



TECHNICAL SUMMARY

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PROJECT COST:

\$71,638



Rodent nests within the drainage pipe are one of the more common maintenance problems for subsurface drainage systems.



RESEARCH
SERVICES SECTION

Subsurface Drainage Manual for Minnesota Pavements

What Was the Need?

When water finds its way underneath roads, the roadway foundation will gradually weaken, causing the surface pavement to eventually fail. Avenues of entrance for water are numerous. For instance, water can infiltrate the surface or enter the foundation from the shoulder, or groundwater may rise up from below.

A [study conducted by the National Cooperative Highway Research Program](#) estimated that excess water reduces the service life of pavement systems by more than half. Although surface drainage practices will prevent some of this damage, subsurface drainage is required to fully address the problem.

An abundance of information is available to cities and counties for dealing with various highway problems, but there was not a single, definitive manual for addressing pavement subsurface drainage.

What Was Our Goal?

The objective of this project was to draw from existing literature and the expertise of practicing design engineers and highway managers to create a manual that would be specific to Minnesota conditions, taking into account the variability of the soils, hydrology and climate of the state.

This manual would be useful to all personnel involved in drainage needs assessment, design, construction, cost-benefit analysis and systems maintenance. The project also offered the hope of demonstrating the cost benefits of subsurface drainage so that practitioners would have an incentive to use the manual to assess their own drainage situations.

What Did We Do?

Investigators conducted a detailed literature review of all available research information and guides that have been assembled by federal highway agencies and industry associations. They compiled and augmented this information to create a design, construction and maintenance manual documenting best practices for pavement types and situations commonly found in Minnesota in six different areas:

- Methods for evaluating the need for subsurface drainage
- Selection of the type of drainage system to use
- Design of the drainage system
- Guidelines on how to construct and install subsurface drainage
- Proper maintenance of a drainage system
- Methods for conducting an economic analysis of subsurface drainage

Appendices to the guide provide recommended procedures, design plans, charts and tables, and additional examples.

What Did We Learn?

The manual identifies key factors determining the need for subsurface drainage, including traffic loads, climatic factors, pavement type and condition, subgrade characteristics, and design features such as pavement thickness and shoulder design. Consideration is also given to how much free water is permeating the pavement subbase and base layers,

“This manual will be a good tool for engineers to reference when making decisions about subsurface drainage systems.”

–Dan Sauve,
Clearwater County
Engineer

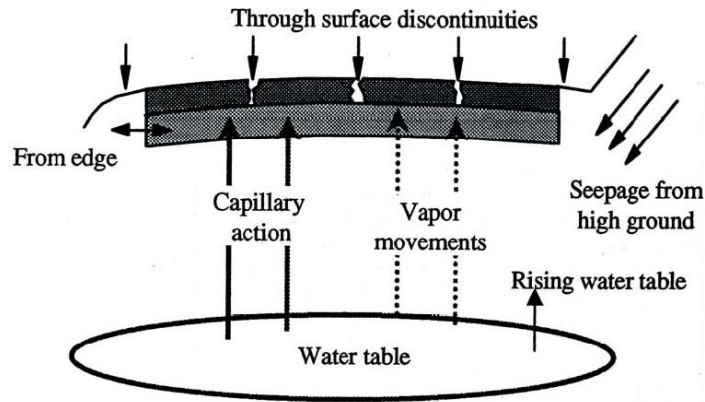
“We had the unique challenge of creating something that currently did not exist anywhere in the world. Initial feedback from engineers indicates that we have successfully done that.”

–Alan Rindels,
Mn/DOT Senior Engineer

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This diagram depicts avenues for moisture to reach the subsurface of a roadway. The main source of water infiltrating into pavement structural sections is from precipitation.

and determining whether this water is causing damage and whether it can be removed in a timely and cost-effective fashion.

Selecting a subsurface drainage system is in part determined by the type of pavement. Concrete pavements generally have lower permeability than asphalt pavements and will more effectively impede water infiltration into the subgrade layer. Data requirements for design and construction of drainage systems will vary depending on whether the system is a retrofit to an existing pavement, an installation for new pavement or a reconstruction.

Regular maintenance of pavement subsurface drainage systems is essential to the drainage system’s long-term success and, subsequently, to the life of the pavement. The manual addresses common maintenance problems such as vegetative growth around the drainage pipe outlets, rodent nests, mowing clippings and sediment collecting on rodent screens at pipe openings.

A number of studies reviewed for this project have reported on the cost-effectiveness of subsurface drainage. [One study](#) comparing cost and performance data found that the addition of drainage systems resulted in a minimum increase of four years of service life for asphalt pavements and a 50 percent increase in the life of concrete pavements. A general recommendation for the incorporation of subsurface drainage systems is that their total costs should never exceed 2 percent of the total installation costs of the pavement structure.

What’s Next?

This project created a manual that did not previously exist. Initial feedback from drainage engineers has been positive, and as more engineers and managers begin to use this manual to assess their own particular subsurface drainage needs, there will be opportunities to respond to their feedback by further tailoring the manual to their needs.

This project was carried out in conjunction with other efforts to refine subsurface drainage best practices; [LRRB Report 2009-08, “Evaluating Roadway Subsurface Drainage Practices,”](#) for example, evaluated the comparative value of centerline and conventional edge drain systems.

This Technical Summary pertains to the LRRB-produced Report 2009-17, “Subsurface Drainage Manual for Pavements in Minnesota,” published June 2009. The full report can be accessed at <http://www.lrrb.org/PDF/200917.pdf>.