TEXAS TECH UNIVERSITY
CENTER FOR MUTLIDISCIPLANARY RESEARCH IN TRANSPORTATION

Project Summary Report 4974-S

Project 7-4974

Authors: Audra Morse, Phillip T. Nash, Sanajaye Senadheera, Andrew Jackson, Richard Tock, Jeremy Leggoe, and Tony Mollhagen

RESEARCH PROJECT SUMMARY

Environmental Characteristics of Traditional Construction and Maintenance Materials: Summary

TxDOT, as well as many other governmental agencies and private industries, is trying to do the three R's—reduce, reuse and recycle. TxDOT has a recycled materials program, which encourages the use of recycled material in TxDOT's construction and maintenance operations. To date, nonhazardous recycled materials (NRM's) have been required to meet environmental standards (DMS-11000, 2000) while the traditional materials the recycled materials are replacing are exempt from environmental regulation, creating a double standard for materials used in DOT applications. Thus, the purpose of this research is to develop a baseline of environmental standards for traditional materials to which NRM's can be compared. These standards will be based on water quality parameters of traditional materials as well as 30 TAC 335, Subchapter S and 30 TAC 350, regarding the Texas Risk Reduction Program.

What We Did...

A literature and state survey was completed to determine if other states had evaluated the environmental impacts of traditional construction and maintenance materials. Eight states provided written information regarding their environmental policy for the use of traditional or recycled materials used in DOT applications. None of the states participating in the survey had regulations to address the environmental impacts of conventional aggregate, bituminous binders, or portland cement. The use of fly ash is regulated by many of the states, with most concern focusing on the contamination of groundwater from fly ash leachate.

Materials investigated in this project include aggregate (limestone, caliche, siliceous gravel, siliceous sand, limestone rock asphalt, and sandstone), cement, lime, bottom ash, fly ash, reclaimed asphalt pavement (RAP), recycled concrete pavement (RCP), and bituminous binders.

Figure 1. Graphite Furnace Atomic Absorption Spectrometer

Matrix materials were portland cement concrete with fly ash or RCP. The different types of bituminous binders evaluated include AC-3, AC-5, PG 64-22, PG 70-22, PG 76-22, MG-10-30, AC-15-5TR, and a patch mix. Cutbacks (MC-30) were also evaluated in this project. Criteria used to select sources of traditional materials tested for this project was (1) volume of use, (2) number of potential material suppliers, (3) suppliers' location.

Leachate analyzed in this project was produced using the Synthetic Precipitation Leachate Procedure for all materials excluding the cutbacks, which was prepared for analysis by the Waste Dilution procedure. All procedures used in this project were obtained from SW-846, "On-Line Test Methods for Evaluating Solid Waste Physical/ Chemical Methods" provided by the U.S. Environmental Protection Agency. The analysis of the leachate from the materials listed above was divided into two categories, metal analysis and semi-volatile organic compound (semi-VOC) analysis. The bituminous binders, cutbacks, and RAP were analyzed for semi-VOC's using a gas chromatograph mass spectrometer (GC/MS), and the metal analysis was performed on the remaining materials, including RAP. Metal analysis was completed using direct aspiration or graphite furnace atomic absorption techniques. Metals examined in the project include aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, silver, selenium, thallium, vanadium, and zinc.

The detection limits used in this project were based on Texas Risk Reduction Standard 2 (RRS2) as provided in 30 TAC 335, Subchapter S, which is specified by DMS-11000, "Guidelines for Evaluating and Using Nonhazardous Recyclable Materials (NRM's) in TxDOT Projects." These values were used to set the detection limit and to determine if the material leachate concentration exceeds the values specified. Henceforth, the values provided in Subchapter S will be referred to as the RRS2 value. Due to a change in the environmental standards midway through the research project, the final recommended values are based on the Texas Risk Reduction Program (TRRP) found in 30 TAC 350.

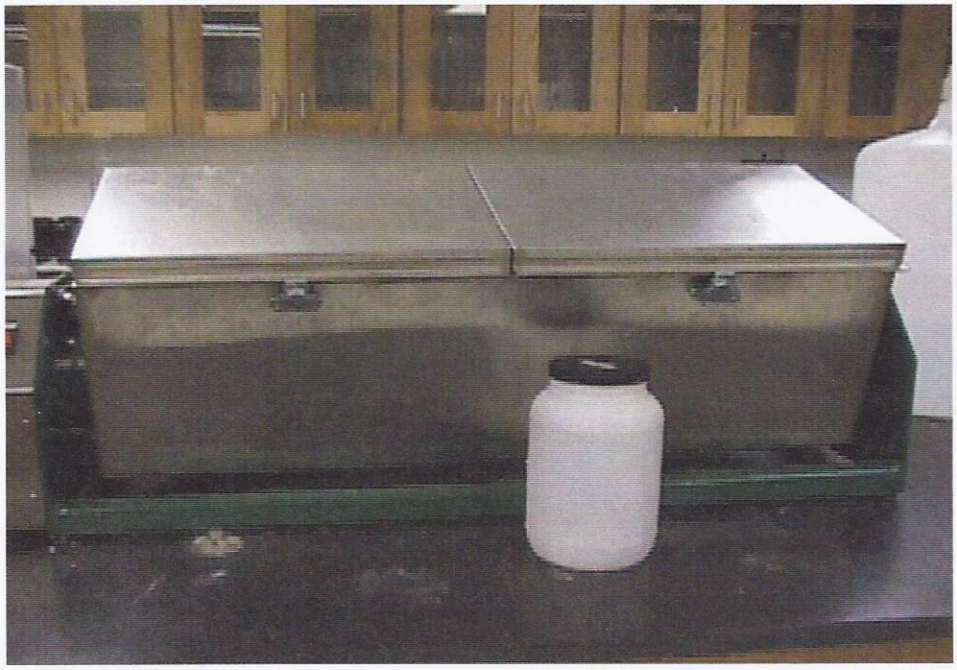

Figure 2: Extraction Vessel and Tumbler

What We Found...

The results of the metal analysis varied according to the material tested. In general, the materials having samples with metal concentrations detected above the RRS2 value are sandstone, siliceous sand, caliche, fly ash, lime, siliceous gravel, cement Type I/II, bottom ash, RCP, RAP, and the matrix samples (Portland cement concrete (PCC), PCC-fly ash, and PCC-RCP. The most common metals having detectable sample concentrations greater than RRS2 are antimony, lead and barium. For more detailed information regarding the results of the metal analysis, please see Report 4974-1, "Environmental Charactistics of Traditional Construction and Maintenance Materials."

The results of the semi-VOC analysis of the bituminous binders analyzed were similar. The bituminous binders were analyzed for 64 semi-VOC, all of which had concentrations less than the minimum detection limit of 5 µg/L.

The results of the cutback materials range from 1.294 to 0.100 mg/kg.

Table 1: Maximum Allowable Metal Levels for NRM's (µg/L)

Metal	Aggregates	Cementitious Materials	Asphaltic Binders
Aluminum	24,000	24,000	24,000
Antimony	13	6	6
Arsenic	50	50	50
Barium	2,007	5,565	2,000
Beryllium	4	4	4
Cadmium	5	5	5
Chromium	100	162	100
Cobalt	1,500	1,500	1,500
Copper	1,300	1,300	1,300
Lead	16	47	15
Manganese	1,100	1,100	1,100
Mercury	10	3	2
Molybdenum	120	237	120
Nickel	490	490	490
Selenium	50	77	50
Silver	120	120	120
Thallium	2	2	2
Vanadium	170	287	170
Zinc	7,300	7,300	7,300

Most of the compounds analyzed had concentrations less than the detection limit. Twenty-eight of the 64 compounds had concentrations greater than the minimum detection limit. For more detailed information regarding the results of the semi-VOC analysis, please see Report 4974-1.

The Researcher Recommends...

After reviewing the results of the traditional construction and maintenance material analysis generated during the testing phase of this project and comparing these results to many regulatory values, recommendations have been developed for determining the environmental applicability of using recycled materials in TxDOT construction and maintenance operations. It is recommended that leachate from SPLP procedure for recycled materials for the metals analyzed be equivalent to the TRRP concentration or the highest metal concentration detected for the group of materials analyzed. For example, if someone is proposing using a nonhazardous recycled material (NRM) as an aggregate replacement, then for the metals analyzed, the concentrations in the SPLP leachate should not exceed the recommended value. When evaluating a cementitious material for vanadium, the average SPLP leachate concentration should be less than 287 µg/L (the recommended value), which is greater than the TRRP value of 170 µg/L.

Table 1 contains the maximum recommended metals values for recycled aggregates, cementitious materials, and asphaltic binders. At the request of TxDOT, Table 1 has been simplified by consolidating the many material categories into three categories taken from the original table in Research Report 4974-1.

For More Details...

The research is documented in the following report:

Report 4974-1, Environmental Charactristics of Traditional Construction and Maintenacne Materials: Final Report.

Research Supervisor: Phillip T. Nash, P.E.
Project Director: Gerald Peterson

To obtain copies of the reports, contact the Research and Technology Implementation Office, (512) 456-7716.

TXDOT IMPLEMENTATION STATUS

August 2001

The research will be utilized by TxDOT to enhance and promote the use of nonhazardous recycled materials (NRM's). The research established the environmental applicability of using NRM's in TxDOT construction and maintenance operations. TxDOT will make modifications to its specifications for NRM's based on the results of this research. This research directly supports TxDOT's efforts to increase the use of NRM's in TxDOT business operations.

For more information, please contact: Bill Knowles, P.E., RTI Research Engineer, at (512) 465-7648 or email at wknowle@dot.state.tx.us.

Your Involvement is Welcome...

This research was performed in cooperation with the Texas Department of Transportation and the U.S. Departmartment of Transportation, Federal Highway Administration. The content of this report reflects the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FWHA or TxDOT. This report does not constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes. Trade names were used solely for information and not for product indorsement.