A Quick Highway Network Health Check Tool – User's Manual

INTRODUCTION

Road agency managers and administrators can assess the needs of their networks and other highway assets and determine the adequacy of their resource allocation efforts by using this quick health check tool[1], which is readily available and can be used with minimum calculations.

Often, an agency needs to know whether its present and planned program actions (reconstruction, rehabilitation, and preservation) will produce a net improvement in the condition of its road network. However, before the effects of any planned actions on the highway network can be analyzed and evaluated, some basic network life concepts need to be understood.

Assume that for every lane-mile of road in a network, the number of years of remaining life (until the terminal condition[2]) is known. If no improvements are made for one year, the number of years of remaining life will decrease by one year for each road segment, except for segments already at zero.

Consequently, the zero-stack will increase significantly because it retains its previous balance and also becomes the recipient of those roads having previously been stacked with one year of remaining service life.

Some highway agencies still continue to assign their highest priorities to reconstructing or rehabilitating their worst roads. However, this practice of **"worst first"** (i.e., continually addressing only those roads in the zero-stack) is a proven death spiral strategy because reconstruction and rehabilitation are the most expensive ways to maintain or restore serviceability of the infrastructure. Furthermore, rarely is sufficient funding ever available to sustain such a wasteful strategy.

Based on the concept of the loss of one year of service life for every elapsed year, the measurable network loss of pavement life can be thought of as the network's total lane-miles multiplied by 1 year, i.e., lane-mile-years. To offset this quantity of network deterioration, the agency would need to perform an annual quantity of work equal to the total number of lane-mile-years lost just to maintain the status quo. Therefore, performing a quantity of work which produces fewer lane-mile-years, while lessening the natural decline of the overall network to some extent, would still fail to maintain the status quo over an extended period. However, if the agency performed more total lane-mile-years of work than the size (lane-miles) of its network, it would improve the network.

By using the Quick Health Check tool, an agency can easily evaluate the effect of an annual program consisting of reconstruction, rehabilitation, and preservation projects on its network. Performing such an assessment involves knowing (or assuming) the

[1] The **Quick Health Check** tool is embodied in an interactive Excel spreadsheet program.
[2] Terminal condition does not mean that a road cannot continue to be used. Rather, it is the lowest acceptable level of operating condition set by management for its road network.

following information required by the Quick Health Check tool.

INPUTS

The following data will be needed to use this tool:

- Network lane-miles
- Project groups,
- Treatment types within each project group,
- Design life or life extension for each treatment type,
- Average cost per lane-mile for each treatment type, and
- Lane-miles of each treatment type.

Within the Excel spreadsheet, the user can select six groups of projects (three each for flexible and rigid pavements) from the drop-box in the Row 3:

1. Flexible reconstruction
2. Flexible rehabilitation
3. Flexible preservation
4. Rigid reconstruction
5. Rigid rehabilitation
6. Rigid preservation

The user is able to select multiple project groups from columns B through L. Based on the project group, treatment types can be selected from drop-down menus in Row 4. For example, the flexible pavement rehabilitation group contains the following treatment choices:

1. Full-depth reclamation,
2. Structural multi-course overlay, or
3. White-topping.

The selection of a treatment type will automatically populate Row 5 with the default design life or life extension (in years) depending upon the treatment type. However, users can override these defaults with their own values of treatment life or life extension based on their local experience.

The next input is the average cost per lane-mile of treatment type within each project group. Finally, the user needs to enter the total network lane-miles in cell B14 and the total annual budget in cell B17. Having entered the above information, the user can start allocating the total treatment lengths (lane-miles) within each treatment type.

When evaluating pavement preservation treatments in this analysis, it is appropriate to think in terms of "extended life" rather than design life. The term design life, as used with reconstruction and rehabilitation, refers to a new pavement's structural adequacy to handle repetitive axle loadings and environmental factors. This concept is separate from pavement preservation. Each type of treatment / repair has unique requirements and benefits that should be matched with the specific nature of a candidate pavement's deterioration. Thus, life extension depends on factors such as type and severity of distress, traffic volume, environment, etc.

OUTPUTS

The user can enter the lane-miles for each treatment selected within the project groups for the road network. The first three group columns (B:D) are used for reconstruction projects (if any). The next three group columns (E:G) are used for rehabilitation projects (if any). In the last five group columns (H:L), the user can choose different preservation treatments. It should be understood that different project groups can be specified within each of these columns.

The first output in Row 8 is the aggregated lane-miles for each of reconstruction, rehabilitation, and preservation. Row 9 displays the percentage of each treatment type, relative to the overall size of the network. Row 10 displays the lane-mile-years contributed by each treatment based on the design life or life extension and number of lane-miles. Row 11 displays the total cost of each treatment based on the treatment cost per lane-mile and lane-miles selected. Cell B13 displays the network's total lane-mile-years. Cell B14 shows the network's gain or loss in lane-mile-years. This quantity is determined by calculating the difference between cells B13 and B12.

If the total lane-mile-years gained by the strategy are greater than the total network size, the health of the road network will improve and vice versa. The network health is assigned a grade based on the difference between lane-mile-years for a strategy and the total network size in lane-miles. Table 1 shows the assessment criteria.

Table 1 Network health assessment criteria

Percent Improvement	Grade
> 10%	A
> 5% and <10%	B
Between +5% and -5%	C
> -5% and < -10%	D
> -10%	F

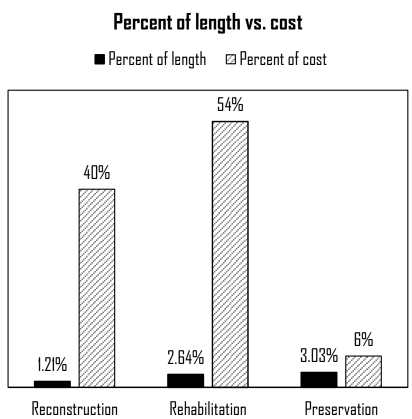
The user will be prompted if the strategy's total cost exceeds the available budget while the treatment lane-miles are being entered. Accordingly, treatment lane-miles can be adjusted to conform to the budget constraint.

DEMONSTRATION EXAMPLES

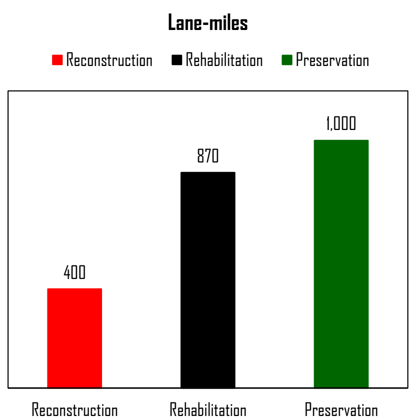
Example 1

Assume an agency has a network size of 33,000 lane-miles and an annual budget of $300 million to improve its road network health. Figure 1 illustrates a fix strategy whose details are shown in Figure 3. It can be seen that this strategy stays within the available budget, but treats more network lane-miles with reconstruction and rehabilitation (R&R) than with preservation.

This example illustrates that if the heavier, more costly treatments are used more extensively to improve a network's health, then less of the network can be treated with preservation in order to stay within the given budget. Such a strategy may not improve the overall health of the network. In fact, this fix strategy adopted in Example 1 will get a grade "F", as the network will lose more lane-mile-years than the network's size in a year.



(a) Percent of network



(b) Lane-miles

Figure 1 Fix Strategy – Example 1

Given this initial result, the next step would be to reduce the quantity of R&R treatments. An agonizing decision must be made about which projects to defer, eliminate, or phase differently within a multi-year horizon.

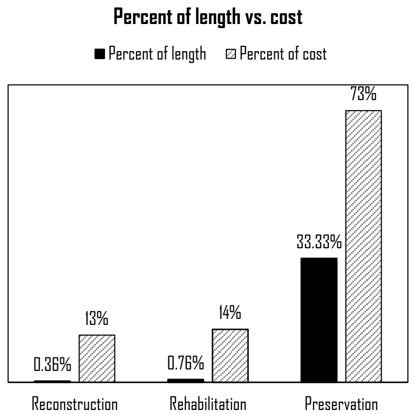
Example 2

For the same network length and budget in Example 1, reduce the quantity of R&R treatments to recover funds for less costly pavement preservation treatments as shown in Example 2.

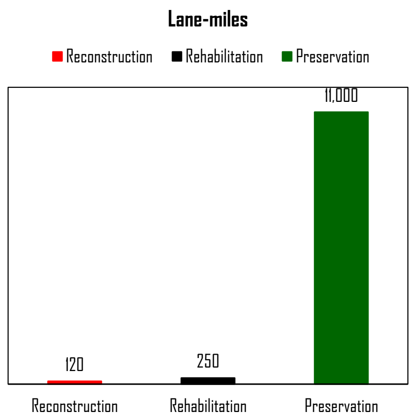
The use of less costly treatments elsewhere in the network to address roads in better condition will increase the number of lane-mile-years restored to the network. A palette of pavement preservation treatments, or mix of fixes, is available to address the network needs at a much lower cost than for traditional methods.

Figure 2 illustrates a revised fix strategy whose details are shown in Figure 4. It can be seen that this revised strategy also stays within the available budget, but treats more network lane-miles with preservation than with R&R.

This example illustrates that if the lighter, less costly treatments, are used more extensively to improve a network's health, then more of the network can be treated with preservation and still stay within the given budget. Such a strategy may improve the overall health of the network. In fact, this revised fix strategy adopted in example 2 will get a grade "A", as the network will gain more lane-mile-years than the network lane-miles in a year.



(a) Percent of network



(b) Lane-miles

Figure 2 Fix Strategy – Example 2

HEALTH CHECK TOOL USAGE

This exercise can be performed for any pavement network to benchmark its current trend. Using this approach, it is possible to see how various long-term strategies could be devised and evaluated against a policy objective related to total-network condition.

Once the pavement network has been benchmarked, it would be possible to make practical adjustments to the programmed results. A decision must first be made whether to improve the network condition or just to maintain the status quo. This is a management decision and would reflect the system goal. Continuing with the previous examples, a strategy may be proposed to prevent further network deterioration until additional funding could be obtained.

Preservation treatments are only suitable if the right treatment is used on the right road at the right time.

In practice, highway agencies would work within their budgets to achieve the greatest improvements in their network conditions. Funds allocated for reconstruction and rehabilitation projects may be viewed as investments in the infrastructure, while funds directed for preservation projects may be seen as protecting and preserving past infrastructure investments. Integrating reconstruction, rehabilitation, and preservation, in the proper proportions will substantially improve network conditions for the taxpayers and the motoring public while safeguarding the highway investment.

A Quick Highway Network Health Check Tool											
Description	Reconstruction			Rehabilitation			Preservation				
Project Group	Frecon	Rrecon	Frecon	Frehab	Frehab	Rrehab	Fpresr	Fpresr	Fpresr	Rpresr	Rpresr
Treatment Type	Fulldepth	JPCP	Multilayer	Structural Multicourse Overlay	Full Depth Reclamation	Rubblize and Overlay	Sand Seals	Chip Seals	Thin Ovrelay	Diamond Grinding	Crack Sealing
Design life/extension (years)	25	25	20	12	15	9	3	4	7	10	2
Cost (lane-mile)	300,000	350,000	275,000	225,000	200,000	115,000	2,500	8,000	15,000	30,000	50,000
Length (lane-mile)	100	100	200	400	200	270	200	300	200	100	200
Sub total	400			870			1,000				
Percent (%) Length	0.30%	0.30%	0.61%	1.21%	0.61%	0.82%	0.61%	0.91%	0.61%	0.30%	0.61%
Lane-mile-years:	2,500	2,500	4,000	4,800	3,000	2,430	600	1,200	1,400	1,000	400
Total Cost	30,000,000	35,000,000	55,000,000	90,000,000	40,000,000	31,050,000	500,000	2,400,000	3,000,000	3,000,000	10,000,000
Sub total	120,000,000			161,050,000			18,900,000				
Percent (%) Cost	40%			54%			6%				

Total Network Length (Lane-miles)	33,000	
Lane-mile-years	23,830	
Network Needs (Loss)	(9,170)	
Total Budget	300,000,000	
Total Cost	299,950,000	Ok
Network Grade	F	

Figure 3 Example 1 – Heavy restoration strategy

A Quick Highway Network Health Check Tool											
Description	Reconstruction			Rehabilitation			Preservation				
Project Group	Frecon	Rrecon	Frecon	Frehab	Frehab	Rrehab	Fpresr	Fpresr	Fpresr	Rpresr	Rpresr
Treatment Type	Fulldepth	JPCP	Multilayer	Structural Multicourse Overlay	Full Depth Reclamation	Rubblize and Overlay	Sand Seals	Chip Seals	Thin Ovrelay	Diamond Grinding	Crack Sealing
Design life/extension (years)	25	25	20	12	15	9	3	4	7	10	2
Cost (lane-mile)	300,000	350,000	275,000	225,000	200,000	115,000	2,500	8,000	15,000	30,000	50,000
Length (lane-mile)	50	50	20	50	100	100	2,000	3,000	2,000	2,000	2,000
Sub total	120			250			11,000				
Percent (%) Length	0.15%	0.15%	0.06%	0.15%	0.30%	0.30%	6.06%	9.09%	6.06%	6.06%	6.06%
Lane-mile-years:	1,250	1,250	400	600	1,500	900	6,000	12,000	14,000	20,000	4,000
Total Cost	15,000,000	17,500,000	5,500,000	11,250,000	20,000,000	11,500,000	5,000,000	24,000,000	30,000,000	60,000,000	100,000,000
Sub total	38,000,000			42,750,000			219,000,000				
Percent (%) Cost	13%			14%			73%				

Total Network Length (Lane-miles)	33,000	
Lane-mile-years	61,900	
Network Needs (Loss)	28,900	
Total Budget	300,000,000	
Total Cost	299,750,000	Ok
Network Grade	A	

Figure 4 Example 1 – Heavy preservation strategy