STATE OF ARIZONA
OFFICE OF THE
AUDITOR GENERAL

A PERFORMANCE AUDIT
OF THE

ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAY MAINTENANCE MANAGEMENT SYSTEM

DECEMBER 1982

A REPORT TO THE
ARIZONA STATE LEGISLATURE

REPORT 82-8

DOUGLAS R. NORTON, CPA
AUDITOR GENERAL

STATE OF ARIZONA
OFFICE OF THE
AUDITOR GENERAL

December 9, 1982

Members of the Arizona Legislature
The Honorable Bruce Babbitt, Governor
Mr. William A. Ordway, Director
Arizona Department of Transportation

Transmitted herewith is a report of the Auditor General, A Performance Audit of the Arizona Department of Transportation, Highway Maintenance Management System. This report is the fourth of a series of reports to be issued on the Arizona Department of Transportation and is in response to Senate Bill 1001 enacted by the Thirty-fifth Legislature, Second Special Session in 1981.

The blue pages present a summary of the report; a response from the Arizona Department of Transportation is found on the yellow pages preceding the appendices.

My staff and I will be pleased to discuss or clarify items in the report.

Respectfully submitted,

Douglas R. Norton

Douglas R. Norton
Auditor General

Staff: William Thomson
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Enclosure

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OFFICE OF THE AUDITOR GENERAL

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SUMMARY

The Office of the Auditor General has conducted a performance audit of the Arizona Department of Transportation (ADOT), Highway Maintenance Management System, in response to Senate Bill 1001 enacted by the Thirty-fifth Legislature, Second Special Session in 1981. This report is one of a series to be completed on the Department of Transportation.

Highway maintenance is a major function of the Arizona Department of Transportation (ADOT). For fiscal year 1982-83, the highway maintenance program has a staff of almost 800 full-time equivalent positions (FTEs) and an appropriation of over $40 million. Further, these figures address only the routine maintenance performed by ADOT employees. Major highway maintenance projects such as pavement overlays or reconstruction are performed by private contractors and are not included in the highway maintenance program budget.

ADOT has developed and operated (for the past 10 years) a highway maintenance management system called "PeCos."* PeCos is an essential part of ADOT's management of the maintenance function and is used to measure and control maintenance productivity. Therefore, the productivity measurement of maintenance workers in ADOT depends to a large degree on the work standards of PeCos.

To review the adequacy of PeCos, we employed the services of Dr. Marvin E. Mundel, an internationally recognized authority on productivity and work measurement. Dr. Mundel was employed because he 1) has particular expertise and experience in governmental productivity and 2) does extensive work with productivity of groups which have varied tasks and duties. For example, he has designed productivity measurement systems for the U.S. Secret Service, design engineers, auditors and administrative law judges. We found this experience particularly applicable for this review

* PeCos is an acronym for "Performance Controlled System" and is used to refer to the Arizona Highway Maintenance Management System.

because ADOT highway maintenance also has varied tasks and duties due to such factors as weather, geography and the number of tasks performed.

Review of the highway maintenance management program revealed that ADOT's maintenance management system (PeCos) does not provide adequate control over the productivity of maintenance workers. As a result, our consultant estimates there is an underutilization of ADOT maintenance labor resources. Further, using PeCos ADOT cannot determine overall productivity of a maintenance unit or compare productivity among maintenance units. By implementing relatively inexpensive modifications to the existing PeCos structure, ADOT could control, measure, plan and take actions for increasing productivity of its highway maintenance program.

Even small increases in the productivity of the maintenance function would yield significant dollar savings. For example, each 1 percent increase in maintenance productivity represents a potential savings of $173,667 the first year.

INTRODUCTION AND BACKGROUND

The Office of the Auditor General has conducted a performance audit of the Arizona Department of Transportation (ADOT), highway maintenance management system, in response to Senate Bill 1001 enacted by the Thirty-fifth Legislature, Second Special Session in 1981. This report is one of a series to be completed on the Department of Transportation.

Highway maintenance is a major ADOT function. As shown below in Table 1, almost 800 employees (in fiscal year 1982-83) are involved in highway maintenance and the annual appropriation is approximately $40 million. Further, these figures address only the routine maintenance performed by ADOT employees. Major highway maintenance projects such as pavement overlays or reconstruction are performed by private contractors and are not included in these figures.

TABLE 1

ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAY MAINTENANCE
FIVE-YEAR SUMMARY OF APPROPRIATIONS AND FTEs*

	1978-79	1979-80	1980-81	1981-82	1982-83
Number of FTEs	756	824	822	796	784
Personal services	$10,784,300	$11,588,600	$12,718,500	$13,132,700	$13,911,500
Employee-related expenditures	2,965,300	3,741,800	4,012,800	3,447,400	3,457,200
Travel	181,400	181,400	199,500	220,000	220,000
Other operating expenditures	795,600	784,900	793,900	839,100	878,500
Materials	4,663,700	5,756,000	6,344,400	7,873,700	9,554,400
Equipment rental	5,654,800	7,161,300	12,233,600	12,291,500	12,327,000
Contingency	500,000	500,000	500,000	500,000	500,000
Total	$25,545,100	$29,714,000	$36,802,700	$38,304,400	$40,889,700

* Full-time equivalent positions

Not only is highway maintenance a major function, it is also highly visible to the traveling public. Additionally, there are indications that the public is concerned about the productivity of maintenance workers. The size of the program coupled with this concern were among the factors considered in selecting this area for audit work.

Two approaches were considered for a review of the productivity of the ADOT maintenance function: 1) actually measure the productivity of maintenance workers or 2) review the adequacy of the system ADOT uses to control productivity. In consultation with work measurement experts, we determined that we did not have sufficient resources to perform actual work measurements on a sufficient scale to be valid. In part this determination was influenced by the following factors:

- Over 264 unique maintenance activities are identified by ADOT;
- The performance of many of these maintenance activities is seasonal, and others are heavily influenced by weather conditions; and
- The maintenance work sites are dispersed throughout the State.

Further, actual measurements of productivity would not by themselves address the changes needed to control and improve productivity.

On the other hand, ADOT has developed and operated for the past 10 years a highway maintenance management system called "PeCos."* PeCos is an essential part of ADOT's management of the maintenance function and is used to measure and control maintenance productivity. Therefore, the productivity measurement of maintenance workers depends to a large degree on the work standards of PeCos.

To review the adequacy of the PeCos system, we employed the services of Dr. Marvin E. Mundel, an internationally recognized authority on productivity and work measurement.**

---

* "PeCos" is an acronym for Performance Controlled System and is used to refer to the Arizona Highway Maintenance Management System.

** Dr. Mundel's qualifications are set forth in the Appendix.

Dr. Mundel was employed because he 1) has particular expertise and experience in governmental productivity and 2) does extensive work with productivity of groups which have varied tasks and duties as opposed to a controlled or assembly line type of function. More than 90 percent of Dr. Mundel's work is performed for organizations which have little or nothing that resembles factories or assembly line productivity measures. For example, he has designed productivity measurement systems for the U.S. Secret Service, design engineers, auditors, veterinarians and administrative law judges. We found this experience particularly applicable for this review because ADOT highway maintenance also has varied tasks and duties due to such factors as weather, geography and the number of tasks performed. The results of Dr. Mundel's work and our own evaluation are contained in the Finding. The full text of Dr. Mundel's report to our Office is contained in the Appendix to the report.

Audit Scope

For the reasons described previously, this audit was limited to a review of the adequacy of the PeCos system.

The Auditor General and staff express appreciation to the Director of the Department of Transportation and his employees for their cooperation and assistance during the course of our audit.

FINDING

CHANGES ARE NEEDED TO CONTROL AND IMPROVE THE PRODUCTIVITY OF HIGHWAY MAINTENANCE CREWS.

The Arizona Department of Transportation (ADOT), Highway Maintenance Management System (PeCos) does not provide adequate control over the productivity of the highway maintenance workers. As a result, our consultant estimates there is an underutilization of ADOT maintenance labor resources. Further, using PeCos ADOT cannot determine overall productivity of a maintenance unit or compare productivity among maintenance units. Adequate control could be provided and productivity increased if ADOT staff would 1) modify the current PeCos system to make more activities measurable, 2) use "earned hours" to measure overall productivity, and 3) actively plan (and take the necessary actions) to increase productivity.

Lack of Control Over Maintenance Work

An analysis of PeCos revealed that it is ineffective in influencing productivity of maintenance crews because a majority of the labor hours are expended on maintenance activities which have no measured outputs or accomplishments.

In fiscal year 1980-81 there were 1.6 million labor hours expended by highway maintenance workers working on various maintenance activities. These maintenance activities can be categorized as "controlled" and "uncontrolled" as follows:

> Controlled* activities: Activity categories where the work-units are expressed in quantified measures of work accomplished, e.g. swath miles mowed, cubic yards of premix applied in hand patching, etc.

* "Controlled" in this context means "evaluating against a performance standard," rather than "keeping a record of expenditures."

Uncontrolled activities: Activity categories where the work-units are manhours expended--a value equal to the resource input with no measure of highway accomplishments.

An analysis of fiscal year 1980-81 labor hours showed that 48 percent or 763,000 maintenance labor hours were expended on uncontrolled maintenance activities and only 37 percent of the labor hours were expended on "controlled" activities.* This means that 763,000 hours were spent on activities which had no quantified measure of work accomplished.

The table below provides examples of some "uncontrolled" activities.

TABLE 2

EXAMPLES OF UNCONTROLLED MAINTENANCE ACTIVITIES

Activity Description	Standard Crew Hours/Day	Work-Units**	Description of Duties
152 - Litter Pickup	8 hours	None	Clean up isolated areas of the roadway that have become littered with trash
303 - Edge and Trim Lawns	8 hours	None	The edging of lawns along curb areas and the trimming of grass around trees
309 - Irrigation System Maintenance	8 hours	None	The maintenance and adjustment of all irrigation systems
611 - Material Handling	8 hours	None	The hauling and handling of supplies and materials

* The remaining 15 percent consists of leave hours.

** Work-units are the means of quantifying how much of an activity category should be accomplished per crew day.

The "uncontrolled" activities shown above illustrate the lack of a recorded or measurable accomplishment. For example, Activity 303, Edge and Trim Lawns has no work-unit attached. This means that a crew could edge 10 feet or 1,000 feet of lawn, but there is no recorded measure of what was accomplished by the crew in the 8 hours they were sent out to perform this activity. Therefore, (aside from foreman supervision over this work) there is no way to determine the recorded amount of work done by a crew in order to compare it to any established standard or even to compare it to the same work performed by that crew on a prior or subsequent workday. Currently, there are some 175* "uncontrolled" activities used in PeCos.

Because more labor hours are expended on "uncontrolled" versus "controlled" activities, our consultant estimates there is a significant underutilization of labor resources. Reviewing the amount of "uncontrolled" labor hours he reported:

> "It is usually taken as axiomatic that when an organization does not work to specific output goals, and this characterizes most of ADOT's highway maintenance, it is most common to achieve only 65 to 70 percent of the 100 percent feasible without undue exertion."

To increase productivity, ADOT needs to begin by "controlling" more activities. This involves establishing quantifiable work measures or work-units for those activities that do not have such measures. In Attachment III of his report (see Appendix), the consultant provides 175 suggested work-units that ADOT can use in this process.

ADOT Cannot Compare Productivity for Controlled Activities

Not only are productivity measurements nonexistent for uncontrolled activities, but the PeCos productivity measurements used for controlled activities cannot be added to obtain an overall productivity measure of a

* They include all individual maintenance activities (including those numbered activities with letter suffixes attached) classified by Dr. Mundel in Attachment I of his report.

maintenance unit. This in turn prevents comparison of the overall productivity of a unit from year to year or comparison of the overall productivity among different units or districts. Table 3 shows some of the measurements used for the controlled activities.

TABLE 3

EXAMPLES OF PRODUCTIVITY MEASUREMENTS FOR CONTROLLED ACTIVITIES

Activity Description	Productivity Standard (per PeCos)	Mean Daily Accomplishment*
Urban curb sweeping	.348 manhours per curb mile swept	23.0 curb miles swept/man
Hand patch with premix	8.89 manhours per cubic yard applied	2.70 cubic yards applied/ three-man crew
Central maintenance guideline painting	.080 manhours per gallon applied	500 gallons applied/ five-man crew

* Mean Daily Accomplishment is the mean of the average daily production range of expected accomplishment for the work activity.

The above examples highlight why overall productivity cannot be measured using the current system. Curb miles per man, cubic yards and gallons per crew cannot be added to make a meaningful total. If a crew or a district exceeds the productivity standard for sweeping curbs but fails to meet the standard for hand patching with premix, you cannot tell whether their overall productivity for both activities is below, above or at the productivity standards. There are 57 "controlled" maintenance activities which contain productivity standards which cannot be added among activities to arrive at a meaningful total.

Earned Hours

To measure overall productivity ADOT should modify its PeCos system to use the concept of "earned hours." Under earned hours, the amount of work performed is converted to an hour value based on the amount of work that should have been performed according to the productivity standard. For example, using the standards in Table 3 each mile of curb swept would produce .348 earned hours. Twenty-three miles of curb swept would produce eight earned hours. If a worker is performing at the standard, he will sweep 23 miles of curb in an 8-hour day and his earned hours will equal his actual hours. If a worker can sweep more than 23 miles in an 8-hour day, he can earn more than 8 earned hours; if he sweeps fewer miles, he earns fewer earned hours.

Earned hours can be computed for all activities that have quantifiable work-units or productivity standards. Further, because earned hours provide a uniform measurement for all measureable activities, the earned hours can be added to determine overall productivity. Table 4 illustrates how this concept works and compares it to the current ADOT productivity measurement system for a sample of actual work performed by two BLCs* or maintenance units. Although the Table represents only a sampling of maintenance activities, a review of the Table shows the type of analysis that can be performed using "earned hours" but that cannot be performed using ADOT's current productivity standards.

First, both BLCs have fewer total earned hours than actual hours expended; this means that total productivity for both BLCs was below what would be expected using the performance standards of the PeCos system. Second, on a percentage basis, BLC C211 has a lower ratio of earned to actual hours (60 percent) than does BLC C213 (82 percent). This means that for the activities shown, BLC C211 is less productive than BLC C213. Third, the aggregated outputs (earned hours) can now be used as a baseline to compare the increase/decrease in maintenance (BLC, district or State) productivity in future periods.

---

* Individual maintenance units are commonly referred to as BLCs. BLC is an abbreviation for Budget Location Code.

TABLE 4

COMPARISON OF EARNED HOURS TO ADOT PRODUCTIVITY MEASUREMENT

Activity Description	Productivity Standard	Amount of Work Performed	Actual Hours	Earned Hours**	ADOT Productivity Measurement
BLC* C211					
Hand patch with premix	8.89 man-hours per cu yd applied	2 cu yd of premix applied	40	17.8	20 man-hours per cu yd*** applied
Hand patch with premix	8.89 man-hours per cu yd applied	2 cu yd of premix applied	16	17.8	8 man-hours per cu yd applied
Routine drainage maintenance	1.46 man-hours per drain openings serviced	8 drain openings serviced	16	11.6	2 man-hours per drain openings serviced
Routine drainage maintenance	1.46 man-hours per drain openings serviced	16 drain openings serviced	16	23.3	1 man-hour per drain openings serviced
Clean cut ditches	.010 man-hours per lin ft of ditches cleared	1,500 lin ft of ditches cleared	40	15.0	.026 man-hours per lin ft of ditches cleared
Clean cut ditches	.010 man-hours per lin ft of ditches cleared	1,500 lin ft of ditches cleared	40	15.0	.026 man-hours per lin ft of ditches cleared
Total BLC C211			168	100.5	
BLC C213					
Hand patch with premix	8.89 man-hours per cu yd applied	1 cu yd of premix applied	16	8.9	16 man-hours per cu yd applied
Hand patch with premix	8.89 man-hours per cu yd applied	1 cu yd of premix applied	16	8.9	16 man-hours per cu yd applied
Routine drainage maintenance	1.46 man-hours per drain openings serviced	14 drain openings serviced	16	20.4	1.14 man-hours per drain openings serviced
Routine drainage maintenance	1.46 man-hours per drain openings serviced	5 drain openings serviced	16	7.3	3.2 man-hours per drain openings serviced
Clean cut ditches	.010 man-hours per lin ft of ditches cleared	300 lin ft of ditches cleared	16	3.0	.053 man-hours per lin ft of ditches cleared
Clean cut ditches	.010 man-hours per lin ft of ditches cleared	3,000 lin ft of ditches cleared	16	29.9	.005 man-hours per lin ft of ditches cleared
Total BLC C213			96	78.4	

* Budget Location Code which identifies a specific maintenance unit.

** Earned Hours = $\frac{\text{Actual Accomplishment}}{\text{Mean Daily Accomplishment}}$ (Standard Hours)

*** In this example, it took 20 man-hours to apply one cubic yard of premix; whereas the ADOT standard says that it should take only 8.89 man-hours to apply one cubic yard of premix.

By comparison, using ADOT's productivity standards for different activities you cannot add the outputs together to obtain total productivity of the BLCs since the productivity measurements (cubic yards, drain openings, lineal feet) are not the same. In addition, you cannot compare productivity between the two BLCs, although ADOT officials have stated that they examine productivity between crews and districts on an activity-by-activity basis, using ADOT's current productivity of the crews or districts. Finally, there is no baseline against which to compare any future increase/decrease in productivity as exists with earned hours. ADOT's activity-by-activity comparison does not provide needed information about whether overall productivity is increasing or decreasing.

Planning for Productivity Improvement

Once maintenance activities have measurable outputs attached, then earned hours can be compared and productivity improvement can be introduced and evaluated. However, ADOT's Highway Maintenance Management System has not been used to plan for specific increases in the productivity of the maintenance activities. First of all, ADOT cannot plan for improvements in productivity of "uncontrolled" activities since by definition these activities have no measurable accomplishments. Second, ADOT has not planned for productivity improvements for those "controlled" activities which do have measurable accomplishments of highway crewmen. The potential exists for savings if ADOT introduces overall planning for improving the productivity of highway maintenance crews and if crew supervisors expect and schedule more productivity for the work force.

"Uncontrolled" activities by definition do not have any measurable work-units; that is, no outputs or accomplishments are recorded (see page 6 of this report). Therefore, no productivity standards exist for these 175 individual maintenance activities; thus, there could be no way to plan for improving productivity of these currently "uncontrolled" maintenance activities.

Although there are 57 "controlled" activities which currently do have productivity measurements, very few of them have had a planned increase in productivity.

We analyzed the annual productivity standards for 48 controlled maintenance activities for a five-year period (fiscal years 1977-78 through 1981-82, inclusive) and noted that the vast majority of the controlled maintenance activities had no planning for productivity improvements but instead retained the same output standards.

TABLE 5

HISTORICAL ANALYSIS OF PRODUCTIVITY PLANNING
FOR 48* MAINTENANCE ACTIVITIES FOR
FISCAL YEARS 1977-78 THROUGH 1981-82

	Number	Percentage
Maintenance activities which had virtually no planned productivity improvements	42	87%
Maintenance activities which did show planned increase in productivity	6	13
TOTAL	48	100%

* A productivity standard is developed annually by ADOT for each of 57 maintenance activities which have measurable work-units. However, five-year data was available for only 48 activities.

Table 5 shows that 42 of the 48 activities with measurable productivity standards have had no planning for productivity improvements in the past five years. When coupled with the 175 "uncontrolled"* maintenance activities (which did not have a method for measuring any change in productivity), 82 percent of all the maintenance activities either had no method for measuring or no plan for improving productivity in the five-year period analyzed.

Introduce Productivity
Improvement Planning

ADOT should plan to achieve increased productivity as a normal course of events. Further, by planning for even small increases in productivity, ADOT could realize significant savings in the highway maintenance area.

Our consultant noted it should be normal to see small ongoing increases in an organization's productivity. He pointed out that nearly each country in the world is undergoing, and has always undergone, slow, creeping increases in productivity because of changes in equipment, materials and procedures. He said he could find no evidence that there had been any change in the productivity of ADOT's maintenance function, but he found it hard to believe that it was

> "...such a peculiar, unique organization that productivity was absolutely and thoroughly inflexible."

Most importantly, he cautions that failure to plan to improve will result in ADOT not realizing any productivity improvement:

> "If no plan is made, during annual planning, to alter the historical ratio between outputs and manpower no change will take place with respect to productivity. Only if ADOT under forecasts the work and the crews to do all the work will productivity fortuitiously rise; over forecasts will produce a reverse result." (emphasis added)

* See pg. 7 of this report for reference to these "uncontrolled" maintenance activities currently used in PeCos.

Potential Savings

Even a 3 percent increase in the productivity of ADOT maintenance crews could result in significant dollar savings, and/or more work performed for the same budget amount. For example, if ADOT increases maintenance productivity by 3 percent and continues to perform the same amount of maintenance work, the maintenance labor budget of $17,368,700 could be reduced by $521,061.* Further, for each additional 1 percent increase in productivity, the budget could be reduced an additional $173,687. If, on the other hand, productivity increases and the labor resource budget remains constant ADOT can increase the amount of work performed.

The savings or increased work is dependent, however, on the ability to control, measure, plan and take actions for increasing productivity. This in turn entails 1) establishing control over "uncontrolled" maintenance activities by establishing quantifiable work measurements, 2) implementing the earned-hour concept, 3) planning to improve productivity, and 4) taking action to improve productivity. All of these actions would require relatively inexpensive modifications which could be adapted to the existing PeCos structure. Although some reprioritization of work loads may be necessary, ADOT staff has the expertise and resources required to modify the PeCos system to control productivity. Further, the consultant's report contains many recommendations to assist ADOT in making the modifications, including an extensive list of suggestions for quantifiable work measures.

CONCLUSION

ADOT cannot control the productivity of its maintenance program using the PeCos system as it currently operates. However, this problem can be corrected by making relatively inexpensive modifications to the system using existing resources.

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* Personal services plus employee-related expenses = $17,368,700.
$17,368,700 x .03 = $521,061.

RECOMMENDATIONS

1. ADOT should establish control over "uncontrolled" maintenance activities by defining measurable work-units (suggested work-units are contained in Attachment III of the Appendix).

2. ADOT should develop an "earned-hour" system for measuring and comparing outputs.

3. ADOT should develop and implement plans to increase productivity after following recommendations 1 and 2 above.

OTHER PERTINENT INFORMATION

ADOT maintenance has awarded a limited number of contracts to private firms to perform certain maintenance functions. In 1982 three contracts were let for pilot maintenance projects. Table 6 below provides a summary of maintenance contracts awarded in fiscal years 1981-82 and 1982-83.

TABLE 6

CONTRACT MAINTENANCE
CONTRACTS AWARDED IN FISCAL YEARS 1981-82 AND 1982-83

Contract Description	Location	Duration of Contract	Contract Price
Litter Pickup; Rest Area Maintenance	Districts 5&7	7/1/81 - 6/30/82	$ 48,645
Crack Sealing of Bituminous Pavement	Statewide	5/82 - 5/83	330,000
Urban Curb Sweeping	Phoenix	10/82 - 10/83	31,520
Landscape Maintenance	State Route 360	10/82 - 10/83	53,421
		Total	$463,586

NOTE: The fiscal year 1981-82 budget for the ADOT Highway Maintenance Program was $38,304,400.

ARIZONA DEPARTMENT OF TRANSPORTATION

206 South Seventeenth Avenue Phoenix, Arizona 85007

BRUCE BABBITT
Governor

WILLIAM A. ORDWAY
Director

December 2, 1982

Mr. Douglas Norton
Auditor General
Auditor General's Office
111 West Monroe, Suite 600
Phoenix, Arizona 85003

Dear Doug:

Thank you for the opportunity to review the revised preliminary report draft of the performance audit of the Arizona Department of Transportation Highway Maintenance Management System. Our review is attached.

Again, thanks for this opportunity to comment and for the cooperation extended by the Audit staff.

Cordially,

W. A. ORDWAY
Director

WAO:HMO:lj

Attachment

ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAY MAINTENANCE MANAGEMENT SYSTEM
PERFORMANCE AUDIT

Finding

CHANGES ARE NEEDED TO CONTROL AND IMPROVE THE PRODUCTIVITY OF HIGHWAY MAINTENANCE CREWS.

ADOT Position - Concur

We agree with the recommendation that many of the "uncontrolled" activities should be converted to "controlled" activities by defining measureable work-units. Preliminary analysis indicates that we can reasonably establish measurable work-units to approximately one-half of the "uncontrolled" activities. It is true that our present system cannot measure the overall productivity of a maintenance section. By implementing the earned-hour concept, all activities can be collectively added to obtain an overall productivity index. This will provide us with useful information to implement our present productivity reports.

We disagree with the implication that ADOT has no plans to increase productivity. Our Highway Maintenance Management System was developed and implemented with a goal of increasing productivity on an annual basis. Implementation of Recommendations 1 and 2 should improve this capability.

APPENDIX

REPORT FROM DR. MARVIN E. MUNDEL TO THE AUDITOR GENERAL
ON THE ADOT HIGHWAY MAINTENANCE MANAGEMENT SYSTEM
(PeCos) AND RESUME' OF DR. MUNDEL

DATE: March 30, 1982 (Rev. 5/18/82)

TO: Auditor General, State of Arizona

FROM: M. E. Mundel

RE: Analysis of selected portions of the operation of the Arizona Department of Transportation's (ADOT) Performance Controlled System (PeCoS) for highway maintenance and related aspects of the performance of ADOT.

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GLOSSARY

The following special terms are used in this report. Where they were taken from PeCoS they are preceded by an asterisk. The others have been introduced to clarify the statements in this report.

* 1. Work-unit: The means of quantifying how much of an activity category should be accomplished per crew day. (See p. 3 of report for examples.)

2. Controlled activities: Activity categories where the work-units are expressed in quantified highway features, e.g., yds. of premix, swath miles, etc.

3. Uncontrolled activities: Activity categories where the work-units are manhours expended; a value equal to the resource input with no measure of highway accomplishments.

4. Earned hours: The activity converted to the hour value of the accomplishment (the work-unit). For instance, if 50 units (of any highway accomplishment) is expected from a 3-crew (24 manhour) day, then:

Accomplishment in work-units		Earned hours
40; 40/50 x 24	=	19.2
50; 50/50 x 24	=	24.0
60; 60/50 x 24	=	28.8

Note: All earned hours in a BLC may be added, for any period of time, and compared to actual hours expended to find how productive the BLC was. Outputs, in highway effects achieved per crew hour, cannot be added to produce a meaningful number for the BLC. However, computed as a State total of such sums, such as total average hours per cubic yard of premix, it can be used as an overall

budget control for the single activity.

5. Direct labor ratios: The ratio of one type of labor to another; e.g., BLC supervisors as X% of work crews.

6. Productivity: The ratio of earned hours to actual hours expended. (See 4, above;also pps. 8 and 9.)

I. INTRODUCTION

A. Specific questions posed by the Auditor General

1. "The appropriateness of the work-units (in PeCoS)." In this context the word "work-unit" refers to "the measurable unit used to quantify accomplishment" of each of the 96 numbered "activity categories."
2. "The reasonableness of the typical crew sizes (for each different activity)." It was understood that two different crew sizes for an activity might be encountered: the standards as specified in PeCoS and the actual sizes in common use, again per each activity.
3. "The reasonableness of the daily production ranges [for outputs] (standard work-unit per crew)." This question was considered from both the viewpoint of annual planning and daily crew assignment.
4. "Identify possible improvements in production, more efficient use of crews, equipment and material and quantification of potential dollar savings."

II. THE APPROPRIATENESS OF THE OVERALL SYSTEM

A. General

1. In any situation the first requirement for establishing full control of an organization is a definitive identification of the outputs in terms related to the objective of the organization. The identification must be all inclusive (all outputs identified) and mutually exclusive (no double counting). Further the method of identification must facilitate:

   a. Long range planning (annual budgeting).

   b. Ongoing planning (daily crew assignments).

   c. Constraining performance against budget dollars.

   d. Performance evaluation (evaluation of accomplishment of work in output terms related to the objective of the organization; for ADOT, in terms of highways and related features).

   e. Evaluation of the impact of change in methods, equipment and management decisions on productivity.

   Further, output identification for budgeting may be (and usually is) in units different from those used in ongoing, daily, workface control.

2. The activity structure of PeCoS (ADOT, Highway Maintenance) is a solid, well structured plan of identifying outputs, with appropriate differences in quantification for budgeting and ongoing, workface control. The outputs are described with two basic terms:

   a. Activity category - the type of work being done, e.g., 101; Hand Patch with Premix: 102; Level with Premix: 103; Fill Cracks with Liquid.

b. Work-unit - the means of quantifying how much of the activity should be accomplished per crew day, e.g.:

(1) 101: 1 to 4 cubic yards.

(2) 102: 30 to 60 cubic yards.

(3) 103: 100 to 180 gallons.

I do not recommend any major changes in the structure of the system. The changes which are suggested later in this report affect only details within the existing system.

III. THE APPROPRIATENESS OF THE WORK-UNITS; ANNUAL PLANNING

A. Coverage of the activities (excluding central sign shop activities)

1. The PeCoS manual contains a detailed form (42-6102 6/75) describing each of the 96 numbered activities. These were divided into eight subsets as follows:

   a. The work-unit count for the numbered activity has a clear, causal relationship to daily and annual staff resource input required. For instance:

      (1) Activity category 156: Cattle Guard Maintenance.

      (2) Work-unit for 156: 5 to 9 grilles serviced.

      One can readily perceive that the amount accomplished is related to:

      (1) Staff engaged.

      (2) Diligence of staff.

      (3) Condition of cattle guards.

      (4) Degree of maintenance provided.

   b. The work-unit count has a less clear causal relationship to daily and annual staff resource input but is probably valid, state-wide, for annual planning. For instance:

      (1) Activity category 305: Fertilize lawns.

      (2) Work-unit: 3,000 to 4,000 pounds.

      or

      (3) Activity category 422: Central Maint. Guideline Painting.

      (4) Work-unit: 350-650 gallons of paint.

      One can perceive that in either of the above activities the ostensible quantity of output in any single crew assignment

will be heavily affected by factors such as, for 305:

(1) Machine setting.

(2) Accessability of lawn (terrain and obstacles).

For 422:

(1) Nozzle settings.

(2) Paint viscosity.

(3) Character and size of highway.

c. The work-unit is implicit in the activity, e.g., a rest area resident (or 7 shifts per week assigned) e.g., Activity 201; a fiat; an appropriate approach to this type of activity. Note: Such work-units are even more causally related to the staff resource input than those classified under a, preceding.

d. No work-unit other than manhours expended; input equals output: No real output quantification.

e. The activity categories and work-units related to overhead (BLC location maintenance, materials handling and stand-by), e.g., 899, Other material overhead. Work-unit is same as category d, above. Output (work-unit) is manhours expended.

f. Support; supervision and clerical.

g. Training.

h. Leave.

2. A table showing the subset number assigned, by activity category, appears in Attch. I, for all activity categories.

3. For FY 80-81 the 1,590,358 hours reported on crew cards, state-wide,

were distributed to the subsets as follows:

a.	Clear, causal work-units (Type a)	28.4 percent
b.	Quantitative work-units acceptable for state-wide annual planning (Type b)	5.6
	Sum of (a) and (b)	34.0
c.	Fiat staffing (Type c)	3.0
	Sum of (a), (b) and (c)	37.0
d.	No quantitative work-units other than manhours equals manhours (Type d)	24.2
e.	Overhead, etc. (manhours) (Type e)	9.4
f.	Support (manhours) (Type f)	13.0
g.	Training (Type g)	1.4
h.	Leave (Type h)	15.1

[(d) + (e) + (f) + (g)]/[(a) + (b) + (c)] (x100) = 131.6 percent

4. A set of tables, giving the work time distribution by (1) state total, appears in Attachment II; by (2) Districts, in Attachment II A. (BLC distributions were left in computer print-out form.)

5. The data of Attch II and IIA suggest that more work is <u>uncontrolled with respect to the quantities of outputs</u> (work-units per crew day), 48.0 percent of State expended hours in FY 1980-81, than controlled 37.0 (quantities of expected outputs per crew day) stated in work-unit terms. Note, leave has been excluded:

   48.0 + 37.0 + 15.1 (leave) = 100.1*

   *Rounding error.

   In other words 37.0 percent of the crew hours expended in a year have counted outputs directly related to highways (or features) categories

a and c, or outputs indirectly related (b), (see III A1 b). of the remaining 63.0 percent, 15.1 is leave; 48.0 percent (including .1 from rounding) have outputs counted only as manhours.

6. It is true that the 63.0 percent referred to is "controlled" (expenditures watched) with respect to:

   a. Budgeted amount.

   b. Constraint of expenditures to budget dollars.

   These limited controls should be retained and but additional detail added, as will be recommended later, to obtain control over workface assignments (where supervision can impact), BLC's, highway related outputs, and productivity.

B. Conclusions re PeCoS and state-wide annual planning

1. The work-units are appropriate for only 37.0 percent of the work.
2. Adding leave (15.1 percent) to the work of 1 supra, only 52.1 percent of the staff resource budget is substantively supported.
3. There is 48.0 percent of the staff resource budget which appears to rest on a simple projection of past experience, unrelated to any specific quantitative evaluation of need or outputs.
4. However, the annual planning work-units (historical, state-wide quantitative values much more specifically stated than the ranges on the standard activity sheets) seem appropriate for the quantified work-units for basic annual planning. For instance, for Activity Category 101, Hand Patch with Premix, annual values appear valid for:

   a. Tons of Premix/year

   b. Avg. crew hours/ton/year. As will be seen later, this validity does not carry to crew-day assignments.

IV. RECOMMENDATIONS FOR ANNUAL PLANNING

A. Introduce ratios (of direct labor) into planning of overhead, support, training and leave

1. In planning the resources for categories (d) thru (h) (see III A), ratios should be used. For instance, controlled work (categories a, b and c) constituted 37.0 percent of the total in FY 80-81.

   a. Category d:

      Was 24.5 percent; 24.5/37.0 = 66.2 percent of controlled labor.

      Note: I consider this a temporary expedient; output related work-units should be introduced for category d activity categories and suggestions to that end appear later in this report.

   b. Overhead = 9.4; 9.4/37.0 = 25.4 percent of controlled activities

   c. Support = 13.0; 13.0/37.0 = 35.1

   d. Training = 1.4; 1.4/37.0 = 3.7

   e. Leave = 15.1; 1.51/37.0 = 40.8

2. The above procedures will provide assurance that these categories of expenditure are changing only as direct labor alters.

B. Introduce productivity improvement planning

1. Basically productivity is the quantity of outputs produced per labor resource input, compared to the same ratio for some base period.

   More specifically, let:

   LPI = Labor productivity index

   AOBY = Aggregated outputs for base year or period

   AOMY = Aggregated outputs for measured year or period

SRBY = Staff resources used, base year or period, in hours or years.

SRMY = Staff resources used in measured year or period, in same units as SRBY

Then:

$$LPI = \frac{\frac{AOMY}{SRMY}}{\frac{AOBY}{SRBY}} \times 100 \text{ (in percent)}$$

2. If no plan is made, during annual planning, to alter the historical ratio between outputs and manpower no change will take place with respect to productivity. Only if ADOT under forecasts the work and the crews do all the work will productivity fortuitously rise; over forecasts will produce a reverse result.

3. Still another impediment to measuring productivity exists in annual planning; the outputs, as counted per crew day cannot be meaningfully aggregated. For instance:

   a. Activity 101, Hand Patch with Premix may show 2.6 cu. yards per crew day.

   b. Continuing, Activity 422, Central Maint. Guideline Painting may show 350 gallons per crew day.

   c. Cubic yards and gallons do not add to make a meaningful total.

4. A new concept, Earned hours must be added. For instance:

   a. Activity 101, Hand Patch with Premix; Expected work-unit for 3-man crew = 2.7 cu. yds.*

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* = Obtained by dividing "Annual Work Quantity" by "No. of Crew Days" as they appear in the F/Y 81-82 "Performance Budget - State Summary" report.

Then 24 hours of earned hours equals 2.7 cu. yds. of Premix and:

3.0 cu yds = (3.0/2.7) x 24 = 26.7 earned hours.

2.0 cu yds = (2.0/2.7) x 24 = 17.8 earned hours.

b. Activity 422, Central Maint. Guideline Painting paint lines; Expected work-unit for 5-man crew is 500 gals.* Hence, 500 gals. equates with 40 earned hours, and:

550 gals = (550/500) x 40 = 44.0 earned hours.

300 gals = (300/450) x 40 = 24.0 earned hours.

c. The earned hours from a and b above can be computed and added to form the AOMY of the basic productivity equation.

5. Productivity planning

a. Let us assume that the workload for FY 82-83 is the same as FY 80-81. The planned, controlled work in FY 80-81 was (a+b+c) 586,507 hours.**

** = Obtained by adding "Grand Total" of Categories a, b and c from Attachment II.

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b. Let us assume that a 3% increase in productivity is desired.

c. The direct planned work is computed as:

$$\frac{586,507}{1.03} = 569,424 \text{ (Budget)}$$

d. Other categories will be computed from this "budget" value using the ratios described in IV A 1.

C. Feasibility of savings

1. For many years countries other than the United States have maintained annual improvements in National Productivity, such as (in round numbers):[1]

1. U.S. News & World Report, March 9, 1981.

Canada	3.8 percent
W. Germany	7.7
France	7.1
Italy	7.5
Japan	14.7

2. Hence, a three percent annual improvement (as suggested in IV B) would seem reasonable. These changes can be attributed to small, intermittent improvements in designs, equipment, tools, materials and staff resource allocations. Certainly these same factors impact on ADOT's highway work.
3. Further, as noted earlier, if the ADOT's historical ratio between staff resources and work-units is not changed, no productivity change can be expected.

D. Specific long range targets

It is usually taken as axiomatic that when an organization does not work to specific output goals, and this characterizes most of ADOT's highway maintenance, it is most common to achieve only 65 to 70 percent of the 100 percent feasible without undue exertion.

E. Examples

1. In 1967 a study was made of the Office of the Solicitor, U.S. Dept. of the Interior. Within six-years, by productivity improvement planning, productivity rose from 100 to 125 percent.
2. A study of shipbuilding, in Japan, was followed within a year by a rise in productivity from 100 to 181 percent.
3. A study of U.S. Health Service Indian Hospitals (U.S.) led to a 22 percent increase in productivity in one year.

Note: Numerous other cases could be cited.

F. Potential dollar savings and costs

1. Savings:

   a. The annual budget of ADOT, highways, was given as:

      a. Labor budget $12,996,000

      b. Employee related expense 3,411,600

      c. Total employee cost $16,407,600

   b. Potential savings or additional work at first year 103 percent productivity; $492,228; $164,076 per percent.

2. Costs:

   a. Develop detailed work-units with suffixes. I would think this could be done in-house without incremental cost.

   b. Add data items to crew cards; negligible cost.

   c. Add runs of crew cards thru computer; nominal costs.

   d. Increase "scouting" of assignment areas and increase supervisory attention to daily performance.

3. Conclusions

   Costs seem nominal relative to potential incremental savings the first year; even smaller downstream when several years of productivity improvement have accumulated.

V. THE APPROPRIATENESS OF THE WORK-UNITS; DAILY PLANNING

A. Coverage of the activities; daily planning and productivity measurement

1. Considering the eight subsets described in III A 1:

a. Reasonable work-units*	28.4 percent

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* Comments concerning "the daily production range" will appear in Section VII item B, C, following.

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b. Not suitable for daily use	5.6
c. Fiat manning	3.0
d. - h. Other manhour work-units	48.0

B. Conclusions, daily control

The conditions described under A 1, above, are not those characteristic of real control leading to productivity improvement, as described in Section IV; too many crew assignments have no assigned quantity of work.

C. Recommendations

1. Re subset a. Add letter suffixes to each activity code to indicate at least integer assignments such as for 101, Hand Patch with Premix, A, B, C or D; 1, 2, 3 or 4 cubic yards per standard crew day, depending on highway type.

   a. It would appear that the individual BLC supervisor may currently make such a decision when assigning a crew to a specific section of a highway, specific features or tasks. However, the variation in performance, reported in Section VII casts some doubt on whether this is done.

b. PeCoS will accept suffixes to codes and ignore them in developing summary printouts for higher management analysis.

c. Such suffixes are necessary if we are to monitor productivity -- a process in which we add weighted manhours earned, as described in Section IV B. An earned manhour is a manhour value of a PeCoS work-unit; as described in Section IV.

Such earned hours could be meaningfully aggregated from diverse activities. Production, in output terms per crew hour, in current use, cannot be meaningfully aggregated other than within one activity. We cannot add production unit data/manhour; cu. yds. of premix/manhour cannot be added to gallons of paint/manhour.

2. Re subset* (b) and some of (a) such as Activity 119, Other Paved

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* Refer to Section III A. 1. for a description of the type of subsets."Subset b " is "less causal relationship" to work count, and Subset a is "Direct causal relationship".

Surface Maintenance:

a. Use suffix letter codes to indicate the type of highway when related to the staff resources needed per work unit. This should reduce the range and make assignments increasingly specific. See notes at end of Attch. III for suggested classifications.

b. Change work-unit used on crew sheet from that on current performance standard to one more indicative of staff resource need, e.g. Activity 109, Spot, Flush Coating from gallons of asphalt to lane feet or lane miles; Activity 422, Central Maintenance Guide Line Painting from gallons of paint to

lane miles, etc.

c. It should be noted that for annual planning, with a relatively fixed inventory of roads, containing a relatively fixed mixture of types of roads, the annual staff resource for Activity 109 and Activity 422 may correlate with gallons but this relationship will not (continued on page 15)

hold at the crew card level.

3. A complete list of suggested changes is contained in Attch. III, including the ratio type work-units referred to in IV, A, preceding.

4. Other subsets

   Follow suggestions for work-units, as given in Attch. III.

5. Change of data on crew cards

   a. Enter activity category with appropriate suffix. The BLC supervisor will thus designate highway type.

   b. Enter allowed travel time to and from work area.

   c. Assign a specific amount of output based on the non-travel time and the quantitative work-unit for the activity. The planned "productivity improvement" must be included in this computation.

   d. Actual hours will appear, as now, on all crew cards.

D. Using the recommendations

1. The data suggested under 5 a, b and c supra may be used to compare at BLC level, District and State:

   a. Earned hours/actual; a measure of productivity. Travel hours will appear in actual but must be added to earned hours to obtain total earned hours on card.

   b. Financial data, using the codes (without the suffixes) can still be aggregated, as is currently done, to maintain budget dollar and gross staff resource control.

   Earned hours, supervision and support, etc., can be computed from (1) above, using the ratios suggested in IV A and identified in detail in Attch. III, and compared with actual.

VI. EVALUATION OF CREW SIZES

A. Data base

The approximately 170,000 crew cards used during the 2 year period 1-1-80 thru 12-31-81 were sorted by:

1. Activity category.
2. Crew size used within activity.

These data were used to compute, for each activity category:

1. Modal crew size used; (most commonly occurring crew size).
2. Range of crew size encompassing 89 or more percent of assignments made to that activity category.

The data appear in Attch. IV.

B. Results

Of the 96 activities scrutinized:

1. Mode size was equal to standard with 86 categories; 89.6 percent.
2. With respect to the assignments of non-standard crew size the most common deviations were ± 1 or ± 2, a discrepancy one would expect to find when assigning crews, from a relatively small population, to a mix of work, taking attendance, etc., into account.
3. Larger discrepancies occured with activity categories:

   106 Seal Coating (Major).

   107 Seal Coating (Minor).

   108 Flush Coating

   145 Tumbleweed removal.

   169 Other Drainage Maint. and Repair.

   Such assignments can obviously vary in work content; the range of crew sizes seems reasonable.

C. Conclusions

It would appear that BLC supervisors use the standard crew sizes which suggests the suitability of crew sizes, deviating for unusually large or small amounts of work assigned. I see no basis for challenging the crew sizes on any wide scale.

VII. RANGE OF WORK PERFORMED

A. Method of evaluation

1. For each activity category with a numerical, output oriented work-unit, limits were computed, using the upper and lower limits of the work-unit.

2. For instance for activity category 101, the first set of limits were based on the range within the stated work-unit, e.g.,

   101, Hand Patch with Premix 1 - 4 cu. yds.

   Std. crew = 3; 24 staff hours/day

   Hence: Lower performance limit = 1/24 = .04 cu. yds/staffhour

   Upper performance limit = 4/24 = .17 cu. yds/staffhour

3. The 85,186 crew cards of FY 80-81 were entered into the computer and the following two categories were rejected from the printout:

   a. Do not meet criterion of 1, above; (not an output oriented work-unit).

   b. Were within the limites computed under 2 above.

B. Data base

1. Total number of crew cards = 85,186 cards
2. Number with output oriented work-units = 30,360 cards

3. Number above or below first set of limits (based on range of work-units)

a. Over	=	7,938 cards
b. Under	=	7,647 cards
c. (1) Total a + b	=	15,585 cards
(2) Percent of 2, above, represented by a + b	=	51.3%

C. Conclusions re the out-of-limits cards

1. In 51.3% of the crew cards with highway-oriented outputs (work-units) the BLC supervisor does not know if the work crews are going to be above or below the limits of the values of the work-units. The hours expended on such cards is therefore 51.3% of 28.4 percent of ADOT total (Sec. III A 3 a) or 14.56 percent of total hours. If we add this to categories (Sec. III A 3) d, e, f and g we have 62.6 percent of total ADOT manhours where there is either only a rough fix on how much work will be done, or none at all. The statements re "lack of workface control" (IV B 5) are reinforced.

2. It may be that the situation is aggrevated by specific assignments being made to specific activity categories and locations which are repeated from year to year without any adjustment to the assignment (see V C 5) to reflect the different amount of work to be done each year.

D. Recommendations

1. Separate travel time on crew cards from work time to remove random effect of distance to work sites (See V C 5).
2. Add suffixes to activity categories to separate by different types of highways (See V C and Attch. III).
3. Compute monthly productivity for BLC's and hold supervisors accountable.
4. Request explanation when crews run under a specified percentage of lower limit of work-unit.

VIII. SUMMARY OF RECOMMENDATIONS

1. See IV A 1. Introduce ratios (of direct labor) into planning of overheads, support, training and leave.
2. Sec. IV B. Introduce productivity improvement planning.
3. Sec. IV B 3 and 4. Convert performance figures to "earned hours" instead of cu. yds/manhours, etc.
4. Sec. IV B 5. Set productivity improvement goals.
5. Sec. IV D. Long range productivity goals.
6. Sec. V A. Add suffixes to activity categories to increase specificity of crew assignments.
7. Sec. V C 2 b. Change work-unit designators.
8. Sec. V C 5. Change data entered on crew cards.
9. Sec. VII D. Reinforcement of 6, 7 and 8 preceding.
10. Misc.: Activity category 145, Tumbleweed removal; 5,979 hours in FY 1980-81; do not see shredder on equipment list; would think this would greatly reduce trucking and improve productivity.

ATTACHMENT I

MAINTENANCE ACTIVITY NUMBERS, FUNCTION CODES, DEFINITIONS AND SUBSET IDENTIFICATION

Activity Number	Function Code	Description of Work Activities	Subset Identification
		PAVED SURFACE MAINTENANCE	
101.	2100	Hand Patch With Premix	a
102.	2100	Level With Premix	a
103.	2100	Fill Cracks	a
104.	2100	Spot Seal Patching	a
105.	2100	Surface/Base Replacement	a
106.	2100	Seal Coating (Major)	a
107.	2100	Seal Coating (Minor)	a
108.	2100	Flush Coating	a
109.	2100	Spot Flush Coating	a
111.	2100	Temporary Hand Patching	
119.	2100	Other Paved Surface Maintenance	d
		A. Follow-up sweeping	
		B. Planing bituminous surfaces	
		C. Sanding bleeding pavements	
		D. Epoxy patching	
		E. Blow-up repairs	
		G. Slurry	
		H. Preparation of equipment or material	

Activity Number	Function Code	Description of Work Activities	Subset Identification
		PAVED SURFACE MAINTENANCE (Continued)	
		I. Surface replacement	
		J. Routing	
		K. Tight blading	
121.	2100	Blade gravel or dirt roads	a
122.	2100	Spot recondition gravel roads	a
129.	2100	Other Gravel & Dirt Surface Maintenance	d
		A. Applying dust palliatives	
		B. Hand patching	
		C. Blading frontage roads	
		D. Blading miscellaneous	
		E. Spot recondition of frontage roads	
		F. Removal of oversize rock from windrow	
		UNPAVED SHOULDER MAINTENANCE	
131.	2100	Blade Gravel or Dirt Shoulders	a
132.	2100	Shoulder and Slope Repair	a
139.	2100	Other Shoulder Maintenance	d
		A. Patching	
		B. Maintenance of turn outs and crossovers	
		C. Flush	
		D. Sod cutting	
141.	2100	Swath Machine Mowing	a
142.	2100	Chemical Control of Vegetation	b
145.	2100	Tumbleweed Disposal	a

Activity Number	Function Code	Description of Work Activities	Subset Identification
		PAVED SURFACE MAINTENANCE (Continued)	
146.	2100	Tree and Brush Removal	a
149.	2100	Other Vegetation Control	d
		C. Hand cutting of weeds	
		E. Area mowing for weed control	
		F. Burning weeds	
		G. Mechanical weed control	
		H. Vegetation control inspection	
		ROADSIDE	
150.	2100	Accident Maintenance and Repair	d
		A. Roadway surface repair	
		B. Fence repair	
		C. Removal and disposal of dead animals	
		D. Flagging	
		E. Chain link fence repair	
		F. Barrier repair (includes glare screen)	
		G. Sign repair	
		H. Crash barrel repair	
		I. Landscape accident repair	
		J. All structure repair	
		K. After accident clean-up	
		L. Livestock round-up	
		M. Repair to barrier glare	
		N. Hazardous materials spills	
151.	2100	Full-Width Litter Pickup	a
152.	2100	Spot Litter & Debris Pickup	d
153.	2100	Accident Guardrail Maintenance	a
154.	2100	Annual Fence Inspection	a
155.	2100	Routine Fence Maintenance	a

Activity Number	Function Code	Description of Work Activities	Subset Identification
		ROADSIDE (Continued)	
156.	2100	Cattle Guard Maintenance	a
157.	2100	Urban Curb Sweeping	a
159.	2100	Other Roadside Maintenance	d
		A. Removal of marking on rocks and walls	
		B. Sidewalk maintenance	
		C. Seeding, sodding and mulching	
		D. Roadside retaining wall maintenance	
		E. Viewpoint maintenance	
		F. Tunnel maintenance	
		G. Firebreak maintenance	
		H. Firefighting - roadside	
		I. Guardrail and reflector tab maintenance	
		J. Crash barrel maintenance	
		K. Rural sweeping	
		L. Sweeper dump disposal	
		N. Routine glare screen maintenance	
		P. Roadside emergency water, (filling water barrels, etc.)	
		S. Special gate inspection and closing	
		DRAINAGE	
161.	2100	Routine Drainage Maintenance	a
162.	2100	Emergency Drainage Maintenance	a
163.	2100	Clean Cuts	a
164.	2100	Minor Slide Removal	a
165.	2100	Routine Major Structure Maintenance	b
167.	2100	Storm and Rock Patrol	d
168.	2100	Roadway Pump Maintenance	d

Activity Number	Function Code	Description of Work Activities	Subset Identification
		DRAINAGE (Continued)	
169.	2100	Other Drainage Maintenance and Repair	d
		B. Minor sand drift removal	
		C. Minor channel and dike repair	
		D. Occasional blading crown or diversion ditches	
		E. Cleaning or reshaping grader ditches	
		F. Minor riprap and bank protection repair	
		G. Retaining wall, cribbing repair	
		H. Work on gunite slopes	
		I. Curb maintenance	
		J. Flume maintenance	
		K. Repair or replacement of minor structures	
		L. Inspection of pipes and structures	
		M. Repair of sand fence	
		P. Pipe cleaning and drop inlet cleaning with Vactor	
		SNOW AND ICE CONTROL	
171.	2100	Plowing, Sanding & Salting	d
172.	2100	Snow and Ice Patrol	d
179.	2100	Other Snow & Ice Control	d
		A. Equipment preparation	
		B. Equipment cleanup	
		C. Mounting and preparation of snow and ice signs	
		D. Setting up and manning road blocks	
		E. Filling sand barrels	
		F. Removing snow from urban streets	
		G. Removing snow from bridges	

Activity Number	Function Code	Description of Work Activities	Subset Identification
		SNOW AND ICE CONTROL (Continued)	
		H. Emergency operation of radio	
		I. Cleanup after storm	
		J. Mixing salt and cinder	
		K. Opening or closing ice signs	
		L. Loader operator for heavy storms	
		M. Erecting, dismantling snow fence	
		N. Emergency supervision	
		P. Repair and maintenance of snow fence	
		R. Repair snow markers	
		EXTRAORDINARY	
18X*	2100	Major Damage and Disaster Maintenance	d
		*Use a different third digit for each occurrence within a BLC.	
		REST AREA	
201.	2200	Interstate Resident Rest Areas Maintenance	c
205.	2200	Interstate Non-Resident Area Maintenance	d
209.	2200	Other Interstate Rest Area Maintenance	d
		A. Water filtration plant repairs	
		B. Well work	
		C. Sewage facility repairs	
		D. Painting facilities	
		E. Equipment replacement	
		F. Building and residence repair	
		G. Vegetation control other than routine	
		H. Water line repairs or replacement	
		I. Hauling water	

Activity Number	Function Code	Description of Work Activities	Subset Identification
		REST AREA (Continued)	
		J. Sweeping/cleanup of parking areas	
		K. Pumping septic tanks	
		L. Microphor toilet repair	
		M. Snow and ice control	
		N. Vandalism repair	
		P. Water samples	
258.	2200	Non-Interstate Rest Area Maintenance	d
		LANDSCAPE MAINTENANCE	
301.	2300	Landscape Mowing	a
303.	2300	Edging & Trimming Lawns	d
304.	2300	Trimming Shrubs and Trees	b
305.	2300	Fertilize Lawns	b
306.	2300	Manual Weed Control	b
307.	2300	Chemical Weed Control	b
308.	2300	Manual Irrigation	b
309.	2300	Irrigation System Maintenance	d
311.	2300	Policing Landscaped Areas	a
315.	2300	Fertilizing Trees and Shrubs	b
319.	2300	Other Landscape Maintenance	d
		A. Insect treatment/rodent control special plant treatment	
		B. Repair of berms and basins	
		C. Sweep grass clippings	
		D. Removal and replacement of trees and shrubs	
		E. Mowing weed areas	

Activity Number	Function Code	Description of Work Activities	Subset Identification
		LANDSCAPE MAINTEANCE (Continued)	
		F. Hand mowing	
		G. Following-day pickup and disposal	
		TRAFFIC SIGNING AND STRIPING	
401.	2400	Maintaining Delineators & Mileposts	a
402.	2400	Paint Guidelines (District)	a
403.	2400	Special Pavement Marking	b
404.	2400	Sign Inspection Maintenance and Installation	a
409.	2400	Other Traffic Maintenance	d
		A. Raised pavement marking maintenance	
		B. Tunnel lighting maintenance	
		C. Spotting centerline and edgeline prior to striping	
		D. Sweeping for striping	
		E. Nigh inspection of paint reflectivity	
		F. For time lost in handling inferior paint, etc.	
		G. Paint barrel handling and recycling	
		H. Dust warning maintenance	
		I. Night sign inspection	
		J. Removal of highway paint	
		K. Washing signs and delineators	
		L. Cleaning base of break-away signs	
		M. Clear coating	
422.	2400	Central Maintenance Guideline Painting	b
423.	2400	Central Maintenance Guideline Painting	b
424.	2400	Central Maintenance Guideline Painting	b

Activity Number	Function Code	Description of Work Activities	Subset Identification
		TRAFFIC SIGNING AND STRIPING (Continued)	
425.	2400	Hot Line Striping	b
450.	2400	Accident Interstate Sign Repair	d
451.	2400	Interstate Sign Inspection	a
452.	2400	Interstate Sign Repair	a
453.	2400	Interstate Sign Washing (Major)	a
454.	2400	Interstate Sign Clear Coating (Major)	a
455.	2400	Interstate Sign Structure Painting	b
456.	2400	Interstate Sign Washing (Minor)	b
457.	2400	Interstate Sign Clear Coating (Minor)	b
459.	2400	Other Interstate Sign Maintenance	d
		A. In yard sign preparation	
		B. Structure modification and repair	
		C. Sign message revisions	
		D. In yard sign dismantling	
		GENERAL	
601.	2600	Supervision	g
602.	2600	Record Keeping	g
603.	2600	Building & Yard Maintenance	f
604.	2600	Equipment Servicing	f
605.	2600	Training	g
606.	2600	Leave	h
607.	2600	Standby	e

Activity Number	Function Code	Description of Work Activities	Subset Identification
		GENERAL (Continued)	
609.	2600	Work for Other Divisions or Departments	d
		A. Department of Public Safety	
		B. Checking station areas	
		C. Work for cities or counties	
		D. Work for federal agencies	
		E. Materials Division	
		F. Motor Vehicle Division	
		G. Work for construction	
		H. Work for aeronautics	
		J. Work for administration	
		K. Water samples	
		L. General pick up and delivery	
		M. Work for Building Maintenance Crew	
		N. Work for Traffic Operations	
		P. Work for R/W Division	
610.	2600	Transporting Equipment	d
611.	2600	Material Handling	e
612.	2600	Work for Equipment Services	e
		NON-ROUTINE MAINTENANCE	
7XX	2700	Non-Routine Maintenance	d
888.	2800	Plant Screening	e
891.	2800	Making Premix Material	e
892.	2800	Stockpiling Material	e
897.	2800	Truck Screening	e
898.	2800	Straightening Guardrail & Sign Posts	e

Activity Number	Function Code	Description of Work Activities	Subset Identification
		GENERAL (Continued)	
899.	2800	Other Material Overhead	e
		A. Preparing cement, weed killer and bags of salt for storage	
		B. Cleaning oil storage tanks	
		C. Salvaging re-usable materials	
		D. Drying wet material	
		E. Loading or unloading mixing table	
		F. Blading and maintaining pit and material storage sites	
		G. Moving crushing/screening plant	
		H. Set up and tear down time	
		I. Changing Screens	
		J. Pit preparation	
		K. Pit clean up	
		L. Adding asphalt to existing materials	
		M. Pushing up stockpile	
		N. Drilling	
		P. Blasting	
901.	2900	Clerical	f
902.	2900	Other Support Activity	f

ATTACHMENT II

WORK TIME DISTRIBUTION BY ACTIVITY CATEGORIES OF III A
STATE OF ARIZONA FY 80-81

Acct. No.	a	b	c	d	e	f	g	h	Percent of total
101	39,634								2.5
102	41,034								2.6
103	36,287								2.3
104	13,554								0.9
105	8,765								0.6
106	1,442								0.1
107	2,751								0.2
108	5,820								0.4
109	5,883								0.4
111	19,100								1.2
119				30,216					1.9
121	6,526								0.4
122	4,191								0.3
129				1,461					0.1
131	5,421								0.3
132	22,854								1.4
139				4,183					0.3
141	13,091								0.8
142		5,837							0.4
145	5,979								0.4
146	10,364								0.7
149				10,477					0.7
150				17,544					1.1
151	14,137								0.9

Act. No.	a	b	c	d	e	f	g	h	Percent of total
152				18,600					1.2
153	17,818								1.1
154	2,548								0.2
155	27,941								1.8
156	5,708								0.4
157	3,950								0.2
159				12,457					0.8
161	18,485								1.2
162	3,646								0.2
163	33,607								2.1
164	4,084								0.3
165		8,630							0.5
167				6,892					0.4
168				4,389					0.3
169				22,387					1.4
171				11,996					0.8
172				1,669					0.1
179				7,613					0.5
180				8,142					0.5
*199									
201			47,067						3.0
205				16,163					1.0
209				9,006					0.6
258				23,388					1.5
301	1,741								0.1

* = Activity 199 not shown on PeCoS Management Manual; however, 40 hours were charged to this activity during FY 80-81.

Acct. No.	a	b	c	d	e	f	g	h	Percent of total
303				2,058					0.1
304		3,592							0.2
305		62							<0.0
306		10,266							0.6
307		8,857							0.6
308		5,788							0.4
309				11,799					0.7
311	8,232								0.5
315		221							<0.0
319				14,350					0.9
401	18,542								1.2
402	10,653								0.7
403		23,798							1.5
404	28,575								1.8
409				6,269					0.4
422		5,617							0.4
423		6,995							0.4
425		7,499							0.5
450				2,493					0.2
451	1,224								0.1
452	6,989								0.4
453	690								<0.0
455		715							<0.0
456		282							<0.0
457		6							<0.0
459				2,190					0.1

Acct. No.	a	b	c	d	e	f	g	h	Percent of total
601						126,426			8.0
602						8,288			0.5
603					32,206				2.0
604					15,360				1.0
605							22,260		1.4
606								240,097	15.1
607					8,394				0.5
609				16,632					1.0
610				14,217					0.9
611					9,621				0.6
612					26,976				1.7
619					2,803				0.2
7XX				109,512					6.9
885					246				< 0.0
886					540				< 0.0
888					6,725				0.4
891					2,903				0.2
892					29,350				1.9
897					906				0.1
898					78				< 0.0
899					12,901				0.8
901						53,124			3.3
902						18,544			1.2
GRAND TOTAL	451,275	88,165	47,067	386,103	149,009	206,382	22,260	240,097	1,590,358
PERCENT	28.4	5.6	3.0	24.2	9.4	13.0	1.4	15.1	100.1*

* .1 = rounding error, cumulative.

ATTACHMENT II A

WORK TIME DISTRIBUTION BY CATEGORIES OF III A

District	a	b	c	d	e	f	g	h	TOTAL	(a+b+c)/TOTAL
0	8,769	21,784	-	7,743	7,971	9,046	626	8,842	64,781	47 percent
1	69,521	28,312	16,353	93,812	15,656	42,549	1,715	46,329	314,247	36
2	73,288	17,944	8,248	51,381	15,166	29,498	2,914	36,607	234,986	42
3	48,564	4,899	3,252	42,719	9,974	17,825	1,700	26,085	155,018	37
4	61,667	4,239	6,231	40,726	26,979	21,201	3,768	26,875	191,686	38
5	48,137	2,551	8,545	59,005	30,784	28,539	4,102	29,108	210,771	28
6	56,097	4,733	4,265	43,382	15,564	26,128	2,131	30,024	182,324	36
7	81,225	3,254	-	57,685	26,903	31,596	5,304	36,227	242,194	35

ATTACHMENT III

Activity No.	(1) Activity Category Function Code	Category Name	(2) Need[1] road type suffix	(3) Work-unit classifier should be: (Miles can be decimal)
101	2100	Hand Patch With Premix	Yes	No change
102	2100	Level with Premix	Yes	Lane miles
103	2100	Fill Cracks	Yes	No change
104	2100	Spot Seal Patching	Yes	Lane miles or feet
105	2100	Surface/Base Replacement	Yes	Lane patch units
106	2100	Seal Coating (Major)	Yes	No change
107	2100	Seal Coating (Minor)	Yes	No change
108	2100	Flush Coating	Yes	No change
109	2100	Spot Flush Coating	Yes	Lane miles
111	2100	Temporary Hand Patching	Yes	No change
119	2100	Other Paved Surface Maintenance	(Details are below)	
119A	2100	Follow-up sweeping	Yes	Lane miles
119B	2100	Planing bituminous surfaces	Yes	Lane miles
119C	2100	Sanding bleeding pavements	Yes	Lane miles
119D	2100	Epoxy patching	Yes	Volume of material
119E	2100	Blow-up repairs	Yes	Lane patches
119G	2100	Slurry	Yes	Volume of material
119H	2100	Preparation of equipment or material	Yes	Include in actual output category
119I	2100	Surface replacement	Yes	Lane miles
119J	2100	Routing	Yes	Pass miles

Activity No.	(1) Activity Category Function Code	Category Name	(2)[1] Need road type suffix	(3) Work-unit classifier should be: (Miles can be decimal)
119K	2100	Tight blading	Yes	Shoulder miles
121	2100	Blade Gravel or Dirt Roads	No	No change
122	2100	Spot Recondition Gravel Roads	No	Lane miles worked
129	2100	Other Gravel & Dirt Surface Maintenance		
129A	2100	Applying dust palliatives	No	Lane miles
129B	2100	Hand patching gravel roads	No	Volume of material
129C	2100	Blading frontage roads	No	Lane miles
129D	2100	Blading - miscellaneous	No	Lane miles
129E	2100	Spot recondition of frontage roads	No	Lane miles
129F	2100	Removal of oversize rock from windrow	No	Add time to C & D
131	2100	Blade Gravel or Dirt Shoulders	No	No change
132	2100	Shoulder and Slope Repair	Yes	Shoulder miles
139	2100	Other Shoulder Maintenance		
139A	2100	Patching isolated soft spots	Yes	Shoulder miles or One each
139B	2100	Maintenance of turn outs and crossovers	Yes	One each
139C	2100	Flush bituminous treated shoulders	Yes	Shoulder miles
139D	2100	Sod cutting	Yes	Sq. yards
141	2100	Swatch Machine Mowing	No	No change
142	2100	Chemical Control of Vegetation	No	Miles of shoulder
145	2100	Tumbleweed Disposal	No	No change
146	2100	Tree and Brush Removal	No	No change

Activity No.	(1) Activity Category Function Code	Category Name	(2) Need[1] road type suffix	(3) Work-unit classifier should be: (Miles can be decimal)
149	2100	Other Vegetation Control		
149C	2100	Hand cutting weeds	No	Swath miles
149E	2100	Area mowing	No	Swath miles
149F	2100	Burning weeds	No	Fire sites
149G	2100	Mechanical weed control	Yes	Pass miles
149H	2100	Vegetation control inspection	Yes	Pass miles
150	2100	Accident Maintenance and Repair	Yes	Item list
150A	2100	Roadway surface repair	Yes	One event
150B	2100	Fence repair	No	One event
150C	2100	Removal and disposal of dead animals	No	One event
150D	2100	Flagging	No	One event
150E	2100	Chain link fence repair	No	One event
150F	2100	Barrier repair (includes glare screen)	No	One event
150G	2100	Sign repair	Yes	One event
150H	2100	Crash barrel repair	No	One event
150I	2100	Landscape accident repair	No	One event
150J	2100	All structure repair	Yes	One event
150K	2100	After accident clean-up	Yes	One event
150L	2100	Livestock round-up	Yes	One event
150M	2100	Repair to barrier glare screen only	Yes	One event
150N	2100	Hazadarous materials spills	Yes	One event
151	2100	Full-Width Litter Pick-up	Yes	No change

Activity No.	(1) Activity Category Function Code	Category Name	(2) Need[1] road type suffix	(3) Work-unit classifier should be: (Miles can be decimal)
152	2100	Spot Litter & Debris Pickup	Yes	Miles of R/W
153	2100	Accident Guardrail Maintenance	No	No change
154	2100	Annual Fence Inspection	No	No change
155	2100	Routine Fence Maintenance	No	No change
156	2100	Cattle Guard Maintenance	No	No change
157	2100	Urban Curb Sweeping	No	No change
159	2100	Other Roadside Maintenance		
159A	2100	Removal of marking on rocks and walls	No	One event
159B	2100	Sidewalk maintenance	No	One event
159C	2100	Seeding, sodding and mulching	No	One event
159D	2100	Roadside retaining wall maintenance	No	One event
159E	2100	Viewpoint maintenance	No	One event
159F	2100	Tunnel maintenance	No	Specific, each tunnel
159G	2100	Firebreak maintenance	No	One event
159H	2100	Firefighting - roadside	No	One event
159I	2100	Guardrail and reflector tab maintenance	No	One event
159J	2100	Crash barrel maintenance	No	One event
159K	2100	Rural sweeping of curb areas	No	One event
159L	2100	Sweeper dump disposal	No	One event
159N	2100	Routine glare screen maintenance	No	One event
159P	2100	Roadside emergency water (filling barrels, etc.)	No	Barrels
159S	2100	Special gate inspection and closing	Yes	One event
161	2100	Routine Drainage Maintenance	No	No change
162	2100	Emergency Drainage Maintenance	No	No change
163	2100	Clean cut	No	No change

Activity No.	(1) Activity Category Function Code	Category Name	(2) Need[1] road type suffix	(3) Work-unit classifier should be: (Miles can be decimal)
164	2100	Minor Slide Removal	No	No change
165	2100	Routine Major Structure Maintenance	No	No change except maybe classify structure size
167	2100	Storm and Rock Patrol	Yes	Miles and spots
168	2100	Roadway Pump Maintenance	No	Pumps
169	2100	Other Drainage Maintenance and Repair		
169B	2100	Minor sand drift removal	No	One event
169C	2100	Minor channel and dike repair	No	One event
169D	2100	Blading crown or diversion ditches	No	One event
169E	2100	Cleaning or reshaping grader ditches	No	One event
169F	2100	Minor riprap and bank protection repair	No	One event
169G	2100	Retaining wall, cribbing repair	No	One event
169H	2100	Work on gunite slopes	No	One event
169I	2100	Curb maintenance	No	One event
169J	2100	Flume maintenance	No	One event
169K	2100	Repair or replacement of minor structures	No	One event
169L	2100	Inspection of pipes and structures	No	One event
169M	2100	Repair of sand fence	No	One event
169P	2100	Pipe cleaning and drop inlet cleaning with Vactor		
171	2100	Plowing, Sanding & Salting	Yes	Pass miles
172	2100	Snow and Ice Patrol	Yes	Road miles
179	2100	Other Snow & Ice Control		
179A	2100	Equipment preparation	No	Ratio; is overhead

Activity No.	(1) Activity Category Function Code	Category Name	(2)[1] Need road type suffix	(3) Work-unit classifier should be: (Miles can be decimal)
179B	2100	Equipment cleanup	No	Ratio; is overhead
179C	2100	Mounting and preparation of snow and ice signs	No	Signs
179D	2100	Setting up and manning road blocks	No	Crew hours, fiat
179E	2100	Filling sand barrels	No	Barrels
179F	2100	Removing snow from urban streets	Yes	Area (width x miles)
179G	2100	Removing snow from bridges	No	Bridges
179H	2100	Emergency operation of radio	No	Ratio; is overhead
179I	2100	Cleanup after storm	Yes	Lane miles
179J	2100	Mixing salt and cinder	No	Ratio; is overhead
179K	2100	Opening or closing ice signs	No	Signs
179L	2100	Loader operator for heavy storms	No	Operator hours; fiat
179M	2100	Erecting, dismanteling snow fence	No	Fence miles
179N	2100	Emergency supervision	No	Ratio; is overhead
179P	2100	Repair and maintenance of snow fence	No	Fence miles
179R	2100	Repair snow markers	No	Markers
18X	2100	Major Damage and Disaster Maintenance	No	Specific assigned std., each occurence
201	2200	Interstate Resident Rest Area Maintenance	No	Areas (Fiat) (or pairs)
205	2200	Interstate Non-Resident Area Maintenance	No	Areas, by types
209	2200	Other Interstate Rest Area Maintenance		
209A	2200	Water filtration plant repairs	No	Event by type
209B	2200	Well work	No	Event by type
209C	2200	Sewage facility repairs	No	Event by type
209D	2200	Painting facilities	No	Event by type

Activity No.	(1) Activity Category Function Code	Category Name	(2)[1] Need road type suffix	(3) Work-unit classifier should be: (Miles can be decimal)
209E	2200	Equipment replacement	No	Event by type
209F	2200	Building and residence repair	No	Event by type
209G	2200	Vegetation control other than routine	No	Event by type
209H	2200	Water line repairs or replacement	No	Event by type
209I	2200	Hauling water	No	Miles hauled + filling
209J	2200	Sweeping/cleanup of parking areas	No	Area
209K	2200	Pumping septic tanks	No	Tanks + hauled miles
209L	2200	Microphor toilet repair	No	Locations
209M	2200	Snow and ice control	Yes	Pass miles
209N	2200	Vandalism repair	No	Specific for event
209P	2200	Water samples	No	Samples + miles
258	2200	Non-Interstate Rest Area Maintenance	No	By areas by type
301	2300	Landscape Mowing	No	No change
303	2300	Edging & Trim Lawns	No	Edge length
304	2300	Trim Shrubs and Trees	No	No change
305	2300	Fertilize Lawns	No	Area
306	2300	Manual Weed Control	No	No change
307	2300	Chemical Weed Control	No	A: Area B: Other: Area Sprayed (see maps)
308	2300	Manual Irrigation	No	No change
309	2300	Irrigation System Maintenance	No	Each event
311	2300	Policing Landscaped Areas	No	Acres
315	2300	Fertilizing Trees & Shrubs	No	Tree units (see 304)

Activity No.	(1) Activity Category Function Code	Category Name	(2) Need[1] road type suffix	(3) Work-unit classifier should be: (Miles can be decimal)
319	2300	Other Landscape Maintenance		
319A	2300	Insect treatment/rodent control special plant treatment	Yes	Area
319B	2300	Repair of berm and basins	Yes	Miles
319C	2300	Sweep grass clippings	Yes	Swath miles
319D	2300	Removal and replacement of trees and shrubs	Yes	Lane miles
319E	2300	Mowing weed areas	Yes	Swath miles
319F	2300	Hand mowing	Yes	Area
319G	2300	Following-day pickup and disposal	No	Area
401	2400	Maintaining Delineators & Mileposts	Yes	No change
402	2400	Paint Guidelines (District)	Yes	No change
403	2400	Special Pavement Marking	Yes	Locations
404	2400	Sign Inspection, Maintenance and Installation	Yes	Specific stds. based on sign density per mile
409	2400	Other Traffic Maintenance		
409A	2400	Raised pavement marking maintenance	Yes	Locations, specific
409B	2400	Tunnel lighting maintenance	Yes	Locations, specific
409C	2400	Spotting centerline and edgeline	Yes	Pass miles
409D	2400	Sweeping for striping	Yes	Pass miles
409E	2400	Night inspection	Yes	Pass miles
409F	2400	For time lost in handling inferior paint	Yes	Indicate on crew painting ticket
409G	2400	Paint barrel handling and recycling	Yes	Overhead if in depot; part of job if on road

Activity No.	(1) Activity Category Function Code	Category Name	(2) Need[1] road type suffix	(3) Work-unit classifier should be: (Miles can be decimal)
409H	2400	Dust warning maintenance	Yes	Signs + pass miles
409I	2400	Night sign inspection	Yes	Pass miles
409J	2400	Removal of highway paint	Yes	Pass miles
409K	2400	Washing signs and delineators	Yes	Pass miles
409L	2400	Cleaning base of break-away signs	Yes	Pass miles + signs
409M	2400	Clear coating	Yes	(Include in 409L)
422	2400	Central Maintenance Guideline Painting	Yes	Pass miles
423	2400	Central Maintenance Guideline Painting	Yes	Pass miles
424	2400	Central Maintenance Guideline Painting	Yes	Pass miles
425	2400	Hotline Striping	Yes	Pass miles
450	2400	Accident Interstate Sign Repair	No	Per event
451	2400	Interstate Sign Inspection	No	Pass miles
452	2400	Interstate Sign Repair	Yes	No change
453	2400	Interstate Sign Washing (Major)	Yes	No change
454	2400	Interstate Sign Clear Coating (Major)	Yes	No change
455	2400	Interstate Sign Structure Painting	Yes	No change
456	2400	Interstate Sign Washing (Minor)	Yes	No change
457	2400	Interstate Sign Clear Coating (Minor)	Yes	No change
459	2400	Other Interstate Sign Maintenance		
459A	2400	In yard sign preparation	No	Shop std. times[2]
459B	2400	Structure modification and repair	No	Shop std. times
459C	2400	Sign message revisions	No	Shop std. times
459D	2400	In yard sign dismantels	No	Shop std. times
501		Cut, Shape, and Sand Sign Materials	N/A	No change

Activity No.	(1) Activity Category Function Code	Category Name	(2) Need[1] road type suffix	(3) Work-unit classifier should be: (Miles can be decimal)
502		Spray Painting	N/A	No change
503		Silk Screen Painting	N/A	No change
504		Design and Fabricate Silk Screens	N/A	No change
505		Sign Layout	N/A	No change
506		Apply Reflective Sheeting	N/A	No change
508		Shipping and Receiving	N/A	Ratio; overhead
509		Other Sign Fabrication	N/A	Ratio; overhead
561		Supervision	N/A	Ratio; overhead
562		Record Keeping	N/A	Ratio; clerical
563		Building and Yard Maintenance	N/A	Ratio; overhead
565		Training	N/A	Ratio; training
566		Leave	N/A	Ratio; leave
567		Standby	N/A	Ratio; leave
569		Work for Other Divisions or Departments	N/A	Use sign shop stds.
57X		Non-Routine Maintenance	N/A	Ratio of mntce. labor
601	2600	Supervision	N/A	Ratio; supervision
602	2600	Record Keeping	N/A	Ratio; clerical
603	2600	Building & Yard Maintenance	N/A	Ratio; overhead
604	2600	Equipment Servicing	N/A	LE; overhead[3]
605	2600	Training	N/A	Ratio; training
606	2600	Leave	N/A	Ratio; leave
607	2600	Standby	N/A	Ratio; overhead
609	2600	Work for Other Divisions or Departments	N/A	Actual time
609A	2600	Department of Public Safety	N/A	Events

Activity No.	(1) Activity Category Function Code	Category Name	(2) Need[1] road type suffix	(3) Work-unit classifier should be: (Miles can be decimal)
609B	2600	Checking station areas	N/A	Events
609C	2600	Work for cities or counties	N/A	Events; actual time
609D	2600	Work for Federal Agencies	N/A	Events; actual time
609E	2600	Materials Division	N/A	Events; actual time
609F	2600	Motor Vehicle Division	N/A	Events; actual time
609G	2600	Work for Construction	N/A	Events; actual time
609H	2600	Work for Aeronautics	N/A	Events; actual time
609J	2600	Work for Administration	N/A	Events; actual time
609K	2600	Water samples	N/A	Samples + miles
609L	2600	General pick up and delivery	N/A	Ratio; overhead
609M	2600	Work for Building Maintenance Crew	N/A	Events; actual time
609N	2600	Work for Traffic Operations	N/A	Events; actual time
609P	2600	Work for R/W Division	N/A	Events; actual time
610	2600	Transporting Equipment	N/A	Include in spec. job
611	2600	Material Handling	N/A	Ratio; overhead
612	2600	Work for Equipment Services	N/A	Ratio; overhead
7XX	2700	Non-Routine Maintenance	Specific	Specific Std.[4] (Annual projection)
888	2800	Plant Screening	N/A	Ratio; overhead
891	2800	Making Premix Material	N/A	Ratio; overhead
892	2800	Stockpiling Material	N/A	Ratio; overhead
897	2800	Truck Screening	N/A	Ratio; overhead
898	2800	Straightening Guardrail & Sign Post	N/A	Ratio; overhead
899	2800	Other Material Overhead	N/A	Ratio; overhead
899A	2800	Preparing cement, weed killer, etc., for storage	N/A	Ratio; overhead

Activity No.	(1) Activity Category Function Code	Category Name	(2) Need[1] road type suffix	(3) Work-unit classifier should be: (Miles can be decimal)
899B	2800	Cleaning oil storage tanks	N/A	Ratio; overhead
899C	2800	Salvaging re-usable materials	N/A	Ratio; overhead
899D	2800	Drying wet material	N/A	Ratio; overhead
899E	2800	Loading or unloading mixing table	N/A	Ratio; overhead
899F	2800	Blading and maintaining pit and material storage sites	N/A	Ratio; overhead
899G	2800	Moving crushing/ screening plant, travel time	N/A	Ratio; overhead
899H	2800	Set up and tear down time	N/A	Ratio; overhead
899I	2800	Changing screens, etc.	N/A	Ratio; overhead
899J	2800	Pit preparation	N/A	Ratio; overhead
899K	2800	Pit clean up	N/A	Ratio; overhead
899L	2800	Adding asphalt to existing material	N/A	Ratio; overhead
899M	2800	Pushing up stockpile	N/A	Ratio; overhead
899N	2800	Drilling	N/A	Hole feet
899P	2800	Blasting	N/A	Blasts
901	2800	Clerical	N/A	Ratio; clerical
902	2800	Other Support Activity	N/A	Ratio; support

FOOTNOTES TO ATTCH. III

1. Highways may be divided into categories which differentiate them relative to the amount of staff resources needed to do a one of (an each) of a concomitant work-unit. Suggested categories are:

A. Urban interstate

B. Rural interstate

C. Divided state

D. Two-way state (not divided)

E. Secondary paved

F. Frontage paved

G. Unpaved

2. It is presumed that shop standard times may be developed for the 500 series so as to assign a standard time to each work allocation to an individual or a crew.

3. LE is a time allowance, per annum or control period, based on weighted fleet count. See activity category 604. More work does not improve highway maintenance. A flat allowance per type of vehicle or piece of equipment should be given per year.

4. A specific standard is one devised, using knowledge and experience, for a specific job.

5. A ratio is where the time assigned a group is a percent of another measured group, e.g., 508, a percent of sign shop direct labor equal to the percent in the base year or period.

ATTACHMENT IV

CREW SIZE ANALYSIS -- DATA BASE 1-1-80 thru 12-31-81

(To be used on and with RU077A, J785A)

(Cut off = 89.0%)

(1) ACTIVITY NO.	(2) NO. STATE TOTAL	(3) STD. CREW SIZE	(4) MODE ASSGND	(5) RANGE ASSGND	(6)# EFFECTIVE RANGE	(7) VARIANCE	(8)# % OF ASSIGNS	(9) NO. OF FLAGMEN	(10) NOTE NO.
101	3207	3	3	1 - 8	2 - 4	+1 -1	89.3	1	
102	1373	7	7	1 - 13	5 - 8	+1 -2	94.4	2	
103	1434	5	5	1 - 10	4 - 7	+2 -1	92.7	1	
104	491	6	6	3 - 9	5 - 8	+2 -1	93.7	1	
105	405	6	6	2 - 11	4 - 8	+2 -2	93.1	2	
106	27	15	14*	7 - 18	8 - 17	+2 -7	92.6	2	Mode less than std.
107	59	9	6*	3 - 14	3 - 18	+8 -3	89.8	2	Mode less than std.
108	167	7	7	2 - 17	5 - 15	+10 -2	91.6	1	
109	176	6	6	2 - 10	4 - 8	+4 -2	90.9	2	
111	2655	3	2*	1 - 9	1 - 3	+1 -1	93.5	1	Eff. range = std crew or less
112	2088	X	2	1 - 13	1 - 6	+4 -1	89.7	X	
121	1610	1	1	1 - 5	1 - 1	+0 -0	99.0	X	
122	158	4	4	2 - 8	2 - 7	+3 -2	93.7	0	
129	183	X	1	1 - 7	1 - 5	+4 -0	95.1	X	
131	688	2	2	1 - 5	1 - 2	+0 -1	92.6	0	
132	1059	5	5	1 - 11	3 - 8	+3 -2	92.9	1	
139	301	X	2	1 - 11	1 - 6	+4 -1	96.0	X	
141	2960	1	1	1 - 3	1 - 1	+0 -0	90.1	0	
142	773	2	2	1 - 4	1 - 2	+0 -1	89.9	0	Power sprayer
145	438	3	3	1 - 10	1 - 5	+2 -2	93.8	0	
146	698	3	3	1 - 7	1 - 4	+1 -2	92.7	0	
149	1360	X	2	1 - 8	1 - 4	+2 -1	94.6	X	
150	2950	X	2	1 - 16	1 - 3	+1 -1	91.1	X	
151	1643	2	2	1 - 6	1 - 2	+0 -1	92.9	0	

* Mode is less than standard.

(1) ACTIVITY NO.	(2) NO. STATE TOTAL	(3) STD. CREW SIZE	(4) MODE ASSGND	(5) RANGE ASSGND	(6)# EFFECTIVE RANGE	(7) VARIANCE	(8)# % OF ASSIGNS	(9) NO. OF FLAGMEN	(10) NOTE NO.
152	3776	1	1	1 - 4	1 - 2	+1 -0	98.2	0	
153	1432	3	3	1 - 9	2 - 4	+1 -1	90.6	0	
154	340	2	2	1 - 3	1 - 2	+0 -1	98.5	0	
155	3496	2	2	1 - 7	1 - 3	+1 -1	96.5	0	
156	488	3	3	1 - 7	2 - 4	+1 -1	94.3	0	
157	921	1	1	1 - 18	1 - 1	+0 -0	89.0	0	
159	1438	X	1	1 - 8	1 - 4	+3 -0	92.4	0	
161	2155	2	2	1 - 9	1 - 3	+1 -1	93.8	0	
162	530	3	2*	1 - 12	1 - 5	+3 -1	94.0	0	Mode is less than std.
163	1699	5	5	1 - 9	3 - 7	+2 -2	95.4	1	
164	192	5	4*	1 - 8	1 - 6	+2 -3	91.7	2	Minor Slides Mode less than std.
165	611	4	4	1 - 8	2 - 5	+1 -2	93.0	2	
167	2788	1	1	1 - 7	1 - 2	+1 -0	97.5	0	Road patrol
168	794	1	1	1 - 9	1 - 3	+2 -0	91.3	0	
169	2315	X	1	1 - 14	1 - 6	+5 -0	91.8	X	Other misc. drainage
171	7379	1	1	1 - 7	1 - 1	+0 -0	95.6	0	
172	660	1	1	1 - 3	1 - 1	+0 -0	96.6	0	
179	1488	X	1	1 - 11	1 - 3	+2 -0	89.3	X	
	1390	X	2	1 - 18	1 - 7	+5 -1	90.6	X	Data error 119 no crew
201	10,020	1	1	1 - 6	1 - 2	+1 -0	99.4	0	Why 2 on res. area
205	4373	1	1	1 - 4	1 - 1	+0 -0	98.7	0	? 4 hard to explain
209	1347	X	1	1 - 9	1 - 3	+2 -0	93.6	X	
258	6590	1	1	1 - 7	1 - 1	+0 -0	94.3	0	Temp. rest
301	482	1	1	2 - 4	1 - 1	+0 -0	97.1	0	Check def. stds.
303	459	1	1	1 - 3	1 - 1	+0 -0	93.9	0	
304	451	2	2	1 - 5	1 - 3	+1 -1	94.2	0	Could use shredder
305	10	2	2	2 - 3	2 - 2	+0 -0	90.0	0	

* Mode is less than standard.

(1) ACTIVITY NO.	(2) NO. STATE TOTAL	(3) STD. CREW SIZE	(4) MODE ASSGND	(5) RANGE ASSGND	(6)# EFFECTIVE RANGE	(7) VARIANCE	(8)# % OF ASSIGNS	(9) NO. OF FLAGMEN	(10) NOTE NO.
306	1297	3	3	1 - 4	1 - 3	+0 -2	99.5	0	
307	1155	2	2	1 - 4	2 - 2	+0 -0	89.4	0	
308	1126	1	1	1 - 2	1 - 2	+1 -0	100.0	0	
309	3031	1	1	1 - 7	1 - 2	+1 -0	99.4	0	
311	1248	2	2	1 - 4	1 - 2	+0 -1	96.7	0	
315	51	2	2	1 - 3	1 - 2	+0 -1	96.1	0	
319	1692	X	2	1 - 6	1 - 3	+1 -1	91.2	X	
401	4351	1	1	1 - 4	1 - 2	+1 -0	98.7	0	
402	836	3	3	2 - 5	2 - 3	+0 -1	90.4	0	
403	1824	3	3	1 - 7	2 - 5	+2 -1	99.0	1	
404	6019	1	1	1 - 5	1 - 2	+1 -0	99.2	0	
409	934	X	1	1 - 11	1 - 3	+2 -0	89.6	X	
422	585	5	5	2 - 5	4 - 5	+0 -1	92.8	0	
425	316	5	5	2 - 5	4 - 5	+0 -1	95.6	0	
450	383	X	3	1 - 5	2 - 3	+0 -1	92.2	X	
451	128	2	2	1 - 5	2 - 4	+2 -0	89.0	0	
452	518	3	3	1 - 5	2 - 3	+0 -1	93.1	0	
453	55	3	2*	2 - 6	2 - 5	+3 -0	92.7	0	Mode less than std.
455	31	3	3	2 - 3	3 - 3	+0 -0	96.8	0	
456	65	2	2.5*	1 - 4	2 - 3	+½ -½	89.2	0	29 assigned crew of 2 and 3 respectively
457	1	2	2	2 - 2	2 - 2	+0 -0	100.0	0	
459	234	X	2	1 - 6	1 - 3	+1 -1	89.0	X	
500 Activities omitted (sign workshop)									
601	4938	1	1	1 - 18	1 - 2	+1 -0	98.9	X	
602	1999	X	1	1 - 6	1 - 1	+0 -0	94.4	X	
603	5480	X	1	1 - 11	1 - 3	+2 -1	94.7	X	

* Mode is less than standard.

(1) ACTIVITY NO.	(2) NO. STATE TOTAL	(3) STD. CREW SIZE	(4) MODE ASSGND	(5) RANGE ASSGND	(6)# EFFECTIVE RANGE	(7) VARIANCE	(8)# % OF ASSIGNS	(9) NO. OF FLAGMEN	(10) NOTE NO.
604	5368	1	1	1 - 10	1 - 2	+1 -0	91.3	0	
605	2885	X	1	1 - 17	1 - 8	+7 -0	89.8	X	
606	(Leave) omitted								
607	1157	X	1	1 - 19	1 - 5	+4 -0	90.8	X	
609	2275	X	1	1 - 9	1 - 4	+3 -0	96.3		
610	3235	1	1	1 - 12	1 - 2	+1 -0	90.7	0	
611	1885	1	1	1 - 8	1 - 2	+1 -0	92.8	0	
612	5538	X	1	1 - 9	1 - 2	+1 -0	94.6	X	
619	83	X	1	1 - 11	1 - 3	+2 -0	92.8	X	Manual contains no activity std.
700	6437	X	3	1 - 18	1 - 7	+4 -2	90.0	X	
885	8	X	4	3 - 4	3 - 4	+0 -1	100.0	X	
886	39	X	4	3 - 4	3 - 4	+0 -1	100.0	X	
888	389	4	3*	1 - 7	2 - 6	+3 -1	99.5	0	Mode lesss than std.
891	557	1	1	1 - 18	1 - 2	+1 -0	97.1	0	
892	4075	1	1	1 - 11	1 - 4	+3 -0	92.8	0	
897	89	3	2*	2 - 5	2 - 3	+1 -0	96.6	0	Mode less than std.
898	10	3	3	2 - 3	3 - 3	+0 -0	90.0	0	
899	1838	X	1	1 - 13	1 - 3	+2 -0	91.1	X	
901	1375	X	1	1 - 10	1 - 2	+1 -0	96.1	X	
902	725	X	1	1 - 6	1 - 2	+1 -0	94.9	X	

* Mode is less than standard.

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