2007. This was the result of the State Council rural road maintenance reform policy stating that prefecture and county communication bureaus would receive a subsidy based on the length of their rural road network (CNY 7,000/km for county roads, CNY 3,500/km for township roads and CNY 1,000/km for village roads).

Table 18: Planned maintenance funding for rural roads in Dehong Prefecture (CNY million)

Item	2004	2005	2006	2007	2008
Vehicle maintenance fee (Fuel Tax)	1.98	1.98	1.98	20.62	11.97
Tractor maintenance fee	4.85	5.00	4.65	5.31	5.60
Vehicle and truck fines	1.05	1.05	1.20	2.28	2.29
Subsidy from prefecture				0.50	0.50
Total	7.88	8.03	7.83	28.71	20.36

Source: Dehong prefecture CB

82. The calculation of the provincial maintenance subsidy from the vehicle maintenance fee can be seen in the table below for the year 2007 in Dehong prefecture. What is also obvious from this table is that the classified road length has increased a lot from the beginning of 2007 to the end of 2008, especially regarding village roads.

Table 19: Planned provincial maintenance subsidy in Dehong Prefecture for 2007 (CNY million)

Road	Length	Subsidy amount/km	Total subsidy
County roads	1,587	7,000	11.11
Township roads	2,484	3,500	8.69
Village roads	816	1,000	0.82
Total	4,887		20.62

Source: Dehong prefecture CB

83. In 2009, the regular vehicle and tractor maintenance fees were replaced by revenue from an increase to the fuel tax (CNY 0.8 per litre for gasoline and CNY 0.7 per litre for diesel). According to the fuel tax reform policy, the allocations to the county communication bureaus are to be based on the 2007 maintenance budget allocations increased by an annual growth rate of 10%, at least for the period 2009-2011 (after this period the rate will be reviewed). As part of this reform, tolls for class II highways were also abolished, although Western provinces were given a grace period during which the toll collection could be continued. As a result, the maintenance budget for rural roads is now almost completely dependent on the allocations from the fuel tax.

84. The transfer of the fuel tax revenue to county level, and the degree to which it is actually able to replace the regular vehicle maintenance fee, the tractor maintenance fee and the class II highway tolls in Yunnan has yet to be assessed. It is also not yet clear if current allocations are based on the 2007 allocations with a 10% annual increase as per the fuel tax reform policy (and as such are no longer dependant on road lengths), or if they continue to follow the rural road maintenance reform policy (2005) with minimum subsidies based on actual road lengths (and as such do not benefit from the 10% annual increase). In the case of the former, annual increase in relative funding will be less than 10% as the length of the road network increases each year. In the case of the latter, there will be no relative increase in funding as the funding per kilometre remains the same. Ideally, funding should be based on actual road lengths whereby the minimum subsidies per kilometre increase as per the annual growth rate of 10%. It is recommended to look at this issue in more detail as part of the current ADB project and possibly also the planned second ADB project.

MAINTENANCE EXPENDITURE

85. As for trunk road maintenance, rural road maintenance expenditure is differentiated in maintenance engineering expenditure and maintenance operating expenditure. The maintenance engineering costs consist of the actual implementation costs for minor, medium and major maintenance. Expenditure for minor maintenance forms approximately 60% of the total engineering expenditure, reflecting an appropriate priority for minor maintenance, although it is expected that this is mainly patching, as the use of the provincial maintenance subsidy for routine maintenance is supposedly restricted to 20% (as per Yunnan's policies

related to the rural road maintenance reform). The other 40% of the engineering expenditure is spent on medium and major maintenance, although very little medium maintenance is actually carried out and by far the major part of this expenditure is spent on more costly major maintenance.

86. Maintenance operating expenditure includes management staff costs, retired staff pension costs, road administration costs, traffic and road condition surveys, staff training, feasibility studies, technical research and operation and maintenance of the county communication bureau building. Operating expenditure on average makes up about a quarter of the available maintenance expenditure, which is acceptable (this appears to be mainly a result of the contracting out of maintenance implementation, resulting in much lower staff costs). Only a quarter of this operating expenditure is formed by the pension costs, which again is more acceptable than the trunk road maintenance expenditure where it forms over half the operating expenditure (this again appears to be the result of contracting out the maintenance implementation). As a result rural road maintenance is more efficient than trunk road maintenance, with three quarters of the expenditure actually spent on maintenance implementation (although some of the operating costs are transferred to the maintenance contractors and as such are hidden within the engineering costs).

Table 20: Expenditure on rural road maintenance in Yunnan Province (CNY million)

Item	2001	2002	2003	2004	2005
Maintenance Engineering	189	201	233	236	256
Minor Maintenance	115	117	136	159	161
Major and Medium Maintenance	74	84	97	77	95
Maintenance operating expenditure	56	61	71	81	89
Administration management cost	26	29	33	38	43
Pensions	14	16	18	22	22
Other	15	17	21	21	24
Total	243	263	305	318	345

Source: YHAB

87. Similar to the trunk road maintenance, the situation for rural road maintenance funding is expected to improve over the next few years as a result of the foreseen annual 10% increase in maintenance funding (if this is actually transferred to the prefecture level). However, with funding per kilometre for rural road maintenance only forming one twentieth of funding per kilometre for trunk road maintenance, the gap between available and required funding is much greater for rural roads, and the improvement is therefore expected to have less of an impact in bridging this gap. Also, the significant increase in rural road network or the continued use of minimum subsidy levels as a basis for rural road maintenance funding, may diminish the possible impact of such a funding increase. A significant increase to rural road maintenance funding, allocating a larger percentage of the furl tax revenue received at provincial level, should be looked at (currently only approximately 50% of this revenue is allocated to trunk and rural road maintenance).

3.3 RURAL ROAD MAINTENANCE PLANNING

88. This section deals with the assessment of road conditions and the subsequent planning of maintenance activities.

ROAD CONDITIONS

89. Road conditions for rural roads are not assessed in the same way as for trunk roads. Automatic measuring vehicles are not used, and the assessment is made by the engineers from the county communication bureaus. The accuracy of these road assessments has yet to be evaluated, as it is clear that not all roads will be assessed each year. It may also be

clear that road conditions are much poorer for rural roads, especially for the lower category roads. Examples of the percentage of rural roads in good condition are given below.

Table 21: Rural roads in good condition in Dehong prefecture in 2009 (% of length)

County roads	Township roads	Village roads
40%	27%	19%

Source: DPCB

90. Especially the conditions of the unpaved rural roads are very poor, as a result of insufficient funding being allocated and inappropriate implementation mechanisms being used. Interesting is the condition of the stone-paved roads, which appears to be quite good even after years without maintenance. These roads only receive maintenance every 5 years or so, replacing the loosened stones, and are found to be in relatively good condition, even where carrying relatively high traffic levels, with only minor repairs required that can be carried out at minimal cost. It is therefore recommended to promote this pavement type for county and township roads where the traffic levels and importance warrant the upgrading from unpaved road. It is expected that the overall investment costs over a longer period will be lower than for asphalt roads that require higher levels of maintenance and have a shorter service life.

RURAL ROAD MAINTENANCE PLANNING

91. Planning of maintenance for rural roads is still a very subjective process. Although a thorough assessment of the planning process was not carried out, from interviews with county and prefecture communication bureaus it is clear that road importance and traffic levels form the most important prioritization criteria, together with road condition. It is not clear, however, to which extent the road condition assessment data is used in the preparation of the annual maintenance plans.

92. A major problem faced in the planning of rural road maintenance, however, is the long delay in the approval of the maintenance budgets. These are generally only approved in October and funding is only received in November or December. Although the funding can be used beyond the end of the calendar year and funding from the previous year is used in the initial months of the year, the relation between the maintenance plans and planned budget on the one side and the actual expenditure and funding received on the other side is very artificial. It is strongly recommended to improve the funding approval process or else to bring the maintenance planning and reporting periods in line with the approval process.

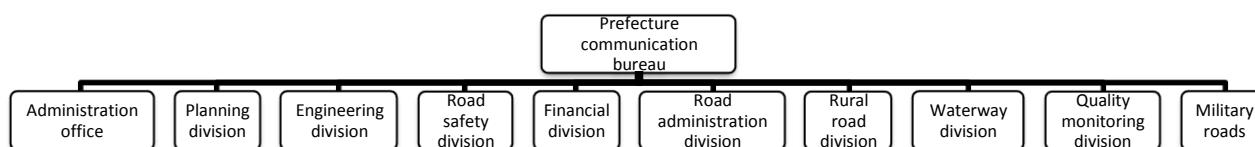
3.4 RURAL ROAD MAINTENANCE IMPLEMENTATION

93. This section looks at the organizational structure regarding the maintenance of the rural road network, and how the maintenance is implemented.

ORGANIZATIONAL STRUCTURE

94. The maintenance of the rural roads is the responsibility of the prefecture communication bureaus, and is implemented through the county communication bureaus. In practice the prefecture communication bureaus have more of a monitoring and policy role, which is carried out primarily by the Rural Road Division.

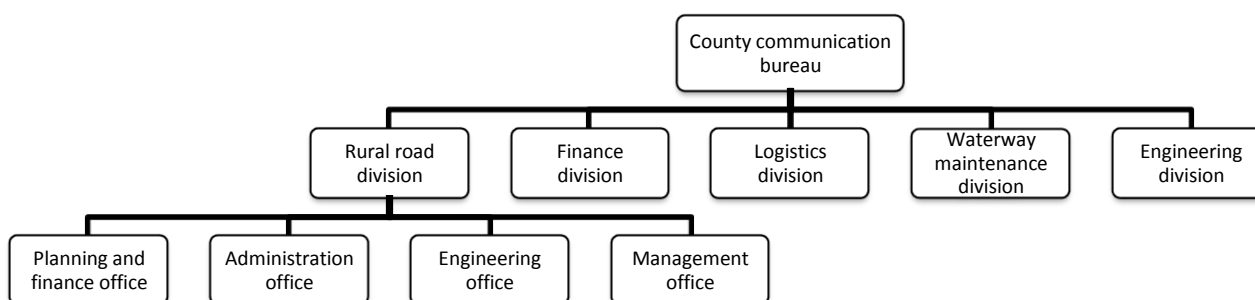
Figure 3: Organizational structure of the Dehong Prefecture Communication Bureau (DPCB)



Source: DPCB

95. Rural road maintenance is implemented by the rural road divisions of the county communication bureaus.

Figure 4: Organizational structure of the Ruili County Communication Bureau



Source: Ruili County Communication Bureau

ROUTINE MAINTENANCE PROCUREMENT

96. Routine maintenance of the rural road network (excluding patching of paved roads) was originally carried out directly by the staff of the rural road division on a seasonal basis. Currently it is mainly carried out by local people. For the county roads and more important township roads individual people or households are contracted part-time on a yearly basis to provide this service. They are inspected every 3 months and work according to a type of performance-based contract. Road lengths under the responsibility of one worker are up to 10km, which is high for effective routine maintenance, especially if only working part-time.

97. The amount of routine maintenance carried out is to a certain extent limited by the regulations limiting the use of the provincial maintenance subsidy from the vehicle maintenance fee (now fuel tax) to 20% (this regulation is particular to Yunnan province). The routine maintenance was supposed to be financed mainly from the tractor maintenance fee and prefecture subsidies, but as the tractor maintenance fee has also been replaced by the fuel tax, it is unclear if it is possible to use a greater part of the maintenance subsidy. From a maintenance perspective, the restriction on the use of available funding for routine maintenance does not make sense, and should be relaxed. Especially for unpaved roads routine maintenance can avoid serious damage to the road surface by ensuring proper drainage.

98. This lack of funding for routine maintenance means that for village roads, most of the routine maintenance (including road surface repairs for unpaved and stone paved roads) is carried out on a voluntary basis once a year, with households from the communities concerned contributing a few workdays a year (the work is mainly carried out by the women from the communities whose time is valued less). This system is unsatisfactory and has not led to significantly improved road conditions. The voluntary nature of the maintenance results in low productivity and motivation, and often means that required maintenance activities are not carried out in a timely manner, as labour input is provided based on

availability rather than need. Also, the technical skills of the maintenance workers are limited, and as a result the implemented work is not always appropriate. It is recommended to professionalize community-based maintenance, ensuring some minimal remuneration to ensure timely input of labour, and providing training for certain community members who can act as supervisors. This will be piloted in the ADB's Gender and Development (GAD) funded pilot project in Dehong prefecture, and later replicated in the rural road component of ADB's Yunnan Integrated Road Network Development Project.

99. For county roads and to a certain extent township roads, the community-based approach may not be the most suitable and it is recommended to introduce microenterprises to carry out the routine maintenance activities. These will be better able to deal with the higher traffic levels and longer road lengths, and may even be involved in repairs to road pavements.

OTHER MAINTENANCE PROCUREMENT

100. The repairs to road pavement as well as medium and major maintenance of county roads are contracted out by the rural road divisions of the county communication bureaus, generally using invited bidding for patching and public bidding for medium and major maintenance. All bidding processes are published on the internet. For township roads and village roads, agreements are generally signed with the township governments making them responsible for the maintenance.

101. The tendering process is open to all bidders, including private sector but also highway maintenance divisions under YHAB. The number of private contractors participating in the bidding process is limited, however. Although a number of contractors exist, most of these are not registered and as such cannot participate. According to the communication bureaus, the management costs of the private contractors are lower than for the maintenance divisions, making the former cheaper to work with.

4. CONCLUSIONS AND RECOMMENDATIONS

102. This chapter summarises the main conclusions and recommendations of the report. It distinguishes between the trunk road network and the rural road network.

TRUNK ROAD MAINTENANCE

103. **Maintenance funding.** One of the main issues regarding trunk road maintenance is the funding. Although available funding is currently insufficient for the amount of medium and major maintenance required, it is expected that the situation can be significantly improved by increasing the efficiency of the minor (especially routine) maintenance and will further improve with the foreseen 10% annual growth of the allocated maintenance funding (implying a minimum 15% annual growth of the maintenance engineering funding). The existing backlog in major maintenance should not determine the general maintenance funding levels, but should rather be addressed separately using additional one-time allocations from provincial or central government, and may also include loans as is the case of the ADB Yunnan Integrated Road Network Development Project. The foreseen annual growth of the maintenance funding and improved efficiencies should be ensured, however, to guarantee that the rehabilitated trunk roads come under an appropriate maintenance schedule and a new backlog is not created.

104. It must also be noted, however, that YPDOT currently only transfers just over half the funding it collects as maintenance subsidies for trunk roads and rural roads, despite the State Council reform policy stating that at least 80% should be used for road maintenance. It should therefore be possible to increase the recurrent maintenance funding to YHAB, or to

fund major maintenance on a more temporary basis to reduce the maintenance backlog. Similarly, central government is understood to have collected approximately CNY 200 billion from the fuel tax revenue in addition to the amounts transferred to the provinces in line with previous maintenance fees. This amount could also be used to increase recurrent maintenance funding or for decreasing the maintenance backlog.

105. **Microenterprises.** The efficiency of minor maintenance, especially routine maintenance, can be increased by contracting out this service. Routine maintenance does not require high skill or equipment levels and can be carried out by microenterprises. These microenterprises can be formed by people living in the vicinity of the road, but can also be formed by the maintenance workers from the maintenance gangs under YHAB. The cost of such microenterprises is likely to be around \$1,500/km, comparing favourably with the current cost of \$2,400/km. All routine maintenance activities can be easily included, and possibly even the repairs to road pavements.

106. **Performance-based contracting.** Another means of increasing efficiency is the introduction of performance-based contracts. By defining different service levels depending on road importance (traffic level), road condition and available funding, microenterprises, contractors or maintenance gangs can be made responsible for all minor maintenance. They will receive a fixed cost per kilometre per month/year, and will be responsible for keeping the road in a specific condition, defined by means of performance indicators for the different road elements for which they are responsible. This has proved to improve efficiency in many countries, decreasing costs, improving road conditions and even increasing profits for the contractors involved. The introduction of such performance-based contracts using different service levels to take account of the different road conditions, is highly recommended and could be piloted in the second ADB project.

107. **Overloading.** For the trunk road network, the most important cause of damage is overloading. Overloading is very severe in Yunnan and results in premature pavement damage and significantly reduced road service lives. The fines currently being given to overloaded trucks are insufficient to deter drivers from overloading, and although the revenue is significant, it is not sufficient to cover the costs of repair. A two-pronged approach is therefore required whereby on the one hand overloading is further discouraged through a combination of higher fines and the use of mobile weighing stations to cover traffic currently not covered by the fixed weighing stations, and on the other hand the pavement strength is increased to avoid the high amounts of damage currently experienced.

108. Regarding the pavement design standards, a major issue is that these are currently based on the class of the road rather than the actual and projected traffic volume and load. Where the existing road class is appropriate to the traffic volume, this is no problem, but for many trunk roads in Yunnan the existing and projected traffic volumes in reality require higher classes with related higher design standards for the pavement and subgrade. This is especially important for class III roads, for which pavement design standards are significantly lower than for class II roads. Especially for such roads it is recommended to base pavement design on actual and projected traffic volumes rather than the road class. This should not entail a change in class, but only an increase in pavement strength in line with traffic volumes.

109. **Medium maintenance.** As mentioned, medium maintenance is currently not taking place. It is highly recommended to promote the implementation of cost-effective medium maintenance, extended to include resealing and overlays, as a means of avoiding the need for more costly major maintenance. Account should be taken, however, of overloading, ensuring sufficient pavement strength as well as other complementary measures mentioned above. By prioritizing medium maintenance, the maintenance budget can cover a larger network. The required major maintenance should be treated as the result of a backlog in

maintenance, and should be addressed from other funding sources instead of using up the recurrent maintenance budget, which leads to a vicious cycle of (re)construction-destruction-reconstruction. It is necessary to promote a more favourable cycle of (re)construction-deterioration-maintenance.

110. **Maintenance procurement.** Procurement for medium and major maintenance is currently not carried out on a competitive basis. Although a certain form of internal competition is promoted between the maintenance divisions, this is limited to the maintenance divisions within the prefecture concerned and precludes the participation of the private sector. To enable a more transparent competition, it is recommended to create legal entities for the different maintenance divisions and to apply public bidding whereby any bidder can participate (in line with YHAB's commercialization reform measure), including all the maintenance divisions in the prefecture concerned as well as from other prefectures and even other provinces, and from the private sector. This will force the maintenance divisions to improve their efficiency and quality, bringing down the costs of maintenance.

111. **Maintenance planning.** Objective planning using maintenance planning models is not yet taking place. It is recommended that YHAB purchase the planning modules for CPMS in order to carry out a better founded use of the available budget, prioritising roads and maintenance types not only on the basis of condition (and traffic), but also taking into account other criteria. A network approach should also be adopted as opposed to a corridor or section approach. Furthermore, the analysis of the road condition assessment data should be presented in terms of affected road length rather than in average values, thus allowing the total number of kilometres requiring specific types of maintenance and the related budget to be estimated. Lastly, maintenance planning should aim to bring longer road segments into a uniform good or excellent condition through the application of different maintenance types according to the condition of the road sections, rather than treating these short road sections in isolation.

RURAL ROAD MAINTENANCE

112. **Funding.** Although rural road maintenance funding has increased considerably as a result of the State Council reform policy, funding levels are still too low in relation to the network size (maintenance funding per kilometre for rural roads is 20 times lower than for trunk roads). The fuel tax reform is likely to change this situation, although it is not clear if funding will continue to be based on minimum subsidies per kilometre or on 2007 allocations increased by an annual growth rate of 10% (or in the ideal case a combination of the two). Also it is not clear whether the tractor maintenance fee is being adequately replaced by an increase in allocation from province level, and if so if the limitations on its use for routine maintenance are being relaxed.

113. The fact remains, however, that the allocated subsidy levels as defined in the State Council reform policy are too low for adequate levels of maintenance for rural roads, especially in the case of village roads (CNY 1,000/km). The funding levels need to be increased if proper maintenance is to be carried out. Funding for this appears to be available at provincial level, as only about half the collected fuel tax revenue is transferred for trunk road and rural road maintenance (while the State Council reform policy states that at least 80% should be allocated to road maintenance). Similarly, at central level additional funding from the fuel tax appears to be available which could also be allocated to rural road maintenance. Without such additional funding for rural road maintenance, the large investments in this sector over the past years will only have a temporary impact on rural access and economic development, as road conditions deteriorate and access becomes worse.

114. **Procurement of major/medium maintenance and pavement repairs.** Medium and major maintenance is contracted out by the prefecture and county communication bureaus, in line with the State Council reform policy. The use of contractors for medium and major maintenance and for pavement repairs seems adequate, although it is recommended to promote contractor development (especially registration) to ensure higher levels of competition.

115. **Routine maintenance of county roads.** Routine maintenance of county and more important township roads is currently contracted out to individual workers, but these are contracted for an insufficient number of days per kilometer per year. It is recommended to decrease the number of kilometers per worker and increase the number of days they are contracted, in order to ensure sufficient workdays are available for the proper maintenance of the roads. It is further recommended to organize these workers into microenterprises or teams in order to improve their productivity and effectiveness, and reduce the management costs. Successful experiences with such maintenance teams exist in Jiangxi province and relevant material in English and Chinese can be found on the following website: www.cartier.dds.nl/china/cdrom/start.htm.

116. **Maintenance of (unpaved) township and village roads.** Maintenance of less important township roads and of village roads, especially unpaved roads, is currently carried out on a voluntary basis which is not resulting in significantly improved road conditions. It is recommended to professionalize the community-based maintenance of these roads by ensuring a minimum remuneration to ensure better productivity and more timely maintenance, and by providing training to community members to ensure more appropriate maintenance. The activities should include general routine maintenance as well as repairs to the road surface (for unpaved roads), but should also include some basic road improvements, especially to the drainage system. Minimum estimated costs are around CNY 3,500/km per year, which would be in line with current maintenance subsidy levels for township roads, although for village roads the funding levels would be insufficient.

ANNEX: RECOMMENDATIONS SECOND ADB PROJECT

117. A second ADB project has been proposed for Yunnan, which will focus on trunk road maintenance. The proposed project is foreseen to have a \$80 million loan from ADB, but the counterpart funding has yet to be determined. The recommendations below focus on issues related to the trunk road maintenance and YHAB, although a number of issues related to rural road maintenance have also been included in case it is decided to include a rural road component.

TRUNK ROAD MAINTENANCE

118. A number of issues related to trunk road maintenance are already being addressed in the ADB funded Yunnan Integrated Road Network Development Project, and it is recommended to further strengthen these aspects of trunk road maintenance. In addition it is recommended to include a number of other issues which it was not possible to include in the first project.

119. **Open bidding for major and medium maintenance contracts.** For this it is proposed to work together with YHAB on creating a suitable environment for open bidding to be possible, where the private sector and state-owned construction companies as well as the maintenance divisions can compete. This will require the creation of independent legal modalities for the maintenance divisions in line with the highway commercialization reform policy (2002, YHAB). Discussions will need to be undertaken with YHAB to see if this is still the way they want to go, as it seems that this policy is no longer being implemented. This may include studies to look at suitable ways of creating company forms and retrenching workers.

120. **Ensuring uniform road conditions for longer road segments.** In planning maintenance, one of the objectives should be to ensure uniform road conditions for longer road segments, thus facilitating subsequent regular maintenance and creating a higher degree of predictability of road conditions for road users. This can be achieved by combining different maintenance types according to existing road conditions, and as such should include the promotion of medium maintenance, extended to include resealing and overlaying.

121. **Application of appropriate pavement design standards.** The application of appropriate pavement design standards based on actual and forecast traffic volumes and loads should be further promoted. This will also require an analysis of the need to upgrade roads, or to limit improvements to pavement strength. This should be done for all project roads in the second project, not just for the ADB financed roads.

122. **Network planning for trunk road maintenance.** This should include the selection of project roads as well as the identification of road segments/sections to be maintained and the types of maintenance to be carried out. The use of the planning modules under CPMS or alternative planning software should be promoted in drawing up a maintenance plan for the whole trunk road network, part of which will be carried out under the second ADB project. This will require inputs from a specialist in road management planning software.

123. **Performance-based contracting for minor maintenance.** Minor maintenance can be carried out using performance-based contracts, which is expected to lead to higher efficiency and effectiveness (especially in light of the high unit costs in Yunnan). It is recommended to include some piloting of this approach in the second ADB project, whereby the existing maintenance gangs can be made responsible for the minor maintenance of certain road sections according to certain performance standards. This may be expanded to

the creation of maintenance microenterprises (or teams) built up of the staff from the maintenance gangs or from community members living along the road concerned.

124. **Funding for trunk road maintenance.** A further analysis and improvement of funding and budgeting for trunk road maintenance should be included under the preparation and implementation of the second ADB project. This should look at the percentage of fuel tax revenue made available to trunk road maintenance, as well as the inclusion of other sources of revenue in the planned maintenance budget. It should also include the timely approval of this budget and the monitoring of both funding (budgets) and expenditure. The focus should lie on the improvement of the funding approval and monitoring processes, rather than on the funding levels themselves.

RURAL ROAD MAINTENANCE

125. In case it is decided to include a rural road component under the second ADB project, the following issues should be looked at.

126. **Funding of rural road maintenance.** A detailed analysis of current funding for rural road maintenance, especially from the fuel tax revenue, should be carried out. This should look closely at how the subsidy is calculated and whether it takes account of the existing road length and the proposed annual growth in funding of 10%, as well as the replacement of the tractor maintenance fee. It should also look into the existing policies in Yunnan regarding the use of these subsidies for routine and minor maintenance, and the relaxation of the existing limitations, especially for unpaved roads. Possibilities of increasing rural road maintenance funding from existing fuel tax revenue should be analysed, in light of the fact that current funding per kilometre for rural roads is one twentieth of that for trunk roads.

127. **Planning, budgeting and monitoring for rural road maintenance.** The planning of rural road maintenance to include all different sources of maintenance revenue, the timely approval of maintenance budgets and the monitoring of maintenance implementation and expenditure in line with plans and budgets, including regular assessment of road conditions, needs to be analysed in detail and improved under the preparation of the second ADB project and its implementation.

128. **Community contracting for unpaved township and village roads.** Based on the experiences of the GAD-funded pilot project and the rural road maintenance component of the first ADB project, community-based maintenance should be promoted further under the second ADB project, especially for unpaved township and village roads.

129. **Team-based or microenterprise-based road maintenance.** For county roads and more important township roads, especially those that are paved, the possibility of introducing maintenance teams or microenterprises should be looked at. These could be made responsible for routine maintenance as well as regular repairs to the road surface under performance-based contracts. Suitable organizational modalities should be looked at.