Vol. 1, Issue 2. Winter, 1985

TECHNICAL QUARTERLY

AN EXCHANGE OF IDEAS
Editors:
Richard L. Tyler Kathleen M. Jones

IN-PLACE RECYCLING WITH THE WIRTGEN REMIXER

The severe rutting of asphalt has become a significant problem in Texas, as well as in many other western states, over the last several years. Many approaches are being taken to try to solve this complex problem. One approach is in-place recycling. While in-place recycling in itself is not a new procedure, there is a new type of equipment, the Wirtgen Remixer, built by the Wirtgen Company of West Germany.

The Wirtgen Remixer differs from more familiar types of recyclers in that it is equipped with a twin shaft, compulsory pugmill mixer into which new material can be metered and thoroughly mixed with the reclaimed material to produce an homogeneous mix before it is relaid on the roadway. It also differs in that it does not use open flame for heating the HMAC. Instead, the heaters operate somewhat like old-style gas space heaters: flames heat ceramiclike plates and these plates radiate heat into the pavement. As the machine is moving forward, new material can be loaded into the front hopper. The mixture is carried by an inclined conveyor belt to a surge bin which functions as a proportioning hopper. The proportioning hopper drops the correct amount of the mixture onto the heated horizontal conveyor belt which, in turn, drops the mixture into the pugmill. In the pugmill the new mixture is blended with the reclaimed HMAC. The scarifier rides in front of a windrowing auger which directs the reclaimed HMAC into the scoop-bladed front of the pugmill. The length of time the new and reclaimed materials are mixed is dependent on the forward speed of the machine. Constant for-

INSIDE...

Front view of Wirtgen Remixer

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ward speed ensures an homogeneous mixture is conveyed to the variable screed. District 11 recently has completed a field trial with the Wirtgen Remixer and has done a preliminary assessment of its capabilities.

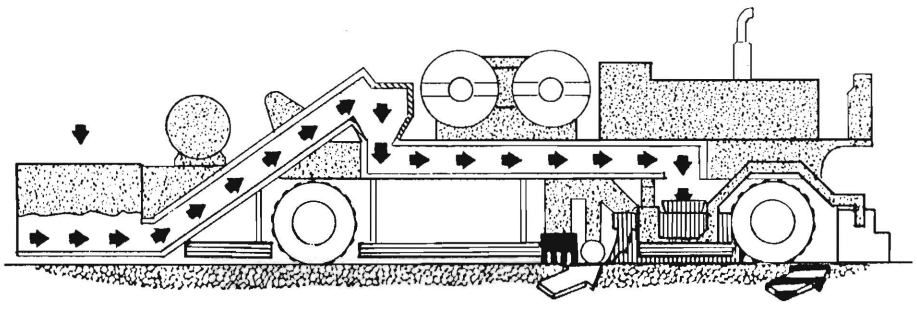
The project limits of this District 11 field trial are between Lufkin and the Neches River on US 59, northbound travel lanes. During the winter of 1980-81, an HMAC overlay of 1½ inches of Item 292 Type "A" base with 1 inch of Item 340 Type "D" riding surface was placed. The mix design utilized a feldspar rock, rhyolite, in the coarse aggregate, since a high polish value of 35+ was required due to the high traffic volume of 20,000 ADT. The mix design was "sensitive" in that small increases of asphalt content above the optimum resulted in a significant decrease in Hveem stability and reduced air voids. During the summer of 1981, the mix became unstable and began to rut severely.

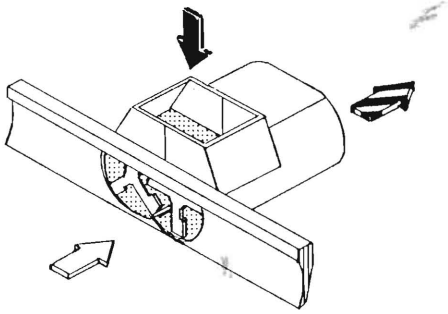
Two alternatives were considered as remedial action. The first involved completely removing the distressed HMAC by cold milling and replacing it with a new overlay. The cost for this operation was estimated at $2.25 to $2.50 per square yard per inch of depth. The second alternative involved in-place recycling to restore stability to the existing HMAC via a mixture of a small percentage of a lean hot mix. Lab tests indicated that an addition of 20 percent of a lean, 4 percent asphalt-content mix would indeed adjust the voids in the mineral aggregate, air voids and, ultimately, Hveem and Marshall stabilities to acceptable levels. This alternative was estimated at $1.25 to $1.75 per square yard per inch of depth. Due to funding constraints, consideration of the availability of the latter technique and its history of success, the decision was made to recycle in-place.

The sole distributor of the Wirtgen equipment, Remixer Contracting Company, Inc. bid the project at $1.33/sq yd for 1 inch depth and $1.66/sq yd for 1½ in. depth recycling. The material to be added to the existing mixture was supplied by the State at rates specified by the Engineer. A 4 percent asphalt, lean, new mix was used initially, but this was soon replaced by a 3 percent asphalt mix. Subsequently, after a short trial section of a 2 percent asphalt, precoated limestone coarse aggregate proved more successful than other additives, a switch was made to this formula. In all cases, 20 percent of the new material was metered into the recycled mix, resulting in a 20/80 ratio of new to old HMAC.

Of the other test sections laid down, one short section (less than 200 feet in length) was placed using a cold Grade 3 rock asphalt at a 20 percent induction rate through the hopper system of the machine. The results were not impressive, although not catastrophic. The mat was segregated and looked worse

The Wirtgen Remixer





Detail of the pugmill

Indirect infra-red heaters

Fresh hot mix asphaltic concrete

Proportioning hopper

Scarifier

Entrance to pugmill for reclaimed HMAC

Pugmill

Screed for spreading blended new and old HMAC

The mentioning of brand names used is strictly for informational purposes and does not imply endorsement or advertisement of a particular product by the Texas State Department of Highways and Public Transportation.

than any of the other variations which had been tried. However, it appeared stable and has not shown any signs of raveling. Another short section (approximately 500 feet) was placed using a cold precoated (2 percent asphalt) limestone aggregate sprinkled on the pavement ahead of the preheater by a chip spreader at the rate of 1 cu yd/120 sq yd. This produced a very acceptable mat, possibly superior to all others placed. This finding is significant in that it has shown that this process can be used in locations where a hot mix plant is not available to furnish hot precoated new material. A third test section involving the recycling of an existing open-graded friction course has resulted in limited success. A fourth test section using non-precoated rock sprinkled ahead of the preheater worked very well. The non-precoated aggregate became well coated with asphalt when it made its way into the pugmill. This test section produced a mat that was nearly as good as the cold, 2 percent asphalt, precoated limestone aggregate section.

Although not bid as part of the original contract, a one thousand foot test section utilizing lightweight (synthetic) aggregate was placed in the southbound lane. There was concern that the lightweight aggregate, being very porous, would not transmit heat very effectively and consequently would not produce a consistent mat. Fortunately, the aggregate absorbed enough asphalt to enable sufficient heat to be transmitted, and an acceptable mat resulted.

The Wirtgen Remixer used is the only one of its kind in the United States, at the present time. It conforms with Special Specification to Item 3199 which states that the processing equipment for in-place recycling must have:

1) A heating mechanism capable of heating the asphaltic concrete pavement surface to a temperature high enough to allow scarification of the material without breaking aggregate particles, without charring the pavement, and without producing undesirable pollutants. The heating mechanism shall be so equipped that heat application shall be under an enclosed or shielded hood.

2) Scarifier sections capable of uniformly loosening the asphaltic pavement.

3) A leveling unit capable of gathering the heated and scarified material into a windrow or otherwise collecting for remixing, and of distributing over the width being processed and finishing so as to produce a uniform cross section and surface.

4) A system for adding and uniformly blending additional aggregate or fresh hot mix asphaltic concrete. The application rate for the additional material shall be synchronized with the machine speed to provide uniform application.

Wirtgen Remixer in action at Lufkin.

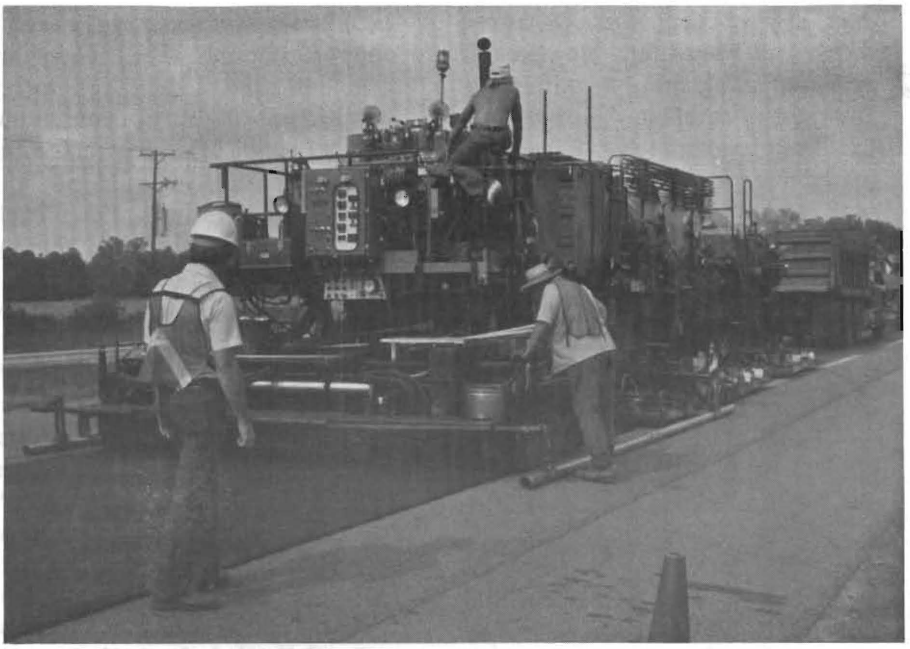
The Wirtgen equipment did a very adequate job of heating the pavement to the full 1½ in. depth; milling the heated pavement to the full 1 ½ in. depth; blending the old and new mix; and relaying the 20/80-blended HMAC.

If there are any complaints with the finished product to date, they would be with ride quality. However, it should be noted that the "before" ride quality as measured by the Mays Ride Meter was 2.0 to 2.5 and the "after" ride quality was 3.0 to 3.5 for an overall improvement of 1.0 numerical value, which is significant. Also, the Wirtgen equipment appears to require a great deal of experience in handling it to bring out its full potential: it produced a much smoother mat in the hands of the German operator who was very familiar with it than it did on automatic in the hands of operators who were not familiar with it. The German operator was able to lay down sections that had "after" Mays Ride Meter readings of 4.2 to 4.5, and even one reading of 4.9.

In noting the effect the processing has on the asphalt as compared to

the original asphalt properties, it appears that with a few limited areas as exceptions, the asphalt has retained much of its penetration, ductility and viscosity values resulting in an asphalt very much like an AC-40 grade on the roadway.

To fully evaluate the recycling process, a series of laboratory tests were conducted. It is noteworthy that the mixture after processing is significantly improved as indicated by the VMA, Hveem stability, Marshall stablilty, Marshall flow, indirect tensile modulus, and roadway densities. The complete set of laboratory data can be found in the newly published Experimental Projects Report 604-2, along with test section diagrams, cost analysis, and other pertinent figures.



Rear view of Wirtgen Remixer showing variable screed.

THE FIRST PAVING EQUIPMENT

The concept of an asphalt pavement seems to have developed independently in various locations more or less by accident early in the 19th century. At that time rock asphalt deposits and natural asphalts were being used to produce mastics and various building products. Peckham states that it was observed that particles of asphaltic materials fell from carts to form excellent roads...The same evidence was found in the Rhone Valley, Trinidad, and California, and the idea that roads could be built from these materials was inevitable wherever it was observed... Thus, the first paving equipment was sloppy carts which could not contain their cargo but which could squash their own dribblings to yield a satisfactory pavement.

*D.G. Tunnicliff, R.W. Beaty, E.H. Holt, "A History of Plants, Equipment and Methods in Bituminous Paving", **Proceedings of the Association of Asphalt Paving Technologists Technical Sessions**, 43A (1974): 160.*

RECENT PUBLICATIONS

Asphalt Pavement Rutting in The Western States; Two Texas Lectures and the WASHTO Report, P. Krugler, J. Mounce, Beteson et al., State Dept. of Highways and Public Transportation, Austin, Jan. 1985, 97p.

Use of Wirtgen In-place Recycling Equipment in Lufkin, District 11, Exp. Proj. 604-2, SDHPT, Austin, Jan. 1985, 18p.

THE TRANSLATED TRANSPORTATION BLUES

A large percentage of technology transfer is done via technical writing. In some respects, technical writing is akin to foreign language translation. However, technical writing—the art of coaxing scientific terms to trade places with more common words without disturbing the meaning—has far fewer pitfalls, less accidental humor, and less of the odd flashes of insight than the skewed perception of faulty translation has. For instance, where in Texas regulations or DHT reports and studies could be found anything as whimsical as this paragraph from Tokyo traffic regulations, translated for use by Americans:

> When a passenger of the foot heave in sight, tootle the horn, trumpet at him melodiously at first, but if he still obstacles your passage, tootle him with vigor, express by mouth the warning Hi,hi! Beware the wandering horse that he shall not take fright as you pass him by. Do not explode the exhaust box at him. Go soothingly by. Give big space to the festive dog that shall sport in the roadway. Go soothingly in the grease-mud as there lurks the skid-demon. Avoid the tanglement of the dog with your wheel spokes. Press the braking of the foot as you roll around the corner to save collapse and tie-up. [1]

*1. Bill Horton, "From the Land of the Rising Standard of Living," reprinted in **The Austin Communicator** 4 (Jan. 1985): 5.*

SUPPLEMENT

6th Annual National Road & Street Maintenance Conference
and Product/Equipment Display

April 30, May 1 & 2, 1985
Oklahoma City, Oklahoma
Lincoln Plaza Hotel and Convention Center

The 6th Annual National Road and Street Maintenance Conference and Product/Equipment Display will be held in Oklahoma City, Oklahoma, April 30 and May 1&2, 1985. The conference will address both materials and procedures that are related to road and street maintenance. The program is designed to be of particular benefit to those involved in the management, design, or supervision of maintenance programs. A vendor display capable of accommodating up to 78 displays and/or large equipment will provide an opportunity for participants to review exhibits and become further aware of new equipment, techniques, products, and services which are useful to their operations. Cost for all three days — $125 per participant. For information regarding session topics, registration, or vendor booth purchase, contact:

Crystal Light
505 Engineering North
Oklahoma State University
Stillwater, OK 74078
(405) 624-6049

Some topics that might be of particular interest to SDHPT personnel are: "Cold, In-Place Asphalt Pavement Recycling"; "Anti-Ice Road Surfacing"; "Cathodic Protection for Bridge Decks"; and "Asphalt Pavement Repair Using Microwave Heat."

For a copy of the agenda, contact the editors of **TQ**.

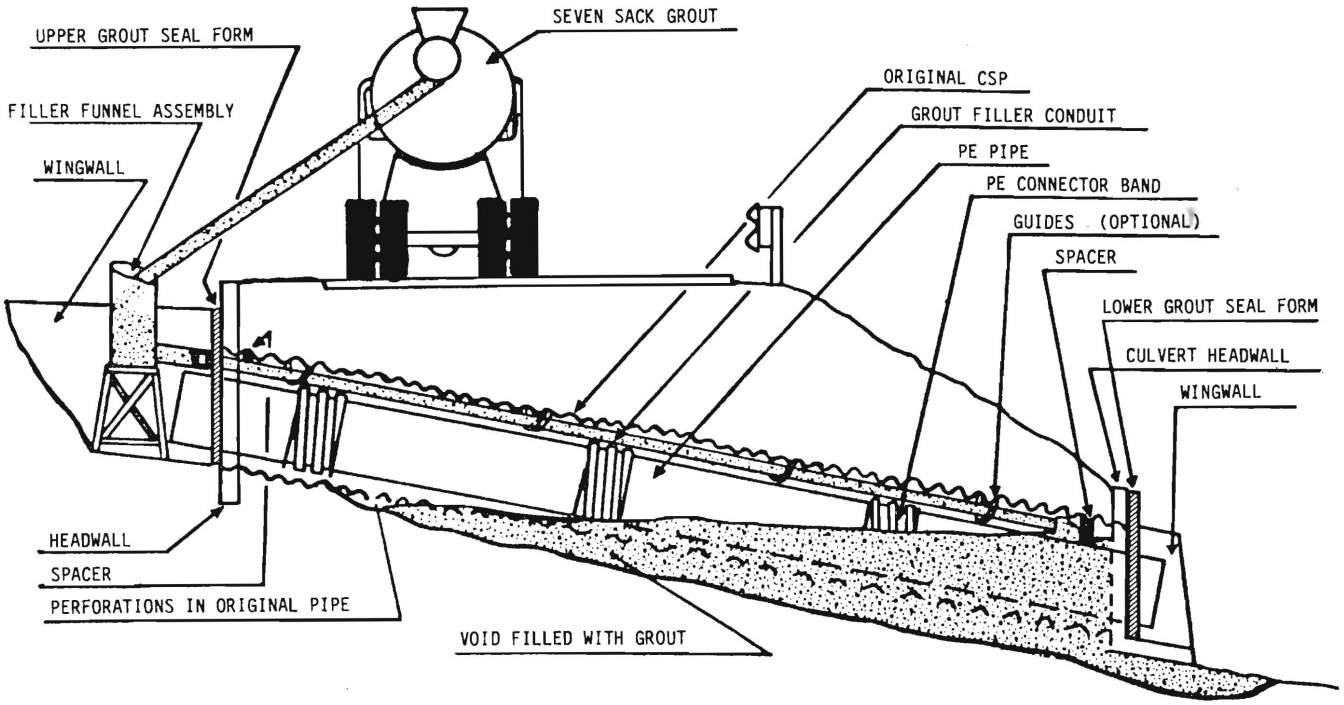
CULVERT REPAIR USING A PLASTIC LINER

During routine inspection in Le Flore County, Oklahoma, a maintenance crew discovered that some 29 of the corrugated metal culverts on US 259 were rusting out and leaking. The water which seeped through the bottom of the culverts was eroding the underlying soil and undermining the culverts. Digging them out and replacing them was considered too expensive and time consuming if other solutions were available. The ODOT Research Division did not feel that the undermining would lead to a catastrophic failure—these culverts are in a pine-forested area of heavy rainfall where the well-aerated ground water has an average pH of 4.5. The high acidity of the water combined with the abrasive nature of the local hard sandstone as it weathers means culverts in Le Flore have had a history of rusting. ODOT simply wanted a way to seal the pipes and stop the undermining.

An obvious possible solution was to have someone crawl into the pipe and fill the voids with grout or concrete in and as far underneath the pipe as possible. However, going into a pipe which was tight, dirty, wet, and which possibly provided habitat for snakes and other vermin, was not a job to inspire enthusiasm in the person who had to do the crawling. Since it had been noticed that the visible water line or water stain in the bottom of the culvert indicated considerable over designing, a decision was made to repair the culvert using a plastic liner.

The particular culvert chosen for the trial was 42 inches in diameter, was on an eight percent grade, and was under 15 to 20 feet of fill dirt. The plastic liner chosen was 27 inches OD (24 inches ID), $12.50 per foot, polypropylene, spiral-corrugated pipe which was to be inserted inside the 42 inch metal pipe. The AASHTO interim specifications are M294-83I and M252-81I. The void between the pipes would then be filled with grout. It took several 20′ sections of pipe to reach across the roadway; they were easily connected by unions made of the same material. Since polypropylene pipe can be cut with almost any kind of wood saw, they used a regular hand saw. Prior to insertion of the new pipe, a 4 inch PVC pipe or conduit was pushed into the old culvert from the upper end all the way to the lower end. The 4 inch PVC was suspended so that the new 24 inch pipe would

Pouring grout.



slide under it and it would serve as the conduit through which the grout was pumped. After the PVC pipe was in place, a section of 24 inch pipe was pushed into the metal culvert from the upper end, a union screwed on, and another joint was screwed into the union until the roadway was spanned.

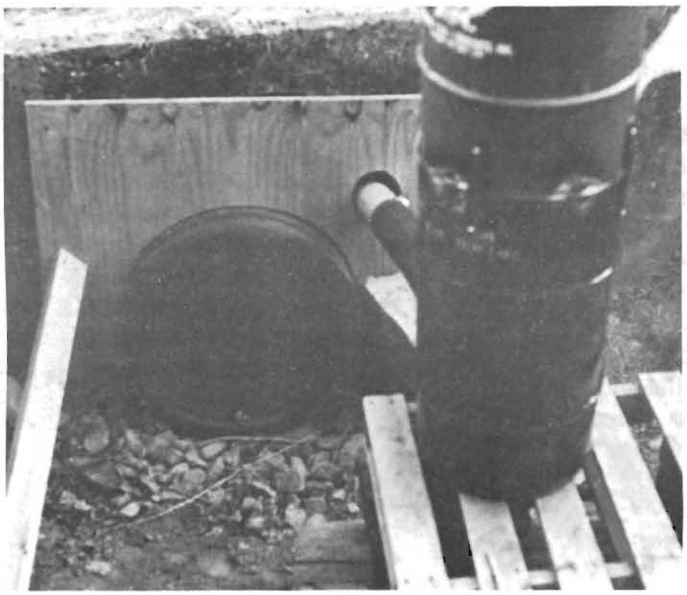
The lower end of the culvert was formed (sealed) and the new plastic culvert was weighted with large stones so it would not move around under the force of the grout. Instead of using a conventional concrete or grout pump, they welded several metal drums end-to-end to form a 60 inch funnel in which they could build up a head pressure. The transit-mix truck stopped over the culvert, set the chute over the funnel and dropped the grout directly into it. As the voids between the two pipes filled, the PVC conduit was systematically pulled out, cut off and reconnected to the funnel.

The central mix plant was at Hugo, Oklahoma, 1½ hours drive away from the job. A retarder was used at the plant, and a superplasticizer was put into the mix at the site. Since the job went smoothly with no major problems, it was decided to repair the other 28 culverts on US 259 using the same method. Meanwhile, more corroded culverts were discovered on US 271, so a maintenance contract has been let to repair all 40 of the rusting culverts with plastic liners. The culverts range in size from 12 to 42 inches and are covered with 3 to 40 feet of fill dirt.

Curtis Hayes, ODOT Research.

Copies of the informal study done by Oklahoma are available from the editors of **Technical Quarterly.**

Upstream end with form and funnel in place.



Downstream end braced and weighted.

EVENTS

MARCH

6-7-8 D-10 Annual Public Transportation Conference, Laredo.

12-13 Title II Traffic Conference, Odessa.

19-20 Regional Maintenance Conference, Pharr.

20-21 Annual District Laboratory/ Engineering Personnel Meeting, Paris.

27 Area I Research, Waco.

27-28 Title II Traffic Conference, San Antonio.

APRIL

2-3-4 Highway Capacity Analyses for Interrupted Flow Facilities.

9-10 Regional Maintenance Conference, Tyler.

16-17 Area III Research, Houston

16-17-18 Automation Administration Meeting, Austin.

16-17-18-19 Wetlands Recognition and Evaluation Course, Corpus Christi.

23-24 Regional Maintenance Conference, Amarillo.

REQUEST FOR AAPT VOLUMES

In our efforts to upgrade the technical library and improve our information searching abilities, we have recently purchased all the volumes of ***Proceedings of the AAPT Technical Sessions*** that are currently in print. Unfortunately, the volumes covering 1940 to 1960 are out of print. We would greatly appreciate the loan or donation of these volumes to the library. Please contact the editors of **Technical Quarterly** (512) 465-7947.

TWO ACCOUNTS OF VEHICLE CONVERSION TO PROPANE FUEL

MISSOURI

An experience of Boone County [Missouri] concerning vehicle conversion to alternate fuels provides some worthwhile insights on the potential for reducing operation costs. After comparing the costs and availability of diesel fuel, gasohol and propane, it was decided by the County Court in 1981 to convert six vehicles to propane. Bids were received from three sources for the conversions and the County proceeded to convert two pickups, two small dump trucks, and two large dump trucks. The County split the work among three different firms to assess their relative capabilities in handling the conversions.

The cost to convert the two pickups was $2,293.44; the single axle dump trucks cost $2,146.00; and the tandem axle dump trucks cost $2,580.00. Vehicle operating costs were then compared for one month before and one month after conversions. Comparisons of fuel use and fuel costs for these periods are summarized below:

The fuel cost per mile in this table are derived from a gasoline cost of $1.125 per gallon and a propane cost of $0.647 per gallon. The fuel efficiency for each vehicle type is better with gasoline. However, the cost difference between propane and gasoline generates a substantial operation benefit for each vehicle type using propane. Based on a typical operation level of 20,000 miles per year per vehicle and the prevailing fuel prices at the time of the conversions, the annual savings for the pickup truck would be about $590 due to reduced fuel costs. The annual savings for the small dump truck would be about $1,470 due to reduced vehicle fuel costs for the propane-powered vehicle. There were fuel cost reductions achieved by the tandem axle dump trucks, however, Bob Hagerty, the Boone County Public Works Director, mentions that with propane fuel the heavier vehicles in loaded conditions had difficulties with performance on hills.

	Pickup Truck	Single Axle Dump Truck	Tandem Axle Dump Truck
BEFORE CONVERSION			
Miles per Gal.	11.52	5.09	4.20
Cost per Mile (Fuel)	$0.098	$0.221	$0.234
AFTER CONVERSION			
Miles per Gal.	9.50	4.39	3.82
Cost per Mile (Fuel)	$0.068	$0.147	$0.170

It should be noted that the unit costs of fuels have fluctuated since this analysis was performed, and the cost of conversion has been reduced. This propane conversion information was extracted from a report prepared by Robert Hagerty entitled, "Conversion of Gasoline Vehicles to Propane Carburetion." The report won a National Association of Counties Achievement Award in 1984. For more detailed information on this project, write: Bob Hagerty, Boone County Dept. of Public Works, Route 1, Box 77, Columbia, MO 65201. [1]

TEXAS

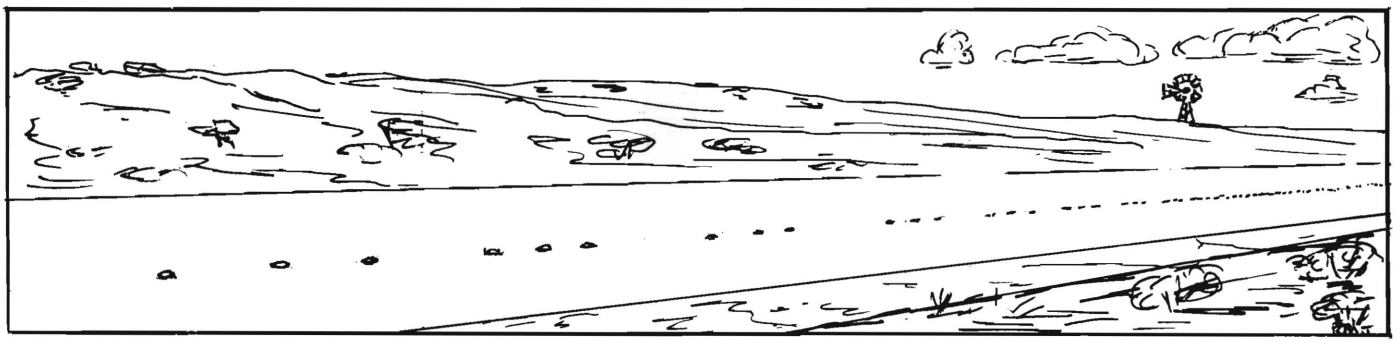
SDHPT truck 7-4347-B.

The Texas SDHPT official experience with vehicles converted to propane fuel is limited to one light truck that was converted May 13, 1980, in Del Rio (old District 22). To date, the 1980 Ford dump truck is in service in the Rocksprings area. It has 71,000 miles on it, gets approximately 5 miles per gallon, and has never needed major engine work. James Adams of San Angelo District, who is familiar with this truck as well as many privately owned propane-converted cars and pickups in West Texas, attributes the low maintenance needs to the fact that pro-

*1. Charles E. Dare, ed., "Boone County Reports on Vehicle Conversion to Propane Fuel," **The Missouri Bulletin** 1 (Nov.1984): 2*

pane and butane burn much more cleanly than gasoline. The oil doesn't get dirty nearly as fast and the spark plugs don't foul as often. Since propane and butane-converted vehicles are not uncommon in West Texas, conversion costs from between $500 to $1200 per vehicle. Depending on the type of butane or propane tank fitted, the vehicle's range can be increased to up to three times that of a normal gasoline-powered vehicle.

Dan Harrison, the driver of the propane-converted truck, said that servicing is not much of a problem. Routine maintenance is performed by SDHPT mechanics; however, if repairs need to be made to the conversion system, mechanics licensed by the Railroad Commission to work on propane machinery are called in. Harrison also thought that if gasoline and propane prices had remained the way they were when the truck was converted, which was 66 cents a gallon for propane as opposed to $1.40 a gallon for gasoline, more trucks might have been converted. If several trucks had been converted, the logical cost saving maneuver would have been to buy propane in bulk, a year's supply at a time as the city of San Antonio does presently for its fleet of propane-powered sanitation trucks. Unfortunately, since propane stands at about 70 cents a gallon to gasoline's 99 cents a gallon in Texas, and since propane vehicles get slightly fewer miles per gallon compared with their gasoline counterparts, conversion to propane fuel offers little cost advantage currently. Diesel is felt to be more cost effective, particularly in heavy equipment where the rule of thumb for propane-powered vehicles seems to be, "The bigger the rig, the less the horsepower." However, propane and butane-converted vehicles are definitely worth looking into in the future, particularly for State cars and light pickups in the vast, sparsely populated, western Districts where the triple range capabilities and low engine maintenance tendencies of these vehicles would be an attractive plus.



EXCHANGE OF IDEAS

Articles, techniques or ideas about any facet of highways or public transportation are welcomed. If you have a new way to handle an old problem, a helpful hint for making better use of a standard procedure or product or new application of a common item, send it to us. It doesn't have to be an earthshaker to be useful and appreciated.

If you have an idea to share, a comment to make or materials to request, use the tear sheet in this issue or call Kathleen Jones at (512) 465-7947.

TECHNICAL QUARTERLY

State Department of Highways and Public Transportation, Transportation Planning Div., Technology Transfer Section, P.O. Box 5051, Austin, TX 78763

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(We'll call you to get the details).

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