A5002: Committee on Low-Volume Roads
Chairman: Gerald T. Coghlan

Opportunities for Low-Volume Roads

GERALD T. COGHLAN, *U.S. Department of Agriculture Forest Service*

The coming of the new millennium provides an excellent time to pause and consider where the low-volume road (LVR) community is headed. This paper summarizes issues and opportunities for the LVR community worldwide in the new millennium.

LVRs provide the primary links to the highway transportation system. They provide links from homes and farms to markets and for raw materials from forests and mines to mills, and they provide public access to essential health, education, civic, and outdoor recreational facilities. The LVR link between raw materials and markets is critical to economies locally and nationally in all countries around the world.

Just what constitutes an LVR depends on an individual's perspective. At the high end, LVRs may be two-lane asphalt paved roads with up to 2,000 vehicles per day. A widely recognized LVR definition sets the upper limit at 400 vehicles per day. Some differentiate urban LVRs from farm-to-market rural LVRs. Many LVRs around the world consist of a single lane with gravel or even native surfacing. In some remote areas of the world, LVRs follow travel routes many centuries old. In developing areas, LVRs may be the first steps up from human and animal pack trails, or they may be all-new roads opening new territory. Even in developed areas, low traffic volumes at the ends of the transportation network may warrant roads with low conventional design standards.

LVRs often just evolved, and engineering was an afterthought. Traditionally, LVRs have not provided the volume of business, funding, or glamour to attract and support a specialized field of engineering. When involved with LVRs, engineers used the best information available. They extended their experience and training in higher-standard roads, pavements, or structures to LVR situations, even though they may have recognized the standards as excessive. The Committee on Low-Volume Roads was established to fill this technology gap, to provide a forum for exploring and exchanging experiences on engineering appropriate to LVRs. Interest in LVRs spans the full range of transportation engineering—planning, route investigation, geometric design, pavements, structures, construction, operations, maintenance, safety, and so forth. It is essential to adopt the rather nonspecific definition for LVRs to include rather than exclude people in this forum, while recognizing that the actual engineering standards may vary significantly even within the range of LVRs. Hence, developing liaisons with people with expertise in other specific areas of technology is essential.

The fewer the road users, the less funding is available for road maintenance and restoration, much less engineering. Consequently, LVRs around the world typically need reconstruction and improvement. Many factors in addition to funding further complicate LVR engineering:

- Whereas they carry only 20 percent of the traffic, LVRs include 80 percent of the transportation system mileage.
- Although traffic volumes may be low, vehicle loads may be high.
- Traditional high-volume highway engineering standards may not be appropriate.
- The highest-volume, highest-rate-of-return proposals receive priority for limited research funding.
- Existing LVR conditions sometimes constrain and camouflage high traffic volume demand.
- LVRs often mix unconventional traffic (e.g., farm machinery, bicycles, and oxcarts) with highway passenger cars, buses, and trucks.
- Few data concerning LVR performance, cost, use, and so forth are available.

These challenges provide a wealth of opportunities for enhancing LVR engineering.

FINANCE AND PLANNING

Issues

Insufficient funding is probably the most important issue associated with LVRs. With only 20 percent of the traffic but 80 percent of the mileage in the transportation infrastructure, LVRs cannot compete with the return on investment of the more expensive, much more heavily traveled, higher-speed highways. Also, LVRs often serve the poorer areas of society, and often access tougher terrain than higher-standard highways. One bright spot is the profitability of extractive resources such as timber and mining. Any resource must be sufficiently profitable to support appropriate access, and that access usually involves larger, heavier vehicles, which in turn result in more substantial roadbeds. The resulting roads often serve other LVR needs well for many years.

Limited funding affects the sufficiency of construction and reconstruction projects and the amount of engineering invested in planning, route investigation, and design. However, the most common manifestation of limited funding is insufficient maintenance. As a consequence, LVRs continue to deteriorate annually, being generally in considerably poorer condition than higher-standard highways, with decreasing user service and a growing backlog of essential restoration and improvement needs.

Unfortunately, statements like “20 percent of the traffic but 80 percent of the mileage” and “in considerably poorer condition than higher-standard highways” are based on informed estimates rather than actual data. Another major problem in developing financing and in planning and managing LVRs is the significant shortage of data on inventory, traffic, condition, performance, accidents, and so forth. In many cases, actual construction drawings have been lost or never existed. With incomplete data, investment strategies and funding justifications are inherently weak, and managers cannot demonstrate priorities, quantify disinvestment, or support maintenance needs. An associated concern is the loss of staffing due to unsupported maintenance needs or nontechnical decisions such as organizational downsizing.

Identifying and modeling the social and economic benefits of LVRs are essential elements of transportation improvement proposals. Whereas a variety of efforts are described in papers from the various TRB international conferences on LVRs, there is little agreement or standardization, which creates a fruitful area for further development.

Despite limited funding and few hard data, several significant road performance studies (e.g., in Kenya and Brazil) have provided helpful models for evaluating existing systems and planning improvements or new systems. Unfortunately, engineers seeking this kind of information are often unaware that it exists or do not know where or how to look for it.

Opportunities

It is essential to provide a forum for information exchange and documentation of critical information. This will be accomplished through technical publications and international LVR conferences. There is a need to generate syntheses and statements of research needs to put needs and opportunities before the larger professional community.

Additional opportunities include the following:

- Exploring alternative forums for data (e.g., for inventory, traffic, or performance);
- Reporting successful funding proposals and creative approaches to funding;
- Reporting on examples of planning, modeling, and prioritizing restoration and maintenance (e.g., using an asset management format for displaying disinvestments);
- Reporting on assessing and modeling social and economic benefits; and
- Reporting on successful matching of commercial resource road development and local LVR needs.

MAINTENANCE, OPERATIONS, AND SAFETY

Issues

LVR managers struggle with limited staffs, skills, equipment, funds, and information. Managers struggle to develop models for prioritizing maintenance and standards appropriate to particular road situations. A particularly difficult decision is between investing in maintenance of a road that has deteriorated beyond a maintainable condition or investing in roads for which maintenance may actually prolong performance and service. Different institutional arrangements for LVR ownership, management, and maintenance (e.g., decentralization of ownership, use of the private sector, and self-help schemes) warrant consideration. Information on new maintenance techniques or equipment is difficult to find, often because reports of this nature are not scientific enough to warrant publication in professional journals.

Similarly, experience with systems operation (e.g., seasonal load restrictions and alternatives such as reduced tire pressure) is difficult to find. Conventional sign and safety standards often are inappropriate to LVRs and may even vary significantly within the various levels of LVRs. Further, the accident reduction usually associated with highway improvements does not clearly extend to LVRs because some LVR improvements result in increased speed, which results in increased accidents. This conundrum is not clearly understood, and how we determine productive safety improvements bears further study and analysis.

Opportunities

Some opportunities include the following:

- Exploring alternatives to better exchange experiences on lower-technology topics (e.g., maintenance techniques, equipment, and operations);
- Reporting on alternative approaches to prioritizing maintenance, including condition surveys and translation of conditions into cost-effective maintenance actions;

- Reporting experience with setting different maintenance/service levels and associated standards for maintenance and signing;
- Reporting on new approaches to old maintenance techniques and equipment, as well as new approaches and equipment;
- Reporting on alternative approaches to overall maintenance management (e.g., contracting or privatization versus traditional force accounts maintenance);
- Reporting on different institutional arrangements for LVR ownership, management, and service delivery; and
- Reporting on the benefits of safety improvements and the relationship between safety improvements and reductions in accident frequencies.

DESIGN

Issues

Conventional highway geometric design relates increasing standards to increasing speed, volume of traffic, and user comfort and convenience. LVR design focuses on sufficient access; speed, volume, comfort, and convenience do not usually control. Unfortunately, sufficient and flexible design standards have not been widely agreed on for lower-speed, often single-lane, and even gravel-surfaced LVRs. Some initiatives are under way, including the American Society of Civil Engineers and Federal Highway Administration local low-volume roads and streets guide and the ongoing American Association of State Highway and Transportation Officials project. Certainly other LVR standards are used or are being developed in other countries, but they have not been incorporated into U.S. practice. There is some concern about increased tort liability from reduced design standards for LVRs.

LVRs provide additional design challenges, such as adequate width for large trucks turning on narrow roads, sharp curves, single-lane roads, pavement markings, and bridge and guardrail standards.

Opportunities

Some opportunities include the following:

- Keeping abreast of efforts exploring LVR standards and possibly establishing a clearinghouse for these efforts,
- Reporting on various efforts exploring LVR standards, and
- Reporting on assessing the safety significance and liability of new LVR design standards.

MATERIALS, STABILIZATION, AND SURFACING

Issues

Much of the existing technical information on highway materials, surface stabilization, and surfacing design can be appropriately applied directly to LVR situations. However, the reality of limited LVR funding leads to the need to consider approaches and solutions that might be adequate but possibly less than desirable. Examples include marginal-quality but available aggregates or dealing with sand or clay roadbeds where conventional surfacing materials are not available or are prohibitively expensive. Lower speeds of LVRs may permit greater risk of surfacing failures, in turn permitting lower-intensity route investigations. Also, the nature and roughness of lower-speed LVRs may permit or even necessitate wider consideration of materials, construction equipment, and construction techniques.

The remote location of many LVRs encourages the need for creative uses of local materials, old technologies, and new materials. There are many examples of creative solutions in the literature (e.g., fly ash; wood chips; paper sludge; asphalt- and portland cement–stabilized sands; and ash-, lime-, and cement-treated clays). There are new applications for geosynthetics, new pavement concepts such as flexible portland cement concrete and thin concrete overlays, reinforced earth and massive stone bridge abutments, and recycled-tire retaining walls. There is also potential for wildly new ideas (e.g., heat-fusing sand or clay to create an in situ or local glass or ceramic aggregate).

The seriously deteriorated condition and special character of LVRs offers a significant challenge in developing and applying strategies and equipment for the investigation of restoration and design.

Opportunities

There will be a need to provide a forum for the exchange of creative experiences in investigation standards and methods, stabilization materials and equipment, materials specification and testing standards, and surfacing design.

RESTORATION AND IMPROVEMENT

Issues

As discussed earlier, there is a significant need for restoration and improvement of LVRs. Resurfacing needs may be the most apparent. Other needs include improved width, drainage, structures, and so forth. A more recent consideration involves protecting the environment (e.g., correcting erosion problems, providing for fish passage through culverts, and stabilizing slopes).

Access; availability of materials, equipment, and skilled workforces; and unconventional designs often add significant challenges to LVR construction. The experiences of others in dealing with these types of situations could be helpful in developing the construction package, informing contractors of what to expect, and planning project administration.

Opportunities

Some opportunities include the following:

- Reporting on restoration project development, justification, prioritization, cost estimating, and accomplishment;
- Reporting on creative resurfacing investigations, designs, and construction;
- Reporting on alternative approaches to construction (e.g., force account, equipment rental, competitive bid versus cost-plus, etc.); and
- Reporting on alternative approaches to contract administration and quality control.

DRAINAGE AND STRUCTURES

Issues

Many LVRs evolved rather than being designed, and many drainage structures are old and poorly maintained. Also, traffic loads have increased, as have performance expectations (e.g., for fish passage and storm capacity). Consequently, there are many LVR needs for drainage and structural improvements. In some locations, only limited hydrologic design data are available. Remoteness of locations may make creative use of local materials more attractive or economical. Considerations such as low water crossings versus bridges, bioengineering technologies, locally rolled culverts, and massive stone or reinforced earth abutments may be appropriate. A number of new approaches to designing and constructing timber structures and restoring existing timber structures are being explored. These new technologies may not only permit consideration of local timber materials but also provide a springboard to new local economic developments.

Opportunities

Again, a forum for exchange of creative experiences in the design, inspection, maintenance, and construction of drainage and structural systems is much needed.

ENVIRONMENT

Issues

Around the world, there is a growing awareness and concern for protecting the environment. Global sustainability summits, current U.S. revisions to the Clean Water Act, and increased drainage discharge permit requirements are examples. These concerns involve highway, including LVR, effects on wildlife habitat, fish, domestic water quality, sedimentation, and mass wasting. Of particular concern is that LVRs are often in stream bottoms and in more rugged, mountainous terrain, and they often involve limited skills and investments. LVRs also follow the routes most attractive to people driving for pleasure and to view wildlife. Appropriate standards for vistas, guardrails, and so forth are needed. Public concerns are increasingly leading to environmental assessments, public involvement, documentation of impacts, and consideration of alternatives and mitigation before decisions to proceed with transportation projects.

Opportunities

There is a need to create a forum for the exchange of creative experiences and alternative standards for environmental protection and restoration and the provision of appropriate amenities for users.

SKILLS, RESEARCH, AND TECHNOLOGY TRANSFER

Issues

Shortage of LVR technical skills and limited technology development derive from several causes. Colleges do not provide training focused on LVR needs. Skills in low-technology aspects of LVRs often come from years of experience and get lost through retirements and downsizing. Traditionally, LVRs have not had the glamour and funding of larger highway projects and therefore have not attracted engineers or research. The low-technology skills and experiences fundamental to operation and management of LVR systems have not been reported sufficiently in scientific and professional journals.

A by-product of this situation is that many fundamentals, creative experiences, training tools, and so forth are lost, and time is spent in reinvention. Exchange of experiences, tools, and ideas; new approaches to old techniques and equipment; and extension of new and high-technology solutions to LVRs requires optimizing communications between organizations involved in LVRs. Surprisingly, there are a number of potential partners in LVR skill and technology development, exchange, and maintenance. A brief list includes TRB’s Committee on Low-Volume Roads, the Federal Highway Administration’s Local

Technical Assistance Program, the American Society of Civil Engineers, the National Association of County Engineers, the World Road Association (PIARC), and the Transport Research Laboratory.

Opportunities
Some opportunities include the following:

- Identifying links between LVR partners and making them stronger,
- Increasing awareness of LVR subjects in engineering curricula,
- Forging a strong partnership with technology transfer organizations, and
- Seeking ways to document and communicate LVR technology experiences and exploring electronic communications opportunities.