

# Quality of Maintenance Materials

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Ascertaining the quality of materials purchased for use in highway maintenance is a continuing challenge, especially with the procurement processes used by governmental agencies. Material quality control ensures that maintenance personnel get the material that will meet their needs and be durable, workable, and economical. The current procurement process in Arizona appears to stand in the way of achieving the goal of purchasing quality materials. The process, which has statutory basis in Arizona, was adopted to ensure that what is needed can be bought at the lowest possible price. The concept has merit, but the implementation details are a major issue. The rules and regulations that were designed to avoid conflicts of interest, ensure competition, and prevent state employees from benefiting from awarded contracts make it very difficult to get the products desired. In contrast to the procurement process used to purchase materials for maintenance, the contracting process used to construct highway facilities has a greater quality control and assurance program, along with the flexibility to adjust to the changing conditions of a construction project. The specifications are very project specific and in most cases are thoroughly researched and tested to ensure that they will sufficiently meet the design life of the project. Reviewed are the things being done in Arizona to close the gap between construction-materials quality control and maintenance-materials quality control. The procurement process is reviewed, and some ongoing research activities that relate to maintenance material quality are outlined. Also considered is what the Holbrook district is doing to address material quality at the local level.

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**T**he process for procuring materials is difficult to understand and even more difficult to relate to maintenance personnel. Table 1 outlines the process as generally used by the Arizona Department of Transportation (ADOT) procurement department (Procurement).

Table 1 shows that to get something on the street and awarded takes up to 3 months, assuming there are no questions or problems with the way specifications are written.

The specification that is provided to Procurement normally is written by individuals who have very little background in material specifications. In some cases, the specifications used are lifted from ADOT's standard specifications used for construction projects, and sometimes the applicable standard drawing is used as part of the request. Often the requestor is the maintenance supervisor, who has limited knowledge of and training in specifying needed material. Thus, in many instances the product that is specified does not fully meet the need of the requestor.

Procurement codes require agency personnel to buy products from the "lowest responsible bidder," which means that the low bid meets the requirements and specifications outlined in the bid package. If the material specified is not well defined, then the low bidder will provide the product that most closely fits the specifications in the bid package.

The actual material specified for a maintenance activity usually does not fully meet the need. The real issues then are, How do we know what we are getting? and, Is what we get really working?

TABLE 1 ADOT Procurement Process

RFP Ideal Timeline	Week 1	Week 2	Week 3	Week 5	Week 7	Week 8	Week 10	Week 11
Initiation of purchase								
Requester writes statement of work								
Requisition is entered into system								
Procurement reviews both requisition and statement of work								
Procurement drafts solicitation and returns for review								
Changes are made to the draft by the requester and returned to Procurement								
Procurement makes changes and completes final solicitation document								
Advertisement								
Pre-bid/Pre-offer conference								
Bids open (minimum of 2 weeks from last advertisement)								
Evaluation meetings if required								
Tentative award (Period to verify insurance, etc.)								
Award notice								
Post award meeting								

## CURRENT RESEARCH PROJECTS AND PROGRAMS

Current attempts to help maintenance personnel obtain quality material include statewide research projects in pavement maintenance and preapproval of proprietary products for use by maintenance forces. A maintenance products evaluation committee and a new research project address procurement processes.

### Pavement Maintenance

The Strategic Highway Research Program investigated the cost-effectiveness of several pavement surface treatment alternatives. However, the resulting data and analy-

sis have not provided needed techniques and information for developing and promoting cost-effective pavement maintenance strategies.

The effectiveness of many maintenance activities, such as pothole repair, crack sealing, flushing, and surface treatments, varies from area to area, and their performance is difficult to quantify at a network or project level. In addition, ADOT makes considerable use of asphalt rubber. The preventive maintenance activities could be significantly different for these roadways. ADOT must establish procedures for the effective treatment of these products.

Many proprietary products have potential for providing cost-effective maintenance treatments. However, low-bid procurement processes often inhibit the use of these products because of a lack of available information with which to develop justifications based on public interest.

Additionally, innovative contracting procedures, such as warranted work, currently are difficult to implement. Evaluation of the current laws and procurement procedures is necessary to determine how some of these alternative procurement processes can be utilized.

The objectives of this project are to (a) identify the maintenance surface treatment alternatives suitable for evaluation by ADOT; (b) develop consensus for which alternatives to test; (c) determine the performance and cost-effectiveness of these treatments; and (d) identify procurement issues that inhibit effective pavement maintenance and then recommend solutions to these issues. This will be accomplished by developing an experimental design and constructing and evaluating test sections. To date, approximately 60 test sections have been constructed.

### **Product Resource Investment, Deployment, and Evaluation**

During the construction of many projects, proprietary products are installed as permanent features of the highway. Once these highway segments are turned over to the ADOT maintenance department, personnel find it extremely difficult to buy replacement parts for these devices, because of language in the state's procurement code and because of ADOT procurement policies. The code is written to encourage and pursue competition in all of the state's purchases, except in situations in which competition is nonexistent. In such cases, justifications are to be submitted and approved by the State Procurement Office (SPO). This process of approvals used to take a long time for each purchase. To address this, the Arizona Transportation Research Center (ATRC), a body within the department that is involved in evaluating products used by the department, implemented a process by which all justifications are submitted for approval by SPO as soon as a proprietary product is approved for use; then a contract is written and issued by ADOT Procurement for the purchase of these parts by any maintenance organization in the state.

### **Maintenance Products Evaluation Committee**

ADOT has established several committees that review new products introduced by vendors. The Maintenance Products Evaluation Committee, administered through ATRC, is one of those committees and is composed of line maintenance and administrative personnel and at least one representative from Procurement. This committee reviews and approves products for use on the ADOT system. The product must meet standard construction specifications, standard plans, and applicable maintenance practices, and it must not require major retooling of maintenance

equipment or processes. Materials approved by the other committees that relate to maintenance activities require approval by this committee before being included on the approved product list.

### **New Research Project on Procurement Process**

On construction projects, new types of guardrail end treatments are often used. This reflects the ever-changing safety standards. However, maintenance sometimes cannot obtain replacement parts in a timely manner because of the proprietary nature of many of these parts and the present procurement process. It can take up to 6 months to obtain repair parts. This leaves a potentially dangerous situation in the field. Similar experiences are reported for road weather information system equipment repairs and for leading-edge pavement repair materials that often are proprietary.

The objective of this research is to establish improved procurement processes that better accommodate the needs of maintenance. The results of this research would be used to modify the current procurement process for maintenance activities.

The research efforts being pursued by ADOT reflect the continuing effort to provide maintenance personnel with more tools with which to perform their functions.

### **HOLBROOK STRATEGIC GOAL AND QUALITY PROCESS**

As part of a larger strategic planning effort within ADOT, the Holbrook district established the goal of maintenance materials quality: establishing and implementing an ongoing program to train maintenance personnel in materials quality and testing along with ensuring that all materials used by maintenance forces meet specifications. The district's HEAT (Holbrook Employees Achieving Together) team was formed with a membership of materials testing personnel and line maintenance personnel. The initial process improvements proposed by the team include training of maintenance personnel in materials sampling and testing, and developing and testing an evaluation program of paving materials being used in the Holbrook district. The paving material that has the most impact on the program is asphalt concrete (AC) cold mix, which is made locally by some of the maintenance forces or purchased commercially.

The training program focuses primarily on educating all maintenance personnel in techniques for sampling and testing soils, aggregates, and asphaltic concrete. The education effort is concentrated in these areas because most maintenance employees should be involved in these

materials-related functions. The course outline is given in Figure 1.

The program for evaluating the AC cold mix was based on the fact that much of the pavement work in the district requires cold mix, and approximately one-half of the maintenance materials budget is spent on cold mix. District maintenance forces have had to purchase more cold mix and mineral aggregate commercially and were not sure of the quality of the product they were getting. There also was the problem that some pavement patches failed because of poor-quality mix. The money and time spent and the impact the quality of AC cold mix had on the maintenance program made this an area the materials quality team wanted to address.

The test results of the materials sampled by maintenance indicate some initial major inconsistencies in their asphaltic cement content and in the aggregate gradations. Later samples show better consistency in both asphaltic cement content and aggregate gradations in the commercial mixes. The changes can be attributed to two factors. Since testing of the products began, the vendors have been making a greater effort to meet the specifications. The second factor is that since maintenance per-

sonnel have been trained in materials quality, they are making a greater effort to address the issue of quality materials. The actual test results for commercial mixes are given in Figure 2.

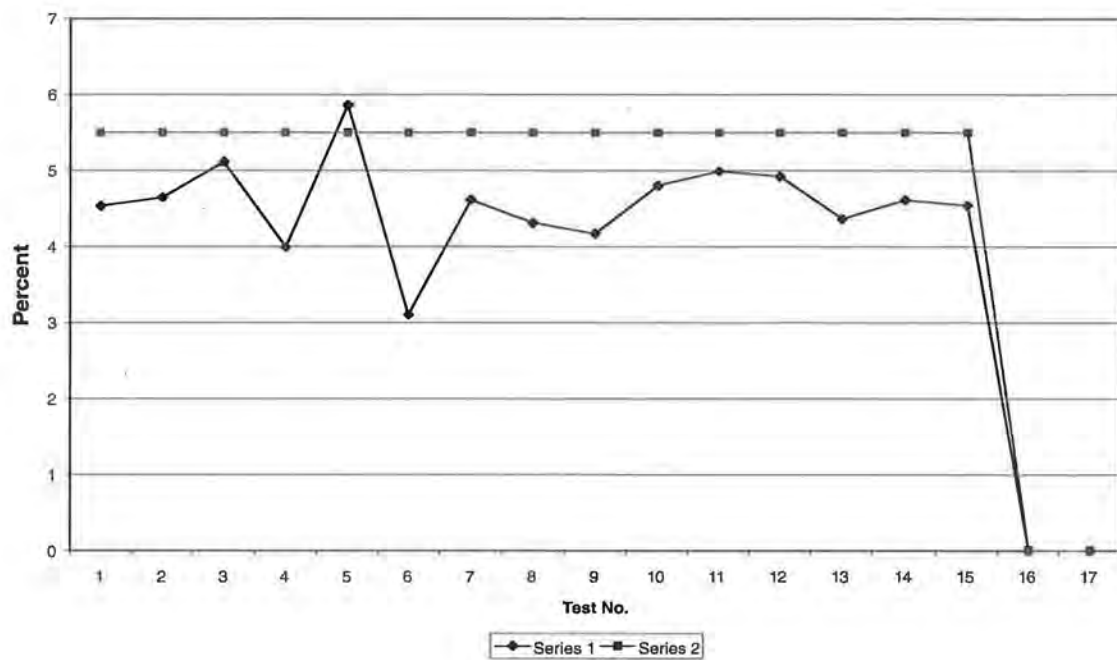
The test results for noncommercial mixes (Figure 3) show a greater variance in oil content and gradation. Much of this variance is attributed to maintenance personnel still doing things "the old way" instead of attempting to apply their new knowledge to an old situation. Another factor is that some of the mineral aggregate being used was not evaluated when delivered, and AC mix designs have not been developed for this material.

The correlation between the test results and the performance of the material is the area that is still being explored. The forms in Figure 4 are examples of what has been distributed to maintenance personnel. As can be seen in the figure, the results to date have been disappointing because of the lack of participation from district personnel, the lack of a scoring system to address the actual performance of the patch, and the continued need to educate personnel about the benefits of doing this evaluation.

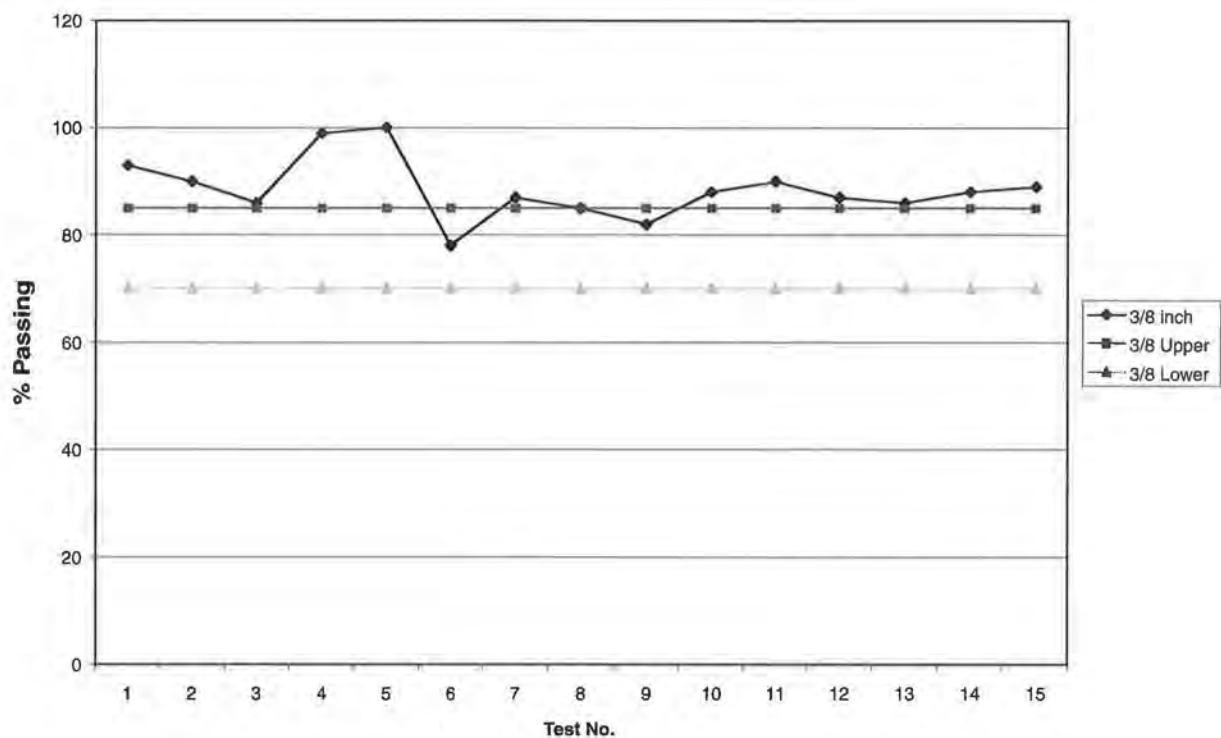
Another measurement is tied to materials and workmanship quality and is also a component of the incentive

<p style="text-align: center;">Maintenance Materials Training Holbrook Lab <b>16 Hours Training</b> <b>2 1/2 Days</b></p>	
<b>Introduction</b>	
<b>A. Purpose of the Seminar</b>	
	<ol style="list-style-type: none"> <li>1. Improve communications.</li> <li>2. Provide useful tools and information.</li> <li>3. Exchange ideas.</li> <li>4. Acquaint Maintenance Personnel with Lab Tests.</li> </ol>
<b>B. Why is testing needed?</b>	
	<ol style="list-style-type: none"> <li>1. Testing tells you if you are getting the product you pay for.</li> <li>2. Testing tells you "how much." It provides you with a way of measuring how much asphalt is in a mix, how much aggregate is in a windrow, etc.</li> </ol>
<b>C. Summary of the Course</b>	
	We will discuss Geology, Soils and Aggregates, Concrete, Asphalts, Asphalt Mixes, and Seal Coats, relating each of these materials to Maintenance uses.
<b>Soils/Soil Classification/Soil Identification. Gradation and P.I.</b>	
	<b>Proctors/Max. Den., Opt. Moisture for Sandy Material. Clayish Material &amp; Silt Material.</b> Shows the curve as materials change weight due to percent moisture added.
	<b>Aggregates:</b> Sampling Stockpiles, Unit Weight Calculations, Stockpile Calculations. Gradation.
	<b>Seal Coats:</b> Chip Spread and Oil Spread Calculations.
	<b>Asphaltic Concrete:</b> Asphalt mixing at a Hot Plant, laying Asphaltic Concrete with a Laydown Machine.
	<b>Asphaltic Concrete Testing:</b> Showed the equipment use to get percent asphalt using the ignition oven.
	Testing of Bituminous Mixtures with Marshall Apparatus. Bulk Density.
	Maximum Theoretical Specific Gravity of Field Produced Bituminous Mixtures (Rice Test)
	Gradation on Aggregates after the Asphalt is burned off.
	<b>Cold Mix:</b> Mixing Cold Mix in a turntable, calculating the amount of aggregates in a windrow, to determine how much oil to add.

FIGURE 1 Maintenance materials course outline.



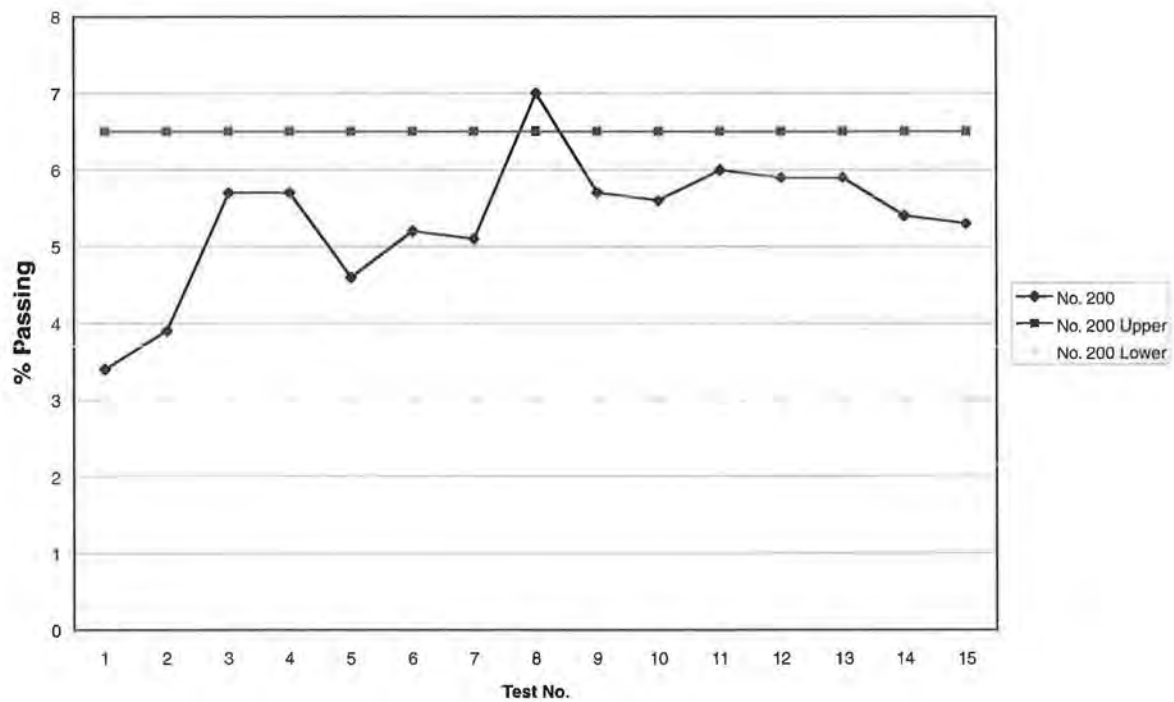
(a)



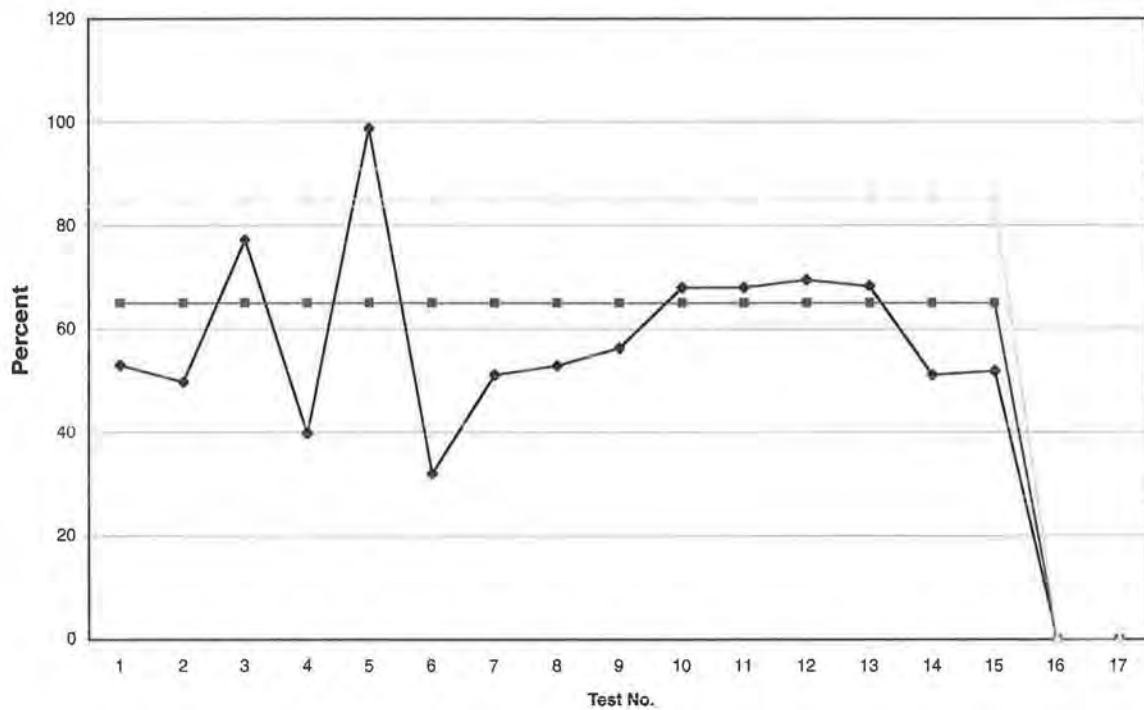
(b)

FIGURE 2 Test results for commercial mixes: (a) cold mix asphalt percent, (b)  $\frac{3}{8}$ -in. gradation (1 in. = 25.4 mm).  
(continued on next page)



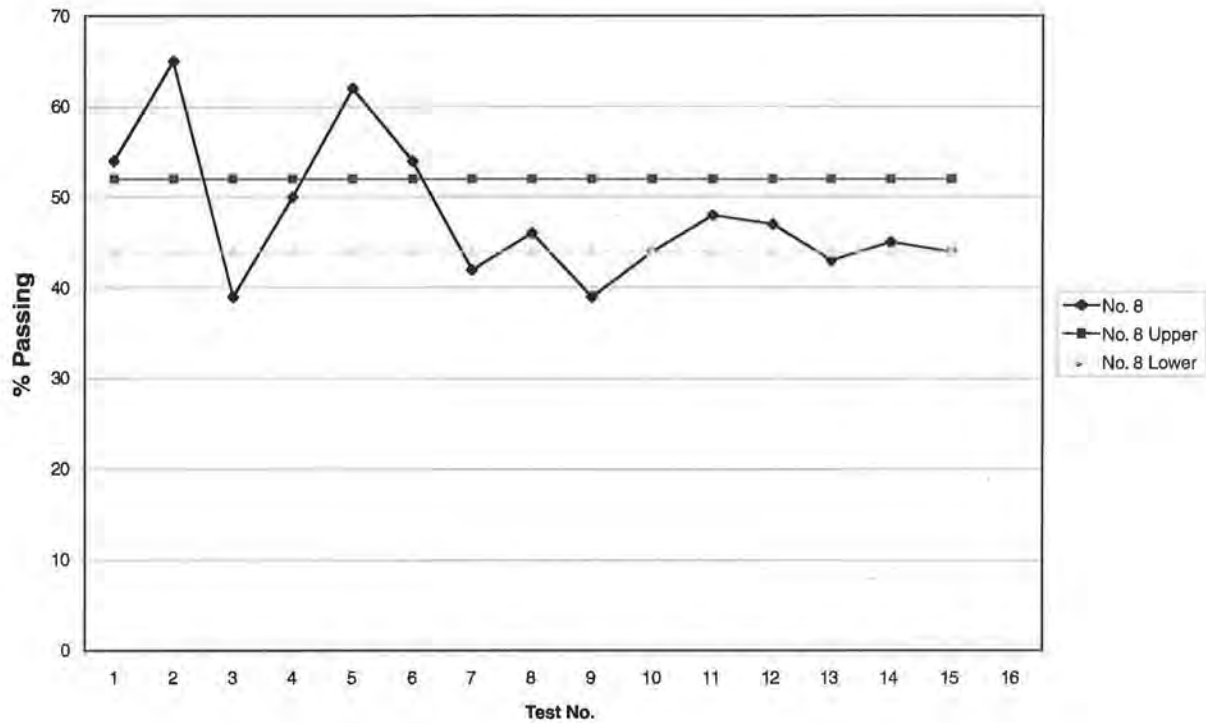


(c)



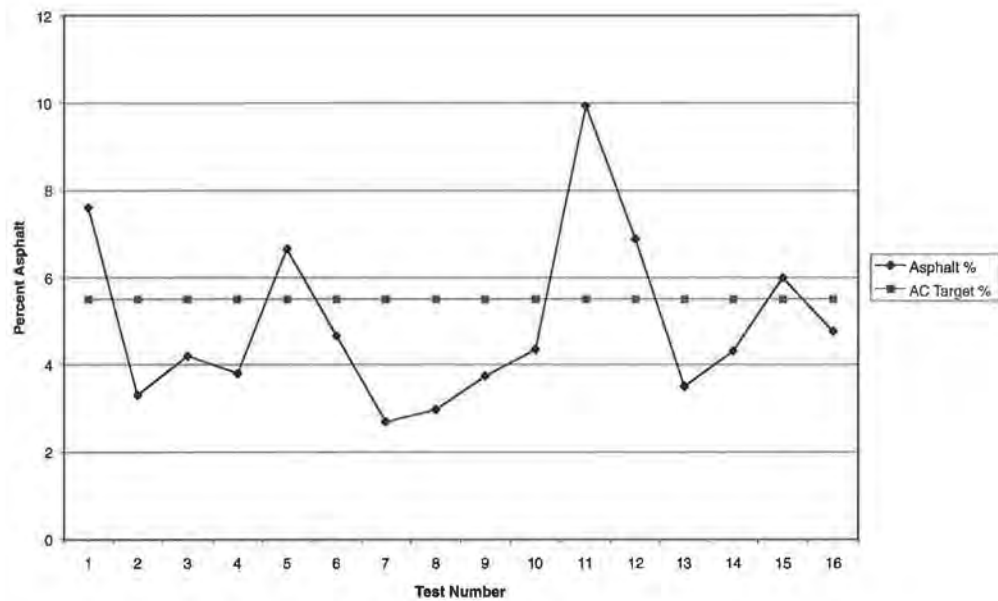
(d)

FIGURE 2 (continued) Test results for commercial mixes: (c) No. 200 gradation, (d) cold mix aeration percent. (continued on next page)



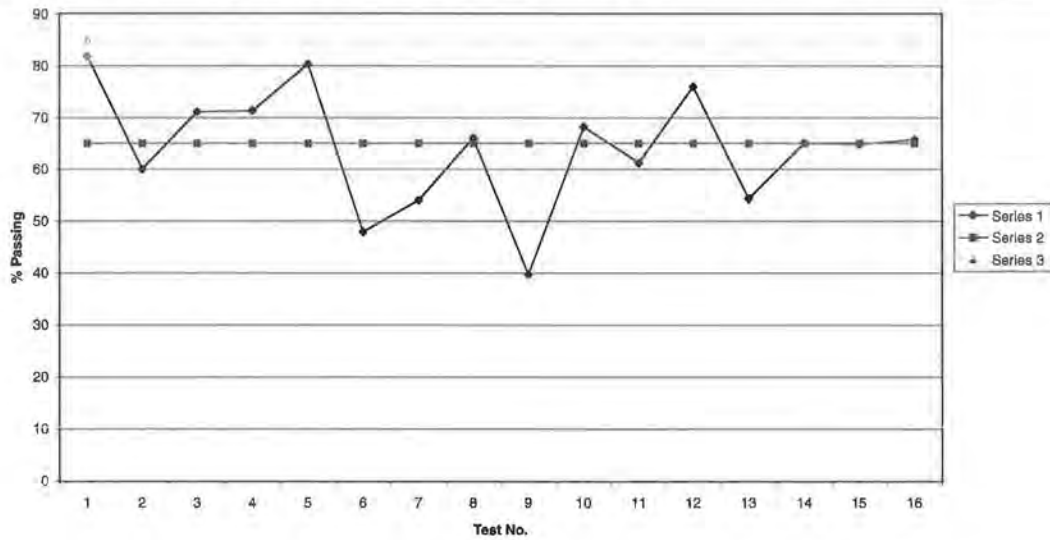
(e)

FIGURE 2 (continued) Test results for commercial mixes: (e) No. 8 gradation.

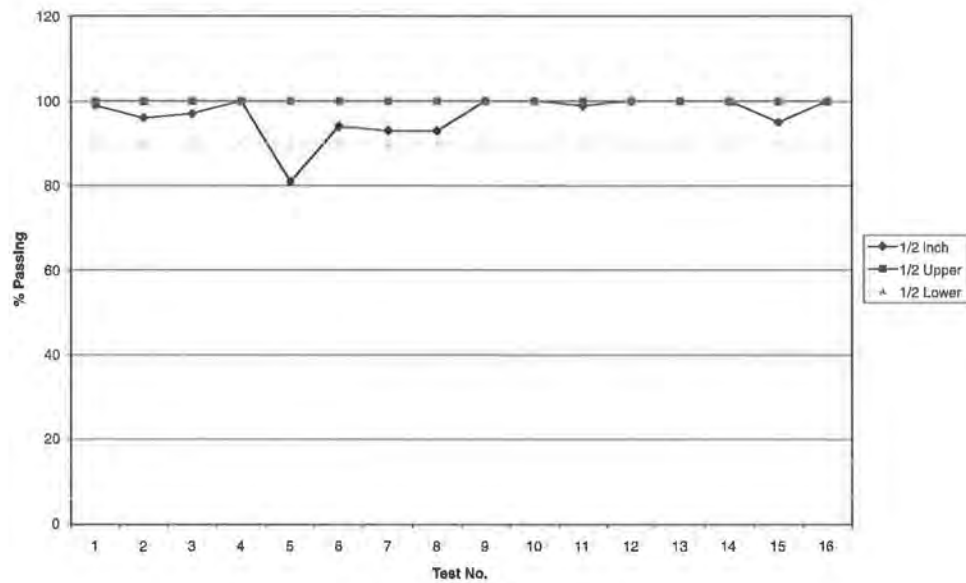


(a)

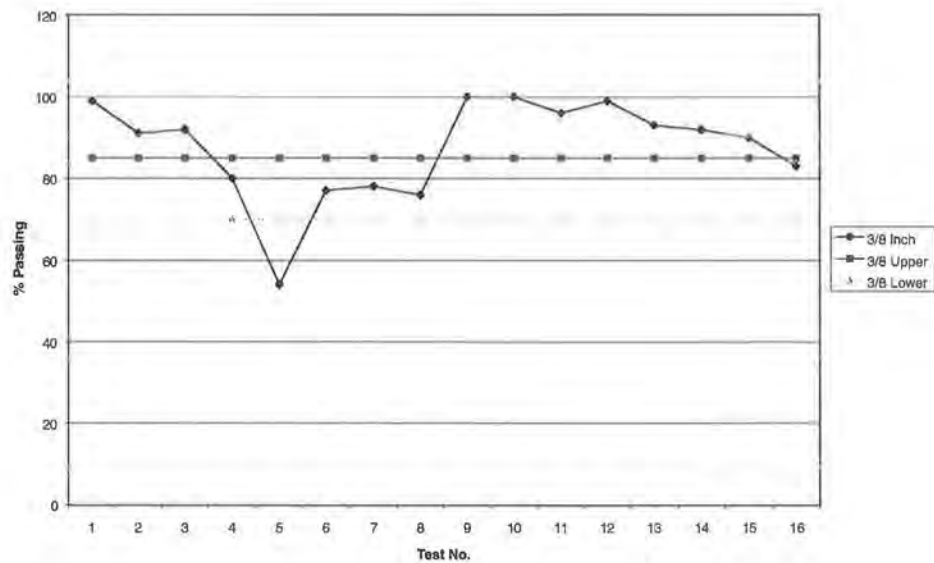
FIGURE 3 Test results for in-house mixes: (a) asphalt content. (continued on next page)



(b)



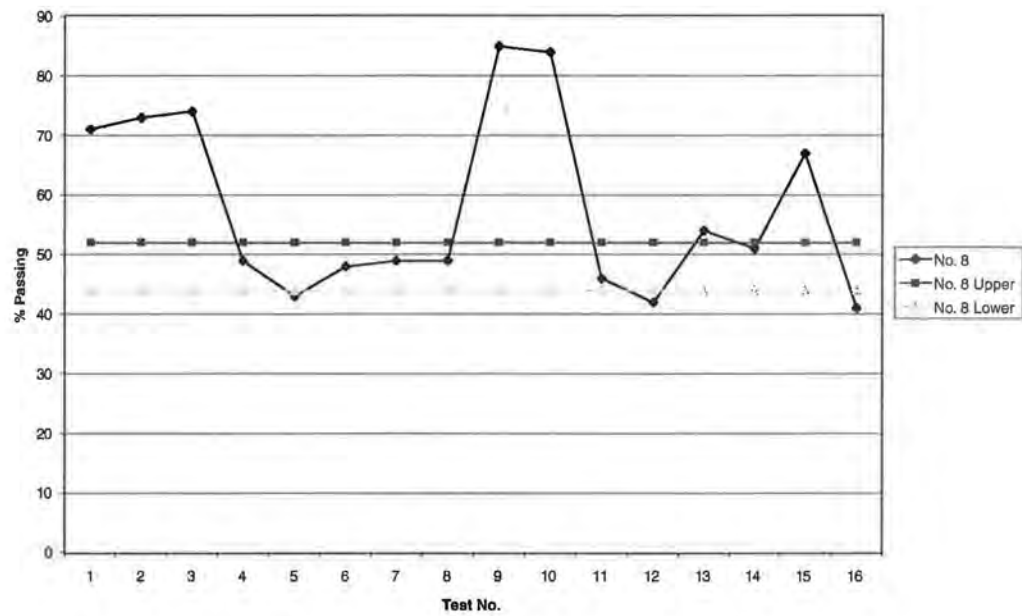
(c)



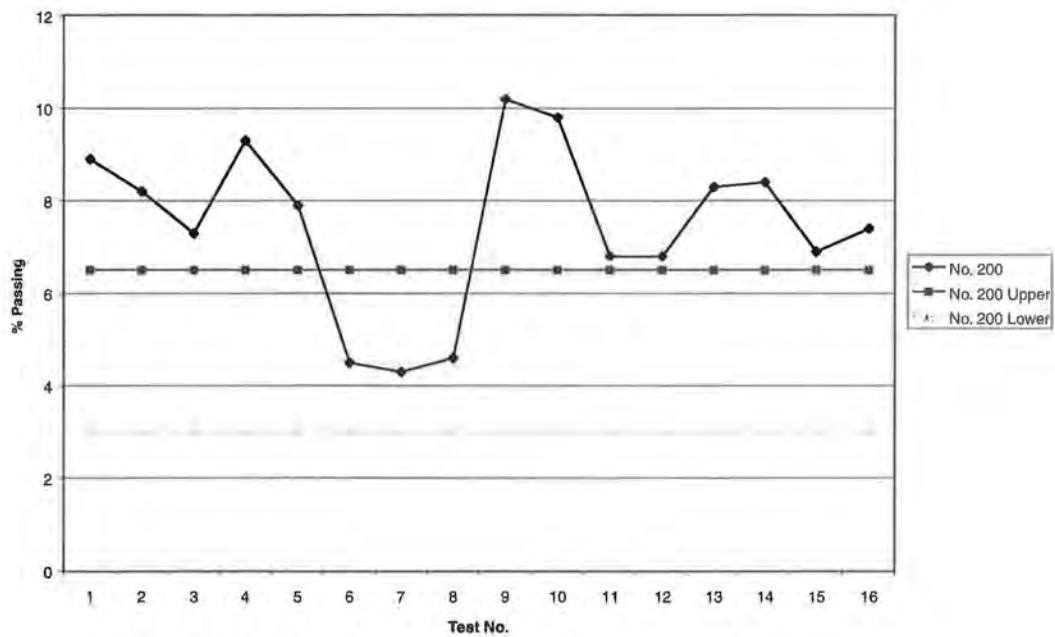
(d)

FIGURE 3 (continued) Test results for in-house mixes: (b) aeration, (c) 1/2-in. gradation, (d) 3/8-in. gradation (1 in. = 25.4 mm). (continued on next page)





(e)



(f)

FIGURE 3 (continued) Test results for in-house mixes: (e) No. 8 gradation, (f) No. 200 gradation.

COLD MIX PLACEMENT						MEASUREMENT	
Date	Location	Weather	Cubic Yards Gallons	Type	Supplier	Date	Comments
7/27/99	160 366.4-366.5		44 100	AC Field Mix MC 250	Southwest Sand & Gravel Paramount	01-18-2000	MATERIALS NOT STARTING 1/3 place.
7/29/99	160 360.6-360.8		29 150	AC Field Mix MC 250	Southwest Sand & Gravel Paramount	01-18-2000	Some are coming out.
7/30/99	160 360.6-360.7		35 100	AC Field Mix MC 250	Southwest Sand & Gravel Paramount	01-18-2000	Some are coming out.
8/23/99	160 423.2-423.8		46 100	AC Field Mix MC 250	Southwest Sand & Gravel Paramount	01-18-2000	Some are coming out.
8/24/99	160 399.4-399.5		38 100	AC Field Mix MC 250	Southwest Sand & Gravel Paramount	01-18-2000	MOST MATERIAL coming out.
8/25/99	160 399.3-399.5		48 75	AC Field Mix MC 250	Southwest Sand & Gravel Paramount	01-18-2000	MATERIAL coming out.
8/26/99	163 399.3-401.9		53 100	AC Field Mix MC 250	Southwest Sand & Gravel Paramount	01-18-2000	MATERIALS is coming out.
9/20/99	163 413.2-413.7		35 150	AC Field Mix MC 250	Southwest Sand & Gravel Paramount	01-18-2000	Not much. Road not sand or gravel out.
9/24/99	163 401.8-401.7		18 150	AC Field Mix MC 250	Southwest Sand & Gravel Paramount	01-18-2000	It
9/27/99	160 459.5-459.6		40 150	AC Field Mix MC 250	Southwest Sand & Gravel Paramount	01-18-2000	Not coming out to material. It's some leveling material coming out due to material blowing.
9/28/99	160 463.4-463.6		48 80	AC Field Mix MC 250	Southwest Sand & Gravel Paramount	01-18-2000	Not coming out. It blows. And to some material. It's blowing.
10/8/99	160 462.5-463.2		36 100	AC Field Mix MC 250	Southwest Sand & Gravel Paramount	01-18-2000	Not coming out. It blows. And to some material. It's blowing.
10/7/99	160 463.4-463.5		28 75	AC Field Mix MC 250	Southwest Sand & Gravel Paramount	01-18-2000	Not coming out. It blows. And to some material. It's blowing.

MATERIALS that we use from Southwest Sand & Gravel are mostly  
sand and not enough gravel in it. we need get better materials  
from Jerry Holaday which we been using all these years.

COLD MIX PLACEMENT							MEASUREMENT	
DATE	LOCATION	WEATHER	CU YD/TON	TYPE	MADE BY ADOT	SUPPLIER	DATE	COMMENTS
4/3/99	I-40 EB F 347.6/348.0	clear 90	10/CYD	02A		B/H	4/3/99	TOP LAYER LOOSE BASE
4/7/99	I-40 WB 361.4 363.0	clear 92	140/CYD	02A		B/H	4/10/99	" "
4/9/99	I-40 WB 360.0 362.0	clear 90	90/CYD	02A		B/H	4/10/99	" "
4/10/99	I-40 WB 360.0/362.0	clear 90	30/CYD	02A		B/H	4/9/99	" "
4/11/99	I-40 364.0 365.0	clear 91	50/CYD	02A		B/H	4/10/99	" "
4/12/99	I-40 WB 366.0 367.0	cloudy rain	35 CYD	02A		B/H	4/1/99	" "
4/18/99	I-40 WB 369.0 369.9	partly cloudy 29	50.0 CYD	02A		B/H	4/1/99	" "

FIGURE 4 Evaluation forms ( $1 \text{ yd}^3 = 0.76 \text{ m}^3$ ;  $1 \text{ gal} = 3.8 \text{ L}$ ).

pay program for maintenance. This measurement is part of the quality measurement and the criteria for several activities. The criteria being used by those evaluating the quality of the mix and the workmanship of the crew are noted in Figure 5. The actual measurements for the leveling activity (Activity 102) are shown in Figure 6. This system could have greater possibilities in the long run because incentive pay for a maintenance section depends on quality results.

## DISCUSSION OF ISSUES

In addressing the issue of procuring quality materials for maintenance and evaluating the performance of the material, several factors come into play. The first is specifying the material needed by maintenance. ADOT says that use of the construction specifications to designate the material for maintenance should be the standard. However, construction specifications are written assuming average conditions, adequate preparation of underlying conditions, and pricing based on mass production techniques, and assuming that the equipment available

to contractors is not available for the smaller projects taken on by maintenance forces.

Another factor is local material variability and microclimates. Construction standard specifications limit certain activities because of climatic conditions, whereas maintenance activities have to be done under a variety of conditions with little regard to climatic conditions. Because construction projects involve larger quantities of material, contractors will choose material sources based on quantity along with quality and economics. Maintenance choices are limited because of the smaller quantities of material needed, and the limited quantities affect the economics. In many cases, maintenance forces buy materials from suppliers that may not be involved in the larger construction projects where quality control is crucial.

The third factor concerns the type of material testing that is required for maintenance materials. Testing technology and procedures may not reflect maintenance conditions. There are standard asphaltic concrete tests, but there are very few standardized tests for AC cold mix. Determination of the performance of different materials is by individual evaluation of condition of the roadway or

<p style="text-align: center;"><b>QUALITY MEASUREMENTS</b></p> <p>To assure ourselves that quality is maintained in the work we are doing through incorporation of the incentive awards in highway maintenance, a quality measurement will be incorporated into the program.</p> <p>This measurement will comprise 20% of the award for the month.</p> <p><b>HOW WILL IT BE MEASURED AND WHO WILL PERFORM THE QUALITY MEASUREMENTS?</b></p> <p>This is a three-fold evaluation system based on a random choice of a work activity using the attached Activity Scoring System.</p> <ol style="list-style-type: none"> <li>1) From District Management on a monthly basis at least one activity per Org shall be evaluated.</li> <li>2) From Org supervision on a weekly basis at least one activity shall be evaluated.</li> <li>3) From the Org members on a weekly basis one activity shall be evaluated and discussed.</li> <li>4) From the Signing and Striping Org, members on a monthly basis, one activity shall be evaluated and discussed.</li> </ol> <p>(It is desirable that the three levels of evaluations are on the same work activity. This is not mandatory, just suggested.)</p> <p>For each of the above separate measurements the scores will be averaged from the Activity Scoring System received and a monthly value earned.</p> <p>For activity being scored, please fill out the following: Date, route and mile post.</p> <p><b>INSTRUCTIONS FOR FILLING OUT THE MEASUREMENT FORM</b></p> <p>STEP 1: Choose the appropriate activity being reviewed.</p> <p>STEP 2: For activity being scored, please fill out the date, route and mile post in the space provided.</p> <p>STEP 3: Scorer: Circle D for District, S for Supervisor or C for Crew in scorer area. Put your name under the activity being scored.</p> <p>STEP 4: From the score column, circle the score that best fits the finished product. (To the right of the score number is the criteria for receiving that score.)</p> <p>STEP 5: Turn in completed form to the Org Maintenance Secretary or the appropriate person.</p>	<p style="text-align: center;"><b>MAINTENANCE INCENTIVE PROGRAM</b></p> <p style="text-align: center;"><b>ACTIVITIES SCORING SYSTEM</b>      Scale: 1-3 on all</p> <p style="text-align: center;"><b>SCORER = D (DISTRICT) S (SUPERVISOR) C (CREW)</b></p> <hr/> <p>Activity / Description      101 Patch with premix</p> <p>ACTIVITY DATE _____ ROUTE _____ MP _____ SCORER D S C</p> <p>SCORE</p> <p>3    1) Finished surface for levelness. 2) Square up &amp; straighten edges. 3) Broom loose excess material. 4) Seal patch as needed. 5) Remove all excess material.</p> <p>2    #1 &amp; 2 accomplished.</p> <p>1    #1 accomplished.</p> <p>Name _____ INSPECTION DATE _____</p> <p><b>COMMENT:</b> _____</p> <hr/> <p style="text-align: center;"><b>MAINTENANCE INCENTIVE PROGRAM</b></p> <p style="text-align: center;"><b>ACTIVITIES SCORING SYSTEM</b>      Scale: 1-3 on all</p> <p style="text-align: center;"><b>SCORER = D (DISTRICT) S (SUPERVISOR) C (CREW)</b></p> <hr/> <p>Activity / Description      102 Level with premix</p> <p>ACTIVITY DATE _____ ROUTE _____ MP _____ SCORER D S C</p> <p>SCORE</p> <p>3    1) Taper new material to match existing. 2) Make sure surface is level. 3) Material stays on road. 4) No bleeding areas. 5) Sweep area. 6) Temporary centerline/lane striping. 7) Clean work area.</p> <p>2    #1, 2 &amp; 6 accomplished.</p> <p>1    #1 &amp; 2 accomplished.</p> <p>Name _____ INSPECTION DATE _____</p> <p><b>COMMENT:</b> _____</p>
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FIGURE 5 Incentive pay measurements. (continued on next page)

MAINTENANCE INCENTIVE PROGRAM					
ACTIVITIES SCORING SYSTEM			Scale: 1-3 on all		
SCORER = D (DISTRICT) S (SUPERVISOR) C (CREW)					
Activity / Description	105	Replace surface/base			
ACTIVITY DATE _____	ROUTE _____	MP _____	SCORER	D	S C
SCORE					
3	1) Finish surface for levelness. 2) Square up area. 3) Shoulder sloped as needed. 4) Temporary centerline/lane striping. 5) Remove all excess material.				
2	#1, 2 & 4 accomplished.				
1	#1 & 2 accomplished				
Name _____			INSPECTION DATE _____		
COMMENT: _____					
MAINTENANCE INCENTIVE PROGRAM					
ACTIVITIES SCORING SYSTEM			Scale: 1-3 on all		
SCORER = D (DISTRICT) S (SUPERVISOR) C (CREW)					
Activity / Description	112	Tight Blading			
Activity date _____	Route _____	MP _____	Scorer	D	S C
SCORE					
3	1) Sweep surface area first. 2) Apply tack coat. 3) Make sure premix surface is level and that new material is feathered to match existing pavement. 4) Roll material. 5) Install temporary centerline and lane striping. 6) Set up signs that read "LOOSE GRAVEL & FRESH OIL" with warning lights after work is completed.				
2	#1, 2, 3 & 4 accomplished				
1	Only 1 of the 6 accomplished				
Name _____			INSPECTION DATE _____		
COMMENT: _____					

FIGURE 5 (continued) Incentive pay measurements.

the material and has very little to do with statistical information, which is available for determining the construction material specifications and testing.

The final factor is that there are no standard specifications that fit most maintenance needs. In some cases, the construction standard specifications do not exist for maintenance actions, and in some cases the specifications that are available are so generic that performance would be in question. Maintenance material needs may be similar to construction material needs, but there are different circumstances that would require further examination to determine the actual material usage quality.

The question is whether maintenance forces are getting the material that is needed and that will work under

the existing conditions. Material specifications are critical in addressing this question. Personnel writing the specifications must be familiar with the products, the needs, and the material characteristics for a local area. The personnel best suited to determine the specifications are the local maintenance personnel. To ensure that local maintenance personnel could specify the needed material, additional training and educational efforts would be required, to provide the technical knowledge necessary to address the specification issue.

Another issue regarding specification is educating the procurement agent to what the local personnel need and how to write the bid documents so that the local issues are addressed. Many times the procurement agents are

ORG ACTIVITY DESCRIPTION			LOCATION	DATE	SCORE	REMARKS
8750	102	Level with Premix	I-40 - M.P. 288.1-288.2	08/18/1999	3	None Listed.
8751	102	Level with Premix	SR 99 - M.P. 39.0 - 41.0	07/07/1999	3	None Listed.
8751	102	Level with Premix	I-40W - M.P. 237.5-238.0	08/25/1999	3	None Listed.
8751	102	Level with Premix	I-40E - M.P. 237.3 - 238.0	09/20/1999	3	None Listed.
8751	102	Level with Premix	SR 87S - M.P. 353 -354	11/16/1999	3	None Listed.
8752	102	Level with Premix	US 160- M.P. 423.4-423.8	08/23/1999	3	Did not sweep. Wasn't necessary.
8752	102	Level with Premix	US 163- M.P. 413.2-413.6	09/20/1999	3	Excellent job. No waste, smooth surface
8752	102	Level with Premix	US 160- M.P. 462.5-463.2	10/06/1999	3	None listed.
8753	102	Level with Premix				No Activities scored for this duration.
8754	102	Level with Premix				No Activities scored for this duration.
8755	102	Level with Premix	I-40 - M.P. 320.4 - 321.8	07/14/1999	3	Curbing on guardrail needs sweeping.
	102	Level with Premix	I-40 - M.P. 312.3 - 312.7	11/12/1999	3	Shoulders need to be swept.

FIGURE 6 Quality measurements for Activity 102.

not fully aware of local conditions and material needs, and they generally will try to write bid documents based on their own experience or based on specifications that had been used before.

The results in Figures 2 and 3 demonstrate that there have been difficulties meeting specification and that the results in the field are showing that the current specification may not be performing well. The results show that the Holbrook district needs to address what material is being bought and made in-house and whether the existing material specifications should be changed.

After a contract is bid and awarded, the issue becomes ensuring that the quality of the material delivered is as originally specified. Continued emphasis on this phase is required, and it should have the same priority as construction materials testing. From the procurement side, there needs to be some flexibility in allowing the local personnel to administer the contract, including approving payments and rejecting noncompliance material. Again, there is an education factor that needs to be addressed for both the maintenance and the procurement personnel, so that they may understand the issues involved in administering contracts on a local level and according to local conditions.

Figure 7 gives an indication of how complex the interaction is among the quality of materials, specification

of the materials, administration of the contract, and the working relationship of the maintenance and procurement personnel. The test results also indicate the complexity of getting what is needed.

## CONCLUSIONS

An effort is needed to educate both procurement and maintenance personnel in specification writing, quality control, quality assurance testing, and identifying specific material needs. The specific educational focus for the maintenance personnel is determining the material required and then writing specifications to those requirements. Interpretations of test results and how they apply to particular situations need to be communicated to maintenance personnel as well.

It is also evident that contract management needs to be less centralized. Not only should there be an effort to educate procurement personnel about local conditions and needs, but the effort should include assigning greater responsibility to maintenance personnel for specifying material requirements. Developing and using a "one-size-fits-all" specification would not work in some areas. Along with the responsibility of specifying material, the maintenance personnel must be responsible for administer-



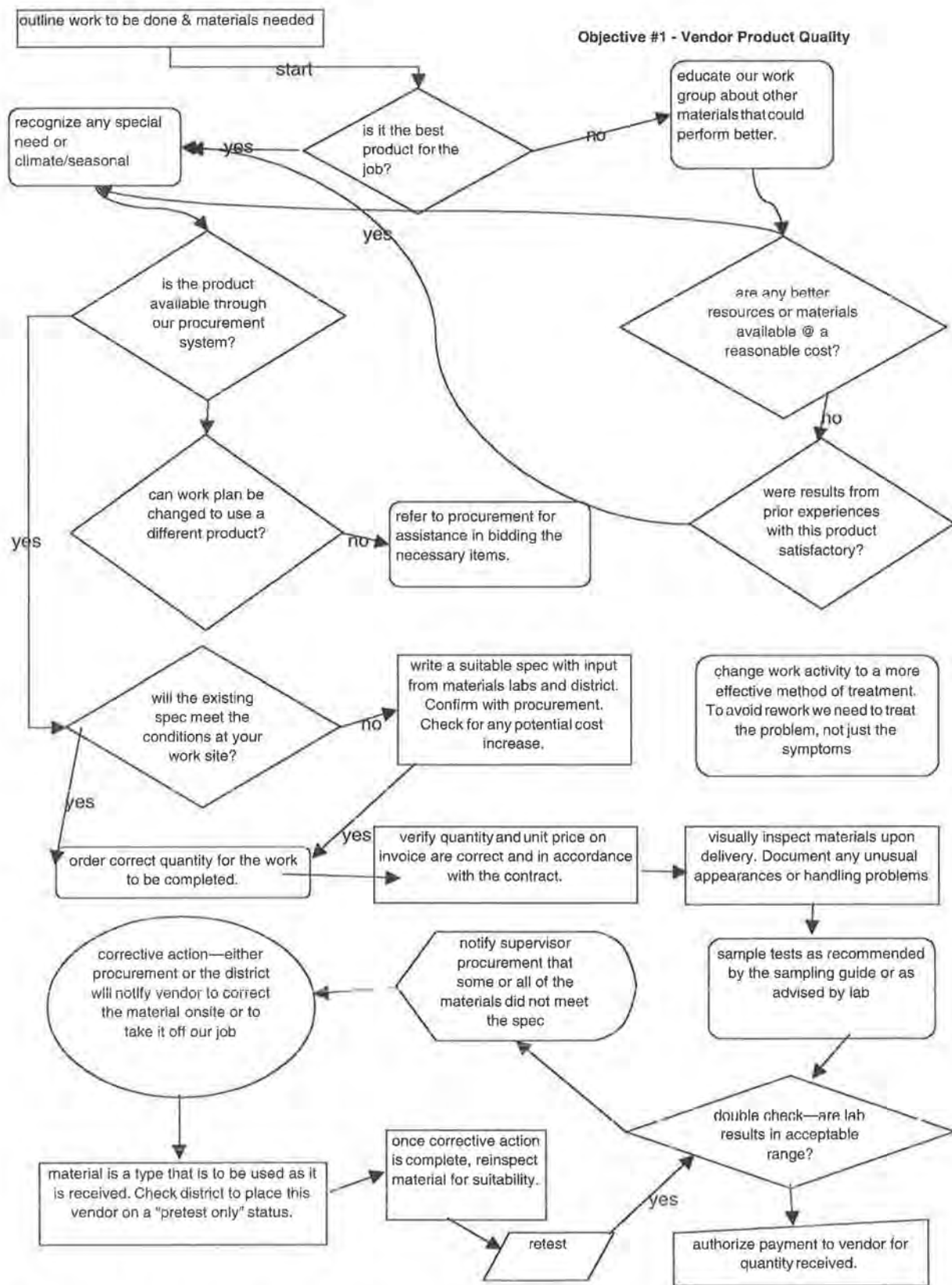


FIGURE 7 Holbrook district flowcharts. (continued on next page)



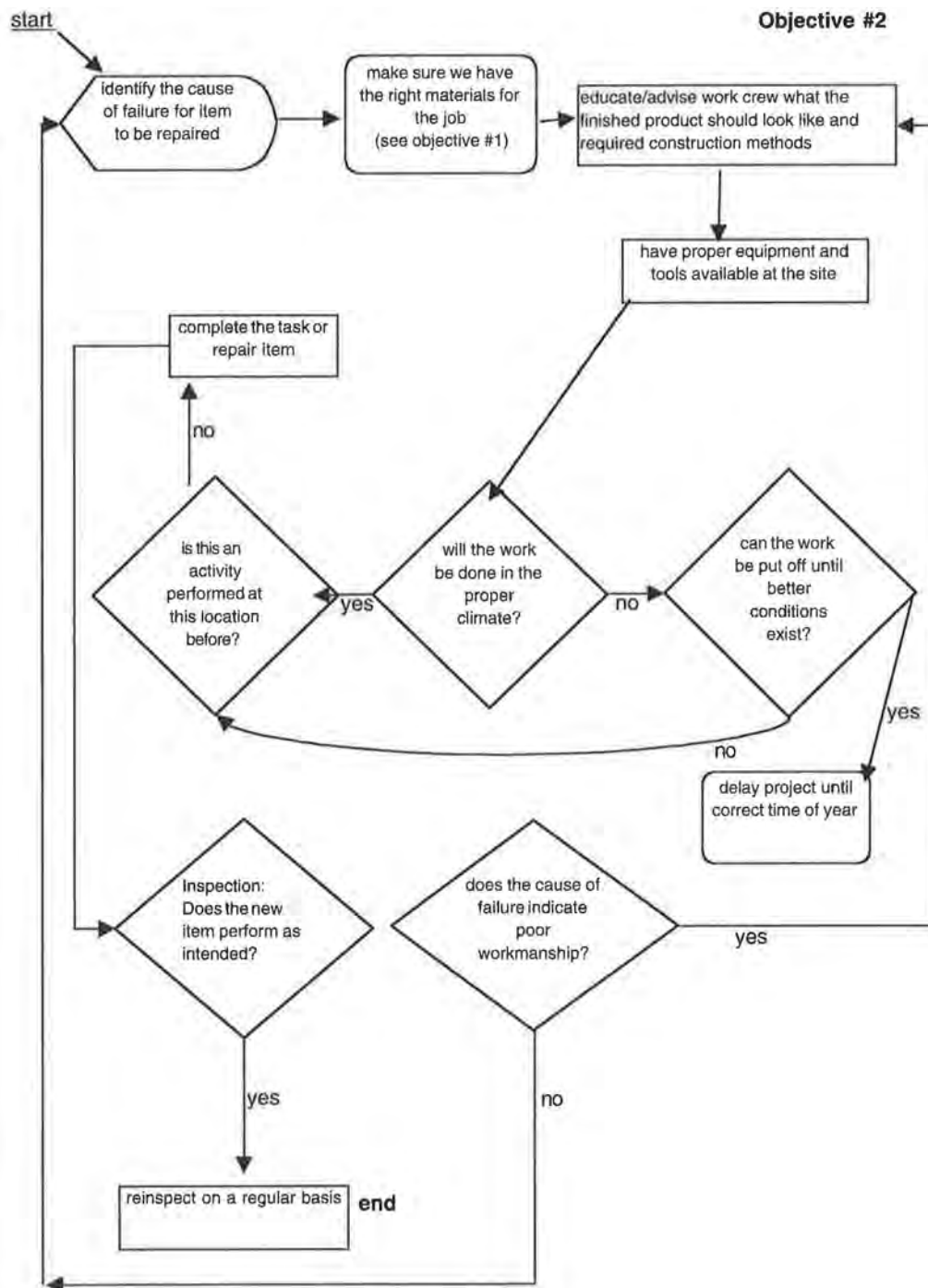


FIGURE 7 (continued) Holbrook district flowcharts.

ing the contract if material is being purchased. They are already responsible for in-house quality products, so they also should be responsible for ensuring that quality products are received from commercial suppliers.

An effort is needed to determine what quality control processes would be best for maintenance materials quality.

### FUTURE RESEARCH NEEDS

Future research is required to determine the level and amount of education for maintenance and procurement personnel in specification writing, quality control, quality assurance testing, and identifying specific material needs. Efforts are needed to define maintenance materials quality requirements and to determine whether changing the procurement process will result in maintenance personnel obtaining quality materials. Another facet of procuring

maintenance materials includes the possibility of obtaining proprietary products and requiring a warranty on these products.

Maintenance materials quality may be similar to construction materials quality, but with the current constraints on obtaining maintenance materials, maintenance must be addressed on its own merits and needs.

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