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LRRB
LOCAL ROAD RESEARCH BOARD

TECHNICAL SUMMARY

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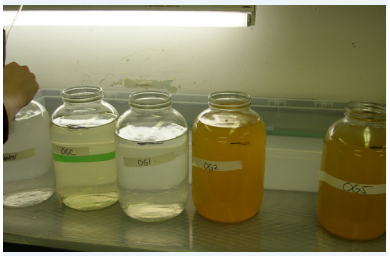
PROJECT COST:
$57,872



Water samples were collected unfiltered in precleaned polyethylene bottles and kept on ice until delivered to the laboratory.

MINNESOTA DEPARTMENT OF TRANSPORTATION
RESEARCH SERVICES SECTION

Assessing the Environmental Impact of Tire Shreds Used Below the Water Table in Road Base Fills

What Was the Need?

Scrap tires are sometimes recycled by being shredded and reused for a number of purposes, including in artificial reefs and as a lightweight fill material for road base construction. Mn/DOT currently uses tire shreds for road bases constructed above the groundwater table through a standing beneficial use determination from the Minnesota Pollution Control Agency. Recent studies have also shown promise for using tire shreds below the water table as a buoyant lightweight fill in wet road bases.

However, it is not currently legal in Minnesota to use tire shreds below the groundwater table because it is not clear to what extent tire shreds leach chemicals into surface and groundwater. While several laboratory and field studies have analyzed tire shred leachate for inorganic materials, organic chemical content has not been comprehensively studied. Further, only a few projects have studied the toxicity of this leachate to aquatic life.

More research was needed on the environmental impacts of tire shreds before they could be used for road construction below the groundwater table.

What Was Our Goal?

The purpose of this study was to determine the environmental effects of chemicals leached from tire shred materials placed below the seasonal groundwater table for use as a lightweight fill in wet road bases.

What Did We Do?

In November 2002, Mn/DOT constructed a low-traffic-volume road section using more than 7 million pounds of tire shreds from a mixture of glass- and steel-belted tires. These tire shreds were enclosed in a geotextile fabric and placed in the road base. Mn/DOT then installed groundwater monitoring wells near this site as well as one background control well.

After three years, researchers analyzed surface and adjacent well water samples for numerous properties, including pH, temperature, metal content and the levels of eight semivolatile organic chemicals identified in other tire material field studies.

What Did We Learn?

Results indicated elevated surface and groundwater chemical concentrations and metal levels, including for chemical oxygen demand, total suspended solids, specific conductance, barium, iron and manganese. Researchers also found an increase in levels of four out of eight of the tire-related semivolatile organic chemicals: aniline, benzothiazole, 2-hydroxybenzothiazole and 4-acetylmorpholine. The concentration of aniline was of particular concern since it exceeded the limit of 10 parts per billion prescribed by state drinking water regulations.

These materials appeared to be leached from the road base, and their concentrations varied in proportion with the thickness of submerged tire shreds. However, concentrations were largely retained within the geotextile fabric wrap. While none of the tire-related organic chemicals was detected in samples collected outside of the road base, barium, iron, manganese and possibly zinc appeared to be migrating beyond the fabric wrap.

continued

"This study was unique in its scale and longevity, and yielded important results not measured in previous studies, including the aniline levels, which are critical to drinking water regulations."

–Robert Edstrom,
Chief Toxicologist,
Mn/DOT Office of
Environmental Services

"Minnesota counties were concerned about leaching from its tire shreds projects but didn't have any real data. This effort provided an opportunity to evaluate the real-world response to tire shreds, both chemical and biological, of the aquatic environment."

–Dan Warzala,
Research Project
Coordinator, Mn/DOT
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Shredded tires were placed within a layer of geotextile permeable fabric and enclosed in "burrito wrap" fashion to form the new road base. This wrap was used to keep the tire material from migrating into the soft undersoils.

Researchers also found significant levels of ammonia in the groundwater, but could not positively identify its source. Although the ammonia may have originated from a sod farm adjacent to the study area, the relatively consistent and elevated concentrations found in the ground as opposed to surface water suggested that tire shreds were a possible source.

Finally, while leached organic materials did not affect the viability of all vertebrates—midges, for instance, appeared unaffected—ecotoxicity testing showed an increase in the mortality of fathead minnows as well as a negative effect on the mortality and reproductive rates of water fleas. This toxicity also appeared to be largely confined within the road base fabric wrap.

What's Next?

This study is unique in that no other field studies have used a geotextile fabric wrap or such a large mass of tire shreds. Results showed that the use of this wrap was environmentally beneficial, limiting the leaching of chemicals from tire shreds by restricting water flow through the road base.

Further, while most studies have measured the environmental effects of tire shreds only within the first 24 months of placement, this study monitored the water quality from the third year to the fifth year of the road base life cycle. These field results have now been made available to resource managers nationwide, so that they may be used to assess the accuracy of bench-scale studies.

Additional research is needed into how harmful tire shred leachates are to the environment, and in a follow-up study already under way, researchers plan to continue to look for similar studies nationwide to assess leachate toxicity. Researchers also recommend continued monitoring of the study's key parameters, including aniline, specific conductivity and total organic carbon.

This Technical Summary pertains to the LRRB-produced Report 2009-02, "Oak Grove Tire Shreds Project: Tire Shreds below the Seasonal Groundwater Table, Years 2006-2008," published November 2008. The full report can be accessed at http://www.lrrb.org/PDF/200902.pdf.