Maricopa County Transportation System Plan

Adopted
February 7, 2007

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Chapter 1
INTRODUCTION

The Transportation System Plan (TSP) Update

The TSP is Maricopa County's long-range plan for transportation. This plan was last produced in 1997. The Maricopa County Department of Transportation (MCDOT) has undertaken the process of updating the Transportation System Plan because much has happened in Maricopa County since 1997, including:

- Rapid population growth and development throughout the county; and
- Adoption of the Maricopa Association of Governments (MAG) Regional Transportation Plan (RTP)

This updated TSP establishes an organized approach to the planning, design and construction of Maricopa County's transportation system through 2026.

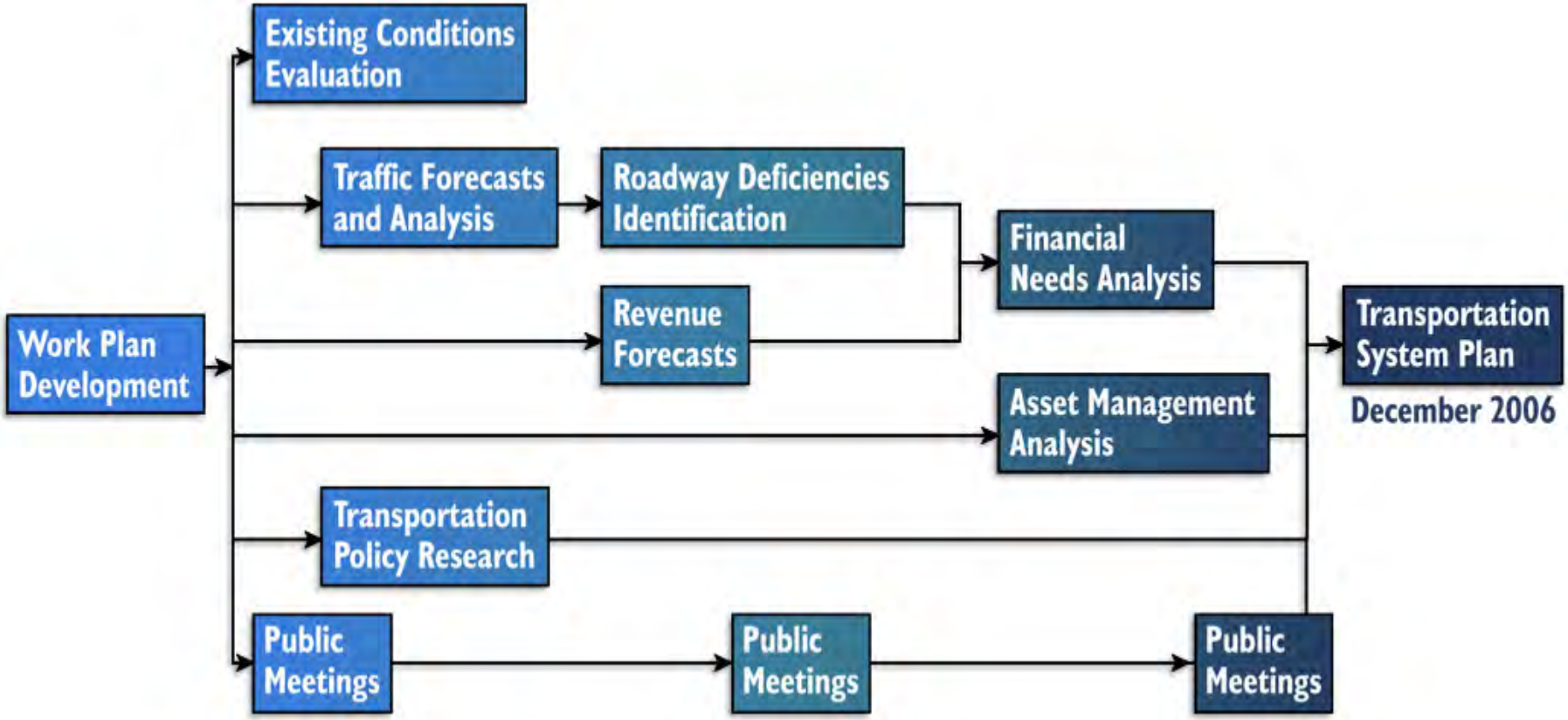
The Transportation System Plan is intended to define the county's role in transportation in the region, foster a seamless transportation system and guide the selection of transportation projects within all unincorporated areas of Maricopa County. In particular, the TSP addresses how to best use limited revenues to maintain and enhance the existing road network, while meeting demand for new facilities in growing areas. Although MCDOT works closely with state and local partners, the TSP does not address state highways or city jurisdiction streets.

This updated TSP serves as a reference for orderly and coordinated development consistent with MCDOT objectives and a clear statement of MCDOT public policy for the Maricopa County Board of Supervisors (BOS), the Transportation Advisory Board (TAB), the Maricopa County Planning and Zoning Commission as well as other agencies, local jurisdictions, the development community and concerned residents. The updated plan also includes an implementation strategy and an action plan covering future TSP updates and issues to be addressed in future plans.

The TSP Update Process

The general process for the development of the TSP Update is depicted in Figure 1-1. The process was initiated in January of 2005. A work plan was developed, policy issues were identified, data was gathered and analysis was conducted throughout 2005. In the fall of 2005, an initial round of public meetings was held in ten locations throughout Maricopa County. At those meetings, citizens, business owners and public officials provided input by commenting on policy issues, identifying transportation problems and concerns, and assisting in refinement of the work plan for the TSP Update. (A more detailed description of the full public involvement process is provided later in this chapter.) Additional direction was provided in the fall of 2005 through individual meetings with local government officials, meetings of the County Advisory Committee (CAC) and work sessions with the Transportation Advisory Board, which served as the steering committee for the TSP Update.

Figure 1-1 Study Process



With a more refined work plan in hand, MCDOT proceeded to follow through with the following early tasks:

- Detailed investigation of policy issues;
- Identification of existing conditions on roadways in unincorporated Maricopa County;
- Forecasting of future population, employment, traffic volumes and other conditions;
- Estimates of future revenues and revenue sources;
- Identification of roadway deficiencies; and
- Preliminary identification of future roadway needs.

After completing these tasks, MCDOT conducted a second round of public meetings at nine locations. In addition, MCDOT held more dialogues with its local government partners (one in the West Valley and one in the East Valley), received further input from the CAC and continued gaining guidance from work sessions with the TAB. This all helped MCDOT to move forward with formation of policy positions and refinement of plan recommendations (in essence, to produce a draft TSP Update). The draft TSP Update was then brought back before the public, local government partners and the CAC for final comment before bringing the document to the TAB for final recommendation to the BOS for ultimate approval late in 2006.

The TSP Update Document

The organization of this TSP Update document reflects the general flow of activities shown in the "Study Process" figure above. Following this introductory chapter, the TSP Update includes chapters on:

- Existing Conditions;
- Future Traffic Analysis;
- Needs Assessment and Options for Securing Additional Revenue;
- Asset Management;
- Transportation Policies; and
- Implementation Work Program.

The final chapter, as listed above, includes major tasks, policy development needs, and other related transportation tasks that need to be done to ensure implementation of the items identified in the TSP Update.

1.1 MISSION AND VISION

To ensure that the MCDOT is aligned with the guidance established in the County Comprehensive Plan, it is important to understand the strategic direction adopted by the Board of Supervisors. The county mission statement is:

> *To provide regional leadership, fiscal responsibility and necessary public services to its residents so they can enjoy living in healthy and safe communities.*

As stewards of public funds, MCDOT strives to ensure all county transportation facilities are well planned, engineered, and constructed. This is done to give taxpayers confidence that funds to provide transportation systems are used wisely. MCDOT has also developed a simple mission statement:

> *To provide a quality transportation system to travelers in Maricopa County so they can experience a safe, efficient, and cost-effective journey.*

The recommendations contained in this document align with these county and MCDOT missions. When implemented, the projects and programs included in the updated TSP will continue to allow residents and visitors to use a wide range of transportation opportunities through the diversification of the transportation network. MCDOTs vision is:

> *We set a standard of excellence regionally enabling us to consistently deliver on our commitment to provide the right transportation system for Maricopa County at the right time and at the right cost.*

What this means in practice is roadway plans and proposals will continue to be evaluated for feasibility by the application of the following three criteria:

- **Is it in the right place?** A roadway proposal should be generally consistent with the use indicated by the land use area in which it lies.

- **Is it at the right time?** Services, particularly roadways, are required for all development. The nature and extent of the services will be indicated by the development area, as well as the demonstrated and timely need based on travel demand or population growth. If services are already in place, planned to be so in the near future, or can be provided by the private sector, then it is the right time to develop.

- **Is it at the right cost?** Do public benefits generated by the proposed transportation improvement exceed the cost for County government to provide services? If the projected benefits exceed the costs, then it is the right cost to county government and the citizens it represents.

1.2 OTHER MANAGEMENT GUIDELINES

To ensure that a safe, efficient and cost effective transportation system is in place, Maricopa County will need to invest in its transportation system in a combination of ways allowed by state statute. In addition to the mission and vision statements established by the Board of Supervisors (BOS) and MCDOT management, further guidance is set forth by the BOS through adoption of

the County Comprehensive Plan. The Comprehensive Plan helps set direction for the county's investment along the following five guidelines:

- Increase safety and mobility along county operated roads.
- Maintain the existing system.
- Serve the needs of existing and future development in unincorporated Maricopa County.
- Serve regional travel.
- Direct future growth to the Urban Service Areas.

These management guidelines are also tied to MCDOTs Strategic Plan through its vision, mission, and goals. As discussed previously, the MCDOT mission reiterates what is outlined in its vision by recommending the department provide a quality transportation system for Maricopa County. The goals identified in the department strategic plan include customer satisfaction, integrity, teamwork, accountability, individual responsibility, regional leadership and professionalism.

The ideas behind the Department's mission, vision and goals provided direction in the development of the management guidelines. For example, maintaining the system is critical to ensure the department's integrity and accountability since investments must be protected through sound maintenance practices. Furthermore, to provide the right system at the right cost and at the right time requires an in-depth understanding of the system and its operation. This is only accomplished by having an accountable team of professionals to provide sound planning guidance.

In 2004, with the aforementioned mission, vision and guidelines firmly in focus, MCDOT sought to redirect its strategic energies by formulating a new set of targeted goals. These new goals additionally sought to affirm MCDOTs fundamental lead role in unincorporated Maricopa County, as well as MCDOTs continuous role as a cooperating partner amongst all MAG member agencies, addressing the realities of the emerging MAG RTP. Thus, the following four goals were included in the 2005 Department Strategic Plan:

- By December 2006 MCDOT will complete a transportation system plan update, including specific policies and strategies that support the implementation of the MAG RTP.
- By December 2006 MCDOT will demonstrate support for the MAG RTP and cooperate with our regional partners by proactively establishing partnership agreements with other local governments on the arterial projects contained in the Plan.
- MCDOT will optimize the existing roadway system by annually deploying 25 safety improvement projects in addition to the Transportation Improvement Program.
- MCDOT will plan for and improve the consistency of our project delivery, thereby improving our capital expenditure rate to 85% and our operations expenditure rate to more than 95%, but less than 98%.

With the release of this TSP Update, the goal of producing the update is accomplished. In addition, MCDOT has demonstrated support for the RTP and is actively cooperating with our local government partners and establishing working agreements. Significant progress has also been made toward meeting our goals related to safety projects and project delivery. Looking forward, MCDOT is again in the process of updating its strategic direction through this TSP Update and related strategic efforts.

1.3 PUBLIC PARTICIPATION

1.3.1 PUBLIC OUTREACH

An extensive, public outreach effort to inform and seek the input of residents, public agencies, and other stakeholders has been a critical component of this update. The goals of the outreach program were the following:

- Inform the public and transportation stakeholders about the TSP update.
- Collect quality input from citizens and stakeholders.
- Build, foster and maintain cooperative regional relationships.
- Increase internal knowledge of other agency/jurisdiction transportation planning.
- Identify opportunities to implement citizen-identified and stakeholder-identified concerns/suggestions.
- Collect information on sub-regional issues.
- Increase opportunities and awareness for project partnerships.
- Minimize, mitigate or avoid potential negative impacts of projects, perceived or actual.
- Enhance positive project impacts.
- Refine and focus project goals and tasks.

The MCDOT Right Roads Program conducted three series of public input meetings throughout unincorporated Maricopa County during key decision points in the update process to gather input from residents, private businesses and property owners, major civic clubs, homeowner's associations and organizations.

Ten public meetings were conducted in Series One during the study "Scoping" phase. Nine additional meetings were conducted during Series Two, the "Alternatives Analysis" phase, and ten public meetings were conducted during Series Three, the final phase, "Findings and Recommendations". The public provided input by identifying both local and regional transportation issues and priorities. Public comment on the development of the work plan for the study was also elicited.

Additional input meetings have been conducted with other identified stakeholder groups that include other local agencies, municipalities, developers and the trucking industry. Input summaries are detailed in separate reports.

1.3.2 PUBLIC COMMENT

During Fall 2005, over 400 people attended Series One "Scoping" public meetings and in Spring 2006, nearly 160 people attended Series Two "Alternatives Analysis" public input meetings. Approximately 170 people attended the final Series Three "Findings and Recommendations" public input meetings conducted during October and November 2006.

Attendees reviewed and discussed the goals and objectives of the TSP Update and informed the MCDOT project team about specific local and sub-regional roadway system issues or concerns. The public commented on preliminary recommendations and reviewed "Update Findings and Recommendations" during Series Three public meetings.

TSP Update information and comment sheets were distributed to all those in attendance. Through written public comment and discussions held with project team members during open house meetings, five prevailing themes regarding transportation priorities emerged, all centering on public safety or quality of life issues.

- Improvements to existing roadways (requests for traffic signal installations, dedicated turn lanes, etc).
- The installation of bike lanes on more roadways.
- Stay ahead of development, respond to development needs quickly and build now for future development.
- Request for expanded public transportation.
- Request for more dust abatement/dirt road paving.

To provide easy access to TSP information and facilitate additional public input on the plan, MCDOT also established a Transportation System Plan web site at http://www.mcdot.maricopa.gov/tsp/index.htm. Comments received through the web site are reflected in the documentation summarized above.

It is the intent of MCDOT for our future transportation initiatives to be:

- In accordance with the Board of Supervisors' mission, vision and strategic priorities;
- Guided by advice from the Transportation Advisory Board;
- Based on sound technical information; and
- Influenced by valuable input received from Maricopa County citizens and other transportation stakeholders in the county.

In developing this TSP update, MCDOT has appreciated the comments provided and has made a sincere effort to appropriately consider and balance the input received.

1.4 PLANNING CONTEXT

Although Maricopa County is responsible for a large number of roads, prior to 1997 there was no mechanism in place to categorize these roads effectively. Most local land use and transportation planning is based on municipal general plans, circulation elements and the MAG RTP. Maricopa County's vast jurisdiction over roads in a variety of circumstances requires MCDOTs planning effort to focus on organizing these roadways.

To accomplish this, three roadway categories were established in the original TSP: primary, secondary and local. Primary roads in the system are the most critical to the success of providing regional travel opportunities. They receive a high priority for funding, maintenance and other activities. Secondary roads are broken into several subgroups, and they generally serve sub-regional travel and have a relatively lower funding priority. At the local road level, MCDOTs effort is generally limited to maintenance and not to improve or extend these roads. A more detailed description of primary, secondary and local roads is provided below.

A new category of roadways which MCDOT must consider is arterial street projects that are in the MAG RTP (and are funded as part of Proposition 400). Where MCDOT has a logical role due to jurisdiction over part of or all of the adjoining land along the roadway itself, these projects may receive medium to high priority. Where MCDOT does not have a logical role, financial participation will normally be less. By focusing appropriate attention on this new category of roadways, MCDOT can play the important role of cooperating partner in the implementation of Proposition 400 projects.

Each category of roadway has unique parameters, criteria and implications for evaluation as candidate projects for the Capital Improvement Program (CIP) and for funding. The information provided in the following text is for planning purposes only. The data represent summary analyses and not specific project level information.

1.5 ROADWAY SYSTEMS

1.5.1 PRIMARY ROADS

Primary Roads satisfy the underlying principle of serving regional travel. They are of major importance to the County Roadway system. Primary roads constitute a seamless roadway system crossing jurisdictional boundaries. Some examples of primary roads would include routes to recreation and employment centers, routes connecting to MAG regional freeways or state highways and roads with scenic or recreational significance.

1.5.2 SECONDARY ROADS

Secondary roads are arterial and collector roadways within county jurisdiction not included in the primary system. This also includes programmed or planned roadways along section lines. They primarily serve sub-regional travel.

1.5.3 LOCAL ROADS

These are the remaining roadways that provide residential access and feed into the secondary system. This primary-secondary-local roadway system is further detailed in Chapter 2.

1.5.4 PROPOSITION 400 ROADS

These roadway projects are part of the MAG RTP and are funded in part through Proposition 400, approved by the voters in Maricopa County in November of 2005. These projects are expected to be completed over the next 20 years with funds generated by the half-cent sales tax, federal funds and other state and local revenue available in the region. Arterial road projects included in the RTP require a 30% local match. In many cases, these arterial projects will require Maricopa County and the city and town sponsors to share in the local match requirements.

1.5.5 ENHANCED ARTERIAL ROADWAYS

Enhanced Arterial Roadways include a limited number of important transportation corridors to be identified in Maricopa County that will provide a higher level of service than the typical arterial street. An Enhanced Arterial Roadway must normally meet the following criteria:

1. Connect to a MAG freeway, an Interstate highway, a state highway, or another gateway road.
2. Provide a non-freeway, high capacity corridor.
3. Be at least 8 miles in length unless it directly serves a freeway or state highway.
4. Be classified as a principal arterial or above with a raised median along most of the corridor.
5. Provide 10% capacity enhancement over standard arterial roadway capacity.
6. Facilitate Real-Time Traffic managed corridors.
7. Be compatible with municipal/tribal plans.
8. Be technically, financially and politically feasible.

Enhanced Arterial Roads (EARs) do not have to be fully owned by the county. The jurisdiction that builds, maintains, and/or operates the corridor should be negotiated on a corridor-by-corridor basis. Access management guidelines should also be negotiated on a corridor-by-corridor basis. Ideally, these corridors would meet county arterial standards or some mutually agreed upon standard. Corridor studies should be completed on each roadway if a study does not already exist. When corridors are adopted, those segments that are owned by cities or towns are eligible for up to 50% county participation (plan, design and construction). In order for county TIP dollars to be committed, an EAR will have to compete against all other TIP requests and meet the criteria established for all projects funded by MCDOT.

There are several initial candidate roadways tentatively identified that meet the criteria. They include MC-85, Riggs Road (from Val Vista to Meridian) and Sun Valley Parkway. In the future, other roadways will be considered, as appropriate.

1.6 INVESTMENT POTENTIAL MATRIX

The performance of the transportation system is vital to its users. As a result of the policy investigations and public outreach conducted as part of this TSP update, MCDOT has refined the decision matrix it uses to prioritize transportation investments to implement its mission and vision. This matrix, shown in Table 1-1, links investment priorities to land use concepts while supporting improvements within the Primary System, Proposition 400 and Enhanced Arterial Roadways.

The Investment Potential Matrix includes six different land use designations that correspond to the Maricopa County Comprehensive Plan. The land use element accommodates growth in unincorporated Maricopa County by identifying goals, objectives and policies that translate into land use designations. These will influence the pattern and timing of land development in the county, while recognizing environmental constraints and the desires of residents to have different types of living and working conditions. Uniform application of these goals, objectives and policies should result in balanced and harmonious communities where a high quality of life can be maintained.

Given the vast area under the jurisdiction of Maricopa County, these six main land use designations embody general land use development concepts. Underlying some of these areas are detailed land use plans that recommend more specific land uses, either through a municipal general plan or by a county area land use plan.

The six land use designations are:

- Incorporated Areas are those areas are under the jurisdiction of the cities, towns and Indian communities.

- General Plan Development Areas (GPDA) are unincorporated areas intended to be annexed into a city or town in the future and are included in an adopted municipal General Plan.

- Urban Service Areas may be designated within a GPDA. Within an urban service area, development will be permitted at urban densities in areas where urban services can be provided. The urban service area is not delineated on the land use map; rather it is defined by the ability of a jurisdiction, improvement district or private entity to provide infrastructure and appropriate urban services to a specific site or project.

- Established Communities/Existing Development Master Plans are unincorporated areas in the County that have an established pattern of development. These areas are characterized by existing patterns of development, guided and/or regulated by land use plans, community plans, development master plans or traditional zoning ordinances.

- Rural Development Areas are those areas generally outside the present and future GPDAs of the cities and towns. Residential development will be allowed at a very low density, generally not to exceed one house per five acres.

- Future Development Master Plans (DMPs) have long been a preferred type of residential development within Maricopa County. These communities have the potential to provide mixed land use opportunities, a wide range of housing choices, open space and recreational opportunities, and an appropriate multi-modal transportation system connected to schools, parks, and retail and employment centers. Future DMPs can be developed in any location in the unincorporated county. Appropriate development guidelines would vary depending on the land use area as defined in the Comprehensive Plan.

The Investment Potential Matrix provides guidance on how to invest county funds. It does not guarantee funding for any specific project in the four system categories. When considering investment potential:

- MCDOT will participate in "(H)igh" priority projects for planning, design and construction. Under this scenario, the availability of partnering opportunities is an advantage, but is not always a requirement.

- MCDOT will also fully participate in "(M)edium" priority projects, but partners are required.

- Finally, MCDOT will only participate in the planning and design of "(L)ow" priority projects, and partners are required.

- MCDOT will not (N) participate in secondary or local road projects in incorporated areas, and will require project developers (DR) to assume primary responsibility for road projects within DMPs.

Table 1-1 Investment Potential Matrix

Land Development Area	*Enhanced Arterial Corridors**	*Primary/ Prop. 400*	*Secondary*	*Local*
Urban Service Area	*H*	*H*	*M to H****	*L*
Rural Development Area	*H*	*H*	*L*	*L*
Established Areas/Existing DMP	*H*	*H*	*L*	*L*
General Plan Development Area	*M*	*M*	*L*	*L*
Incorporated Area	*M*	*L to M***	*N*	*N*
New Development Master Plan	*DR*	*DR*	*DR*	*DR*

* *Will follow guidelines established for Enhanced Arterial Roadway program.*
** *Will vary based on percentage of adjoining land under county jurisdiction.*
*** *Will vary based on continuity of corridor and percentage of adjoining land under county jurisdiction*

Chapter 2
EXISTING CONDITIONS

2.1 OVERVIEW

The purpose of this chapter on existing conditions is to create a transportation database of existing conditions for the MCDOT. The existing conditions report establishes the framework for the remainder of the TSP Update. The report identifies current population and employment data and 2015 and 2026 planning horizon projections. It describes the MCDOT transportation system, including roadway functional classification, facility type, pavement condition, and Level of Service. The report identifies facilities supporting non-motorized modes such as bike paths and trails. The report also discusses county island roadways and the broad MCDOT roadway categories used to prioritize transportation improvements.

The MCDOT transportation system is linked to the systems of other transportation agencies, including the Arizona Department of Transportation (ADOT) and the cities and towns within the County. The TSP Update primarily focuses on identifying deficiencies and recommending improvements on MCDOT facilities. The existing conditions report presents the system in its regional context. Figure 2-1 shows the Maricopa County study area and state highways.

2.2 POPULATION AND EMPLOYMENT

Covering 9,226 square miles, the Maricopa County land area is greater than that of seven states. Maricopa County has also become one of the most populous counties in the United States. Since the completion of the original plan in 1997, the county has added over a million residents. The current county population of 3.6 million is expected to grow to 6.1 million by the year 2026. With population growth comes the need for increased and improved transportation opportunities.

The communities in the outer regions of the Phoenix metro area, including Buckeye, Goodyear, Gila Bend, Queen Creek and Surprise, are projected to have the highest growth rate in Maricopa County. In absolute numbers, however, Phoenix is expected to have the greatest growth, at over 660,000. Table 2-1 lists 2015 and 2026 population projections and percent growth from year 2005 by Municipal Planning Area and unincorporated portion of the county. Figures 2-2 through 2-4 show population by Socioeconomic Analysis Zone (SAZ) for 2005, 2015 and 2026.

Adopted MAG projections show employment growth following a pattern similar to population. Table 2-2 lists 2005 actual employment and 2015 and 2026 employment projections by Municipal Planning Area and for the unincorporated portion of the county. Figures 2-5 through 2-7 show employment by Socioeconomic Analysis Zone for 2005, 2015 and 2026.

Figure 2-1 Study Area

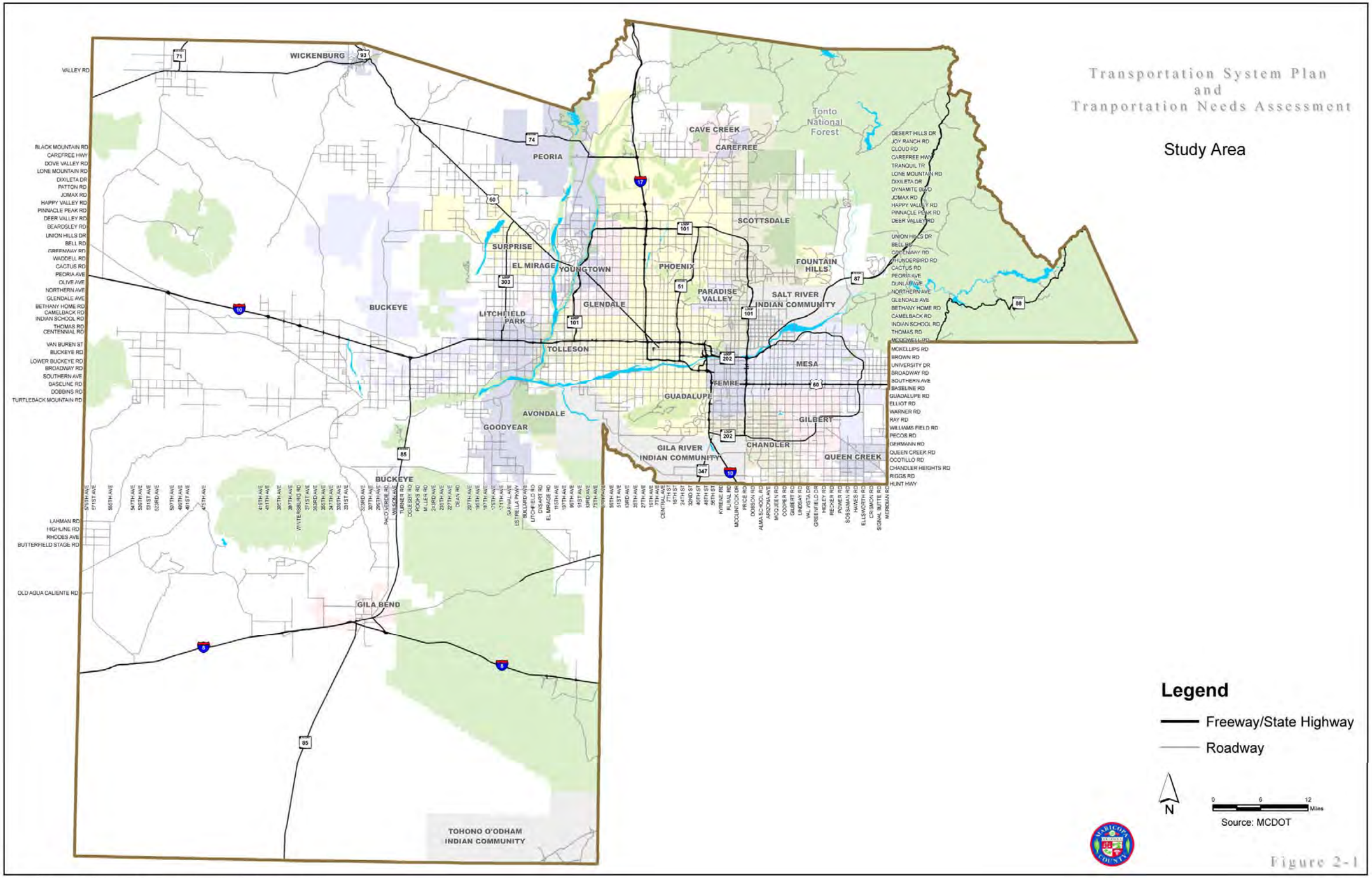


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Table 2-1 Projected Population by Municipal Planning Area

Municipal Planning Area	2005	2015		2026	
		Total	% Growth from 2005	Total	% Growth from 2005
Avondale	59,980	102,297	71%	161,395	169%
Buckeye	37,610	105,992	182%	380,569	912%
Carefree	3,505	4,434	26%	4,895	40%
Cave Creek	4,483	5,437	21%	12,897	188%
Chandler	222,672	273,299	23%	288,590	30%
County Areas	89,087	101,406	14%	138,010	55%
El Mirage	19,205	30,535	59%	33,075	72%
Fountain Hills	22,623	27,555	22%	30,742	36%
Gila Bend	2,545	4,414	73%	17,823	600%
Gila River Indian Community	2,944	3,694	25%	5,219	77%
Gilbert	160,993	241,573	50%	290,481	80%
Glendale	260,350	299,237	15%	312,182	20%
Goodyear	41,296	111,231	169%	330,411	700%
Guadalupe	5,228	5,359	3%	5,620	8%
Litchfield Park	5,440	10,367	91%	14,210	161%
Mesa	489,861	577,856	18%	647,760	32%
Paradise Valley	14,626	15,446	6%	15,883	9%
Peoria	137,471	183,700	34%	253,395	84%
Phoenix	1,525,390	1,861,382	22%	2,187,506	43%
Queen Creek	13,156	38,562	193%	88,130	570%
Salt River Pima Maricopa Indian Community	6,915	7,440	8%	7,527	9%
Scottsdale	228,692	270,189	18%	292,706	28%
Surprise	76,466	164,257	115%	395,474	417%
Tempe	167,610	182,769	9%	196,697	17%
Tolleson	5,572	6,189	11%	6,257	12%
Wickenburg	7,574	8,844	17%	15,960	111%
Youngtown	4,214	5,806	38%	6,557	56%
TOTAL	**3,615,501**	**4,649,265**	**29%**	**6,139,971**	**70%**

Source: Maricopa Association of Governments, 2003.

Figure 2-2 Population by SAZ 2005

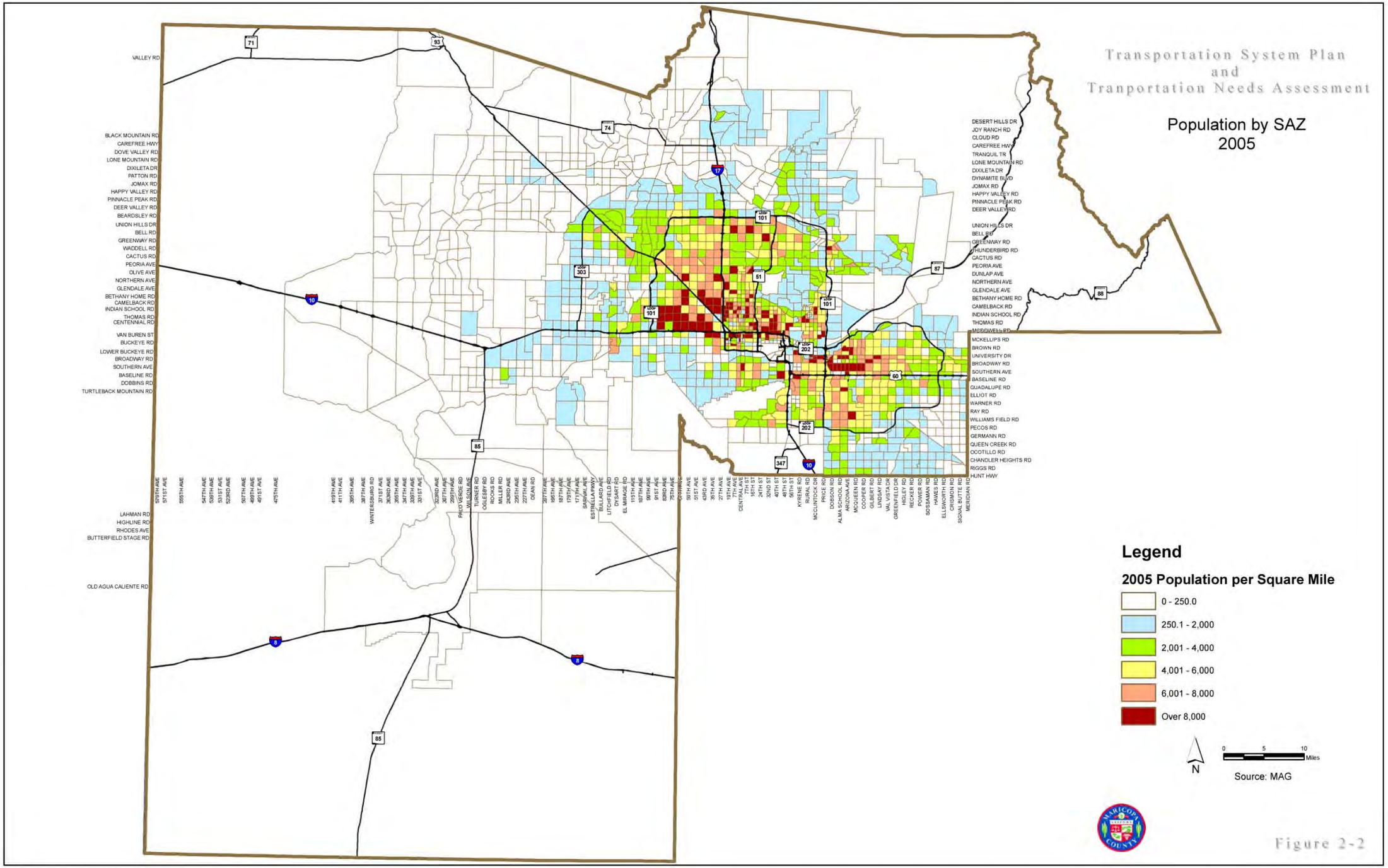

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Figure 2 – 3 Population by SAZ 2015

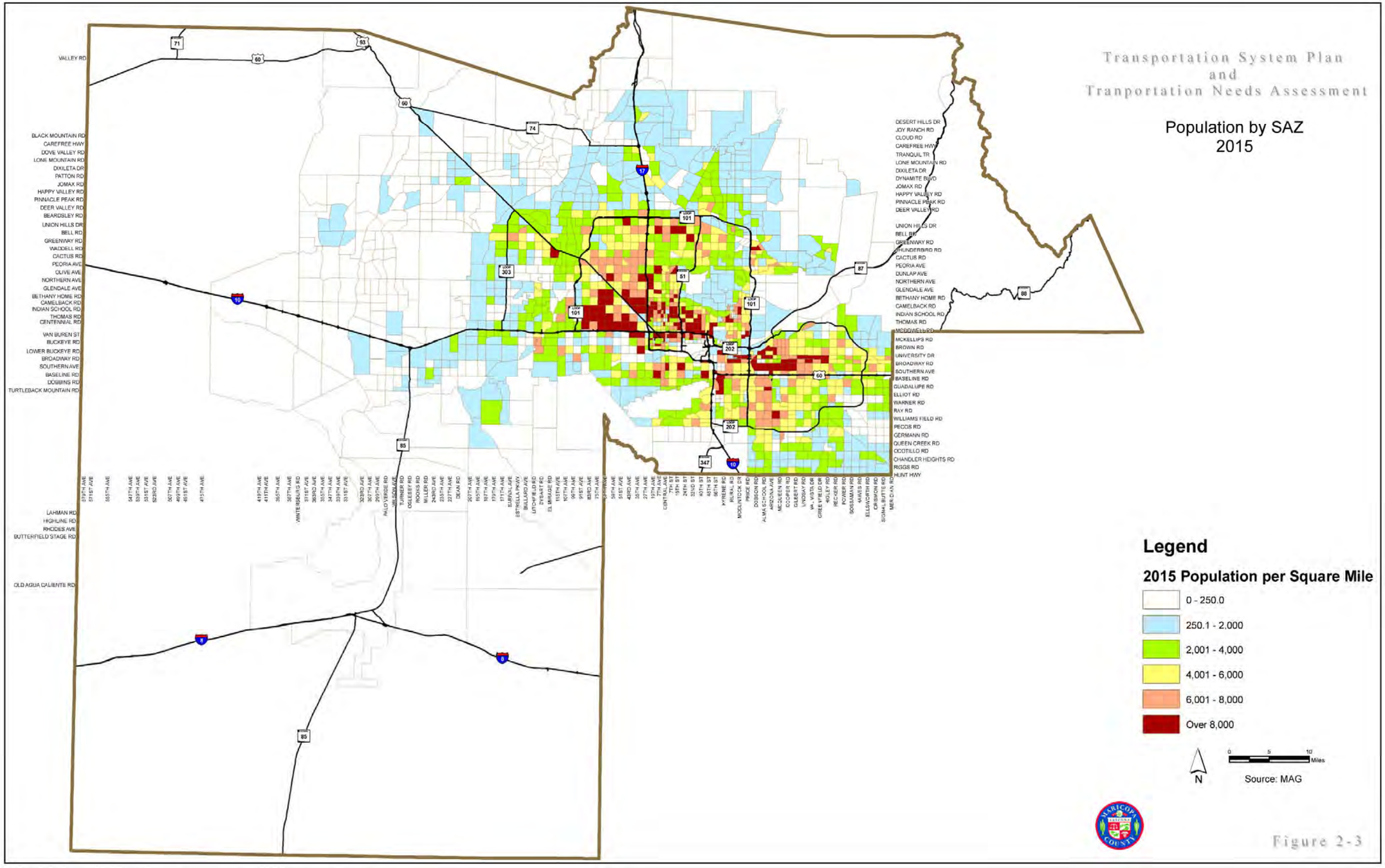

Figure 2 – 4 Population by SAZ 2026

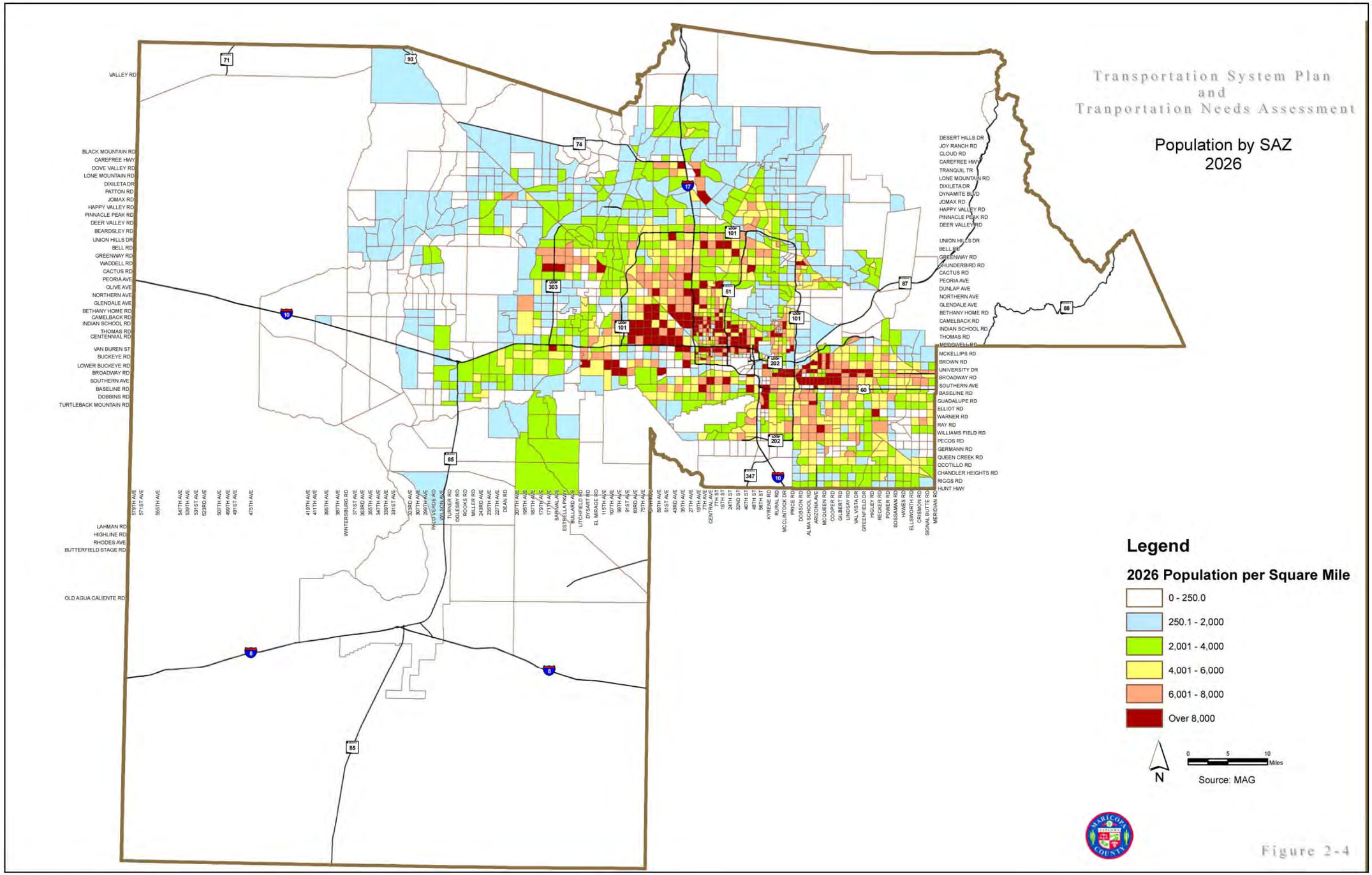

Table 2-2 Projected Employment by Municipal Planning Area

Municipal Planning Area	2005	2015		2026	
		Total	% Growth from 2005	Total	% Growth from 2005
Avondale	15,473	36,372	135%	59,448	284%
Buckeye	16,644	45,175	171%	194,394	1068%
Carefree	2,148	2,984	39%	3,150	47%
Cave Creek	1,352	2,019	49%	3,664	171%
Chandler	102,952	150,507	46%	184,528	79%
County Areas	32,637	35,255	8%	54,487	67%
El Mirage	3,213	6,855	113%	23,560	633%
Fountain Hills	5,986	8,325	39%	8,634	44%
Gila Bend	1,540	2,328	51%	11,651	657%
Gila River Indian Community	4,263	5,763	35%	8,701	104%
Gilbert	52,643	85,685	63%	118,175	124%
Glendale	107,532	144,433	34%	190,225	77%
Goodyear	22,385	48,819	118%	105,826	373%
Guadalupe	1,112	1,640	48%	1,786	61%
Litchfield Park	2,395	4,117	72%	4,263	78%
Mesa	206,282	267,247	30%	318,115	54%
Paradise Valley	5,478	5,733	5%	5,907	8%
Peoria	39,833	69,348	74%	141,492	255%
Phoenix	820,550	996,618	21%	1,264,062	54%
Queen Creek	4,012	13,079	226%	36,802	817%
Salt River Pima Maricopa Indian Community	7,522	8,414	12%	19,598	161%
Scottsdale	166,692	193,577	16%	214,841	29%
Surprise	18,544	39,521	113%	118,383	538%
Tempe	176,880	209,417	18%	241,099	36%
Tolleson	14,412	18,162	26%	30,904	114%
Wickenburg	4,486	5,454	22%	11,626	159%
Youngtown	1,461	1,661	14%	1,679	15%
TOTAL	**1,838,418**	**2,408,500**	**31%**	**3,377,000**	**84%**

Source: Maricopa Association of Governments, 2003.

Figure 2 – 5 Employment by SAZ 2005

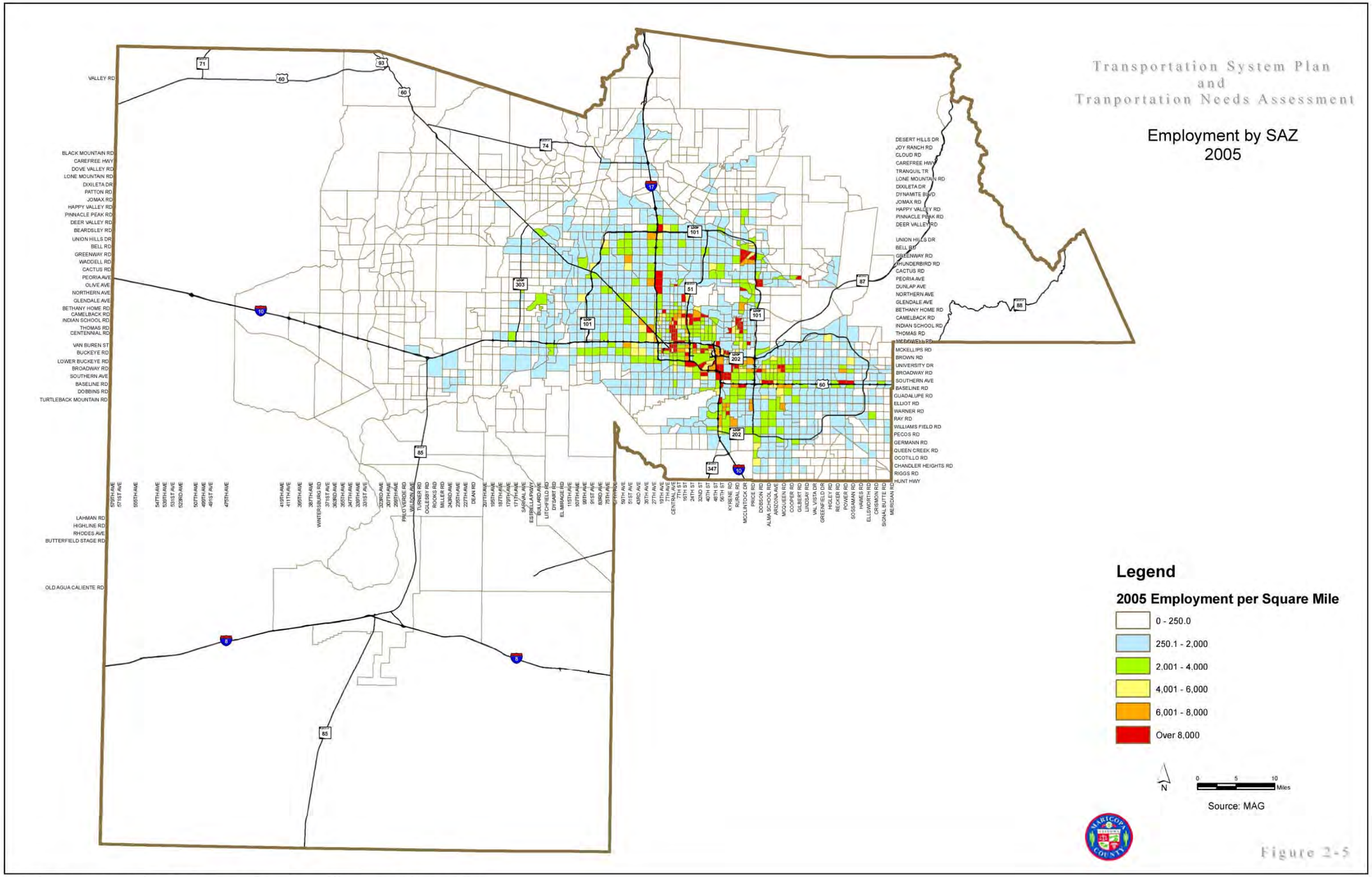

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Figure 2 – 6 Employment by SAZ 2015

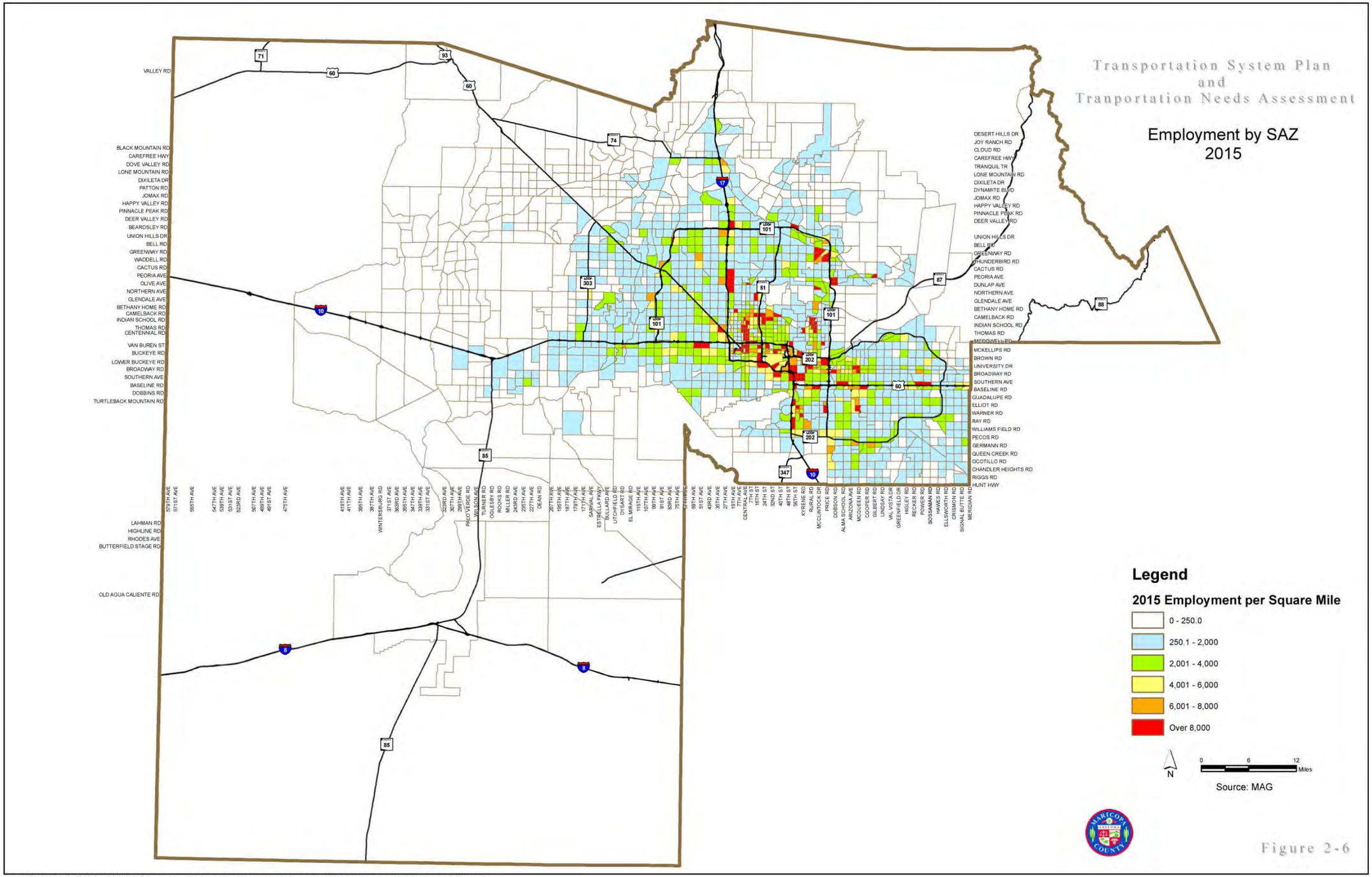

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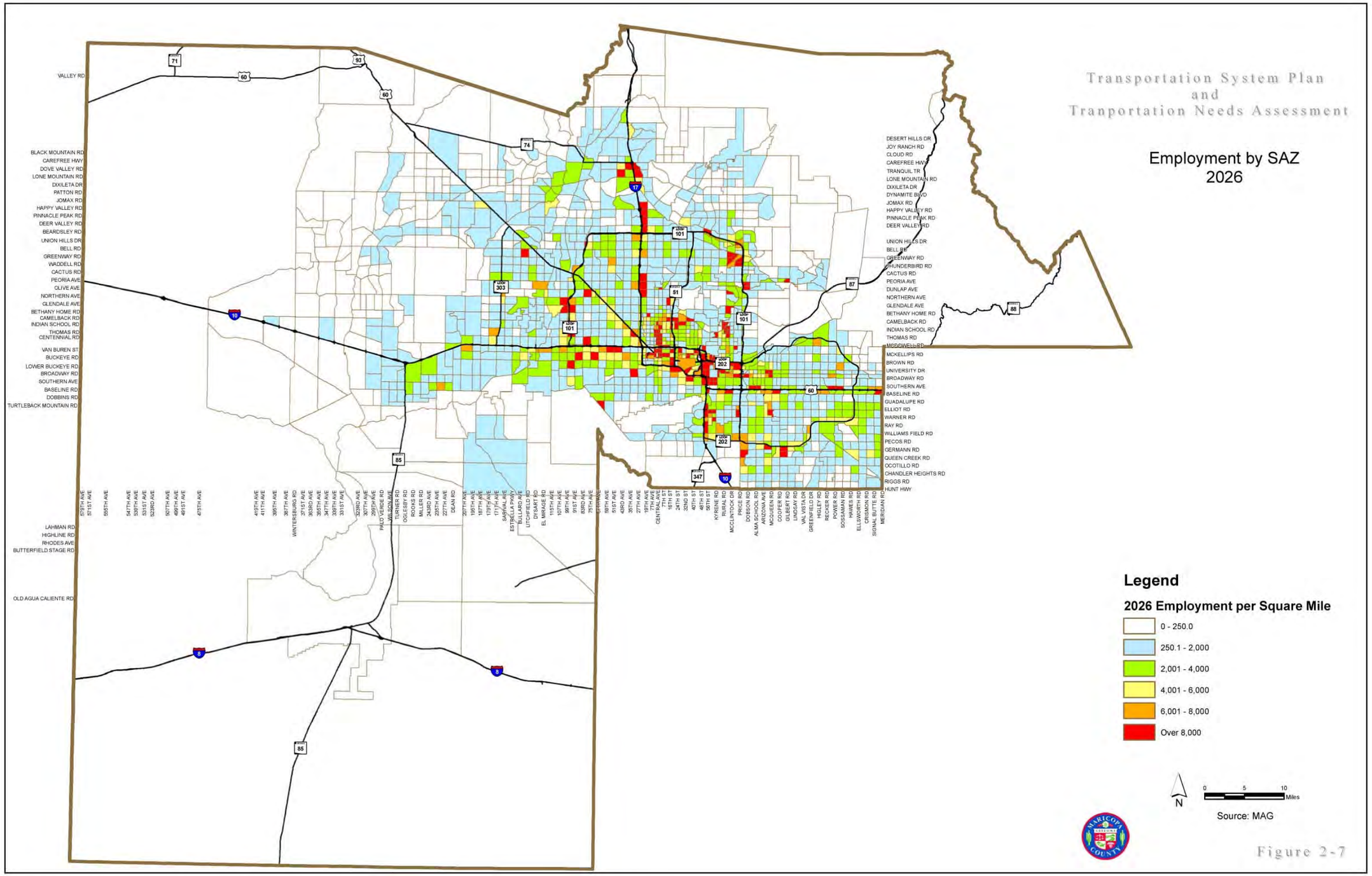
Figure 2 – 7 Employment by SAZ 2026



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2.3 ROADWAY SYSTEM

The MCDOT roadway facilities are diverse. They vary from unpaved two-lane roads in remote portions of the county to six-lane principal arterials that provide intercity travel in the Phoenix metropolitan area. This section provides descriptive information about the characteristics of the MCDOT roadway system.

2.3.1 SYSTEM SUMMARY

Table 2-3 summarizes the major components of the existing transportation system. Part of the dynamics of growth in Maricopa County is that cities and towns continue to annex unincorporated portions of the county. These ongoing annexations have resulted in a net decrease in system miles under MCDOT jurisdiction, from 2,829 miles in 1997 to 2,628 miles in 2005.

Table 2-3 summarizes 2005 MCDOT system by surface type. Figure 2-8 shows the location of the paved roads and unpaved roads in the County system.

Table 2-3 Existing Transportation System Surface Type Summary

Surface Type	Centerline-Miles	Lane-Miles
Paved Road	2,069	4,503
Unpaved Road	559	1,109
Total Roadway	2,628	5,612

Source: Maricopa County Roadway Inventory System, 2005

2.3.2 ROADWAY FUNCTIONAL CLASSIFICATION

MCDOT roadways are also classified by their role in the transportation system. This classification system includes arterial, collector, and local roadways. This functional classification system is further divided into major and minor facilities.

Table 2-4 provides a summary of MCDOT system mileage by functional classification. Table 2-5 describes the characteristics of each functional classification, Figure 2-9 shows the MCDOT system by functional classification and Table 2-6 shows the centerline-miles of the MCDOT system by facility type.

Figure 2 – 8 Paved and Unpaved Roadways in the County System

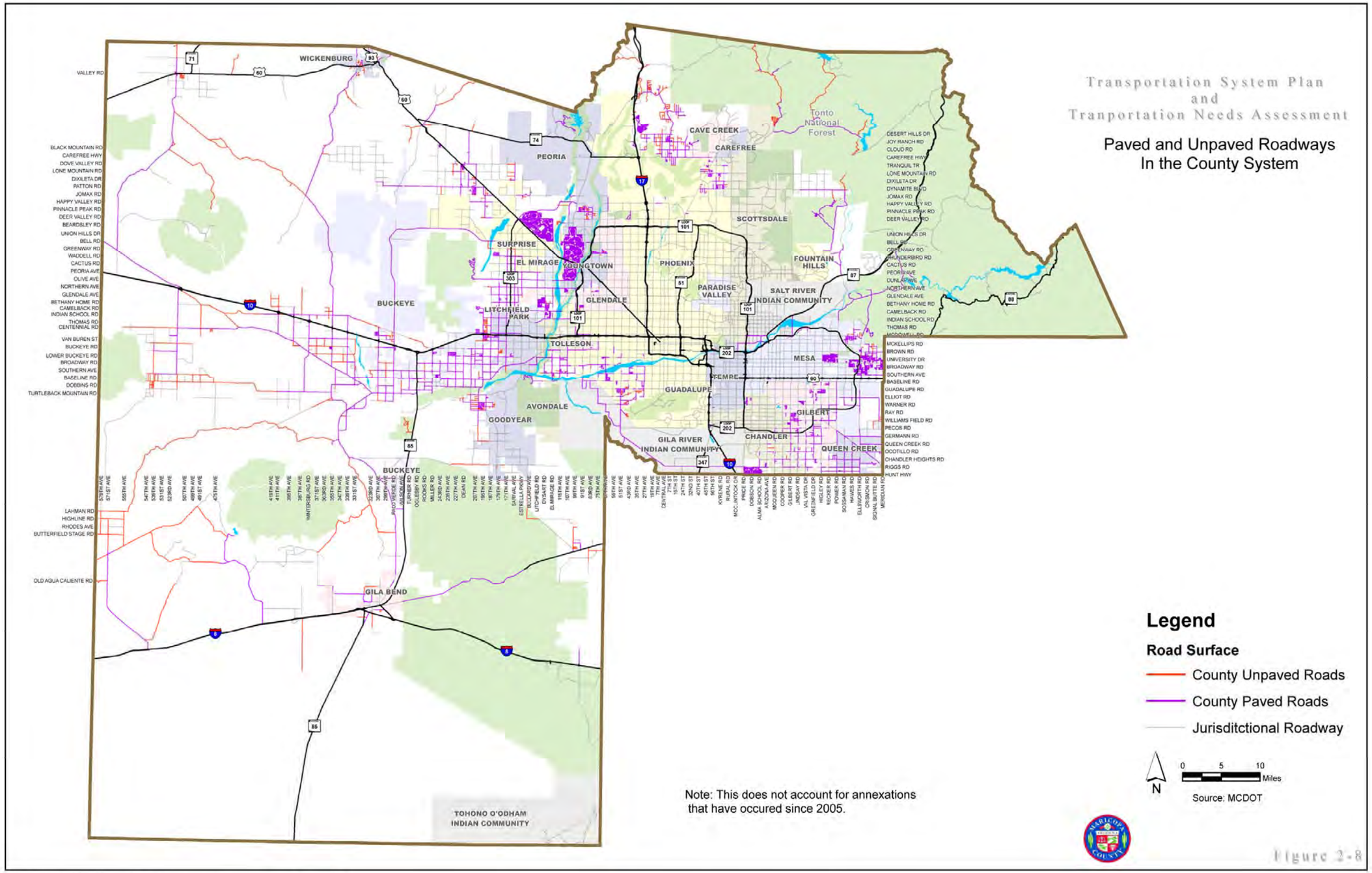

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Table 2-4 Centerline Miles by Roadway Functional Classification

Description	Miles
Principal Arterial	153
Minor Arterial	488
Major Collector	321
Minor Collector	407
Local Road	1,259
Total	**2,628**

Source: Maricopa County Roadway Inventory System, 2005

Table 2-5 Roadway Functional Classification Characteristics

Functional Classification	*Characteristics*
Principal (Major) Arterial	• *Through movement and major circulation in urban areas.* • *Substantial regional travel.* • *Accounts for large portion of total urban travel with minimum mileage.* • *Movement between urban areas with populations generally greater than 25,000.*
Minor Arterial	• *Major circulation movements with emphasis on development access.* • *Traffic movements do not penetrate residential areas.* • *Movement between areas with population less than 25,000.*
Major Collector	• *Provides both circulation and access.* • *Direct frontage development with industrial, commercial, and neighborhood access.* • *Service, movement between traffic generators, larger cities, and routes of higher classification.*
Minor Collector	• *Same as major collector, with increased emphasis on residential access.*
Local Road (Residential)	• *Relatively shorter travel distances compared to collectors or higher systems.* • *Traffic movements between adjacent lands and collectors or other roads of higher classification.*

Source: Federal Highway Administration (FHWA) Functional Classification Guidelines, 1989.

Figure 2 – 9 Roadway Functional Classification

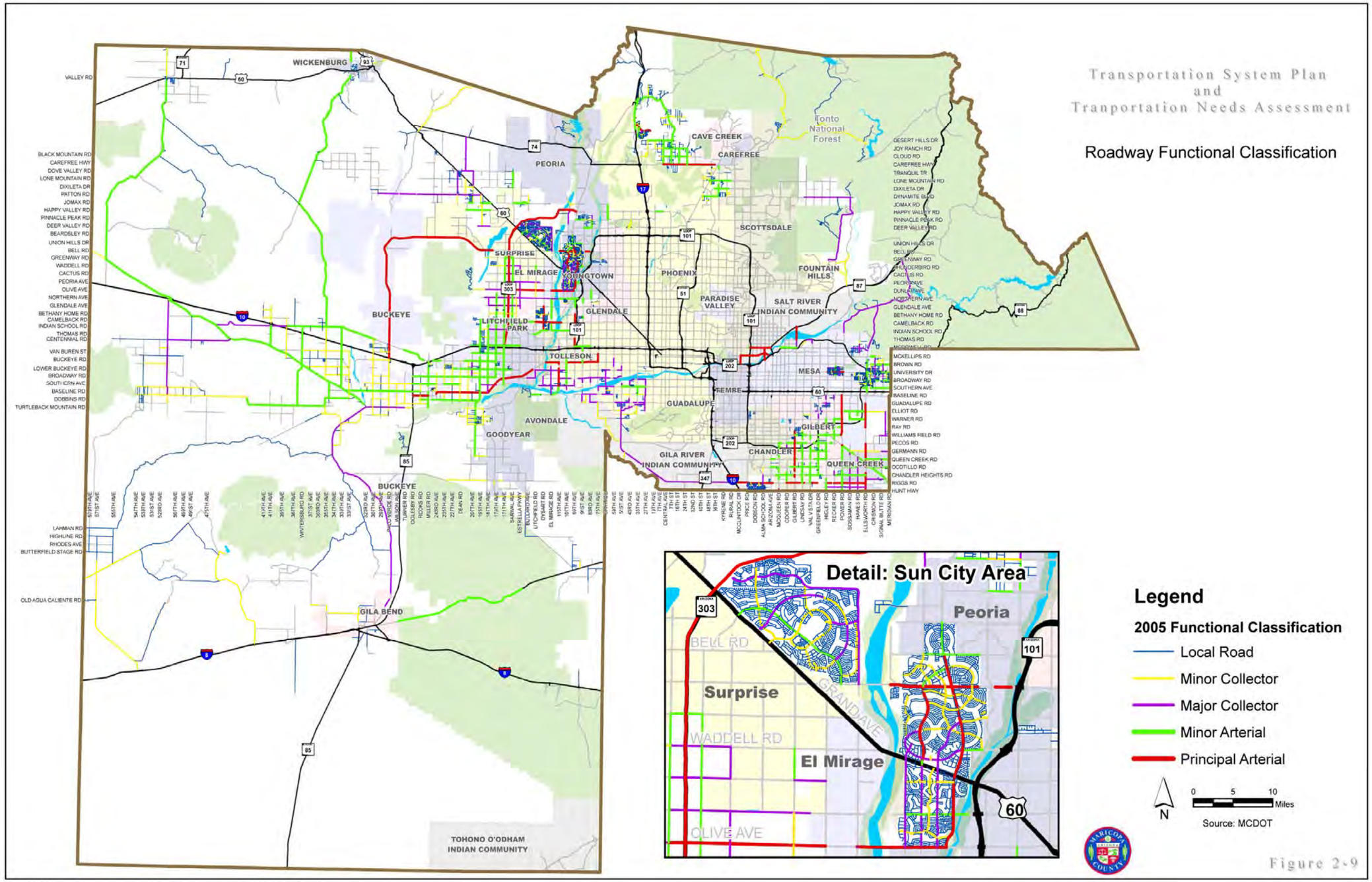

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Table 2-6 Centerline-Miles by Facility Type

Facility Type	*Miles*
Urban Principal Arterial	*58*
Urban Minor Arterial	*126*
Urban Major Collector	*98*
Urban Minor Collector	*74*
Urban Local	*671*
Total Urban	***1,027***
Rural Principal Arterial	*95*
Rural Minor Arterial	*362*
Rural Collector	*556*
Rural Local	*588*
Total Rural	***1,601***
Total	***2,628***

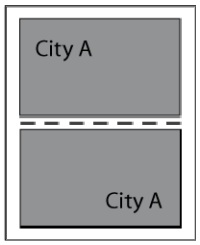
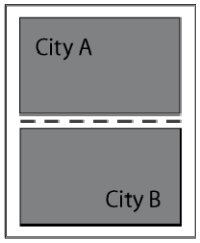
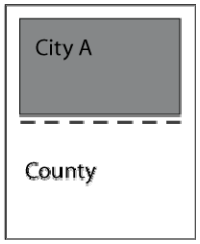
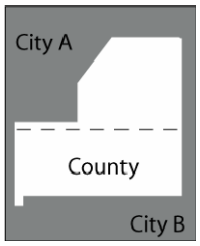
Source: Maricopa County Roadway Inventory System, April 2005

2.3.3 COUNTY ISLAND ROADWAYS

Annexation often occurs in growing regions of the county. Sometimes, when an annexation is being considered by a city or town, property owners wish to remain unincorporated within the county or a municipality elects not to include certain properties in the annexation. The un-annexed properties that remain in the unincorporated county after surrounding areas are annexed by a municipality are called "county islands". A county island roadway is a MCDOT roadway segment that serves a county island area and is surrounded by one or more municipalities. These segments also exist because Arizona state statute allows incorporated cities to annex land without annexing the transportation facilities that serve it.

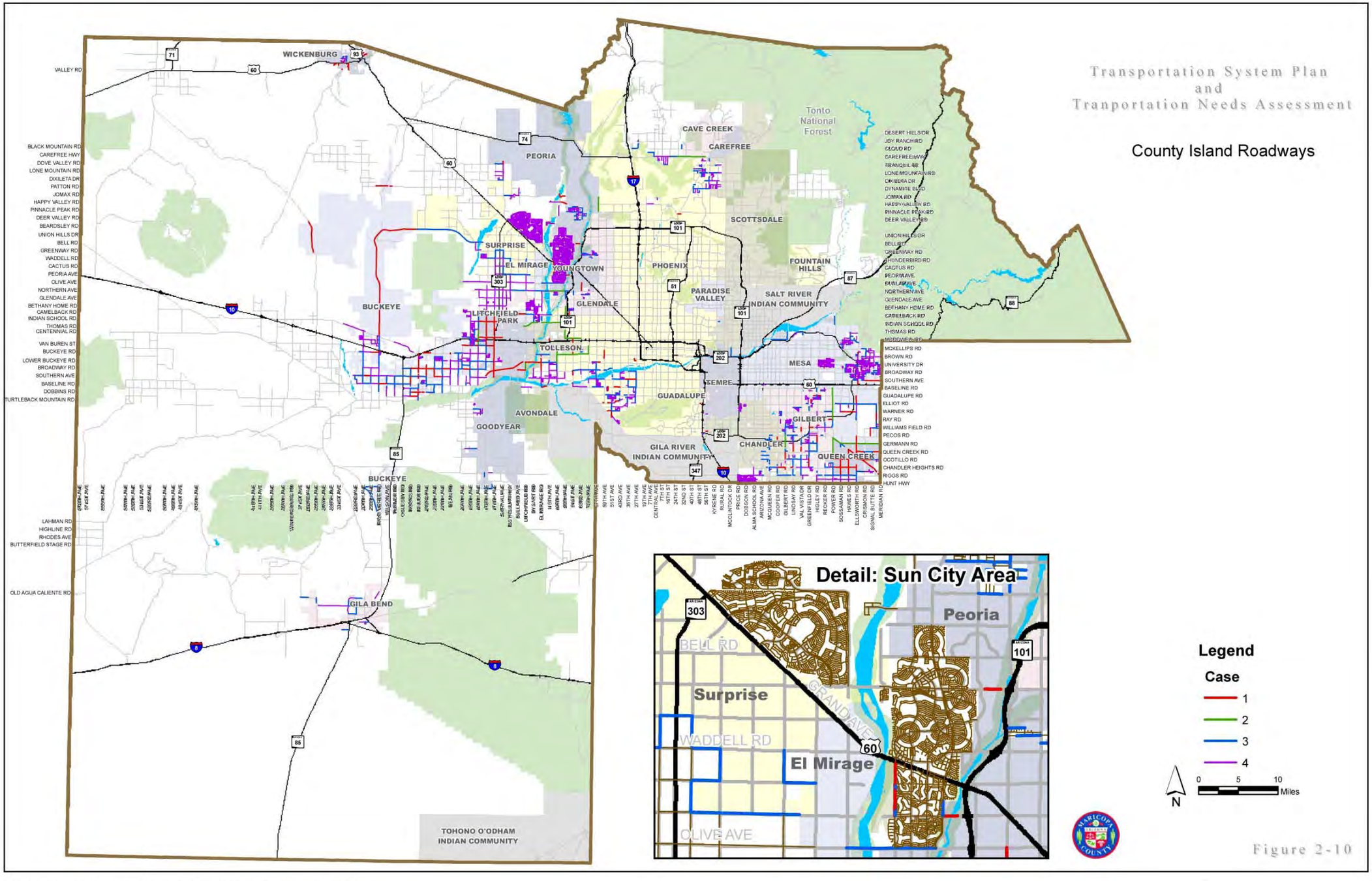
Maricopa County has the responsibility for maintaining these “island” roadways. The responsibility for funding expansion of these roads (adding lanes, for example) when development occurs in these areas is more complicated and may be shared by the county and the municipality in which the development occurs. County island roadways fall into four distinct cases, illustrated in Table 2-7. MCDOT has 1,474 centerline-miles of county island roads, 56 percent of its total system. This is a 34% increase from 966 centerline-miles in 1996. Figure 2-10 identifies the Maricopa County island roadways by case. One-third of the county island roadways are located in the communities of Sun City (225 miles), Sun City West (175 miles), Dreamland Villa (30 miles), Sun Lakes (46 miles), and Anthem (23 miles).

Table 2-7 County Island Roadway Descriptions

Case Number	*Description*
Case 1 	*Only the roadway is unincorporated and it is bounded on both sides by one municipality.* ***138 Miles***
Case 2 	*Only the roadway is unincorporated and it is bounded by different municipalities on each side.* ***41 Miles***
Case 3 	*The roadway is unincorporated and is bounded by a municipality on one side. The other side is unincorporated lands.* ***274 Miles***
Case 4 	*The roadway and adjacent lands are unincorporated but the unincorporated lands are totally bounded by one or more municipalities.* ***1,021 Miles***
TOTAL	***1,474 Miles***

Source: Maricopa County Department of Transportation, 2005

Figure 2 – 10 County Island Roadways



2.3.4 PRIMARY/SECONDARY/LOCAL ROADWAY SYSTEM

The MCDOT has established three broad roadway categories to better organize and prioritize its long range planning efforts: primary, secondary and local. Primary roads form the backbone of the MCDOT system and receive the highest priority for funding, maintenance and other activities. Secondary roads are lower priority corridors where MCDOT participation would be more limited. MCDOTs only effort on local roads may be to maintain the road or to provide technical assistance for planning and design. (A description of these roadway categories is provided in Chapter 1). Figure 2-11 shows the MCDOT primary, secondary and local roadway system.

2.3.5 INTELLIGENT TRANSPORTATION SYSTEMS

Several Intelligent Transportation Systems (ITS) deployments exist on various corridors within local authorities encompassing the county boundaries. These facilities include coordinated signals, Close Circuit Television (CCTV) cameras, Dynamic Message Signs (DMS) and detection technologies to enable the agencies to provide real-time traffic management, incident response and traveler information services. The operators at the traffic management centers use the ITS tools to monitor traffic conditions and if required they dynamically change signal timings to relieve congestion; post messages on the DMS to alert motorists to roadway conditions, including crashes and closures; and dispatch incident response teams. The real-time services enabled through ITS help in reducing delays and enhancing safety. MCDOT is deploying ITS infrastructure on congested County corridors such as Bell Road.

MCDOT also serves as a program leader for the AZTech Regional Transportation Partnership. Through regional collaboration this partnership aims at integrating and improving regional traffic management. Individual cities and towns deploy, operate and maintain their ITS systems and equipment, and MCDOT helps to integrate these efforts to facilitate better regional traffic management and coordination. The regional AZTech activities that are coordinated through MCDOT Traffic Management Division include:

- Institutional collaboration and public-private partnerships
- Center-Center Communications infrastructure development
- Inter-agency operations
- Regional traveler information support
- Incident Management through Regional Emergency Action Coordinating Team (REACT)

2.3.6 SYSTEM PERFORMANCE

2.3.6.1 Level of Service

Roadway network performance is generally measured by its ability to process travel demand while maintaining acceptable Levels of Service. The Highway Capacity Manual (HCM 2000) prepared by the Transportation Research Board (TRB) Committee on Highway Capacity and Quality of Service outlines six Levels of Service (LOS) ranging from A to F:

LOS A – Best, free flow operations (on uninterrupted flow facilities) and very low delay (on interrupted flow facilities). Freedom to select desired speeds and to maneuver within traffic is extremely high.

LOS B – Flow is stable, but presence of other users is noticeable. Freedom to select desired speeds is relatively unaffected, but there is a slight decline in the freedom to maneuver within traffic.

LOS C – Flow is stable, but the operation of users is becoming affected by the presence of other users. Maneuvering within traffic requires substantial vigilance on the part of the user.

LOS D – High density but stable flow. Speed and freedom to maneuver are severely restricted. The driver is experiencing a generally poor level of comfort and convenience.

LOS E – Flow is at or near capacity. All speeds are reduced to a low, but relatively uniform value. Freedom to maneuver within traffic is extremely difficult. Comfort and convenience levels are extremely poor.

LOS F – Worse, facility has failed, or a breakdown has occurred.

2.3.6.2 Roadway Level of Service Conditions

Actual traffic counts were used to establish Level of Service on MCDOT roadways. Roadway Levels of Service based on 2004 count data are depicted in Figure 2-12. The MCDOT Level of Service standard for its facilities is C. Over 97% of the MCDOT roadways operated at LOS A in 2004. As reported in the next chapter, this will not be the case in the future.

Figure 2 – 11 Primary, Secondary and Local Roads

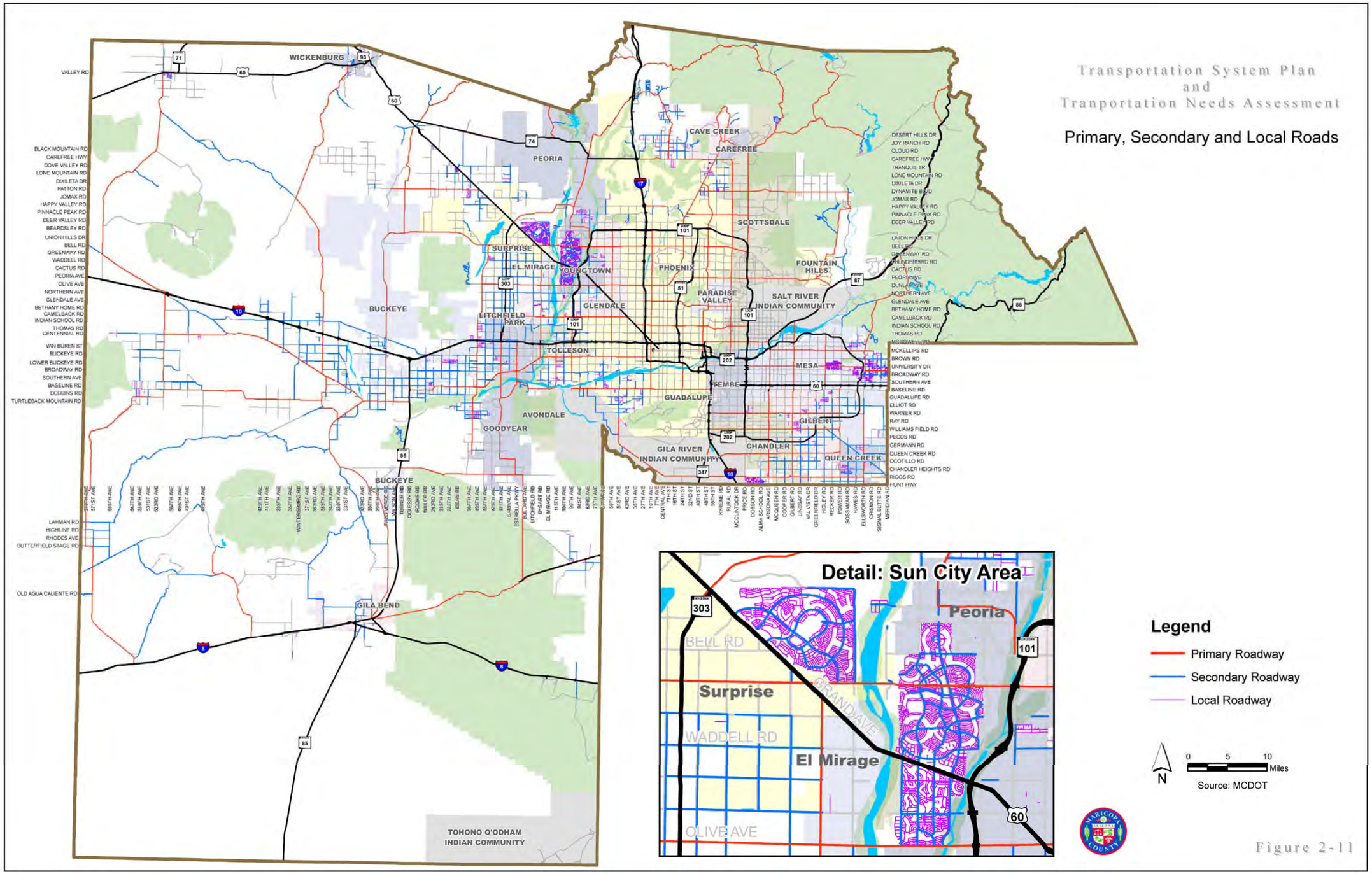


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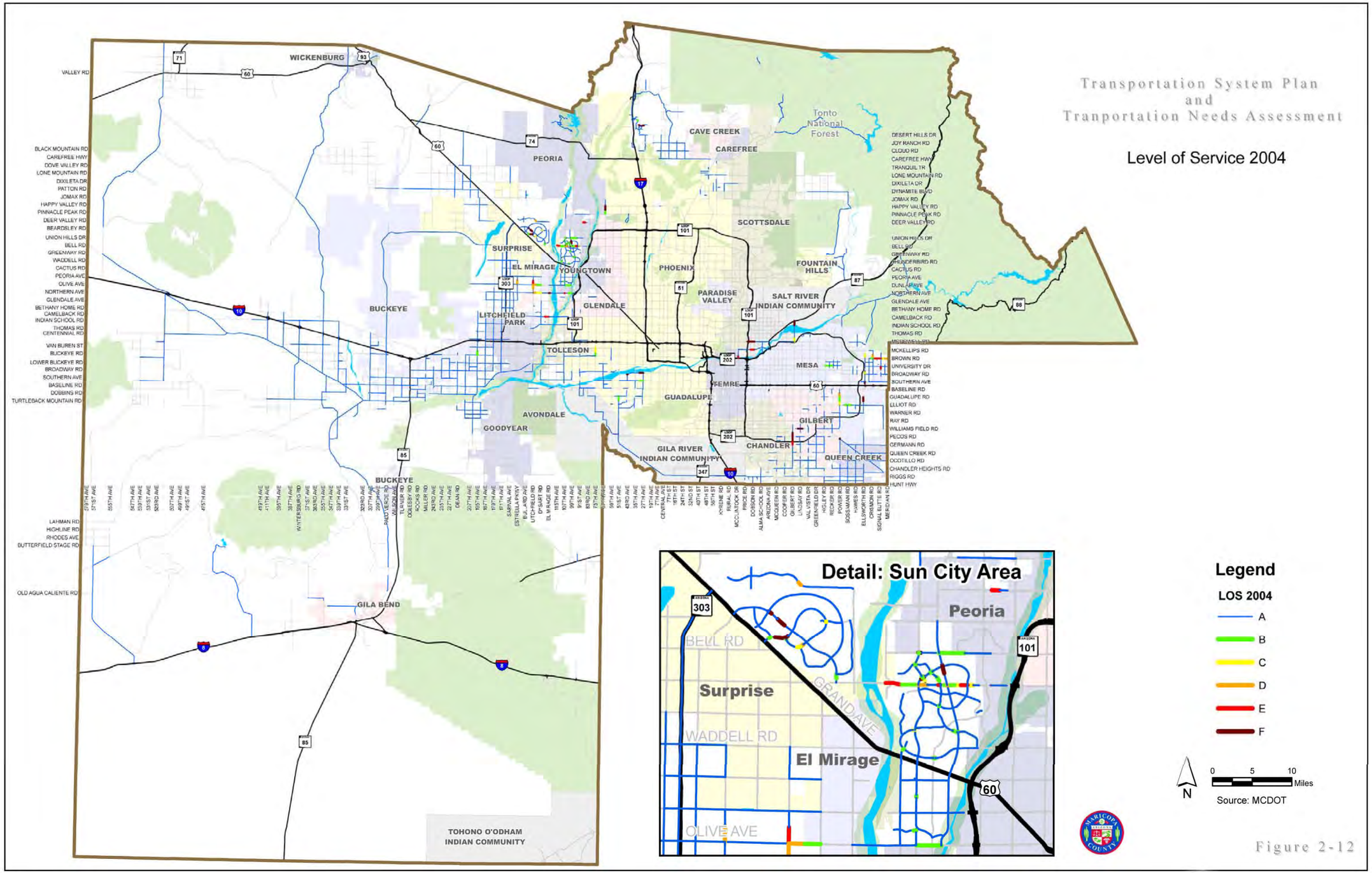
Figure 2 – 12 Level of Service 2004



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2.3.7 TRANSIT MODES

Many municipalities within Maricopa County provide transit alternatives. Service varies from local and express buses operating on a fixed route with a defined schedule to dial-a-ride service for those disabled or with no access to transportation. The majority of fixed route service in the Phoenix metro area is provided by the City of Phoenix. Tempe, Scottsdale, Glendale, Chandler, Peoria, and Mesa also provide significant transit service to their communities.

Outside of the Phoenix metropolitan area, in rural unincorporated areas of the county, demand-responsive dial-a-ride service is the only transit option. The Maricopa County Special Transportation Services Department provides demand-responsive service for social service and medical trips to the entire unincorporated county.

2.3.8 NON-MOTORIZED MODES

Maricopa County has extensive facilities to support non-motorized transport, including on-road bike lanes, bike paths, and multi-use trails for horseback riders and hikers. Figure 2-13 shows the existing MAG Regional Bikeway Plan. This plan includes seamless integration of county and municipal facilities. As well, many paved county roadway facilities incorporate a paved shoulder that also serves as a bike lane or route.

Figure 2-14 shows the Maricopa County Trail Plan. This Plan will provide extensive access throughout the Phoenix metropolitan area using a combination of municipal and county trails. One important note for long range transportation planning is that county policy requires that both new roads and roadway widening projects accommodate trail crossings.

Figure 2 – 13 Existing Bikeways in Maricopa County

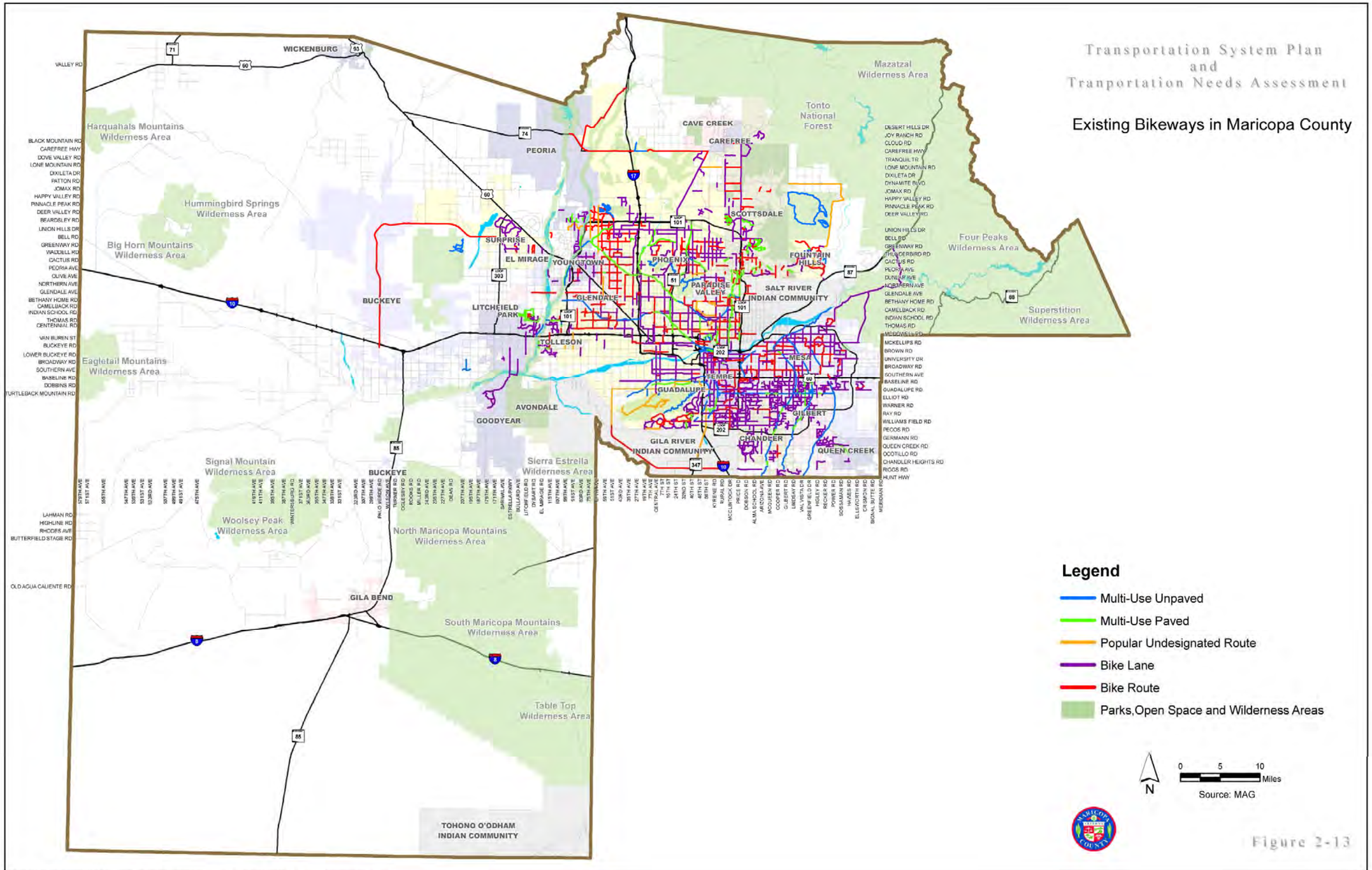

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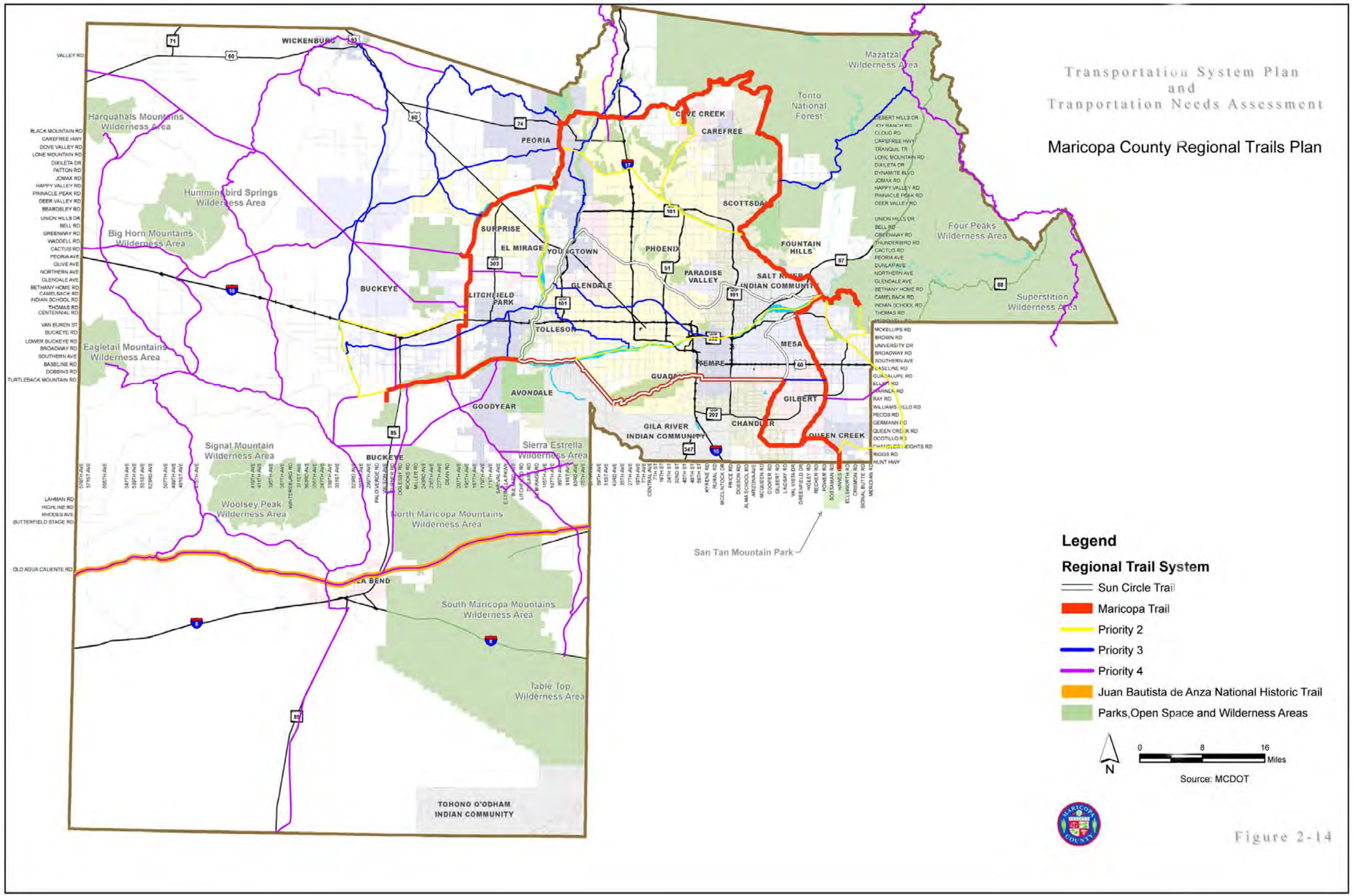
Figure 2 – 14 Maricopa County Regional Trails Plan



Chapter 3

FUTURE TRAFFIC ANALYSIS

3.1 FUTURE TRAFFIC ANALYSIS

3.1.1 INTRODUCTION

The purpose of this chapter is to present the analysis of future traffic conditions on roads that are currently owned and maintained by the MCDOT. To accomplish this task, future travel demands on MCDOT roadways were forecast and compared with the roadway capacities to evaluate their future traffic operational performance. Two future horizon years, 2015 and 2026, were evaluated in the study. The purpose of the evaluation was to determine whether the roadway network in each of the horizon years would be able to accommodate the forecast travel demand. Where a roadway capacity deficiency was identified, potential roadway widening improvements are recommended.

3.1.2 TRAFFIC OPERATIONAL PERFORMANCE METHODOLOGY

For each evaluation year (2015 and 2026), an analysis was completed on a base network that has the same roadways that exist or are planned to be completed in the previous evaluation year. For example, the existing 2005 network represents the 2015 base network. The 2026 base network includes all the 2015 improvements.

The volume/capacity (v/c) ratio was used as the measure of effectiveness. The forecast daily traffic volumes for the evaluation year were obtained from the models and evaluated against the capacity of the base roadway network on a segment-by-segment basis. The roadway capacity was obtained by multiplying the per lane capacity (from MAG models) by the number of lanes in the base network. The v/c ratio was computed on each section of the MCDOT roadway network. Table 3-1 shows how the v/c ratios relate to the LOS classification.

Table 3-1 Relationship Between V/C Ratio and LOS

V/C	LOS
0.75 or less	C
0.76 to 0.90	D
0.91 to 1.00	E
1.01 or greater	F

As stated earlier, capacity improvements identified in one evaluation year are incorporated into the base network of the following evaluation year. For example, improvements identified in 2015 are incorporated into the base condition for the 2026 evaluation year.

3.1.3 SUMMARY OF RESULTS

An analysis of the base network has been conducted for each analysis year (2015 and 2026) and an estimate has been made of the number of lanes that would need to be added to that base network in order to achieve and maintain LOS C. For the lane-mile calculations it was assumed:

- New construction would add a 2, 5, or 7-lane roadway;
- Widening of a 2 or 3-lane roadway would be accomplished through total reconstruction; and
- Widening of a 4 or 5-lane roadway would be accomplished through saving the existing lanes and adding the additional lanes.

The estimated miles of roadway that need to be widened to achieve LOS C in 2015 and 2026 are shown in Tables 3-2, 3-3, 3-4, and 3-5. The roadways that would need to be reconstructed or widened are shown, by Supervisor District, in Figures 3-1 through 3-5 at the end of this chapter.

As shown in Table 3-2, 232 centerline-miles of roadway, 36% of the 640 centerline-miles of arterial streets under county jurisdiction, would need to be widened to achieve/maintain LOS C in the Year 2015, and another 266 miles would need to be widened by 2026. In addition, 193 centerline-miles of new arterial streets would need to be constructed to serve growth in unincorporated Maricopa County by the end of calendar year 2015 (Table 3-3), and another 170 centerline-miles would need to be constructed by the end of calendar year 2026 (Table 3-4).

Table 3-2 Traffic Operational Performance of Base Network

Planning Horizon	Miles of Roadway Widening Needed to Achieve LOS C (Centerline-Miles)			Total
	LOS D	LOS E	LOS F	
By 2015	111	40	81	232
By 2026	117	51	98	266

Tables 3-3 and 3-4 summarize the new construction, reconstruction, and widening that would need to occur through the 2015 and 2026 planning horizons, respectively, in order to achieve/maintain LOS C.

For the period from 2005 through 2015:

- New Construction (i.e. arterial streets going from 0 to 2, 5, or 7 lanes): 193 miles resulting in 454 new lane-miles
- Total Reconstruction (i.e. reconstruction of an existing 2- or 3-lane arterial street): 203 miles resulting in a net gain of 680 lane-miles
- Widening of Existing Facility (i.e. adding lanes to an existing 3- or 5-lane arterial street): 29 miles resulting in 81 new lane-miles.

Table 3-3 Arterial Street Widening Needed Through Year 2015 to Achieve LOS C

Widen From-To (lanes)	Centerline-Miles	Constructed Lane-Miles	Replaced Lane-Miles	Additional Lane-Miles
New Construction				
0-2	173	346	0	346
0-5	16	80	0	80
0-7	4	28	0	28
Total New Construction	**193**	**454**	**0**	**454**
Reconstruction				
2-5	166	830	332	498
2-7	36	252	72	180
3-5	1	5	3	2
Total Reconstruction	**203**	**1087**	**407**	**680**
Widening of Existing Facility				
4-7	23	69	0	69
5-7	6	12	0	12
Total Widening	**29**	**81**	**0**	**81**

For the period from 2016 through 2026:

- New Construction (i.e. arterial streets going from 0 to 2, 5, or 7 lanes): 170 miles resulting in 408 new lane-miles
- Total Reconstruction (i.e. reconstruction of an existing 2 or 3-lane arterial street): 207 miles resulting in a net gain of 647 lane-miles
- Widening of Existing Facility (i.e. adding lanes to an existing 4 or 5-lane arterial street): 59 miles resulting in 132 new lane-miles

Table 3-4 Arterial Street Widening Needed from Year 2015 Through Year 2026 to Maintain LOS C

Widen From-To (lanes)	Centerline-Miles	Constructed Lane-Miles	Replaced Lane-Miles	Additional Lane-Miles
New Construction				
0-2	150	300	0	300
0-5	16	80	0	80
0-7	4	28	0	28
Total New Construction	**170**	**408**	**0**	**408**
Reconstruction				
2-5	194	970	388	582
2-7	13	91	26	65
3-5	0	0	0	0
Total Reconstruction	**207**	**1,061**	**1,268**	**647**
Widening of Existing Facility				
4-7	14	42	0	42
5-7	45	90	0	90
Total Widening	**59**	**132**	**0**	**132**

Table 3-5 provides information on how many lane-miles of arterial streets could be under MCDOTs jurisdiction (if funding is available) after the necessary new roadway construction and widening of existing facilities occurs. *This is a "worst-case" calculation that does not include allowance for periodic roadway annexations by municipalities that are a natural result of urban growth.* There are currently 2,460 lane-miles of arterial streets under MCDOTs jurisdiction. Using this as a base for 2015, the 454 lane-miles of new arterial streets, the 1,087 lane-miles of reconstructed arterials, and the 81 miles of widened arterials, minus the 407 lane-miles that are replaced through reconstruction result in a 50% increase in the number of lane-miles under MCDOT jurisdiction. Following the results through to the year 2026, without annexation, lane-miles under county jurisdiction would nearly double.

Chapter 4 presents a discussion of the financial needs to construct the arterial street system outlined in this chapter. The basis of the needs discussion is the fact that MCDOT will have to construct 1,622 (454+1,087+81) lane-miles of arterial streets by the year 2015, and another 1601 (408+1,061+132) lane-miles from 2016 through 2026.

Table 3-5 Lane-Miles of Arterial Streets Needed

Description	2005	2015	2026
Lane-Miles on MCDOT Arterial System	2,460	2,460	3,675
New Arterials	N/A	454	408
Reconstructed/Widening	N/A	1,087	1,061
Replaced	N/A	(407)	(414)
Widening	N/A	81	132
New Total	**N/A**	**3,675**	**4,862**

3.2 TRAFFIC MANAGEMENT

Growing traffic volumes on the County roads will lead to a greater demand for real-time traffic management solutions to reduce (or hold steady) travel times and minimize the impacts of accidents and road closures. MCDOT has recently instituted the Traffic Management Division to meet the current and future needs. ITS infrastructure elements including coordinated signals, dynamic message signs, CCTV cameras, fiber optic communications and traffic detection will be required on the key County corridors as summarized in Table 3.6 for effective traffic management.

MCDOT Traffic Management Center (TMC), built in 1998, provides real-time traffic management services on the MCDOT and regional roads using the ITS technology. MCDOT's Traffic Management Center is responsible for the following tasks: management and surveillance, real-time data analysis, interagency signal coordination, incident detection, public notification, coordination with the REACT program, control of automated flood warning signs, construction information updates, special event management, modernization of the existing signals and support for design and implementation of new ITS infrastructure.

The challenge for TMC operations is the physical space limitation of the center. Expansion of the physical area of the TMC should be considered. Preliminary estimates have indicated that with the expected expansion of services, ultimately the TMC will need approximately 3,000 square feet of space.

Figure 3 – 1 Capacity Needs: Supervisor District 1

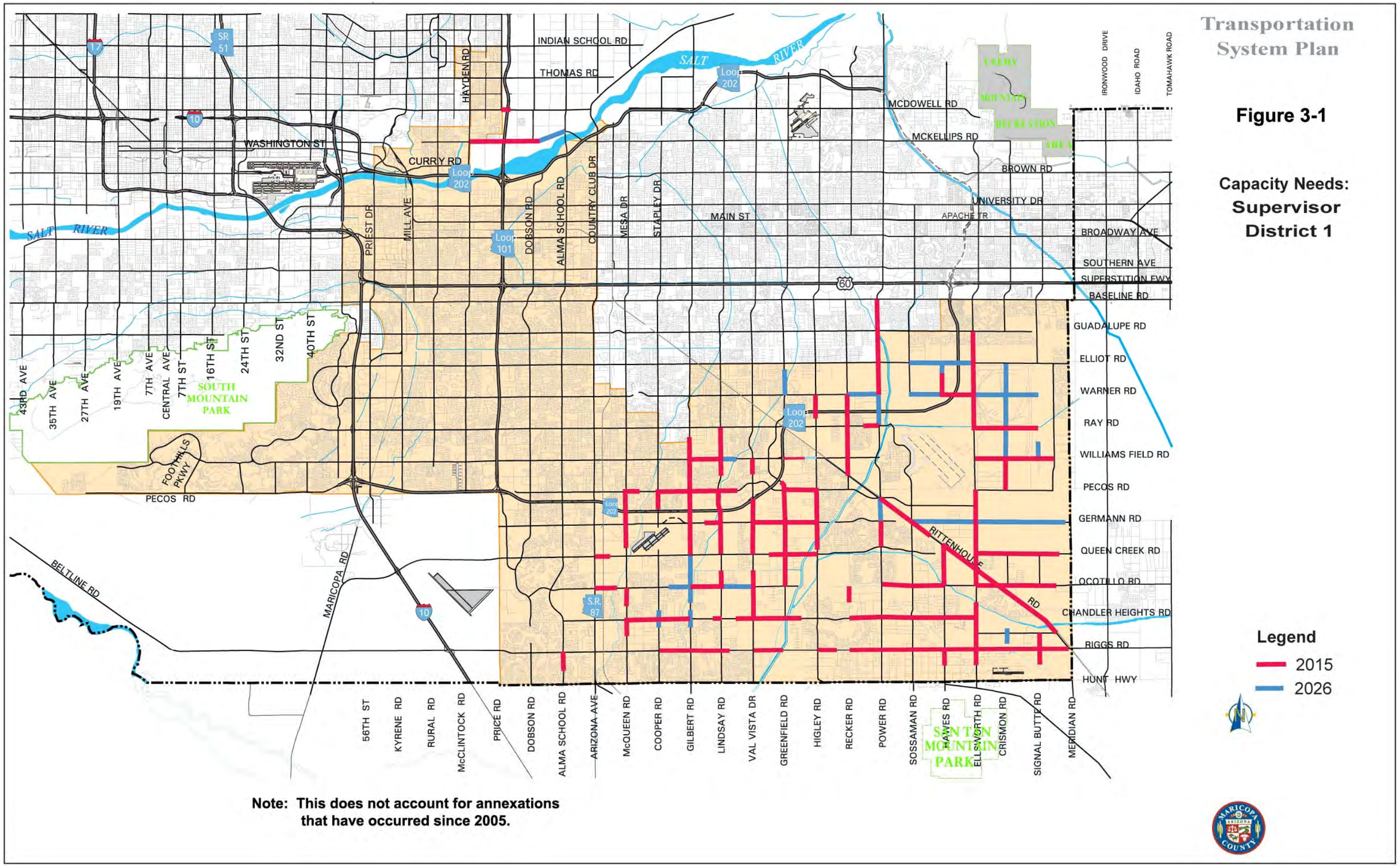


Figure 3 – 2 Capacity Needs: Supervisor District 2

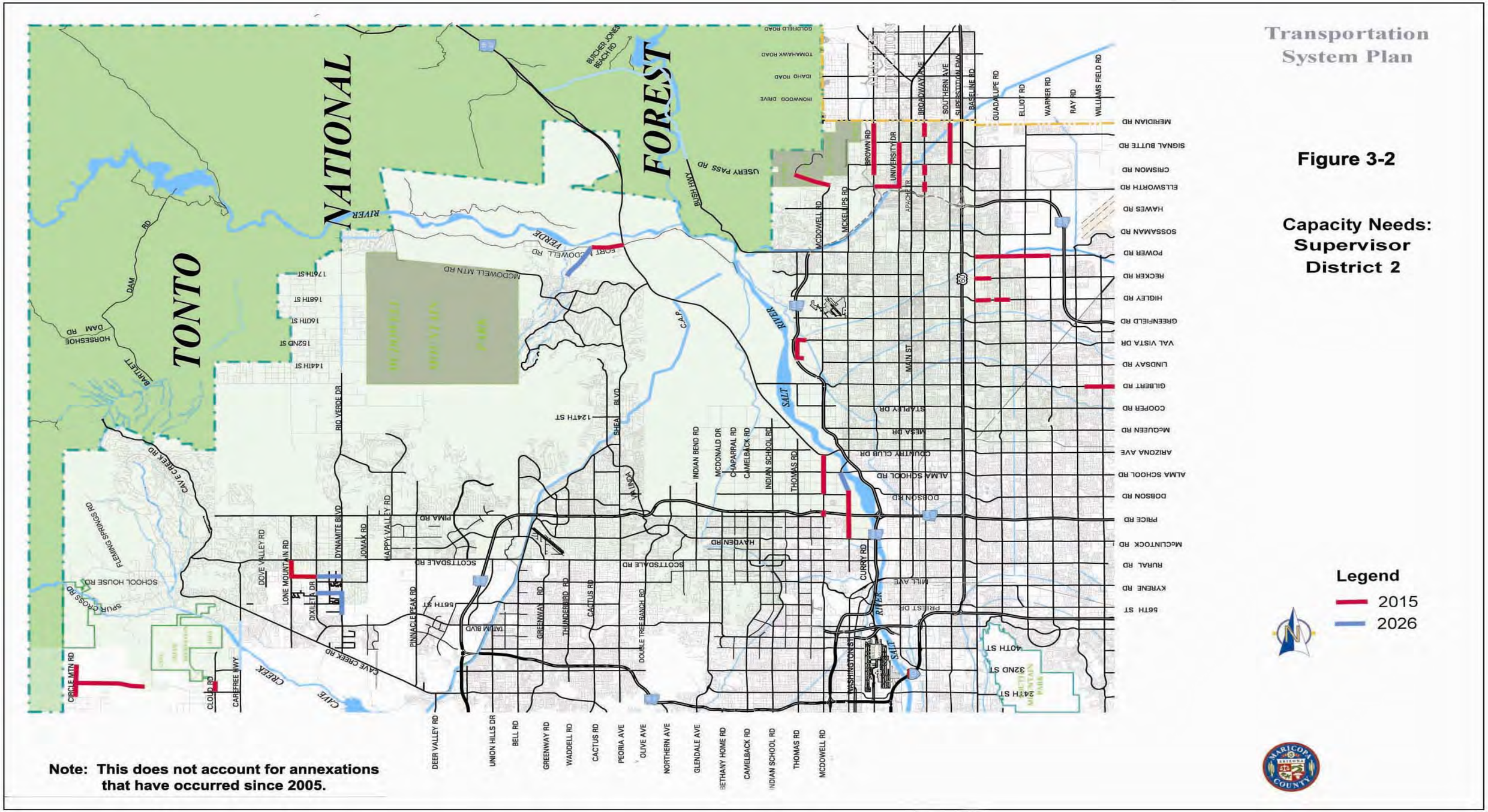


Figure 3 – 3 Capacity Needs: Supervisor District 3

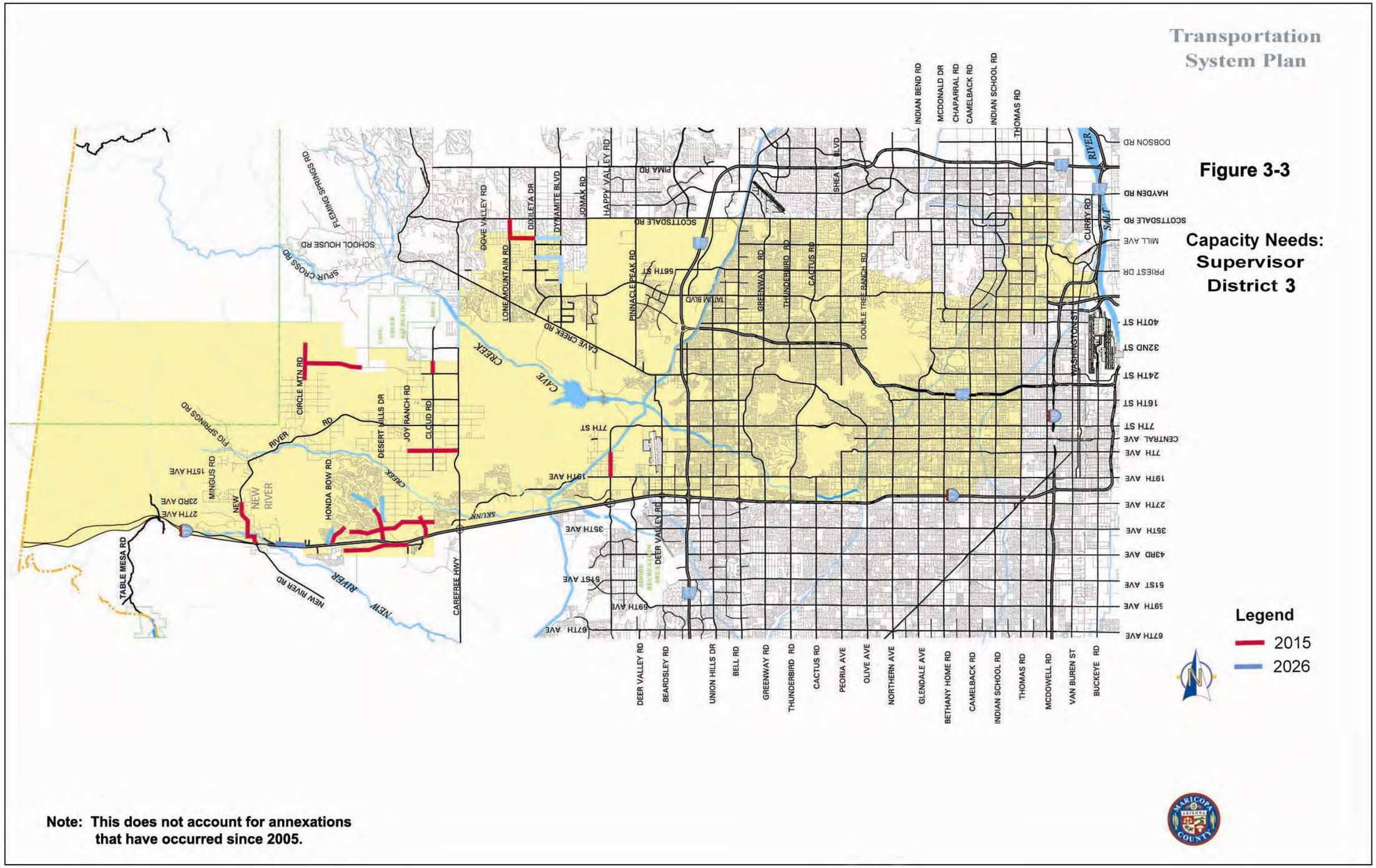


Figure 3 – 4 Capacity Needs: Supervisor District 4

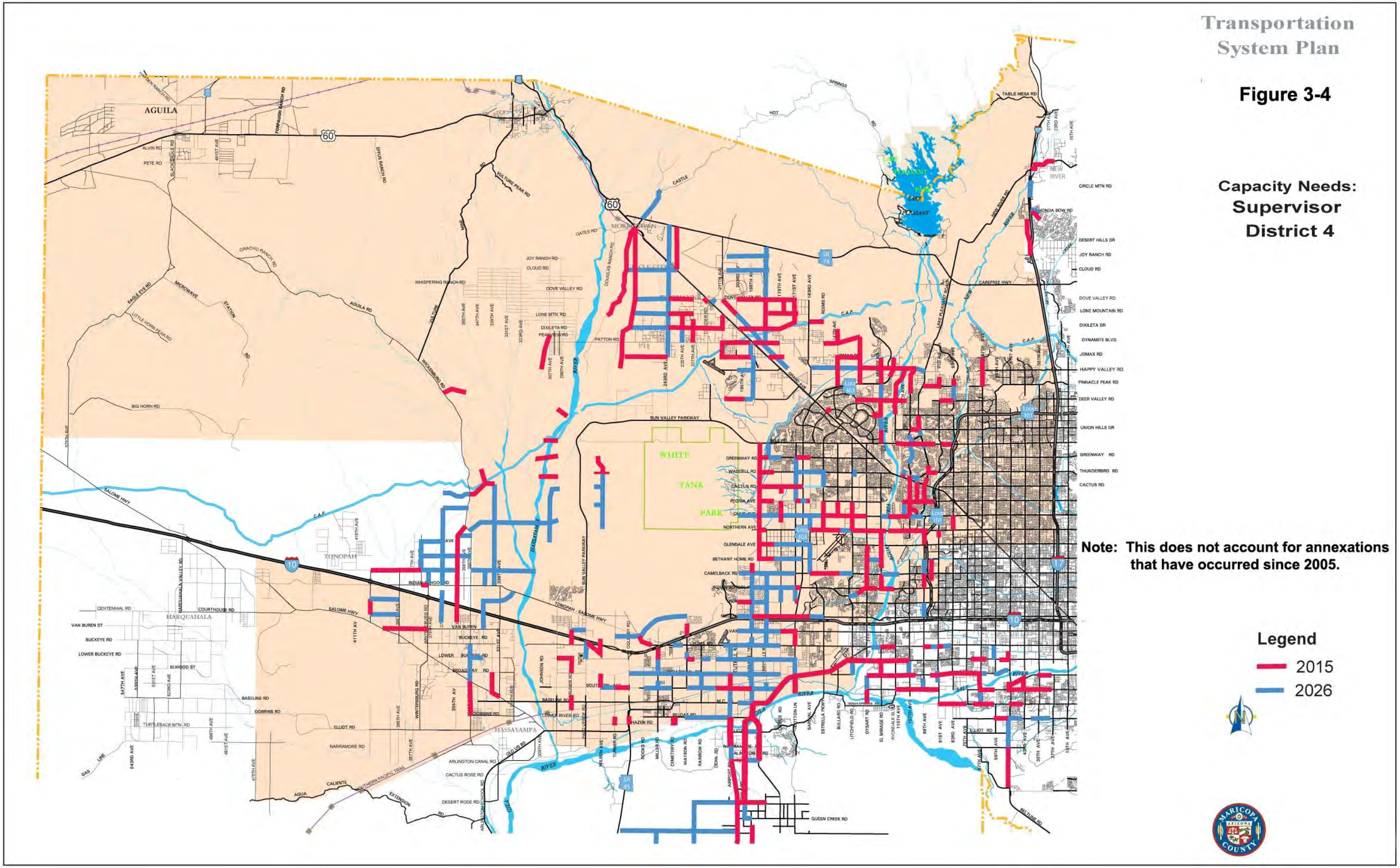


Figure 3 – 5 Capacity Needs: Supervisor District 5

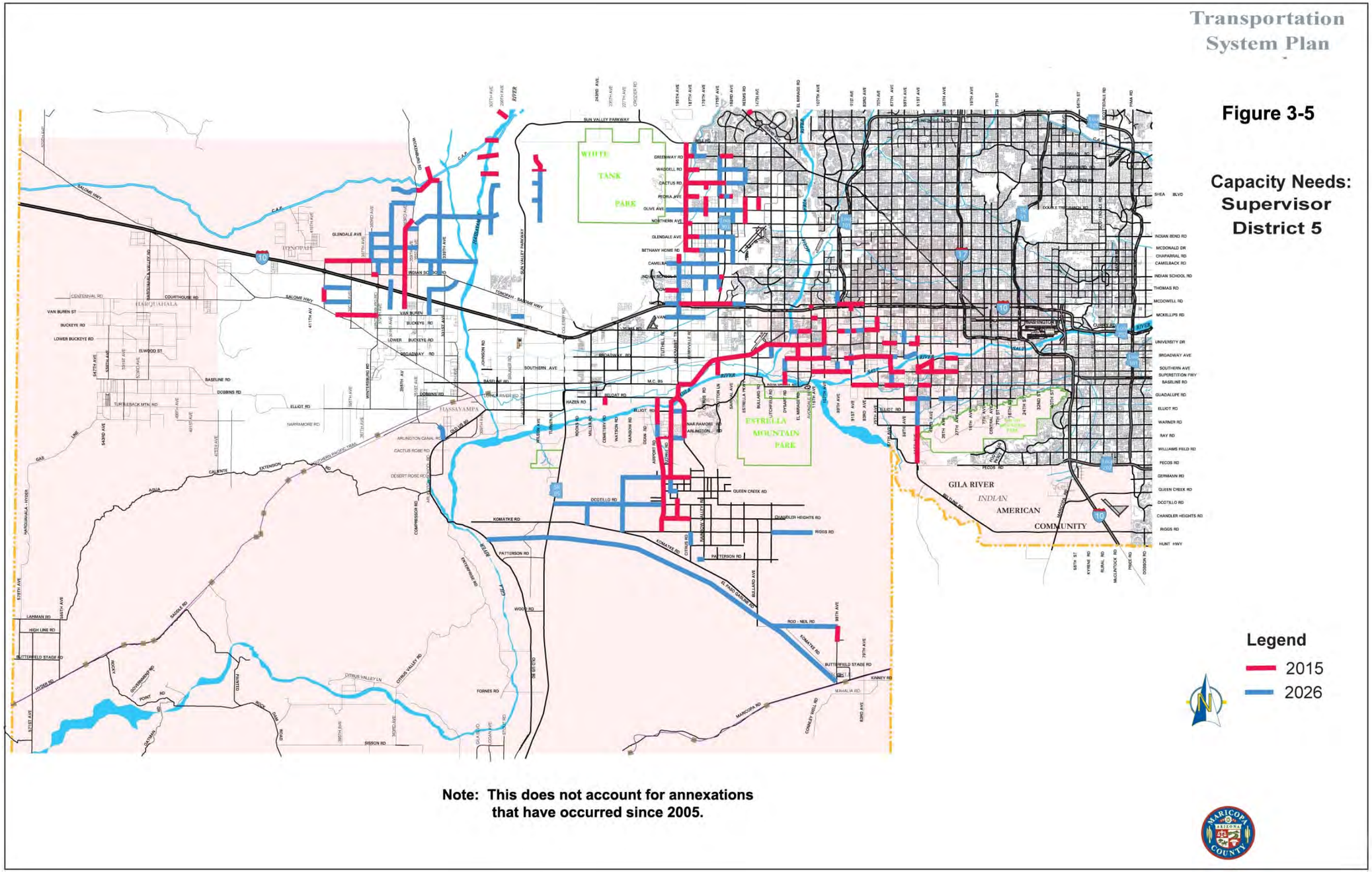


Table 3-6 Designated Arterials for requiring ITS infrastructure by Region

Corridor	Limits	Length	Classification
North Region			
Anthem Way	I-17 to Daisy Mountain Drive	2.5 miles	Principal Arterial
Daisy Mountain Drive	I-17 to Anthem Way	2.5 Miles	Principal Arterial
Carefree Highway	New River Road to 56th Street	16.0 Miles	Principal Arterial
Gavilan Peak Parkway	Anthem Way to Daisy Mountain Dr.	1.6 Miles	Principal Arterial
East Region			
Bush Highway	Mesa City Limits to Recreational Facilities	5.0 Miles	Minor Arterial (Rural ITS)
Alma School Road	Loop 202 to McKellips Road	1.0 Mile	Principal Arterial
Northwest Region			
Bell Road	Sun Valley Parkway to Grand Avenue	9.0 Miles	Principal Arterial
Sun City West	All Links	20.0 Miles	Collectors
99th Avenue	Olive Avenue to Beardsley Road	7.0 Miles	Principal Arterial
Litchfield Road	Last Mile Connection	1.0 Mile	Principal Arterial
Southeast Region			
Riggs Road	SR 87 to I-10	5.0 Miles	Principal Arterial
Southwest Region			
Olive Avenue	West Limits to Loop 101	14.0 Miles	Principal Arterial
MC 85	Jack Rabbit Trail to 75th Avenue	15.0 Miles	Principal Arterial
West Region			
Sun Valley Parkway	I-10 to Loop 303	28.0 Miles	Enhanced Arterial

Chapter 4

NEEDS ASSESSMENT AND OPTIONS FOR SECURING ADDITIONAL REVENUES

4.1 INTRODUCTION

This Needs Assessment is essentially a comparison of projected revenues and projected costs for the period 2006 through 2026. Projected costs in excess of projected revenues result in a revenue shortfall.

Projected costs are heavily dependent on the Level of Service (LOS) Maricopa County intends to provide on its roadway system. This issue is especially a factor with establishing the capital needs and costs through 2026. This summary reports needs and costs relative to achieving LOS C on MCDOT system roadways. (The Technical Supplement to the TSP provides needs and cost information if the goal is LOS D or E.) Projected costs are measured as capital improvement costs, operation and maintenance O&M costs, and personnel costs.

Findings include the following:

- MCDOT faces a revenue shortfall through 2026 of $2.9 billion to produce a system at LOS C.

- An option for securing additional revenues that is potentially available to the county is a roadway development impact fee program. A county roadway development impact fee could generate revenues of between $326.3 million under the most constrained assumptions to $4.4 billion under the least constrained assumptions.

- An expanded improvement district program has a low overall potential for generating new revenues, but any new revenues could be specifically targeted to “niches” in the MCDOT system, especially for rural areas where existing residents and businesses are requesting that the county pave their roads and include them in the county's maintenance system.

- The State Legislature exerts total control over a revenue source with great potential for generating needed new revenues: the statewide gasoline and use fuel taxes. Three options for raising these taxes were reviewed, with projections of additional Highway User Revenue Fund (HURF) revenue for MCDOT ranging from $335.6 million to $1.03 billion.

The timing of annexation of currently unincorporated areas within Municipal Planning Areas and the schedule for constructing roadway improvements within these areas will greatly affect MCDOTs forecast of needs and revenue. Every lane-mile of new capacity that goes to construction after annexation would be the responsibility of the annexing jurisdiction, not MCDOT. Additionally, annexation will influence MCDOTs projected O&M costs.

On the revenue side, annexation could reduce the County's share of statewide population, thereby reducing its proportional share of HURF revenues. Furthermore, if the County establishes a development impact fee program, annexation will affect MCDOTs revenues from this new source, depending upon whether annexation occurs before or after the development occurs and the County has collected the fees.

4.2 NEEDS ASSESSMENT

4.2.1 INTRODUCTION

Projected revenues and costs have been examined to determine the extent of the revenue shortfalls facing MCDOT from 2006 through 2026.

4.2.2 PROJECTED REVENUES

Table 4-1 provides the revenue estimates for 2006 through 2026. The projection is for $4.1 billion in revenues, with $1.5 billion between 2006 and 2015 and $2.6 billion from 2016 through 2026. State shared revenues, HURF and Vehicle License Tax, are the principal source of revenues, constituting $3.7 billion (almost 90%) of total revenues. The next largest source of revenues is other IGA revenues, at $227.4 million. Table 4-1 assumes the statutory formulas for distributing HURF revenues will not change and the county's share of unincorporated population will remain the same.

4.2.3 PROJECTED COSTS

Costs are projected through 2026 in three categories: capital improvement costs, operation and maintenance costs and personnel costs. Capital improvement costs include roadway costs and other capital costs (bridges and other structures, bicycle lanes, etc.). Levels of costs are established based upon needs, not upon available revenues or what MCDOT has spent in the past.

4.2.3.1 Capital Improvement Costs for Roadways

Capital improvement costs for roadways include capacity enhancements to existing roads and new roads.

As developed in Chapter 3, 1,622 lane-miles of construction would be needed to achieve LOS C by 2015 and 1,601 additional lane-miles would be needed to achieve LOS C by the end of 2026. Thus, the total need would be for 3,223 lane-miles of construction through the year 2026. This includes capacity enhancements to existing roads as well as construction of new roads.

Table 4-1 MCDOT Revenue Projections, 2006 – 2026

Revenue Source	2006-2015	2016-2026	Total
State Shared Revenues			
State Shared HURF	1,225,400,000	2,164,400,000	3,389,800,000
State Shared Vehicle License Tax	106,400,000	176,500,000	282,900,000
Subtotal State Shared Revenues	1,331,800,000	2,340,900,000	3,672,700,000
Other IGA Revenues			
IGA Revenues	103,680,000	123,750,000	227,430,000
Maricopa County Controlled Revenues			
Licenses/Permits Revenues	19,800,000	22,000,000	41,800,000
Miscellaneous Revenues	16,345,000	19,800,000	36,145,000
Interest Income Revenues	6,230,000	7,150,000	13,380,000
Gain on Fixed Assets Revenues	3,125,000	3,575,000	6,700,000
Subtotal Maricopa County Controlled Revenues	45,500,000	52,525,000	98,025,000
Grant Revenues			
Federal Grant Revenues	40,000,000	44,000,000	84,000,000
Developer Contributions Revenues	8,850,000	9,900,000	18,750,000
Subtotal Grant Revenues	48,850,000	53,900,000	102,750,000
TOTAL REVENUES	**1,529,830,000**	**2,571,075,000**	**4,100,905,000**

Table 4-2 presents projected capital improvement costs for roadways, for 2006 – 2015 and 2016 – 2026, assuming an average cost per lane-mile of $1,270,000 (including planning, design and construction management). This estimate of cost per lane-mile was provided by MCDOT, based upon their methodology for calculating improvement costs for the Highway Economic Requirements System (HERS) Model, a methodology developed by the Federal Highway Administration to help with estimates of future investment requirements in roadway systems. When MCDOT last compiled data for HERS in early 2006 the average cost/lane-mile was just over $1.26 million. This estimate has been rounded up to $1.27 million/lane-mile, to take into account inflation of costs since MCDOTs last input into the HERS Model.

For LOS C, roadway capital improvement costs by 2015 would be $2.1 billion and for 2016 – 2026 the costs would total $2.0 billion. Therefore, the total projected capital improvement cost for roadways would be $4.1 billion (see Table 4-2).

Table 4-2 Estimated Capital Improvement Costs for LOS C, by Period

Period	Cost Categories	Lane-Miles/Costs*
2006-2015	Lane-Miles Needed	1,622
	Capital Costs	2,059,940,000
2016-2026	Lane-Miles Needed	1,601
	Capital Costs	2,033,270,000
Total	Lane-Miles Needed	3,223
	Capital Costs	4,093,210,000

- Assumes cost of $1.27 million per lane-mile.

4.2.3.2 Adjusting Projected Capital Improvement Costs

The capital improvement costs estimated above are for roadways only. MCDOT, however, will encounter other costs for capacity improvements. The Arizona Association of County Engineers (AACE) "Year 2004 Roadway Needs Study Update," for example, reports on $116.9 million in needs for "New Bridges on Existing Roads" in Maricopa County between 2005 and 2014. The 1999 MCDOT Needs Study lists several "capacity enhancement" needs in addition to those on roadways, including bridge capacity enhancements, bike lanes, signalization capacity enhancements, capacity-related safety projects, system wide capital projects, and capital expenditures for AZTech model deployment. Together, these "other" needs accounted for $382.2 million or 25.2% of the total $1.52 billion in "capacity enhancement needs" identified in the 1999 study. Based on these sources, relying only on costs of roadway capacity needs will understate actual total capital capacity costs. Table 4-3 presents adjusted estimates of capacity needs, assuming that other (non-roadway) capital needs would add 25% to total costs. For LOS C, the 2015 costs would increase to $2.6 billion; 2026 costs would rise to $2.5 billion; and total capital improvement costs would grow to $5.1 billion.

Table 4-3 Adjusted Estimate of Capital Capacity Costs

Period	Capital Costs*	Adjusted Capital Costs**
2006-2015	2,059,940,000	2,574,925,000
2016-2026	2,033,270,000	2,541,587,500
Total	**4, 093,210,000**	**5,116,512,500**

* Includes roadway costs only.
** Includes roadway costs plus other capital costs.

4.2.4 PROJECTED OPERATIONS AND MAINTENANCE COSTS

In addition to estimates of the costs of new roads and capacity enhancements on existing roads, the Needs Assessment must include an estimate of O&M costs through 2026.

In its benefit-cost analyses, MCDOT estimates O&M costs at $12,100 per lane-mile. The average number of lanes for all paved roads is 2.18, which translates into average O&M cost per mile of approximately $26,400.

This estimate does not include an estimate of what the Arizona Association of County Engineers (AACE) "Year 2004 Roadway Needs Study Update" identified as "operating expenses" for system support efforts that include administrative costs, upkeep and expansion of maintenance yards, education programs, citizen involvement and transportation planning … and other system wide projects" that represent 10% of O&M costs. Applying the AACE 10% to the estimated annual O&M Costs of $26,400 would increase estimated annual O&M costs to $29,040, which has been rounded up to $30,000/mile of paved road.

There are 1,893 miles of paved road in the MCDOT maintenance system and 719 miles of unpaved roads, for a total existing system of 2,628 miles. It is assumed the inventory of unpaved roads will continue to decline, as MCDOT completes paving programs needed for air quality compliance. It is estimated an average of 10 miles of unpaved roads will be paved each year, increasing the paved road inventory to 1,993 miles. It is further assumed with construction of new roads and the conversion of County roads through annexations, the net MCDOT paved roadway system through 2026 will remain at 1,993, rounded to 2,000 miles of paved roads.

Assuming average annual costs/mile of $30,000 and a net of 2,000 paved miles in the County maintenance inventory, annual O&M needs would be $60 million per year, with $600 million in the period of 2006 through 2015 and $660 million for 2016 through 2026, for total O&M needs of $1.26 billion.

4.2.5 PROJECTED PERSONNEL COSTS

The methodologies described above, to estimate capital costs and O&M cost, do not include an accounting of personnel services costs. The County's Fiscal Year 2007 budget includes recommended expenditures of $29.9 million for personnel services, for a staff of approximately 480 employees. For simplicity, this amount is rounded up to $30 million per year and an average annual expenditure of that amount is assumed through 2026. That results in projected personnel services costs of $300 million for the period through 2015 and $330 million for the period through 2026, for total costs of $630 million.

4.2.6 TOTAL PROJECTED COSTS

Table 4-4 summarizes total projected costs for a system at LOS C through 2026. Total costs for 2006 – 2015 are $3.5 billion, costs for 2016 – 2026 are $3.5 billion, and costs over the entire period are $7.0 billion.

Table 4-4 Combined Projected Costs, 2006 through 2026 for LOS C

Cost Categories	2006-2015	2016-2026	Total
Capital Improvement Costs	2,574,925,000	2,541,587,500	5,116,512,500
Operations and Maintenance	600,000,000	660,000,000	1,260,000,000
Personnel Services Costs	300,000,000	330,000,000	630,000,000
Total Needs	**3,474,925,000**	**3,531,587,500**	**7,006,512,500**

4.2.7 CALCULATION OF PROJECTED REVENUE SHORTFALLS

Table 4-5 shows projected revenue shortfalls for a system at LOS C. From 2006 through 2015, the revenue shortfall would be the largest, at $1.9 billion (56% of existing revenues). From 2016 through 2026, the revenue shortfall decreases somewhat but is still substantial at $960 million (27.2%). For the entire period, the shortfall would be $2.9 billion (41.5%).

4.3 OPTIONS FOR SECURING ADDITIONAL REVENUES

MCDOT faces a revenue shortfall of $2.9 billion for a system at LOS C. As is true for transportation departments throughout the country and at all levels of government, MCDOTs transportation revenue picture has not improved, and might have worsened, over the decade since the 1999 study. Facing a future of increases, some probably dramatic, in the Construction Cost Index, revenue constraints will continue to worsen unless MCDOT can take steps to find additional revenues.

The technical supplement to the TSP includes a review of options for increased revenues, such as implementation of a roadway development impact fee program or expanded use of improvements districts. It also demonstrates the capacity for increased revenues, for MCDOT and all other transportation agencies in the state, if the Legislature were to increase the statewide gasoline/use fuel taxes and index both of them to inflation in the future.

Under any scenario regarding new revenues, HURF revenues will continue to be the major source of funding for MCDOT. If gasoline and use fuel taxes remain frozen at the levels set in the early 1990's, the purchasing power of this revenue source will continue to decline, while the costs of new capacity and O&M continue to increase, with the effects of inflation and increase in demand. Raising these taxes would improve the revenue picture for MCDOT, as well as every other jurisdiction in the County.

Either an impact fee program or increased gasoline/use fuel tax could help raise significant new revenues for MCDOT. For example, the lowest estimate for impact fee revenues was $326.3 million and for gas/use fuel tax increase was $335.6 million. Combined, these options would generate an additional $662.0 million in revenues for MCDOT.

Table 4-5 Estimated Revenue Shortfall for LOS C, 2006 - 2026

	2006-2015	2016-2026	Total
Needs			
Operations and Maintenance	600,000,000	660,000,000	1,260,000,000
Capital Improvement Costs	2,574,925,000	2,541,587,500	5,116,512,500
Administrative Costs	300,000,000	330,000,000	630,000,000
Total Needs	**3,474,925,000**	**3,531,587,500**	**7,006,512,500**
Revenues			
State Shared Revenues	1,331,800,000	2,340,900,000	3,672,700,000
Other IGA Revenues	103,680,000	123,750,000	227,430,000
Licenses/Permits Revenues	19,800,000	22,000,000	41,800,000
Miscellaneous Revenues	16,345,000	19,800,000	36,145,000
Interest Income Revenues	6,230,000	7,150,000	13,380,000
Gain on Fixed Assets Revenues	3,125,000	3,575,000	6,700,000
Federal Grant Revenues	40,000,000	44,000,000	84,000,000
Developer Contributions Revenues	8,850,000	9,900,000	18,750,000
Total Revenues	**1,529,830,000**	**2,571,075,000**	**4,100,905,000**
Shortfall (Revenues Less Costs)	**-1,945,095,000**	**-960,512,500**	**-2,905,607,500**
Shortfall (% of Total Needs)	-56.0%	-27.2%	-41.5%

In addition, what the future holds in store for MCDOT, both in terms of revenues (existing and new) and costs will be affected by how quickly annexation proceeds. The department should closely monitor this issue and adjust its projections of revenues and costs accordingly.

Ultimately, elected officials and policy makers have the responsibility to determine if and when it is prudent to pursue additional revenue sources. Whether additional revenues are pursued or not, MCDOT will continue to be well served by following its guiding vision to provide the right transportation system, at the right time, and at the right cost.

Chapter 5

ASSET MANAGEMENT

5.1 PURPOSE

The primary purpose of Asset Management is to improve the allocation of funding by developing long-term budget scenarios that show the implications of alternative investments in maintenance, operations and capital. Maintenance is the preservation or extension of the life of an asset or the correction of a distress that impedes mobility, safety, serviceability or engineering integrity. Operations are a focus on real-time service and operating efficiency that enables a facility to provide the maximum level of service before expansion is necessary. Capital improvement is the addition of physical capacity to an existing facility or creating new capacity constructing a new facility. The task of developing long-term budget scenarios will focus primarily on the maintenance and operations functions. MCDOT has years of experience in long-range planning on the capital side, while having minimal experience with forecasting long-range needs and project programming for maintenance and operations.

There are five tasks necessary to achieve the development of the long-term budget scenario objective:

1. Evaluate existing MCDOT programs, determining the program funding alternatives that can be evaluated by MCDOT using appropriate strategies.

2. Benchmark program performance measures against peer agencies.

3. Develop a list of performance measures for each program.

4. Estimate the optimal distribution of revenues among maintenance, operations and capital.

5. Recommend a MCDOT program funding distribution and methodology.

5.2 EXISTING MCDOT PROGRAMS

The MCDOT Planning Division uses the HERS Model to analyze system condition and performance. The results and analysis may enable decisions to be made regarding maintenance versus capital expenditures utilizing a benefit/cost (B/C) ratio for each project. There are numerous variables that need to be incorporated into the modeling, such as roadway condition information, volume/capacity (V/C) ratio and geometrics. The benefits from various expenditure levels are determined by setting multiple deficiency levels in the HERS Model. In the HERS Model the pavement condition is measured by the International Roughness Index (IRI), a universally recognized international standard. The HERS Model determines the surface improvements needed and selects roads for maintenance by the highest B/C ratio. However,

there is uncertainty as to whether the HERS Model has the ability to be utilized effectively for programming capital versus maintenance, because it is only capable of looking at one maintenance strategy at a time. The HERS Technical Report provides the background information for deterioration curves and equations that are used within HERS. MCDOT adjusted the default curves to better reflect the climate and conditions of the environment in Maricopa County.

MCDOT has established a Pavement Condition Rating (PCR) index that provides individual roadway section and overall system pavement ratings. The evaluation information is contained in the MCDOT Road Management System (RMS). The MCDOT accepted overall rating for arterial roads has been a PCR in the 80 to 90 range. In the late 1990's, the arterial overall rating was going up (90+) because of additional funds being transferred from the capital program. More recently the arterial network has normalized (81+) because the maintenance budget has not been augmented as substantially and new equipment is being used to more accurately measure the road profile. The questions remain: What will happen to the system condition if maintenance continues at the current funding level and what happens if funding is varied?

The primary tool for planning and programming roadway maintenance is the Roadway Management System (RMS). The RMS utilizes roadway inventory data such as: name and cross reference, segment length, functional classification, number of lanes, lane width, surface type, shoulder width and type, maintenance history and traffic volumes. The RMS also maintains the Pavement Condition Rating (PCR) and the detail for each road segment. The surface distress measures include: cracking, rutting, raveling, shoving, patching and excess asphalt. The individual road ratings can then be combined to develop an overall system rating. This process is detailed in the MCDOT Road Management System Procedures. The IRI is determined using a triple (3) laser road profiler.

PCR and IRI are the two measures of the overall system performance that can provide the comparative data necessary to determine the impact of various expenditures on future pavement condition. Monitoring these measures over time will assist in establishing an acceptable standard of performance for the PCR, IRI, and support future budget decisions.

RMS Phase 1 (completed April 2004) is the edit module. The edit module includes: generating rating schedules, updating PCR and IRI ratings and developing maintenance plans. RMS Phase 2 is the business analysis and budget optimization modules, including: system analysis, budget options, custom reporting and multi-year prioritization (to be completed in 2006-2007). The goal of the RMS is to enable the creation of funding scenarios in order to keep the network at an established, acceptable performance level. There is a need to develop a set of pavement degradation curves for the MCDOT pavement network.

Operations must be recognized as having a strategic role in maximizing the roadway system's capacity and be established as a key element of good system management. Transportation operations have always been a logical component of highway management. Lower cost operational improvements that enhance the system performance are routinely evaluated and applied prior to or within transportation improvement Projects. MCDOT uses MUTCD warrants to evaluate congestion and safety issues.

The third program is Capital improvements. MCDOT has years of experience in long-range planning on the capital side with a very sophisticated process for selecting projects. The

Transportation Improvement Program (TIP) programming process takes projects through a rigorous series of steps that includes: review of the initial project request, scoring, prioritization, corridor studies, Candidate Assessment Reports (CAR) and Design Concept Reports (DCR) that enable MCDOT to develop long-range plans for capital construction. The capital program utilizes the annual TIP funding and develops alternative funding sources with developers and agreements with cities and towns in the form of Inter-Governmental Agreements (IGA).

5.3 BENCHMARK PROGRAM PERFORMANCE MEASURES

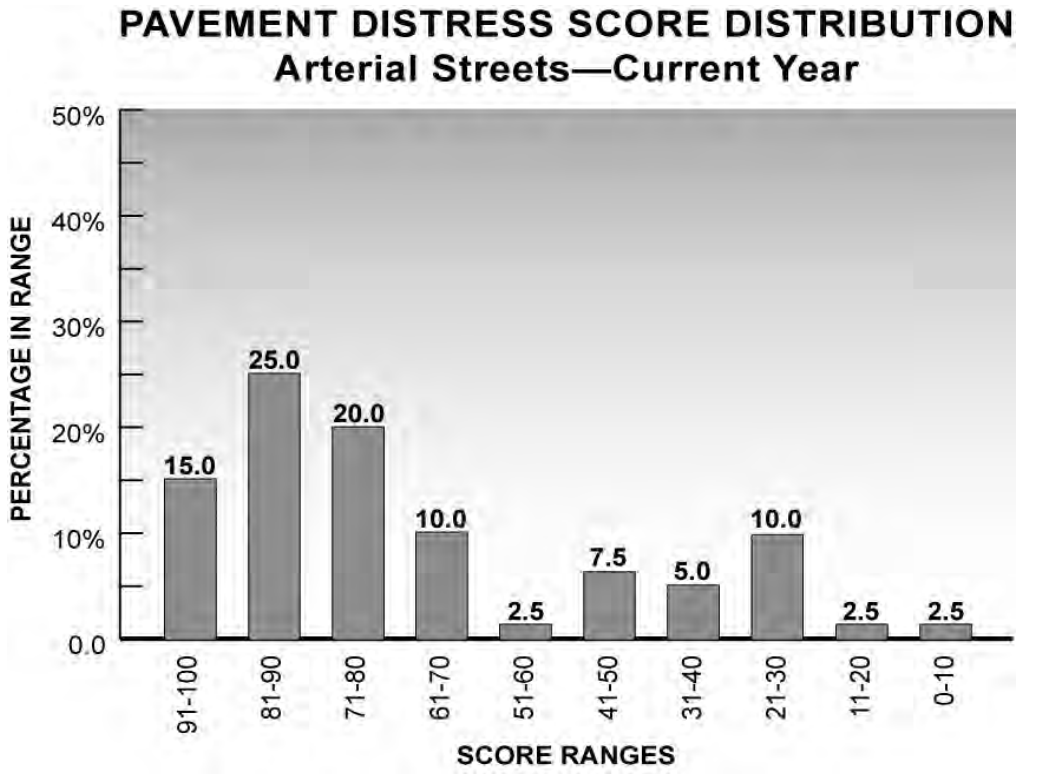
Specific meetings were held with representatives from several counties and a software consultant to research benchmarking methods. A search of best practices of county, local, state and federal agencies was conducted, including the Federal Highway Administration Long-Term Pavement Performance (LTPP) Program, a twenty-year ongoing project with extensive pavement measures performance data.

Some counties and cities use proprietary software programs to evaluate system performance based on varying budget levels. Figure 5-1 shows a typical pavement analysis for a single roadway classification. The figure shows both the current condition of the pavement and the pavement condition in fifteen years, assuming no increase in funding. This type of analysis can be done in annual increments with varying funding amounts. The process uses an empirical analysis that may be tempered with staff judgment. The primary focus is on a pavement condition rating of individual roadway segments as well as the entire system.

One of the perceived difficulties of using system performance indexes as a benchmark is the inability to make a direct comparison with other agencies that use different techniques and roadway evaluation parameters. Most agencies have generally accepted the utilization of a pavement condition index (100-point system) and the IRI as good measures for reporting on system performance. There are two primary differences among agencies regarding the use of the pavement condition index. The first difference is what surface distress measures are used to determine the index. This varies among agencies by the number and the type. The second difference is establishing the value to be used as the agency performance standard. An overall system index in the 85 range is generally considered acceptable. The actual target value seems to be one of agency preference, and in some cases this value is part of an agency policy or resolution.

The IRI is a roughness index measured mechanically and scored on a sliding scale from 1 to 500 with 500 representing an extremely rough road. The local agency determines the IRI targets. An IRI for a roadway segment in the 65 to 75 range is considered excellent by most agencies, however, MCDOT has a slightly higher standard for excellent, which is less than 60. Table 5-1 shows the pavement condition ratings for a sample of cities and counties across the country.

Figure 5-1 Pavement Distress Score Distribution



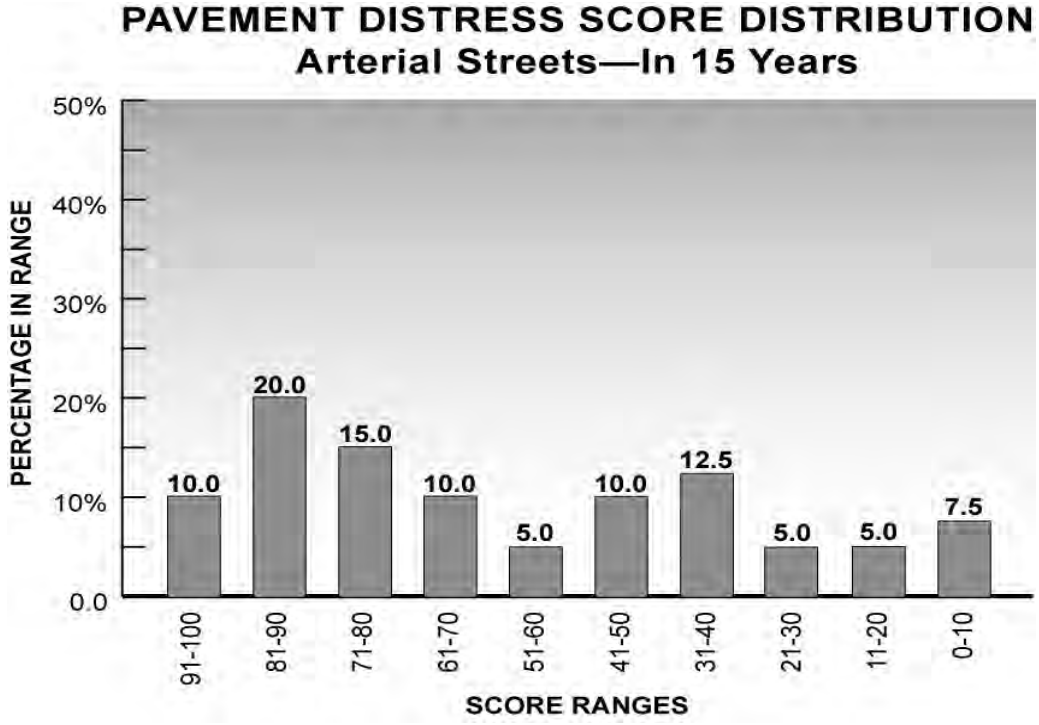


Table 5-1 Typical Pavement Condition Performance Ratings

Agency/Organization	Pavement Rating System	Performance Standard
MCDOT	Pavement Condition Rating (PCR) 0-100 Based on Pavement Surface Distress Evaluation	85
Yuma County	Pavement Condition Rating (PCR) 0-100 Based on Pavement Surface Distress Evaluation	100% of Pavements >75
City of Mesa	Pavement Condition Index (PCI) 0-100 Based on Pavement Surface Distress Evaluation	85 (Arterials)
City of Oxnard, CA	Pavement Condition Index (PCI) 0-100 Based on Pavement Surface Distress Evaluation	>90 (Arterials)
Bay Area, CA (MTC, Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Salano, Sonoma)	Pavement Condition Index (PCI) 0-100 Based on Pavement Surface Distress Evaluation	75-80
City of Lake Oswego, OR	Pavement Condition Index (PCI) 0-100 Based on Pavement Surface Distress Evaluation	>80
City of Stockton, CA	Pavement Condition Index (PCI) 0-100 Based on Pavement Surface Distress Evaluation	>80
Ohio DOT	Pavement Condition Rating (PCR) 0-100 Based on Pavement Surface Distress Evaluation	90% >75
Washington DOT	Pavement Structural Condition (PSC) 0-100 Based on Pavement Surface Distress Evaluation	80
Nebraska DOT	Pavement Condition Rating (PCR) 0-100 Based on Pavement Surface Distress Evaluation	82% >70

Operations have a number of indicators that can be used as performance measures. Local agency preferences are sometimes influenced by the impact of the general public acceptance and policy issues. Level of Service (LOS) is a generally accepted standard and is used by most agencies. However, the acceptable LOS and the application of the LOS to the road system may vary significantly. Therefore, it is important to understand the application of the LOS as well as what the chosen quality of performance means to the driving public. LOS can be applied to a system, area or individual roadway section. Other measures include travel time and V/C ratio. As with the pavement measures, there is variation among agencies as to the application and acceptable level, and it generally comes down to agency preference.

5.4 MCDOT PERFORMANCE MEASURES

An evaluation of the performance measures used by numerous other agencies and the current information, available data and measures used by MCDOT indicate there is significant consistency among agencies regarding performance measures. The differences arise from the individual agencies' application of the performance measure.

MCDOT currently sets pavement condition target values in their Managing for Results (MFR) program and in their Asset Management program. In both cases, the Pavement Condition Rating (PCR) is used as the primary measure. The PCR ranges from 0 to 100 with 100 indicating the pavement is in perfect condition.

The Asset Management/GASB 34 program states that "MCDOT will maintain 85% of all paved roads to a PCR of 70 or above and no more than 5% will be allowed to fall below 55." The target results are weighted by lane-miles in the Asset Management program. Currently, 86.5% have PCR values above 70, and 0.1% have PCR values below 55. Typically, non-arterial (local) roads are maintained at a lower level than arterial roads since speed limits are much slower on local roads. Approximately 94.8% of MCDOT local roads have PCR values above 70 while 81.6% of non-local roads have PCR values above 70.

Optimally, MCDOT would be able to maintain roads to a PCR level of "excellent" (85 to 100). This would minimize the noise emitted from the tires of vehicles traveling on the roads and would minimize future maintenance needs about 58% of MCDOT pavements have PCR values of 85 and above.

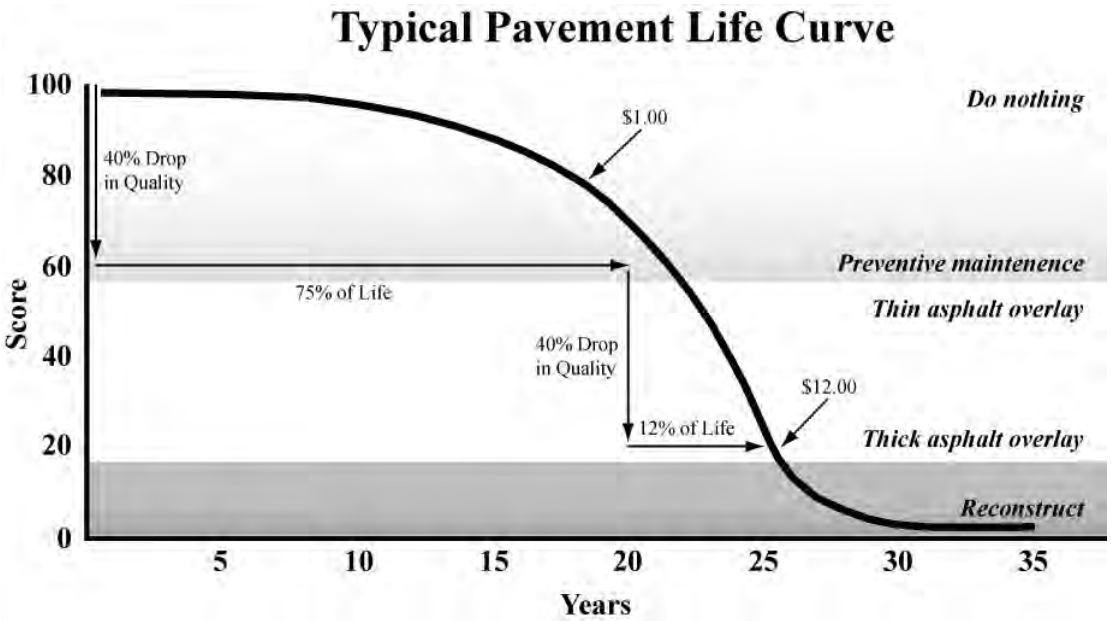
Given the Asset Management/GASB 34 targets and the speed limit considerations, MCDOT should strive to maintain 80% of arterial roads above a PCR value of 70. MCDOT should also strive to maintain 70% of local roads above a PCR of 70.

Asset Management targets are currently the only measures used to indicate the most justifiable levels for MCDOT to set pavement condition target values. MCDOT is in the process of developing Phase 2 of the MCDOT Roadway Management System (RMS). RMS Phase 2 will provide much more detailed information to aid in the current and future management of MCDOT pavements. It should also allow MCDOT to set pavement condition target values based on economic criteria such as life-cycle cost analyses and cost effectiveness of multiple management options. MCDOT will use RMS Phase 2 to set future targets when the application becomes available.

5.5 ESTIMATE THE OPTIMAL FUNDING DISTRIBUTION BETWEEN MAINTENANCE, OPERATIONS AND CAPITAL

Some agencies utilize pavement life curves, such as the one shown in Figure 5-2, to help in making decisions about allocation of funding among maintenance, operations and capital programs or needs.

Figure 5-2 Typical Pavement Life Curve



The current MCDOT budget process is relatively straightforward and is guided by the Office of Management and Budget (OMB). OMB annually provides the budget target for both capital and operations. MCDOT recommends the specific items that go into capital budget. With approximately 95% of the MCDOT budget being state shared revenues, Highway User Revenue Fund (HURF) and Vehicle License Tax (VLT), the funding levels are predictable and show modest growth into the future.

The maintenance program would be well served by having analysis and reports to support the appropriate funding level. The current maintenance budget is based on last year's expenditures and not on how the system is performing or on the predicted future performance. The program funding distribution process should be driven by MCDOT, based on the funding levels provided in the OMB. This process improvement will enable MCDOT staff to make budget adjustments based on actual needs versus arbitrary increases in the annual budget provided by OMB.

5.6 RECOMMEND A MCDOT PROGRAM FUNDING DISTRIBUTION AND METHODOLOGY

An issue that must be recognized is that the development of the maintenance, operations and capital budgets are independent exercises, and the final determination of the respective amounts in those budgets is based on policy and adopted performance standards. The process recognizes that there will always be limited resources. Trade-offs will have to be made in order to financially constrain the budgets.

Agencies have a significant investment in their existing roadway system, which demands that maintaining that investment is a top priority. There are a number of issues that will need to be resolved to determine the appropriate funding for maintenance. First, establish the appropriate performance standard for the pavement condition rating. Secondly, determine the system performance over time based on various funding levels. To achieve this it will be necessary to develop pavement degradation curves.

The operations process should be similar to the one for maintenance. There must first be agreement on the standards and their application. What is the appropriate LOS for the system and how are travel time and V/C used in the operational improvement process? The key is to be able to determine when to make operational improvements versus capacity expansion improvements. Utilization of the HERS Model may prove to be useful in making operational versus capacity expansion improvements.

Chapter 6

TRANSPORTATION POLICIES

The MCDOT Transportation System Plan update includes a long range assessment of roadway infrastructure needs to accommodate increasing travel demand associated with population growth. The magnitude of the transportation needs associated with these growth forecasts raises a variety of issues within MCDOT.

As part of the update, MCDOT has investigated options relative to several important transportation policy issues to better help the agency meet public expectations. These policy issues involved the following subject areas:

- Transportation Impact Fees and Improvement Districts
- Needs of an Aging Population
- Roadside Amenities
- Scalloped Street Improvements
- Major Bridges
- Intersection Improvements
- MCDOT Role in Regional Transportation

Research was conducted and policy papers were prepared on each individual policy issue. In addition, input on each policy issue was received from cities, towns, and the Maricopa County Transportation Advisory Board (TAB). The full text of each policy paper may be found in the Appendix.

6.1 IMPACT FEES AND IMPROVEMENT DISTRICTS

Increased travel demand driven by population growth puts increased pressure on MCDOT to both provide new roads and upgrade existing facilities to accommodate travel demand. In fact, between 2006 and 2026, more than $7 billion would be required to maintain the MCDOT road system and fund needed capital improvements. Over the same period, $4.1 billion in revenues are anticipated.

These growth pressures on the MCDOT road system and the revenue shortfall make it important that development pays its fair share of roadway expansion costs. Arizona state statutes allow counties to implement development impact fee ordinances. Impact fees can be assessed for water and sewer infrastructure, parks and public safety facilities in addition to streets. Pima County and Yavapai County are the only two Arizona counties that currently assess development impact fees. As of September 2006, Pinal, Cochise, and Santa Cruz counties are considering impact fees. Within Maricopa County, ten cities impose impact fees for transportation. Maricopa County itself uses a thorough yet informal process of negotiating developer contributions through the development agreement process.

Both transportation impact fees and improvement districts may have merit as a means to assess development for the infrastructure costs of growth. Recognizing that a decision to implement or not implement a formal program lies with the Board of Supervisors, this discussion provides a primer for decision makers to help shape potential new policy as they see fit.

6.2 NEEDS OF AN AGING POPULATION

Elderly residents and visitors within Maricopa County comprise a significant proportion of drivers using MCDOT facilities. One major challenge for these drivers, among others, is the ability to negotiate roadway segments and intersections safely. Current MCDOT roadway design and operations standards have been reviewed relative to guidelines provided by Federal Highway Administration (FHWA). This analysis determined that current MCDOT standards closely match or exceed FHWA recommendations.

Comments solicited from cities and towns indicated that municipalities are implementing measures to facilitate navigation through the roadway system. These measures include larger signs, larger fonts on signs, illuminated signs, advance street signs in medians, and longer crossing times for pedestrians. These measures are applied uniformly through coordination with the MAG Safety Committee.

Specific areas where modifications to MCDOT standards or practice were considered include: intersection median design, sight distance enhancements, and improved pavement markings and signing. MCDOT believes an appropriate approach is to work closely with the MAG Safety Committee on these matters and adopt measures as appropriate in coordination with the MAG cities and towns.

6.3 ROADSIDE AMENITIES

MCDOT often engages in multi-jurisdictional roadway improvement projects. While intergovernmental agreements with municipalities provide funding mechanisms, delays in design and construction sometimes result when MCDOT design standards and the partner city's design standards are different. While MCDOTs historical role has been providing farm-to-market transportation infrastructure, these city-county partnerships put increasing pressure on MCDOT to provide urban roadside amenities.

Current MCDOT standards and practices have been examined related to roadside amenities including roadside landscaping, raised medians, sidewalks, street lighting, and utilities sitting. It is recommended that MCDOT should maintain its focus on following currently adopted guidelines to provide safe and adequate transportation facilities.

6.4 SCALLOPED STREET IMPROVEMENTS

Patterns of development coupled with municipal annexation create 'scalloped streets' on many MCDOT arterials. This is a situation where either one side of the street is improved and the other is not or the number of travel lanes along a roadway segment is otherwise inconsistent. Scalloped streets are aesthetically undesirable and may sometimes create potential operational and safety challenges. Most occurrences of scalloped streets exist around growing communities due to developers building half-street improvements to the roadway centerline along the project frontage. The full arterial cross section should be built as infill occurs. However the timing of developments does not always coincide. As a result, roadways on the periphery of the metropolitan area often evolve with lane imbalances.

Funding for improvements to scalloped streets is the primary challenge. Currently, MCDOT prioritizes improvements to scalloped streets through its Transportation Improvement Program (TIP) process that many times include intergovernmental agreements.

In addition to continuing to apply appropriate criteria for identifying and prioritizing scalloped street improvements, MCDOT has considered the following policy options, among others, during this TSP update effort.

1. MCDOT could support/develop a region-wide policy that requires developers to over pave beyond the roadway centerline to maintain centerline orientation, providing a balanced number of lanes in both directions as an interim operation improvement, thus avoiding scalloped street patterns.

2. MCDOT could support/develop a policy that would require the first new development on an unimproved section-line road to improve both sides of the entire roadway segment with costs to be shared by subsequent developers. This policy should include a threshold (i.e., units, trips, or length of frontage) that would trigger implementation of this policy.

3. MCDOT could consider earmarking funds for scalloped street improvements.

While it may or may not prove prudent to pursue any of the above options, MCDOT will work with municipalities in the county to develop an appropriate strategy regarding scalloped streets. The selected strategy could be applied countywide or tailored to specific working relationships with individual municipalities.

6.5 BRIDGE IMPROVEMENTS

Increased travel demand from rapid population growth is creating a greater demand for new and wider bridges across major stream and river channels on the MCDOT roadway system. Currently five bridges are under development. Three bridges from Proposition 400 are on the MCDOT system. There is also a recently completed bridge needs study for Agua Fria River crossings between Interstate 10 and Bell Road.

Most bridge construction over the past ten years has been funded by developers. Maricopa County is certified to administer the expenditure of federal funds, however few bridges off of the state highway system are built with federal monies. MCDOT could perform an oversight role for bridge design and construction due to its historical knowledge of bridges within the county. Further, some of the growing West Valley communities may not have necessary expertise to provide oversight for bridge design and construction. This may generate a need for MCDOT assistance.

Funding is a challenge because of the significantly high cost of constructing a major bridge. For the foreseeable future, MCDOT will continue to prioritize and schedule bridge projects based on need and will conduct additional studies similar to the Agua Fria River Crossing Study model, as appropriate.

6.6 INTERSECTION IMPROVEMENTS

Intersection widening has been evaluated as an interim measure for providing capacity improvements on existing MCDOT roadways. While there are no formal guidelines or policies governing the implementation of intersection improvements versus general roadway widening, MCDOT recognizes the benefit of increasing capacity at intersections to ease system bottlenecks.

Travel time research conducted as part of this policy analysis indicated that interim intersection improvements could provide a clear travel time savings for a relatively modest capital investment. As a result, MCDOT will specify that its future design concept reports consider interim intersection improvements in the matrix of potential capacity solutions together with general segment widening. MCDOT will also be open to consideration of such projects as candidates for Special Project Fund monies, as determined by the Transportation Advisory Board.

6.7 MCDOT ROLE OPTIONS

As part of this TSP update, MCDOT has carefully considered its fundamental roles and has conducted dialogues with its partner agencies regarding appropriate MCDOT roles for the future. As a result, it appears appropriate that MCDOT roles could include the following:

1. Continue to build, maintain, and operate roads in unincorporated Maricopa County. (This is the county's fundamental statutory role.)

2. Transition rural roads to urban roads by constructing the right road, at the right time, and at the right cost, and then transferring these streets to the cities and towns.

3. At the request of, and in cooperation with, cities and towns, manage large multi-jurisdictional arterial street projects through the DCR, design, construction phases and traffic management.

4. Identify and preserve major street corridors in unincorporated areas of the county to serve regional travel.

5. Continue to identify bridge needs on major waterways, and build partnerships in the design and construction of these bridges.

6. Continue to lead and coordinate the AZTech program to provide Intelligent Transportation System (ITS) for roadways in Maricopa County.

7. Preserve right-of-way for identified high capacity corridors (enhanced arterials roadways, super streets, parkways, and potentially freeways, as deemed appropriate).

Chapter 7

IMPLEMENTATION WORK PROGRAM

7.1 PROLOGUE

Keeping the TSP up to date is critical for Maricopa County due to the continued growth this region will experience. It will be essential that the findings of future area studies, corridor studies and other transportation related studies be incorporated into the findings of this report to keep it current. As these studies are completed in the future, it is expected that the findings will be merged as appropriate. This is especially critical in the area west of the Hassayampa River and the area south of Interstate-10 in the Southwest portion of unincorporated Maricopa County.

Planning is a dynamic process that must adjust to ever changing conditions, such as major changes to the transportation networks or land-use changes. These changes should be monitored and accommodated in a timely fashion. Triggers may include, but should not be limited to, major changes to freeway corridor implementation, the addition of major rail transit corridors or the addition of new large master planned communities. Planning is often preparation, and if significant changes do occur, the guiding principals in this document should not stay static. Rather, they must be dynamic and refined to meet changing needs.

Transportation System Plan Update Process:

Keeping the Transportation System Plan current will be an ongoing effort for Maricopa County. The TSP will be monitored annually to address any major changes in the region that would require significant changes to this planning document. The TSP will also have to address any changes to the County Comprehensive Plan as those come along. Major updates to the TSP will take place every ten years, or sooner if required because of changes to the Comprehensive Plan or other major regional efforts.

Minor updates to the TSP may need to be considered on a regular basis. To ensure that these changes are evaluated and processed in a prompt manner, three types of updates will be considered:

- The first type of update will be the annual certification of the roadway network. This will include changes to the Primary, Secondary and Local Road Networks. This certification will be approved by the TAB during each fiscal year.

- The second type of update will occur through various transportation plans completed by MCDOT or another partner agency. These updates may be considered throughout the year and the findings from a given study will be considered part of the TSP when they have been adopted by the Board of Supervisors.

- The last type of update considered will be those due to special circumstances. These types of changes are considered when major impacts to the County roadway network are encountered. This could include changes to the regional freeway system, new large commercial developments or large residential developments that had not been anticipated. These types of updates can be considered throughout the year and will be brought forth by MCDOT staff.

7.2 FUTURE WORK AGENDA

There are significant work items that the TSP did not address, but have been identified and documented here as areas for further consideration. These items can be grouped in the following categories: future transportation studies, design guidelines, policy considerations, safety considerations, and other.

7.2.1 ONGOING MCDOT ACTIVITIES

- Annually complete the State of the System Report.

- Annually complete the Bridge, Safety and Congestion Management Reports.

- There are still many transportation corridors (both existing and those that will be identified as part of other planning studies) where corridor studies will be required. MCDOT will continue to program to start several new corridor studies each year as the need exists.

- Detailed transit planning in unincorporated communities such as the Sun Cities, Sun Lakes, and Anthem will be required in the future when the regional transit service begins to abut these communities. These studies will need to be completed soon and should include identifying alternative funding mechanisms since Maricopa County does not have the same funding options available as the cities and towns.

- Detailed bicycle plan updates should be investigated every ten years.

- There are still areas of Maricopa County where bridge needs must be further studied. These studies will primarily be focused in the west valley, but there may also be a need to evaluate bridge needs over large flood control structures and a need to look at grade separation strategies over rail lines throughout the County.

- As part of the policy analysis done for the TSP update, the roadway amenities the county should provide as part of roadway construction was evaluated. There were no recommendations made as part of the TSP, but there is ongoing work being conducted by the department on this issue and this area will require further work.

- The transportation needs analysis and funding options report that was completed as part of the TSP update identified a significant funding shortfall for country transportation needs. Both MCDOT and Maricopa County need to continue to investigate other funding alternatives that could be considered to meet the funding shortfall that is anticipated.

- Scalloped streets will continue to occur throughout the Maricopa Country region. MCDOT staff must continue to talk to all of the cities and towns in the region and establish an over-pave policy or some other alternative to help reduce the burden that growth and development cause.

- Assist the Statewide Over-Dimensional Vehicle Task Force in their efforts and follow through on oversize vehicle planning needs as they are identified.

- Continue development of Pavement Degradation Curves that apply to Maricopa County region.

- Continue refinement to the Performance Goals and Objectives established in the TSP.

7.2.2 NEW ACTIVITIES FOR MCDOT CONSIDERATION

- There are a number of transportation studies that will need to be completed in the future. MCDOT will partner with the Maricopa Association of Governments on two area studies in the West Valley: the I-10/Hassayampa Valley Roadway Framework Study and the Hidden Valley Roadway Framework Study. When completed, these studies will provide vital transportation needs analysis that should be incorporated as part of the TSP. Upon the completion of these two studies, MCDOT should immediately update the Major Streets and Routes Plan to account for all the new roadway corridors identified in these two area studies.

- One of the new programs identified as part of the TSP update is the Enhanced Arterial Roadways Program. There will be a need to identify pilot roadways that meet the program criteria and formally adopt those in the future.

- Complete a study to identify existing scallop streets.

- Maricopa County needs to complete a system-wide access management plan.

- MCDOTs current cost share policy will need to be updated to be in alignment with the new investment potential matrix and with what Maricopa County learned through the TSP update process. The policy work is critical and is a high priority for completion.

- Study the Single Vehicle Crash Phenomena to determine are there any programs or geometric changes that could help lower this crash type.

- Start a Safety Audits Program for Maricopa County.

- Investigate ways to increase funding for safety issues.

- Develop a Roundabout Strategy for MCDOT.
- Take lead in advancing the 511 traveler information service to encompass the regional arterial roads in Maricopa County.
- Provide leadership in improving the regional signal coordination to improve traffic flows and reduce delays on major corridors.
- Expand the REACT incident response program valley-wide through collaboration with cities and towns in Maricopa County.

MARICOPA COUNTY
TRANSPORTATION SYSTEM PLAN

TECHNICAL SUPPLEMENT

February 2007

The papers included in the Technical Supplement, as was the Transportation System Plan itself, were prepared through the cooperative efforts of MCDOT Transportation Planning Division staff and the consultant team of HDR Engineering, Wilson & Company, Curtis Lueck & Associates, Kittelson & Associates, and The CK Group.

INTRODUCTION

The Technical Supplement to the 2006 Transportation System Plan includes information that was developed during the study that was used in the preparation of the Transportation System Plan itself. Information included in the Supplement has been divided into two sections.

POLICY RESEARCH

During the preparation of the Transportation System Plan for the Maricopa Department of Transportation, a number of policy issues were identified and researched. The complete reports on each of these issues are presented in the following papers.

1. Elderly Drivers and Pedestrians Policy Review
2. Roadside Amenities Policy Review
3. Scalloped Street Improvements Policy Review
4. Major Bridge Policy Review
5. Interim Intersection Improvements Policy Review
6. MCDOT Role in Regional Transportation Review

REVENUE AND NEEDS DATA

This section includes a paper of revenue generation and calculations as to the funds needed to provide a transportation system that operates at Level of Service D and at Level of Service E. (This supplements the data in the main report that bases all analysis on maintaining Level of Service C.)

1. Needs Assessment Based upon Levels of Service D and E.
2. Development Impact Fee Potential.
3. Analysis of the Potential of Development Impact Fees and Improvement Districts for Providing New Revenues.
4. McDOT Revenues
5. Needs Assessment

Elderly Drivers and Pedestrians Policy Review

Maricopa County Department of Transportation

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Elderly Drivers and Pedestrians Policy Review

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1.0 INTRODUCTION

The objective of this working paper is to review current MCDOT roadway design and operations policies and standards relative to guidelines recommended by the FHWA for addressing the needs of elderly drivers and pedestrians. Areas where current policies and standards do not conform to the FHWA recommendations are identified and the impacts of implementing these recommendations are assessed.

2.0 ELDERLY DRIVER/PEDESTRIAN ISSUES

Nationally, drivers 65 or older are expected to exceed 20 percent of the total driving population by 2020. As such, the "design driver," typically represented by the 85th percentile performance characteristics, will be an individual over 65 years of age. The "older" design driver is certainly a reality in Maricopa County with the annual influx of temporary residents from colder climates and the attraction of the area as a permanent retirement destination.

National safety research has concluded that the single greatest safety issue associated with elderly drivers and pedestrians is their ability to negotiate intersections safely. Situations that involve complex speed-distance judgments, as required when traveling through an intersection, are problematic for elderly drivers and pedestrians as a result of diminished physical and mental capabilities. Studies have found that the following driving tasks become increasingly difficult with age:

- Reading street name signs.
- Making a left-turn.
- Traversing an intersection.
- Locating the beginning of a turn lane.
- Following pavement markings.
- Responding to traffic signal changes.

Consequently, the following roadway features become more important to drivers as they age:

- Size, number, and location of traffic signal indications.
- Intersection lighting.
- Pavement markings at intersections.
- Turn lane delineation.
- Travel lane width.

A survey of drivers 81 years and older reported the following common problems at intersections:

- Difficulty in turning their heads at skewed angles.
- Difficulty in making a right turn at tight corners.

- Visibility of raised medians at night and in the rain.
- Finding oneself in the wrong lane due to poor visibility of pavement markings or signing.
- Merging into an adjacent lane when a lane drop occurs within 500 feet of an intersection.

3.0 REFERENCE DOCUMENTS

The primary FHWA information source used for this review was *Guidelines and Recommendations for the Accommodation of Elderly Drivers and Pedestrians* (FHWA-RD-01-051), published in 2001. This document is a compendium of information and recommendations from the following published guides:

- A Policy on Geometric Design of Highways and Streets, AASHTO, 1994.
- *Highway Capacity Manual*, Transportation Research Board, 1999.
- Intersection Channelization Design Guide, NCHRP Report No. 279, 1985.
- Traffic Engineering Handbook, ITE, 1999.
- Manual on Uniform Traffic Control Devices, FHWA, 2000.
- Roadway Lighting Handbook, FHWA, 1978.
- Roundabouts - An Informational Guide, FHWA, 2000.
- Railroad-Highway Grade Crossing Handbook, FHWA, 1986.

The document provides recommendations on roadway design, striping, signing, traffic signal design and operations that are intended to enhance the safety and ease of use of the roadway system for older persons, as well as the entire driving population. Recommendations are provided for at-grade intersections, grade-separated interchanges, roadway curvature/passing zones, construction/work zones, and highway-rail grade crossings. The review of MCDOT practices and guidelines focused on at-grade intersections and roadway curvature/passing zones.

In addition to discussions with county staff, the following MCDOT guidelines were reviewed to determine current standards and practice:

- Roadway Design Manual, April 2004
- Pavement Marking Manual, 2005
- Standard Specifications
- Supplement to the MAG Standard Specifications, 2005
- Traffic Sign Manual

4.0 ASSESSMENT RESULTS

The assessment of MCDOT compliance with the specific FHWA recommendations is presented in Appendix 1. For each recommendation, MCDOTs current standard or practice is noted. Overall, MCDOTs roadway design and operations standards and practice closely conform, or exceed, the recommendations. Specific areas where MCDOT should consider modifications to their standards or practice are discussed on the next page.

Intersection Channelization

- The use of raised sloped (wedge curb) medians is recommended for channelizing right and left-turn lanes instead of striping only. MCDOT uses raised medians (vertical curb) to provide access control and to accentuate channelization where necessary. While the implementation of traversable medians may improve the visibility of the beginning of turn lanes at intersections, this treatment will have construction and maintenance cost implications. There is also the potential that the introduction of a median, even though it is traversable, can create a safety issue and therefore increase an agency's liability. There are other simpler and more cost effective methods that should be considered first, including the use of reflective raised pavement markers, either at the beginning of the turn lane stripe or continuously along the stripe.
- The application of retroreflective treatments to median noses is recommended in order to enhance visibility. While MCDOT uses yellow paint to delineate median noses, the application of reflective RPMs either on top of the median curb or directly in front of the median should be considered. The use of RPMs would provide the desired luminance contrast level with the "white" curb surface.

Intersection/Roadway Design

- In order to increase intersection sight distance, MCDOT should consider increasing the minimum gap from 7.5 to 8.0 seconds and applying the sight distance requirement to left-turns from a major roadway as well as from a stop controlled minor street. On roadway construction or reconstruction projects, this change could affect the horizontal or vertical alignment of the roadway, as well as landscaping.

Pavement Markings and Signing

- Although the MCDOT specifications do not address luminance contrast level, this is typically only an issue with "white" pavement surfaces (i.e. Portland cement pavement or chip seals). MCDOT may wish to consider specifying the application of slightly wider black stripe primer to white/yellow lane and edge line striping for these types of pavement surfaces where the contrast level is lower than on asphaltic concrete pavement. The addition of a painted black stripe could increase striping cost by 25%.
- Installation of roadway and intersection signing is determined based on standard MCDOT signing practice as well as evaluation of potential or demonstrated safety issues. While there currently does not appear to be a need to standardize the installation of intersection signing recommended in the FHWA guidelines, MCDOT may wish to consider upgrading the standard sign sheeting for warning, regulatory

signs, and post mounted street name signs. An upgrade from Type I (Engineer grade) to Type II (Super Engineer grade) will add approximately 10% to the cost of a sign.

- The use of 6” minimum lettering on street name signs can also be considered in order to improve visibility to elderly drivers. The cost impact will depend upon the need to increase the size of each sign and the potential need for added sign posts and foundations.
- The application of 2-way refectorized RPMs, one side white and the other red should be considered at signalized and un-signalized intersections to better delineate the departure lane(s) for left-turns.

APPENDIX A

ASSESSMENT OF MCDOT STANDARDS AND PRACTICES WITH FHWA RECOMMENDATIONS ON ELDERLY DRIVERS AND PEDESTRIANS

Intersection Design Elements	MCDOT Standard or Practice
A Intersecting Angle (Skew)	
1. In the design of new facilities or redesign of existing facilitates where right-of-way is not restricted, all intersecting roadways should meet at a 90-degree angle.	MCDOT Roadway Design Manual stipulates that roadways shall not intersect at less than 80 degrees.
2. In the design of new facilities or redesign of existing facilities where right-of-way is restricted, intersecting roadways should meet at an angle of not less than 75 degrees.	
3. At skewed intersections where the approach leg to the left intersects the driver's approach leg at an angle of less than 75 degrees, the prohibition of right turn on red (RTOR) is recommended.	Prohibition of right-turn on red is based on traffic engineering study.
B Receiving Lane (Throat) Width for Turning Operations	
1. A minimum receiving lane width of 3.6 m (12 ft) is recommended, accompanied, wherever practical, by a shoulder of 1.2 m (4 ft) minimum width.	12-foot lane widths are included in MCDOT standard roadway cross sections. Paved shoulders vary from 5 to 5. 5 ft.
C Channelization	
1. Raised channelization with sloping curbed medians is recommended over channelization accomplished through the use of pavement markings (flush), for the following operating conditions:	MCDOT does not use sloped or wedge curbed medians on arterial roadways.
1a. Left- and right-turn lane treatments at intersections on all roadways with operating speeds of less than 65 km/h (40 mi/h).	
1b. Right-turn treatments on roadways with operating speeds equal to or greater than 65 km/h (40 mi/h).	
2. Where raised channelization is implemented at intersections, it is recommended that median and island curb sides and curb horizontal surfaces be treated with retroreflectorized markings and be maintained at a minimum luminance contrast level* as follows:	MCDOT pavement marking manual requires that median noses be painted yellow; however the entire median curb is not reflectorized. The use of reflectorized RPMs on top of curbs could be considered to enhance visibility.
2a. With overhead lighting, a contrast of at least 2.0 is recommended.	
2b. Without overhead lighting, a contrast of at least 3.0 is recommended.	
Contrast should be calculated according to this formula:	

Intersection Design Elements	MCDOT Standard or Practice
luminance (L) contrast = (Ltreatment- Lpavement)/Lpavement * Luminance is the amount of light reflected from a surface to the eye of a driver. This is different from retroreflectivity, which is a property of a material. While increasing retroreflectivity generally results in higher luminance, brightness—especially at night—may vary greatly for the same target depending upon such factors as the location and intensity of its source of illumination, and the angle at which a driver views it. It is the apparent brightness (more accurately," luminance contrast") of a target in its surroundings, under representative viewing conditions, that determines its visibility (delectability) and is the critical predictor of a safe driver response. Since nighttime visibility of roadway features is most problematic for older drivers, the contrast calculation for this design element should be based on nighttime luminance measures; these should be obtained under low-beam headlight illumination from a passenger vehicle at a 5-spreview distance upstream of the intersection. Direct readings of the luminance of a surface can be obtained with a hand-held light meter that has a through-the-lens viewing system to enable accurate targeting of the design element. The luminance measurements of the target and surrounding area may be obtained from any location judged to be in the line of sight of the driver at the 5-s preview distance.	MCDOT specifications do not address luminance contrast level.
3. If right-turn channelization is present at an intersection, an acceleration lane providing for the acceleration characteristics of passenger cars as delineated in AASHTO specifications (1994) is recommended.	Implementation of an acceleration lane is dependent upon local geometric and traffic conditions.
4. The use of sloping curbs rather than barrier curbs for channelization is recommended, except where the curbs surround a pedestrian refuge area or are being used for access control.	MCDOT does not use sloping or wedge curbs on arterials.
5. If right-turn channelization is present and pedestrian traffic may be expected based on surrounding land use, it is recommended that an adjacent pedestrian refuge island conforming to MUTCD (FHWA, 2000) and AASHTO (1994) specifications be provided.	Tear drop islands are typically provided with channelized right-turn lanes
6. To reduce unexpected midblock conflicts with opposing vehicles, the use of channelized left-turn lanes in combination with continuous raised-curb medians is recommended instead of center, two-way, left-	The use of a raised median is based on an evaluation of safety and access control requirements

Intersection Design Elements	MCDOT Standard or Practice
turn lanes (TWLTL) for new construction or reconstruction where average daily traffic volumes exceed 20,000 vehicles per day, or for remediation where there is a demonstrated crash problem, or wherever a need is demonstrated through engineering study.	along each roadway.
D Intersection Sight-Distance Requirements	
1. Where determinations of intersection sight-distance requirements for any intersection maneuver (turn left, turn right, crossing) that is performed by a driver on either a major or a minor road incorporate a perception-reaction time(PRT) component, it is recommended that a PRT value of no less than 2.5 s be used to accommodate the slower decision times of older drivers.	MCDOTs design guidelines do not include a separate PRT component.
2. Where determinations of intersection sight-distance requirements for a left-turn maneuver from a major roadway by a stopped passenger car are based on a gap model (see NCHRP Report 383), it is recommended that a gap of no less than 8.0 s, plus 0..5 s for each additional lane crossed by the turning driver, be used to accommodate the slower decision times of older drivers.	MCDOTs roadway design manual does not specify a sight distance requirement for a left-turn from a major roadway. Rather, it specifies a minimum gap of 7.5 seconds for a left-turn from a stop-controlled minor street onto a multi-lane roadway. A minimum gap of 6.5 seconds is used for a left-turn onto a 2-lane roadway. 0.5 seconds is added for each additional lane (beyond two) and median to be crossed. MCDOT should consider adopting the 8.0 sec + 0.5 sec gap recommendation for left turns form major streets.
E Offset (Single) Left-Turn Lane Geometry, Signing, and Delineation	
1. Unrestricted sight distance (achieved through positive offset of opposing left-turn lanes) is recommended whenever possible, for new or reconstructed facilities. This will provide a margin of safety for older drivers who, as a group, do not position themselves within the	MCDOT pavement marking manual includes a 4-ft offset of opposing left-turn lanes. MCDOT should consider increasing the

Intersection Design Elements	MCDOT Standard or Practice
intersection before initiating a left turn.	offset to 5 feet.
2. At intersections where engineering judgment indicates a high probability of heavy trucks as the opposing turn vehicles during normal operations, the offsets required to provide unrestricted sight distance for opposing left-turn trucks should be used for new or reconstructed facilities.	
3. At intersections where the left-turn lane treatment results in channelized offset left-turn lanes (e.g., a parallel or tapered left-turn lane between two medians), the following countermeasures are recommended to reduce the potential for wrong-way maneuvers by drivers turning left from a stop-controlled, intersecting minor roadway:	
3a. In the implementation of DIVIDED HIGHWAY CROSSING signs, and WRONG WAY, DO NOT ENTER, KEEP RIGHT, and ONE WAY signs at the intersection, as per MUTCD (FHWA, 2000) specifications, oversized signs (sizes larger than MUTCD-specified standard sizes for conventional roadways) are recommended.	Appropriate warning signs are installed based on a safety assessment.
3b. It is recommended that the signs listed in Recommendation (4a) above be fabricated using retroreflective sheeting that provides for high retroreflectance overall, particularly at the widest available observation angles, to provide increased sign conspicuity and legibility for older drivers.	MCDOT specifications denote Type 1 (Engineering Grade) sheeting for most warning, regulatory, and street name signing. Diamond grade sheeting is specified for No Passing Zones, School Zones, Stop/Yield Ahead, and metro street name signs. Higher reflectivity sheeting (i.e. Type 2 or Super Engineering grade) should be considered as the minimum retrorefectance.
3c. Retroreflective lane-use arrows for channelized left-turn lanes are recommended.	Pavement lane arrows are used for left and right turn lanes only.
3d. Retroreflective pavement marking extensions of the center line that scribe a path through the turn are recommended, except where extensions for opposing movements cross, to reduce the likelihood	Skip striping is used to delineate turning paths for dual left-turn lanes or where geometry dictates

Intersection Design Elements	MCDOT Standard or Practice
of wrong-way movements.	it would improve lane tracking.
3e. Placement of 7.1-m- (23.5-ft-) long retroreflective wrong-way arrows in the through lanes is recommended for wrong-way traffic control allocations determined to have a special need, as specified in the MUTCD(FHWA, 2000), sections 2A.24, 3B.19, and 2E-50.	Not included in pavement marking guidelines. Could consider using red/white reflective RPMs to warn drivers of wrong way travel at intersections.
3f. Delineation of median noses using retroreflective treatments to increase their visibility and improve driver understanding of the intersection design and function is recommended.	Pavement marking manual includes the use of painted median noses. Should consider using reflective RPMs on median noses to increase visibility.
F Treatments/Delineation of Edgelines, Curbs, Medians,	
1. It is recommended that a minimum in-service luminance contrast level between the marked edge of the roadway and the road surface be maintained as follows:	
1a. At intersections with overhead lighting, a contrast of 2.0 or higher is recommended.	MCDOT specifications do not address luminance contrast level.
1b. At intersections without overhead lighting, a contrast of 3.0 or higher is recommended.	MCDOT could consider using white or yellow on black pavement markings on PCC pavement.
2. It is recommended that all curbs at intersections (including median islands and other raised channelization) be delineated on their vertical face and at least a portion of the top surface, in addition to the provision of a marked edgeline on the road surface.	Pavement marking manual includes the use of painted median noses. Should consider using reflective RPMs on median noses to increase visibility.
G Curb Radius	
1. Where roadways intersect at 90 degrees and are joined with a simple radius curve, a corner curb radius in the range of 7.5 m to 9 m (25 ft to 30 ft) is recommended as a tradeoff to: (a) facilitate vehicle turning	MCDOT roadway design guidelines specify a maximum corner radius of R=45 ft at

Intersection Design Elements	MCDOT Standard or Practice
movements, (b) moderate the speed of turning vehicles, and (c) avoid unnecessary lengthening of pedestrian crossing distances, except where precluded by high volumes of heavy vehicles.	uncurbed intersections and R=35 ft at curbed intersections. Smaller radii can be used depending upon the type of intersection (i.e. arterial/arterial, arterial/collector, collector/collector, etc.)
2. When it is necessary to accommodate turning movements by heavy vehicles, the use of offsets, tapers, and compound curves is recommended to minimize pedestrian crossing distances.	MCDOT recommends the use of three-centered curves where there is a high percentage of large trucks.
H Traffic Control for Left-Turn Movements at Signalized Intersections	
1. The use of protected-only operations is recommended, except when, based on engineering judgment, an unacceptable reduction in capacity will result.	Signal phasing is determined based on an evaluation of intersection capacity and safety. Typical left-turn phasing is protected-permitted.
2. To reduce confusion at an intersection approach, the use of a separate signal face to control turning phase (versus through) movements is recommended for all operating modes.	Separate signal face is only used for protected only left-turn phasing. Typically, a 5-section head with includes through and left-turn movements is used.
3. Consistent use of the R10-12 sign, LEFT TURN YIELD ON GREEN, during protected-permitted operations is recommended, with overhead placement preferred at the intersection.	This sign is not typically used.
4. Where practical, the use of a redundant upstream R10-12 sign (i.e., in addition to the R10-12 sign adjacent to the signal face) is recommended to advise left-turning drivers of permitted signal operation. It is also recommended that the sign be displayed at a 3-s preview distance before the intersection, or at the beginning of the left-turn lane, as per engineering judgment, accompanied by a supplemental plaque bearing the message, AT SIGNAL.	This sign is not typically used.
5. A leading protected left-turn phase is recommended wherever protected left-turn signal operation is implemented (as opposed to a	MCDOT has adopted protected-permitted left-turn phasing.

Intersection Design Elements	MCDOT Standard or Practice
lagging protected left-turn phase).	
6. To eliminate confusion about the meaning of the red arrow indication, it is recommended that the steady green arrow for protected-only left-turn operations terminate to a yellow arrow, then a steady circular red indication(instead of a red arrow).	This objective is achieved where 5-section heads are used. Where protected only left-turn phasing is used, MDOT should consider a solid red ball in lieu of a red arrow.
7. Where minimum sight-distance requirements as per recommendations for Design Element D are not practical to achieve through geometric redesign/reconstruction, or where a pattern of permitted left-turn crashes occurs, it is recommended that permitted left turns be eliminated and protected-only left-turn operations be implemented.	Protected phasing is implemented based on evaluation of intersection capacity and safety.
I Traffic Control for Right-Turn/RTOR Movements at Signalized Intersections	
1. It is recommended that a steady circular red indication be used at signalized intersections where a right turn on red is prohibited, instead of a red arrow indication.	MCDOT typically uses signing where right-turn on red is prohibited. A separate signal indication for right-turns is not typically used.
2. It is recommended that at signalized intersections where a right turn on red is prohibited, a supplemental NO TURN ON RED sign, using be placed on the overhead mast arm and at a location on either the near or opposite side of the intersection where, per engineering judgment, it will be most conspicuous.	
3. At skewed intersections where the approach leg to the left intersects the driver's approach leg at an angle of less than 75 degrees, he prohibition of right turn on red (RTOR) is recommended.	Prohibition of right-turn on red is determined based on safety evaluation.
4. The posting of (black on white) signs with the legend TURNING TRAFFIC MUST YIELD TO PEDESTRIANS is recommended wherever engineering judgment indicates a clear potential for right-turning vehicles to come into conflict with pedestrians who are using the crosswalk for permitted crossing movements.	This sign is not typically used.
J Street-Name Signing	
1. To accommodate the reduction in visual acuity associated with increasing age, a minimum letter height of 150 mm (6 in) is recommended for use on post-mounted street-name signs (MUTCD	Not specified in the MCDOT street sign manual or specifications. MCDOT should consider adopting

Intersection Design Elements	MCDOT Standard or Practice
sign number D3) on all roads where the posted speed limit exceeds 40 km/h (25 mi/h).	larger sign lettering.
2. The use of overhead-mounted street-name signs with mixed-case letters is recommended at major intersections as a supplement to post-mounted street-name signs. Minimum letter heights of 200-mm (8-in) uppercase letters and150-mm (6-in) lowercase letters are recommended at major intersections with approach speeds of 56 km/h (35 mi/h) or less. At major intersections with approach speeds greater than 56 km/h (35 mi/h), the minimum letter height on street-name signs should be 250-mm (10-in) uppercase and 200-mm (8-in) lowercase letters.	Overhead street name signs are used at signalized intersection. Illuminated signing at arterial intersections is standard in many local jurisdictions throughout Maricopa County.
3. In the design of overhead-mounted street-name signs, the use of larger letter heights will require a larger sign panel if the Standard Alphabets for Highway Signs are used. To minimize sign panel size, while accommodating the larger letter size, it is recommended that the border be eliminated on street-name signs when using Standard Alphabets.	
4. Wherever an advance intersection warning sign is erected (e.g., W2-1, W2-2, W2-3, W2-4), it is recommended that it be accompanied by an advance street-name plaque (W16-8) using 200-mm (8-in) black letters on a yellow sign panel.	
5. The use of redundant street-name signing for major intersections is recommended, with an advance street-name sign placed upstream of the intersection at a midblock location.	Advanced street name signs are not typically installed at major intersections.
6. When different street names are used for different directions of travel on a road, the names should be separated and accompanied by directional arrows on both midblock and intersection street-name signs. Or, a two-line sign format may be used to address support and wind load issues.	
7. For post-mounted street-name signs installed at intersections in areas of intensive land use, complex design features, and heavy traffic, it is recommended that retroreflective sheeting that provides for high retroreflectance overall, and particularly at the widest available	MCDOT specifications denote Type 1 (Engineering Grade) sheeting for most warning, regulatory, and street name

Intersection Design Elements	MCDOT Standard or Practice
observation angles, be used to provide increased sign conspicuity and legibility for older drivers.	signing. Diamond grade sheeting is specified for No Passing Zones, School Zones, Stop/Yield Ahead, and metro street name signs. Higher reflectivity sheeting (i.e. Type 2 or Super Engineering grade) should be considered as the minimum retro reflectance.
K One-Way/Wrong-Way Signing	
1. It is recommended that divided highways be consistently signed. Use of the DIVIDED HIGHWAYCROSSING sign (R6-3) is the recommended practice, pending new treatments that are demonstrated through research to provide improved comprehensibility to motorists.	Appropriate warning and regulatory signs are installed based on a safety assessment.
2. For divided highways with median widths less than 9 m (30 ft), the use of four ONE WAY signs is recommended, located in the left median and far-right corner of the intersection.	
3. For medians ranging from 9- to 13-m (30- to 42-ft) wide, or where offset left-turn lanes are used with any median width, the use of six ONE WAY signs is recommended, as diagrammed in Recommendation (4) of Design Element E(see page 20).	
4. For T-intersections, the use of a near-right-side ONE WAY sign and a far-side ONE WAY sign is recommended; the preferred placement for the far-side sign is opposite the extended centerline of the approach leg as shown in MUTCD figure 2A-6 (FHWA, 2000). Where the preferred far-side location is not feasible (e.g., because of blockage, distracting far-side land use, or an excessively wide approach leg), engineering judgment should be applied to select the most conspicuous alternate location for a driver who has not yet initiated the wrong-way turning maneuver (see diagram below).	
5. For the intersection of a one-way street with a two-way street, ONE WAY signs placed at the near-right/far-left locations are recommended, regardless of whether there is left-to-right or right-to-left traffic (see diagram below).	

Intersection Design Elements	MCDOT Standard or Practice
6. As a general practice, the use of DO NOT ENTER and WRONG WAY signs is recommended at locations where the median width is 9 m (30 ft) and greater. Consideration should also be given to the use of these signs for median widths narrower than 9 m (30 ft), where engineering judgment indicates a special need.	
K Stop- and Yield-Controlled Intersection Signing	
Recommendations to improve the safe use of intersections by older drivers, where the need for stop control or yield control has already been determined, include the following:	
1. The use of standard size (750-mm [30-in]) STOP (R1-1) and standard size(900-mm [36-in]) YIELD (R1-2) signs, as a minimum, is recommended wherever these devices are implemented, with the option of using larger R1-1(900-mm [36-in] or 1200-mm [48-in]) signs where engineering judgment indicates that greater emphasis or visibility is required.	MCDOT complies.
2. A minimum sign background (red area) retroreflectivity level (i.e., coefficient of retroreflection [RA]) below which a need for sign replacement is indicated, is recommended for STOP (R1-1) and YIELD (R1-2) signs as follows:	MCDOT specifications denote Type 1 (Engineering grade) sheeting for most warning, regulatory, and street name signing. Diamond grade sheeting is specified for No Passing Zones, School Zones, Stop/Yield Ahead, and metro street name signs. Higher reflectivity sheeting (i.e. Type 2 or Super Engineering grade) should be considered as the minimum retro reflectance.
2a. 12 cd/lux/m² for roads with operating speeds lower than 65 km/h (40mi/h).	
2b. 24 cd/lux/m² for roads with operating speeds of 65 km/h (40 mi/h) or higher.	
3. The use of a 750-mm x 450-mm (30-in x 18-in) supplemental warning sign panel (W4-4p), mounted below the STOP (R1-1) sign, is recommended for two-way stop-controlled intersection sites selected on the basis of crash experience; where the sight triangle is restricted; and wherever a conversion from four-way stop to two-way stop operations is implemented.	Appropriate warning and regulatory signs are installed based on a safety assessment.

Intersection Design Elements	MCDOT Standard or Practice
4. It is recommended that a STOP AHEAD sign (W3-1a) be used where the distance at which the STOP sign is visible is less than the AASHTO stopping sight distance (SSD) at the operating speed, plus an added preview distance of at least 2.5 s.	Appropriate warning and regulatory signs are installed based on a safety assessment.
5. The use of transverse pavement striping or rumble strips upstream of stop-controlled intersections where engineering judgment indicates a special need due to sight restrictions, high approach speeds, or a history of ran-stop-sign crashes is recommended.	MCDOT pavement marking manual includes optional use of rumble strips when considered appropriate.
L Devices for Lane Assignment on Intersection Approach	
1. The consistent overhead placement of lane-use control signs (e.g., R3-5, R3-6,R3-8) at intersections on a signal mast arm or span wire is recommended.	Overhead lane use control signing is not typically used. Ground mounted signing for right-turns are used.
2. The consistent posting of lane-use control signs plus application of lane-use arrow pavement markings at a preview distance of at least 5 s (at operating speed) in advance of a signalized intersection is recommended, regardless of the specific lighting, channelization, or delineation treatments implemented at the intersection. Signs should be mounted overhead wherever practical.	Lane control signing is typically only used for right-turn lanes. Pavement arrows are typically only provided for left and right-turn lanes.
M Traffic Signals	
1. A maintained performance level of 200 cd for peak intensity of a 200-mm (8-in) red signal is recommended to ensure delectability and improve conspicuity of this critical control element.	Incandescent signal heads are re-lamped at 6-month intervals to maintain the appropriate intensity. LED signal heads, which provide a higher intensity are re-lamped at a 9-month interval.
2. To accommodate age differences in perception-reaction time, it is recommended that an all-red clearance interval be consistently implemented, with length determined according to the Institute of Transportation Engineers (1992)expressions given below:	All-red intervals are used on all MCDOT signals.
2a Where pedestrian traffic is prohibited, or no pedestrian crossing facilities are provided, use:	

Intersection Design Elements	MCDOT Standard or Practice
r = (W + L)/V	
2b. Where pedestrian crossing facilities are provided, use: r = (P + L)/V where: r = length of red clearance interval, to the nearest 0.1 s. W=width of intersection (m [ft]), measured from the near-side stopline to the far edge of the conflicting traffic lane along the actual vehicle path. P=width of intersection (m [ft]), measured from the near-side stopline to the far side of the farthest conflicting pedestrian crosswalk along the actual vehicle path. L=length of vehicle (recommended as 6 m [20 ft]).V=speed of the vehicle through the intersection (m/s [ft/s]).	
3. The consistent use of a backplate with traffic signals on all roads with operating speeds of 65 km/h (40 mi/h) or higher is recommended. The use of a backplate with signals on roads with operating speeds lower than 65 km/h (40 mi/h) is also recommended where engineering judgment indicates a need due to the potential for sun glare problems, site history, or other variables.	Use of signal backplates is standard.
N Fixed Lighting Installations	
1. Wherever feasible, fixed lighting installations are recommended as follows:	
1a. Where the potential for wrong-way movements is indicated through crash experience or engineering judgment.	The current MCDOT policy of roadway and intersection lighting does not include specific guidelines. MCDOT is currently developing a roadway lighting policy and design manual.
1b. Where twilight or nighttime pedestrian volumes are high.	
1c. Where shifting lane alignment, turn-only lane assignment, or a pavement-width transition forces a path-following adjustment at or near the intersection.	
2. Regular cleaning of lamp lenses, and lamp replacement when output has degraded by 20 percent or more of peak performance (based on hours of service and manufacturer's specifications), are recommended for all fixed lighting installations at intersections.	Street light re-lamping is performed per manufacturers specifications based on an 80% light intensity requirement.

Intersection Design Elements	MCDOT Standard or Practice
O Pedestrian Crossing Design, Operations, and Control	
1. To accommodate the shorter stride and slower gait of less capable (15th percentile) older pedestrians, and their exaggerated "start-up" time before leaving the curb, pedestrian control-signal timing based on an assumed walking speed of 0.85 m/s (2.8 ft/s) is recommended.	At schools and in retirement areas, a 3 ft/s speed is used in addition to doubling the standard walk time to 14 sec. At all other intersections, the walk speed is 4 ft/s and walk time is 7 sec.
2. For pedestrian crossings where the right-turn lane is channelized, it is recommended that:	
2a. An adjacent pedestrian refuge island conforming to MUTCD (FHWA, 2000) and AASHTO (1994) specifications be provided.	Inclusion of a right-turn island and location of the crosswalk is determined based on local geometric and traffic conditions.
2b. If a crosswalk is within the channelized area, it should be located as close as possible to the approach leg to maximize the visibility of pedestrians before drivers are focused on scanning for gaps in traffic on the intersecting roadway.	
3. It is recommended that a placard explaining pedestrian control signal operations and presenting a warning to watch for turning vehicles be posted at the near corner of all intersections with a pedestrian crosswalk.	MCDOT has adopted the educational placard as recommended in the MUTCD.
4. It is recommended that at intersections where pedestrians cross in two stages using a median refuge island, the placard be placed on the median refuge island, and that a modified placard modified be placed on the near corner of the crosswalk.	
5. The posting of (black on white) signs with the legend TURNING TRAFFIC MUST YIELD TO PEDESTRIANS is recommended wherever engineering judgment indicates a clear potential for right-turning vehicles to come into conflict with pedestrians who are using the crosswalk for permitted crossing movements.	Appropriate warning and regulatory signs are installed based on a safety assessment
6. At intersections with high pedestrian volumes, high turning-vehicle volumes, and no turn on red (NTOR) control for traffic moving parallel to a marked crosswalk, a leading pedestrian interval (LPI), timed to allow slower walkers to cross at least one moving lane of traffic is recommended to reduce conflicts between pedestrians and turning	At schools and in retirement areas, a 3 ft/s speed is used in addition to doubling the standard walk time to 14 sec. At all other intersections, the walk speed is 4

Intersection Design Elements	MCDOT Standard or Practice
vehicles. The length of the LPI, which should be at least 3 s, may be calculated using the formula: LPI = (ML + PL)/2.8where: LPI =seconds between onset of the WALK signal for pedestrians and the green indicator for vehicles. ML = width of moving lane in ft. PL = width of parking lane (if any) in ft. 2.8 = walking speed in ft/s. 2.8 ft/s = 0.85 m/s	ft/s and walk time is 7 sec.
P Roundabouts	
1. Whenever practical, it is recommended that roundabout installations be limited to one-lane entrances and exits, and one lane of circulating traffic, with the inscribed circle diameter limited to approximately 30 m (100 ft).	MCDOT roadway design manual only includes a single lane roundabout design.
2. It is recommended that pedestrian crossings at single-lane roundabouts be set back a minimum of 7.5 m [25 ft] behind the yield line.	Crosswalk location is not specified.
3. To control for wrong-way movements, calm traffic, and provide a pedestrian refuge for all roundabout categories, it is recommended that raised splitter islands be used, as opposed to pavement markings, to delineate the channelization. The pedestrian crosswalk area should be designed at street level (crosswalk cut through splitter island).	Raised splitter islands are required.
4. To enhance the conspicuity of roundabouts in all categories, it is recommended that the sides and tops of curbs on the splitter islands and the central island be treated with retroreflective markings, and be maintained at a minimum luminance contrast level as follows:	MCDOT pavement marking manual requires that median noses be painted yellow, however the entire median curb is not reflectorized. The use of reflectorized RPMs on top of curbs could be considered to enhance visibility.
4a. At roundabouts with overhead lighting, a contrast of 2.0 or higher is recommended.	
4b. At roundabouts without overhead lighting, a contrast of 3.0 or higher is recommended.	
Roadway Curvature and Passing Zones	

Intersection Design Elements	MCDOT Standard or Practice
A Pavement Markings and Delineation on Horizontal Curves	
1. Recommendations for the maintained brightness of white edgelines on horizontal curves are presented in terms of measured effective luminance contrast level (C), where, a. highways without median separation of opposing directions of traffic, the recommended minimum in-service contrast level for edgelines on horizontal curves is 5.0. b. On highways where median barriers effectively block the drivers' view of oncoming headlights or where median width exceeds 15 m (50 ft), the recommended minimum in-service contrast level for edgelines on horizontal curves is 3.75. Contrast should be calculated according to this formula: *luminance (L) contrast =' (Ltreatment- Lpavement)/Lpavement*	MCDOT specifications do not address luminance contrast level.
2. For horizontal curves with radii less than 1000 m (3280 ft), it is recommended that standard centerline markings be supplemented with raised pavement markers (RPM's) installed at standard spacing (i.e., 12 m [40 ft] apart), and that they be applied for a distance of 5 s of driving time (at 85th percentile speed) on the approach to the curve and continued throughout the length of the curve.	MCDOT installs raised pavement markers at locations where it is determined that additional delineation of edgelines and lane lines is needed. Spacing of RPMs is dependent upon speed and/or curvature of the roadway.
3. In addition to the installation of chevron alignment signs (W1-8) as specified in section 2C.10 of the MUTCD (FHWA, 2000), it is recommended that	
3a. Roadside post-mounted delineation devices (PMD's) be installed at a maximum spacing (S) of 12 m (40 ft) on all horizontal curves with a	MCDOT installs roadside delineators on curves, as

Intersection Design Elements	MCDOT Standard or Practice
radius (R) of 185 m (600 ft) or less	necessary to provide supplemental guidance.
3b. The standard formula specified in MUTCD section 3D.4, Table 3D-1(FHWA, 2000) be used to define roadside delineator spacing intervals for curves of radii more than 185 m (600 ft), where: English: Metric: Where: R=radius of curve (in feet)R=radius of curve (in meters)S=spacing on curve (in feet)S=spacing on curve (in meters)	
B Pavement Width of Horizontal Curves	
1. For horizontal curves on two-lane non-residential facilities that have 3 degrees or greater of curvature, it is recommended that the width of the lane plus the paved shoulder be at least 5.5 m (18 ft) throughout the length of the curve(assuming AASHTO [1994] design values for superelevation and coefficient of side friction).	MCDOTs standard cross section for a 2-lane collector roadway includes a 12-ft lane and 5-ft shoulder (17 ft) in each direction of travel.
C Crest Vertical Curve Length and Advanced Signing	
1. To accommodate the exaggerated decline among older drivers in response to unexpected hazards, it is recommended that the present criterion of 150 mm(6 in) for obstacle height on crest vertical curves be preserved in the design of new and reconstructed facilities.	MCDOT design manual stipulates an assumed eye height of 3.5 feet and object height of 2 ft.
2. Where a need has been determined for installation or replacement of a device to warn motorists that sight distance is restricted by a crest vertical curve, the message SLOW / HILL BLOCKS VIEW is recommended, using the special sign size of 900 mm x 900 mm (36 in x 36 in) as a minimum.	Appropriate warning signs are installed based on an evaluation of sight distance conditions.
3. If a signalized intersection is obscured by vertical or horizontal curvature in a manner that the signal phase becomes visible at a preview distance of 8 s or less (at operating speed), then it is recommended that the standard (W3-3)advance signal warning sign be augmented with a yellow placard bearing the black legend PREPARE TO STOP and a flashing yellow beacon interconnected with the traffic signal controller. The yellow flasher should be activated at a sufficient interval prior to the onset of the yellow signal phase and sustained after the onset of the green signal phase to take into account the end of queues experienced during peak traffic conditions, as determined	MCDOT installs advanced warning signs with and without flashers based on an evaluation of sight distance and traffic conditions.

Intersection Design Elements	MCDOT Standard or Practice
through engineering study.	
D Passing Zone Length, Sight Distance	
1. To accommodate age-related difficulties in judging gaps and longer decision-making and reaction times exhibited by older drivers, the most conservative minimum required passing sight distance (PSD) values, as determined by AASHTO (1994, table III-5), are recommended.	The MCDOT roadway design manual has adopted the equations specified in the 2001 AASHTO Green Book to calculate passing sight distance on crest vertical curves. A drivers eye height of 3.5 feet and object height of 2 ft is recommended.
2. Use of the MUTCD (FHWA, 2000) special-size (1200-mm x 1600-mm x1600-mm [48-in x 64-in x 64-in]) NO PASSING ZONE pennant (W14-3),or the standard size (900 mm x 1200 mm x 1200 mm [36 in x 48 in x 48 in])using fluorescent yellow retro reflective sheeting, as a high-conspicuity supplement to conventional centerline pavement markings at the beginning of no passing zones is recommended.	MCDOT typically does not use fluorescent yellow reflective sheeting No Passing Zone signs. Yellow diamond grade sheeting is specified. Fluorescent yellow is used for school crossing signing.
3. To the extent feasible for new or reconstructed facilities, the implementation of passing/overtaking lanes (in each direction) at intervals of no more than 5 km (3.1 mi) is recommended.	Passing/climbing lanes are constructed based on a safety evaluation.

Roadside Amenities Policy Review

Maricopa County Department of Transportation

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1.0 INTRODUCTION

The Maricopa County Department of Transportation (MCDOT) often engages in multi-jurisdictional roadway improvement projects. While intergovernmental agreements with municipalities provide funding mechanisms to implement needed capacity improvements, delays in design and construction sometimes result when MCDOT design standards vary from those of the partner city. While MCDOTs historical role has been providing farm-to-market transportation infrastructure, these city-county partnerships put increasing pressure on MCDOT to provide urban roadside amenities, such as landscaping.

Current MCDOT policy is to negotiate design standards and the level of roadside amenities project by project. However, this is a time consuming process that raises the question of whether MCDOT should adopt minimum design standards for urban roadside amenities. Further policy questions include what the appropriate investment level for MCDOT should be for roadside amenities when partnered with a municipality.

The purpose of this paper is to first evaluate current MCDOT policy relative to roadside amenities in the context of peer agency policy and then to provide recommendations on how to improve current policy. In addition to the basic facilities needed for safe and efficient travel by the motorist, what other features should be included in roadway design to meet other community needs and values, and under what circumstances?

Design features are often based on the functional classification of the roadway. The table below briefly summarizes the types of roads under MCDOTs jurisdiction. Given the rapid growth and development in Maricopa County, there is a continuing trend toward the building of new roads, the widening and/or upgrading of existing roads, and the land use surrounding an existing road changing from rural to urban over time.

Table 1
Characteristics of Roads Under MCDOT Jurisdiction

Principal Arterial (divided)	4-6	30	to	60	4	10	to	40	ARTERIALS
Minor Arterial	4	5	to	35	4	5	to	35	182 miles
Major Collector	2	1	to	9	2	1	to	9	COLLECTORS
Minor Collector	2	1	to	5	2	1	to	5	1,246 miles

Sources: MCDOT Roadway Design Manual; MCDOT 2003 State of the System Report.

MCDOT has already developed design and maintenance standards for bike lanes and crosswalks, as well as curb-and-gutter. This paper therefore examines appropriate policies relative to the following potential roadway features:

- Roadside landscaping

- Raised medians
- Sidewalks
- Street lighting
- Utilities sitting

Since the cost of each of these elements includes design, right-of-way, construction and maintenance, it is important to carefully consider what elements should be established as standards. There may be localized circumstances that would warrant provision of enhanced amenities beyond the minimum standards, such as noise barriers or special architectural treatments, but these are beyond the scope of this effort.

Finally, all elements of roadway design need to take into account the other elements to ensure a compatible integrated system.

2.0 REFERENCES CITED

Multiple sources were used for this review. The primary source of information on roadside amenities came from interviews with the following officials at peer transportation agencies:

Grant Anderson, Senior Civil Engineer, Road Division, Resources and Development Management Department, County of Orange, California, telephone interview, Santa Ana, CA. January 2006.

Felix Calixto, Engineering Manager, Regional Transportation Commission of Southern Nevada, telephone interview, Las Vegas, NV, January 2006.

Les Henley, Assistant Director of Public Works, Clark County, Nevada, telephone interview, Las Vegas, NV, February 2006.

Ben Goff, Deputy Director of Transportation Systems and Operations, Pima County, Arizona, telephone interview, Tucson, AZ, January 2006.

Bob Goralka, County Engineer, San Diego County, California, telephone interview, San Diego, CA, January 2006.

A secondary data source was relevant literature from the following transportation agencies:

- Pima County Department of Transportation, Arizona
- Clark County Department of Transportation, Nevada
- Orange County Department of Transportation, California
- San Diego County Department of Transportation, California

In addition, the following documents were reviewed to identify existing conditions and policies relevant to roadside amenities in Maricopa County:

- Maricopa County Roadway Inventory System, MCDOT, 2005
- Maricopa County Roadway Design Manual, MCDOT, 2004
- Maricopa County 2003 State of the System Report, MCDOT, 2003

3.0 ROADSIDE AMENITIES

This working paper examines appropriate policies relative to the following potential roadway features.

- Roadside landscaping
- Raised medians
- Sidewalks
- Street lighting
- Utilities sitting

3.1 Roadside Landscaping

Roadside landscaping includes vegetation and other physical features affecting the appearance of the non-traveled way within a roadside cross-section. Landscaping is critical to the aesthetic character of a road, and should be designed to be consistent with the road's environment.

The MCDOT Roadway Design Manual includes 20 pages of landscape design standards (Chapter 9), which comprehensively address key landscape planning factors, even including a list of plant species that are appropriate for roadside use. Key factors in landscape design include safety considerations, water conservation, maintenance costs and maintenance practices.

MCDOT does not accept responsibility for maintenance of any new landscaping, and allows private installation of plants only after executing a legally binding agreement with the party that will be obligated to provide landscape maintenance.

Landscaping construction costs vary widely depending upon the plants, irrigation systems and other materials used. As an illustrative calculation, expenses of $2 per square foot for ten feet on each side of one mile of roadway would produce a cost of about $211,000 per mile.

3.2 Raised Medians

Raised median islands direct traffic that enters a roadway from a cross street to turn right, rather than make a through movement or left turn that would compromise traffic flow or safety on the main road. Motorists who have been required to travel out-of-direction may then correct their course by utilizing their next legal left turn opportunity, often at a signalized intersection.

Raised median islands offer both opportunities and challenges as a roadside amenity. Opportunities include the potential for visual enhancement, glare screening, and a street-crossing refuge for pedestrians. Challenges include added cost and right-of-way considerations, as well as safety issues for maintenance workers.

The typical raised median construction cost is approximately $15.00/linear foot. The concrete nose of a raised median costs an additional $5.00/square feet to construct. A one-mile section would potentially have openings at one-quarter mile intervals. Based strictly on the $15 figure, the cost per mile would equate to roughly $80,000 per mile.

3.3 Sidewalks

Sidewalks are an important amenity providing dependable linkages needed by pedestrians for utilitarian travel and recreational use. Sidewalks are normally provided on both sides of a street, serving adjacent land uses on either side and thus not encouraging unnecessary street crossings. In the absence of sidewalks, pedestrians may walk along the edge of the road or even in the roadway, with adverse safety consequences for the motorist and pedestrian alike.

A basic sidewalk normally parallels the road without unnecessary meanders or deviations that would require additional right-of-way. A basic sidewalk is typically made of concrete, although many styles of pavers and other aesthetic upgrades are available at a higher cost.

Standard specifications for sidewalks (and many other elements of public infrastructure) have been developed for the Phoenix Metropolitan Area by the Maricopa Association of Governments (MAG), of which Maricopa County is a key member. MCDOT complies with the Pedestrian Area Policies and Design Guidelines adopted by the MAG Regional Council in April 2005. These guidelines help to ensure consistency of facility design across jurisdictional boundaries, such as where unincorporated County areas meet incorporated municipal areas.

As noted in Section 5.36 of the MCDOT Roadway Design Manual, all newly constructed sidewalks shall be in compliance with requirements of the Americans with Disabilities Act (ADA). Sidewalks shall be a minimum of five feet in width, with a minimum clear width of four feet. Sidewalks are normally not required in rural portions of the County, required in urban portions, and considered on a case-by-case basis in developing urban portions.

The cost of constructing sidewalks varies depending on the location, design parameters and adding beautification features. Assuming typically sidewalk construction costs of $5.00 per square foot, providing a five-foot sidewalk on each side of a road would total approximately $265,000 per mile.

3.4 Street Lighting

Street lighting enhances safety for motorists, bicyclists and pedestrians in a transportation corridor. Lighting is especially important at intersections, for the avoidance of traffic movement conflicts and car-bike and car-pedestrian conflicts. Lighting also enables motorists to safely find, identify and turn onto a desired cross-street. Beyond “standard” light poles and fixtures that are purely utilitarian, decorative alternatives are available at higher cost for aesthetic purposes where desired.

Street lighting must be carefully planned because it also has adverse impacts. Light poles themselves, even if designed as breakaway structures, do represent a fixed hazard for vehicle crashes. Street lighting requires ongoing operating expense for power as well as maintenance. Lighting should be designed to illuminate only the roadway and not intrude into adjacent properties. Past use of excessive and/or unshielded lighting has resulted in light pollution and led to enactment of so-called “Dark Skies” legislation in a number of states and communities.

MCDOT does not have specific guidelines for roadway and intersection lighting but is in the process of developing a roadway lighting policy and design manual.

The cost for street lighting varies widely with the type, use, size and other parameters. According to ADOT Construction Cost (1999), the estimated cost for each luminaire varies from

$400 to $900. The estimated lump sum cost for removing and salvaging existing lighting poles varies between $2,500 and $3,000. However, this estimate does not include accessories such as brackets.

3.5 Utilities Sitting

Above-ground utilities in a roadway corridor generally have adverse effects both visually and with regard to motorist safety. For example, the Federal Highway Administration has reported that utility poles are involved in ten percent of all fixed-object fatal crashes in the United States. Nevertheless, transportation corridors are logical locations for utility lines because of their connectivity, public ownership, and accessibility for maintenance.

A more aesthetic and more expensive alternative to above ground utilities is to bury the transmission lines within the transportation right-of-way. Utilities are often located below ground on asphalt-surfaced, lightly-traveled neighborhood streets. On more heavily traveled roadways, an appropriate location for utility lines would be in a roadside trench. To minimize right-of-way needs, multiple utility lines can be located together in a single trench, protected by concrete encasement, called a duct bank.

The estimated cost for a typical underground duct bank (6”) for electrical and telephone cables varies from $150 to $200 per linear foot, or about $1 million per mile. Additional cost will include excavating, trenching and backfilling cost. This does not include utility pole relocation and right-of-way acquisition cost. Utility pole relocation could be as high as $50,000/ pole.

4.0 PEER AGENCY POLICY REVIEW

4.1 Roadside Landscaping

Pima County (Arizona) has detailed landscaping requirements that are comparable to those used in Maricopa County. Additionally, extra efforts are required for projects in areas that have been designated as environmentally sensitive.

Orange County (California) has established a general policy to not provide landscaping with street or highway construction. When landscaping is approved under special circumstances, it may not be maintained with road funds, and a method for funding its maintenance must be established prior to approval of the street improvement.

In Clark County (Las Vegas metro area), public right-of-way on County roads ends at the back of the sidewalk, and thus any roadside landscaping is privately owned and maintained.

4.2 Raised Medians

Pima County requires a raised median on 4-lane and 6-lane divided urban arterials. The standard median width is 24 feet, and there is a required minimum width of 20 feet. Median openings should be spaced one-quarter mile apart, but generally no closer than 660 feet from other median openings and major intersections.

Orange County normally requires a median width of 14 feet on Principal, Major, and Primary highways. A striped median is preferred. A raised median may be acceptable under certain circumstances, including for continuity with the design of contiguous portions of the roadway, and where necessary to control turn movements and access on heavily traveled arterials with commercial frontage and multiple driveways. Curbed medians normally are paved with two inches of asphalt concrete.

Orange County also has an approved Landscaped Median Detail. Landscaped medians are not maintained with public funds. A method of funding maintenance is established prior to approval of street improvement plans.

Clark County's median island typical section indicates a raised median of variable width, consisting of a 4-inch concrete slab or 1.5 inches of asphalt concrete pavement. The Regional Transportation Commission indicates that the installation of raised medians to reduce left turn conflicts and provide for pedestrian refuge areas shall be addressed during the project design. Median islands or continuous left-turn lanes shall be built on all jobs where feasible.

San Diego County's typical roadway sections call for no medians on rural streets and urban "light" collectors. A 12-foot median is specified for a two-lane "town collector," and a 14-foot median is specified for major roads and prime arterials. Medians normally should be surfaced. Where landscaped medians are approved, they are required to include a concrete maintenance walkway 1.5 feet in width, adjacent to the curbs.

4.3 Sidewalks

Pima County requires pedestrian walkways along major roadways where warranted by pedestrian travel. The standard width for sidewalks is 5 feet; if the sidewalk is placed abutting the back of curb, then a sidewalk six feet in width is required.

Orange County requires no sidewalks on rural roadways (local streets, collector streets). A sidewalk width of eight feet is required on urban roadways that are local or collector streets, and on secondary or primary arterials. Sidewalks of nine feet in width are required along major and principal arterials (6 or 8 lanes, directionally divided).

In Clark County, sidewalks with a minimum width of five feet are specified for urban streets. Sidewalks are not required for rural streets.

San Diego County requires sidewalks to be five feet wide and contiguous with the curb. Pathways may be approved in lieu of sidewalks.

4.4 Street Lighting

Pima County has developed a Street Lighting Design Manual applicable to arterial lighting systems.

In Orange County, street improvements constructed by the County require lighting only at intersections and as needed for traffic safety purposes. In areas without standard street lighting, it can only be provided based on the recommendation of the Orange County Traffic Committee.

However, for streets constructed in conjunction with new private land developments, street lighting conforming to adopted County standards is required.

In Clark County, safety lighting is required at the intersection of any two streets that are part of the Regional Transportation Plan. Clark County maintains 100,000 street lights, and is gradually replacing incandescent equipment with more energy-efficient, lower-maintenance lighting, such as high-pressure sodium vapor luminaries. This program is funded by the Regional Transportation Commission.

San Diego County has a Countywide Lighting District. In areas where property owners desire a higher level of street lighting than is normally provided, the property owners can annex into the Countywide District, and thus will be assessed a property tax to pay for the improvements.

4.5 Utilities Sitting

Pima County has an adopted Design Guide for Constructing and Relocating Utilities within *Public Right-of-Way*. Pima County allows new above ground facilities such as utility poles and overhead utility lines along its roadways. For uncurbed, rural roads, the utility structures must be outside the clear zone, while for urban, curbed roadways, they must be two feet beyond the curb (outside or median). Pima County encourages shared use of duct banks for underground utilities, including electric power lines of up to 35 Kilovolts.

In Clark County, typical roadway cross sections indicate that underground dry utilities should be placed in a utility corridor under the sidewalk. The County does not require the use of duct banks, and cooperation on utility sitting among the local utility providers is strictly voluntary.

Orange County does not have standard plans for utility lines in County road corridors, but instead works with the respective providers to accommodate their needs on a case-by-case basis.

In San Diego County, in areas that include pedestrian pathways, above-ground utilities are required to be located a minimum of five feet from the back of the curb or berm. In new subdivisions built by developers, all utilities are required to be placed underground.

5.0 POLICY OPTIONS

The review shows that, overall, MCDOT standards and guidelines for roadside amenities are consistent with peer agencies. MCDOT should maintain its focus in following its guidelines to provide safe and adequate transportation facilities. However, MCDOT may wish to consider the following recommendations related to specific roadside amenities, as appropriate.

5.1 Roadside Landscaping

Maricopa County's landscaping design standards appear to be comprehensive and appropriate. The review of practices from peer counties did not suggest the need for any changes to the current MCDOT landscaping policy. As MCDOT does not have a funding source for landscaping and maintenance, it should continue its practice of not accepting maintenance responsibility for any new landscaping. The decision to install and maintain roadside

landscaping should be left wholly to the community served by the roadway through a long term maintenance agreement.

5.2 Raised Medians

Based on the peer review, raised median islands may be worth considering for busy urban arterials of four or more lanes. A standard width of 14 feet, used in California, reduces right-of-way costs as compared to the 24-foot width specified by Pima County. Landscaped medians have issues of irrigation and drainage, as well as vegetation maintenance hazards and expense. Therefore, non-landscaped medians are preferable. The decision to install landscaping in a median should be left wholly to the community served by the roadway through a long term maintenance agreement.

5.3 Sidewalks

MCDOTs sidewalk specifications are ADA compliant and consistent with those of the peer counties. It is appropriate for sidewalks to be required in urban areas, not required in rural areas, and considered on a case-by-case basis in developing areas. In developing areas, it may be beneficial to reserve right-of-way for future sidewalk installation. The decision to fund and install sidewalk amenities above and beyond that specified in MCDOTs Roadway Design Manual basic sidewalk specifications should be left to the community served by improvements and specified in an intergovernmental agreement.

5.4 Street Lighting

Street lighting should be provided wherever warranted for motorist or pedestrian safety, based on a history of crashes or pedestrian incidents. Often, this will be along roads with higher motor vehicle and/or pedestrian travel demand (e.g., urban principal and minor arterials). It is recognized that MCDOT is in the process of developing lighting standards. Newly installed lighting should utilize modern, higher-efficiency equipment. All lighting should be designed in a manner that minimizes light pollution (skyward) and light trespass (into adjacent properties).

5.5 Utilities Sitting

It is desirable for both safety and aesthetic reasons to place utilities underground. As this is expensive, it makes more sense to do so in urban areas than in rural areas, because in urban settings a larger number of people would likely benefit for the same cost. Whenever it is not possible to place the utilities underground, shielding and breakaway poles are recommended with adequate warning signs.

Shared use of utility structures, whether above-ground poles or underground trenches, should be encouraged. MCDOT can work toward this goal by developing a standard design for shared use trenches or duct banks for its urban roadway cross-sections. Having such a design available, even as an alternate detail for consideration on a case-by-case basis, could be useful in bringing utility providers to the discussion table.

APPENDIX A: PEER AGENCY POLICY REVIEW

Maricopa County Department of Transportation	Parameters for identifying and prioritizing improvements to address roadside amenities typically include: • Street classification • Traffic volumes • System continuity	• Highway User Revenue Funds (HURF) • Intergovernmental Agreements for projects crossing municipal boundaries • Developer agreements • Roadway Improvement District	• Municipal annexation patterns • Magnitude of improvements needed to address street deficiencies • Landscape maintenance responsibility	• Coordination between County, municipalities and developers on development review • Intergovernmental Agreements with municipal partners to improve deficient roadways • MCDOT does not accept maintenance responsibility for any new landscaping
Pima County Department of Transportation Systems and Operations		• Highway User Revenue Funds (HURF) • Intergovernmental Agreements for projects crossing municipal boundaries • Developer agreements • Transportation Bond improvement Plan • Roadway Improvement District	• Municipal annexation patterns • Distribution of development impact fees	• Coordination between County, municipalities and developers on development review
Clark County, Nevada, Department of Public Works		• "Fair share" tax initiative • Local and state gas tax and property taxes • Federal funding • Developer agreements • County can assess adjacent property for cost of street improvements	• Municipal annexation patterns • Board of County Commissioners is sensitive to placing special assessment districts for road improvements on single family residential neighborhoods	• County not responsible for landscaping
San Diego County, California, Department of Public Works		• Multiple funding sources available depending on situation • Cost sharing program with adjacent developer	• Regional corridors require competition for funding at San Diego Association of Governments (SANDAG)	• First development responsible for entire roadway improvements, with costs to be shared by subsequent developers
County of Orange, California, Resources and Development Management Department, Road Division		• Cost sharing program with adjacent developers • Local and state gas tax and property taxes		• Developer could be required to provide full roadway cross section to meet need shown in traffic impact study • Developer responsible for sidewalk, curb and gutter and other amenities on property frontage

Scalloped Street Improvements Policy Review

Maricopa County Department of Transportation

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1.0 INTRODUCTION

In Maricopa County, development coupled with municipal annexation policies continue to create a 'scalloped street' phenomenon on many MCDOT section-line roads. This is a situation where one side of the street is improved by the adjacent developer and the other is not improved for a variety of reasons. Scalloped streets are lane imbalances that can be aesthetically undesirable and may create issues related to safety and traffic operations.

The scalloped streets phenomenon presents a funding challenge for both Maricopa County and the municipalities who are involved. The cost of addressing scalloped streets on county arterials is a growing concern. MCDOT staff completed an analysis in the East Valley and determined that the cost of addressing existing scalloped street issues in the Town of Gilbert alone could cost over $30 million.

Through this paper, MCDOT seeks to identify long term solutions to minimize future scalloped streets from developing as growth starts to shift to the West Valley and develop options for cleaning up scalloped streets that exist today.

The purposes of this paper are to:

- Discuss the origins of scalloped streets;
- Discuss funding and prioritization issues associated with scalloped street improvements;
- Evaluate current MCDOT scalloped street policy in the context of peer agency standards and practice;
- Provide policy options for MCDOT to consider in updating its scalloped street policy;
- Develop short-term options for "cleaning up" scalloped streets that exist today; and
- Identify long-term solutions to avoid or minimize the formation of new scalloped streets.

This document is organized in the following sections:

- References Cited
- Origins of Scalloped Streets
- Peer Agency Policy Review
- Scalloped Street Improvement Options

2.0 REFERENCES CITED

Multiple sources were used for this review. The primary source of information on scalloped street policies came from interviews with the following officials at MCDOT and peer transportation agencies:

Grant Anderson, Senior Civil Engineer, County of Orange Resources and Development Management Department, Road Division, telephone interview, Santa Ana, CA., 25 January 2006.

Fidel Calixto, Engineering Manager, Regional Transportation Commission of Southern Nevada, telephone interview, Las Vegas, NV., 17 January 2006.

Denis Cederburg, Director of Public Works, Clark County, NV., telephone interview, Las Vegas, NV., 23 January 2006.

Ben Goff, Deputy Director of Transportation Systems and Operations, Pima County, AZ., telephone interview, Tucson, AZ., 23 January 2006.

Bob Goralka, County Engineer, San Diego County, telephone interview, San Diego, CA., 19 January 2006.

Don Herp, Deputy Street Transportation Director, City of Phoenix, telephone interview, Phoenix, AZ., 17 January 2006.

Ron Lisonbee, Development Services, City of Mesa, telephone interview, Mesa, AZ., 17 January 2006.

Dan Nissen, Assistant City Engineer, City of Peoria, telephone interview, Peoria, AZ., 17 January 2006.

Tim Oliver, Transportation Systems Planning Manager, Maricopa County Department of Transportation, telephone interview, Phoenix, AZ., 13 January 2006.

Terry Johnson, Deputy Director of Transportation, City of Glendale, telephone interview, Glendale, AZ., 17 January 2006.

Jon White, Intergovernmental Policy Manager, Maricopa County Department of Transportation, telephone interview, Phoenix, AZ., 20 January 2006.

A secondary data source was relevant literature from the following agencies:

- Pima County Department of Transportation, Arizona
- Clark County Department of Transportation, Nevada
- Orange County Department of Transportation, California
- San Diego County Department of Transportation, California

In addition, the following documents were reviewed to identify scalloped street improvement needs and to develop relevant policy options and standards:

- Maricopa County Roadway Inventory System, MCDOT, 2005
- Maricopa County Roadway Design Manual, MCDOT, April 2004
- Maintenance of County Island Roadways, MCDOT, 2000
- Maricopa County Transportation System Plan DRAFT Existing Conditions Report, MCDOT, 2005
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3.0 Origins of Scalloped Streets

Scalloped streets can result when development only occurs along one side of a road. Today, most municipal zoning codes require the developer to make section-line road improvements along their frontage. In many cases these improvement are only along half the road, leaving the other half of the road in its original condition (typically a single lane). Scalloped streets are found throughout the metropolitan area and involve most governing agencies. For Maricopa County, the scalloped street issue is further complicated because of the way land develops and because of municipal annexations. Arizona statutes allow municipalities to annex land from the counties without including the transportation facilities. This too, can contribute to the scallop streets problem.

3.1 Land Development

On the Phoenix-area urban fringe, where farm land or desert is being developed, urban growth is typically a patchwork of subdivisions. As a result, subdivisions are often not contiguous and 'leapfrog' patterns of development are commonplace.

In most cases, developers are required to provide half-street improvements by constructing roadway improvements to the center line along their project frontage. Within newly developing areas, the half-street improvement pattern varies in width depending on where development has occurred. Where subdivisions are built on both sides of the street, the full roadway cross section would be in place, however, development on just one side of the arterial typically means that only one side of the road is fully improved. This would leave the opposite side of the facility unimproved, typically resulting in one lane in the non-improved direction.

As infill occurs, the full arterial cross section should be built. However, the timing of developments does not always coincide. Roadways on the developing periphery are often beset with lane imbalance due to erratic development patterns that result in a scalloped street.

3.2 Annexations

Scalloped streets can be found throughout the MCDOT system. A typical scalloped street could be owned by MCDOT on one side of the roadway and owned by a municipality on the other side, but that is not always the case. Typically, all local governments (Maricopa County included) require the developer to improve its frontage of a section-line road. This could include adding lanes, curb and gutter, landscaping, and street lights, depending on the design standards required by the community.

In situations where one side of the road is in the county and the other is in a city or town, questions often arise regarding which jurisdiction design standards should be uses. This is further complicated when the land across from a new city subdivision is unincorporated and has developed as low density lot-split type development. These areas generally will not be annexed by the adjoining community, and it is unlikely a developer will come in at a later date to make the necessary road improvements to the unimproved side of the road.

To better understand this issue, Maricopa County prepared a position paper on scalloped streets in 2000. (See Appendix A.) Seven policy options regarding county island roadway maintenance and improvements were outlined. (Much of this analysis was framed on several county island roadway definitions described in the 1997 Transportation System Plan.) The policy options ranged from providing no maintenance or improvements on county island roadways to pursuing legislative options to alter municipal annexation patterns. To date, none of these policy options have been formalized or acted upon legislatively.

4.0 PEER AGENCY POLICY REVIEW

The objective of the peer agency review was to ascertain how similar sized counties with similar growth and annexation issues address the scalloped street issue. In addition to a number of Arizona, California, and Nevada locations, the review also included several Phoenix-area cities.

This peer agency review, as summarized in Appendix B, included telephone interviews with agency officials and a review of design manuals and development guidelines readily available on agency websites. It focused on project identification, prioritization, and funding. The review sought to identify key agency issues related to scalloped streets and agency practices for addressing those issues.

4.1 Improvement Identification and Prioritization

The review showed that peer agencies use standard performance measures to identify and prioritize improvements needed to address scalloped streets (very similar to what MCDOT uses today for Transportation Improvement Program projects). The measures these peer agencies uses include:

- Congestion;
- Delay;
- Safety;
- Traffic volume;
- System continuity; and
- Accessibility and mobility

The peer agencies typically handle scalloped street improvement decisions on a case-by-case basis, as determined by the parameters above. Citizen complaints and neighborhood issues adjacent to street improvements are also taken into account by the peer agencies.

4.2 Funding Mechanisms

Peer agencies use multiple types of funding mechanisms to address scalloped street issues. In rapidly growing areas, developers are responsible for roadway and related-improvements along their subdivision roadway frontage. Whenever possible, new development is required to improve any scalloped street location at or around their project vicinity to the degree that the new development impacts segment(s) where scalloped streets currently exist. Again, this is very consistent with what Maricopa County tries to do today.

Public funding is a more significant issue in developed urban areas where infill has not occurred and scalloped streets have existed for a number of years. Improvements to address scalloped street issues in these established areas typically have a higher agency priority than in developing areas. Local jurisdictions typically take the initiative to improve scalloped streets whenever improvements are warranted by safety, congestion or inadequate capacity. Most often, these government-led improvement projects are included in the jurisdiction's multi-year Capital Improvement Program (CIP).

CIP funding involves local, state and federal funding sources. Scalloped streets crossing jurisdictional boundaries are typically funded through a cost-sharing Intergovernmental Agreement (IGA) between the municipality and the county. In addition, funding could also be allocated through special assessment districts. Nevada state statute allows a county to impose a special assessment district on property owners to close gaps in an arterial one-half mile or less.

4.3 Agency Issues and Practices

While a variety of funding mechanisms exist to fund roadway improvements, competition for a limited pool of money makes funding the most common peer agency issue related to improving scalloped streets. Typically, peer counties seek IGAs with adjacent communities to fund priority improvements to address scalloped street issues. Often in these situations, after a county facility is improved, the municipal partner will agree to annex the road and take over operations and maintenance.

Clark County, Nevada, home to two large urban/suburban communities, Las Vegas and Henderson, requires developers to overpave up to 17 feet beyond the roadway centerline. The practice helps avoid scalloped street improvement patterns by maintaining a centerline orientation to the roadway. Clark County does not require installation of sidewalks, curb and gutter, or street lighting on these improvements, which are considered interim.

The County of Orange, California, requires half-street improvements along the development frontage. However, the County indicated that in some cases developers have been required to improve an entire segment based on needs warranted by a traffic impact study.

5.0 SCALLOPED STREET IMPROVEMENT OPTIONS

5.1 Improvement Identification and Prioritization

MCDOT should consider establishing criteria to define small segments or “remnants” of unimproved urban scalloped streets for improvements. These urban or suburban remnants would likely remain unimproved without MCDOT intervention. MCDOT should apply street improvement standards (including sidewalks, bike lanes and aesthetics) and adopt a policy to provide its own funding, particularly when safety problems, and/or congestion exists. Through this new mechanism, remnant scalloped streets could be prioritized and put on an appropriate schedule for improvement. The potential for developing a mechanism to assess large adjacent property owners at a later date when infill development occurs for the remnant street improvement should also be explored.

5.2 Funding Mechanisms

While traditional funding sources would work in most instances to address scalloped street issues, MCDOT should consider earmarking some operations and maintenance funds for improvements to small urban remnants.

5.3 Policy Options

In addition to defining criteria for identifying and prioritizing scalloped street improvements and an earmarking mechanism, MCDOT should also consider the following policy options:

1. MCDOT should support/develop a region-wide policy that requires developers to over pave beyond the roadway centerline to maintain centerline orientation, providing a balanced number of lanes in both directions as an interim operation improvement, thus avoiding scalloped street patterns.

2. MCDOT should support/develop a policy that would require the first new development on an unimproved section-line road to improve both sides of the entire roadway segment with costs to be shared by subsequent developers. This policy should include a threshold (i.e., units, trips, or length of frontage) that would trigger implementation of this policy.

3. MCDOT should pursue the county island policy options that seek a legislative solution to modify annexation patterns by requiring municipalities to include transportation facilities when annexing new territory.

4. MCDOT should support/develop a legislative solution to require property owners to participate in special assessment districts to for closing gaps in an arterial or local roadway facilities which measure one-half mile or less.

Regardless of the policy option or options pursued by MCDOT, the department should work with municipalities in the county to develop an appropriate strategy regarding scalloped streets. The selected strategy could be applied countywide or tailored to specific working relationships with individual municipalities.

APPENDIX A

MCDOT County Island Policy Options			
Policy Options		**Legal Obligations**	**Liability Issues**
1.	No maintenance or Capital Improvement of County Island Roadways	Cannot legally abandon maintenance unless permitted by statute or such action only "deferred" maintenance until a later date.	Would probably result in litigation; especially if "known" safety problems are allowed to persist.
2.	Establish separate maintenance standards for County Island Roadways; implement a policy of No Capital Improvements	A policy of differing maintenance standards for county island roadways can be implemented. The most egregious cases would be considered for differential maintenance standards.	Low level maintenance unless allowed by law or ordinance, will be a liability problem.
3.	Maintain all County Island Roadways "As-Is" but implement a policy of No Capital Improvements Unless annexation occurs	Possible under state statutes. No jurisdiction is "mandated" to improve roads. Capital improvements can be avoided on policy grounds alone.	Known safety problems would have to be rectified, even if it means new capacity.
4.	Maintain all County Island Roadways "As-Is" but pursue a policy to "swap" maintenance responsibilities	Obligated to maintain all roads under current legislation, but services could be "swapped" "sold" or "bought" by cooperating jurisdictions.	Cooperative jurisdictions should have similar or "like" maintenance standards.
5.	Status Quo: Maintain all County Island Roadways County "As-Is" and Continue County Island Roadway Eligibility for Capital Improvements	Obligated to maintain all roads under current legislation.	No extra liability is incurred under the status quo situation.
6.	Seek a legislative solution for retroactive County Island boundary changes or pursue legislation to halt annexation that does not include transportation facilities	Create statutory legal obligations to absorb islands into cities; Halting new annexations without transportation facilities takes new legislation.	Cities may have a legitimate argument that taking a county facility that is not to their standard will incur extra liability.
7.	Pursue state legislation to create a Boundary Review Commission	Places authority in 3rd party to resolve boundary and service issues proactively.	Boundary Commissions prevent liability issues with good planning.
Source: Maintenance of County Island Roadways, MCDOT, 2000			

APPENDIX B

Peer County and City Scalloped Street Policy Review				
Transportation Agency	**Improvement Identification and Prioritization**	**Funding Mechanism**	**Key Issues**	**Practices**
Maricopa Department of Transportation	Parameters for identifying and prioritizing improvements to address scalloped streets typically include: ▪ Traffic congestion, ▪ Traffic delay ▪ Safety, ▪ System Continuity and Accessibility and Mobility	▪ Highway User Revenue Funds (HURF) ▪ Intergovernmental Agreements for projects crossing municipal boundaries ▪ Developer agreements ▪ Roadway Improvement District	▪ Municipal annexation patterns ▪ 'Leapfrog' Development Patterns ▪ Half-street property frontage improvement policy ▪ Magnitude of improvements needed to address scalloped street deficiencies	▪ Coordination between County, municipalities, and developers on development review ▪ Intergovernmental Agreements with municipal partners to improve deficient roadways
Pima County Department of Transportation Systems and Operations		▪ Highway User Revenue Funds (HURF) ▪ Intergovernmental Agreements for projects crossing municipal boundaries ▪ Developer agreements ▪ Transportation Bond Improvement Plan ▪ Roadway Improvement District	▪ Municipal annexation patterns ▪ Distribution of development impact fees	▪ Coordination between County, municipalities, and developers on development review ▪ Uniform roadway standards and grade lines
Clark County, Nevada, Department of Public Works		▪ "Fair Share" tax initiative ▪ Local and state gas tax and property taxes ▪ Federal funding ▪ Developer agreements ▪ County can assess adjacent property for cost of street improvements	▪ Municipal annexation patterns ▪ Board of County Commissions is sensitive to placing special assessments for road improvements on single family residential developments	▪ On half-street improvements, county requires developers to over pave up to 17 feet beyond roadway centerline to maintain centerline orientation ▪ County not responsible for sidewalk, curb and gutter, and streetlights ▪ Uniform roadway standards and grade lines used by all entities ▪ State law allows county to force a special improvement district on property owners to close gaps one-half mile or less ▪ Rural Neighborhood Preservation Areas do not require construction of sidewalks, curb and gutter, and other amenities
San Diego County, California, Department of Public Works		▪ Multiple funding sources available depending on situation ▪ Cost sharing program with adjacent developer	▪ Regional corridors require competition for funding at San Diego Association of Governments (SANDAG)	▪ Agencies lobby SANDAG jointly for key project funding ▪ Intergovernmental Agreements with municipal partners to improve deficient roadways ▪ First development responsible for entire roadway improvements with costs to be shared by subsequent developers
County of Orange, California, Resources and Development Management Department, Road Division		▪ Cost sharing program with adjacent developers ▪ Local and state gas tax and property taxes	▪ Half-width improvements on portion of arterial segment may not meet design standards for roadway functional class	▪ Developer could be required to provide full roadway cross section to meet need shown in traffic impact study ▪ Developer responsible only for sidewalk, curb and gutter, and other amenities on property frontage ▪ Actual roadway striping could meander off centerline to maintain symmetrical travel lanes ▪ Full roadway improvements are not required for aesthetic purposes ▪ Remnant roadway sections become a capital improvement project

Peer County and City Scalloped Street Policy Review				
Transportation Agency	**Improvement Identification and Prioritization**	**Funding Mechanism**	**Key Issues**	**Practices**
City of Phoenix Street Transportation Department	Parameters for identifying and prioritizing improvements to address scalloped streets typically include: ▪ Traffic congestion, ▪ Traffic delay ▪ Safety, ▪ System Continuity and Accessibility and Mobility	▪ City ordinance allows assessment of adjacent property for cost of improving scalloped streets	▪ On-going process to address scallop streets within city jurisdiction ▪ City will not annex unimproved county streets without funding mechanism	▪ Intergovernmental Agreement required for projects crossing city boundary ▪ Interested in partnership with county to address scalloped street improvement issues ▪ Aims to partner with county to improve and annex streets
City of Mesa Transportation Division		▪ City ordinance allows assessment of adjacent property for cost of improving scalloped streets	▪ On-going process to address scallop streets within city jurisdiction	▪ Intergovernmental Agreement required for projects crossing city boundary
City of Peoria Public Works Department		▪ City ordinance allows assessment of adjacent property for cost of improving scalloped streets.	▪ On-going process to address scallop streets within city jurisdiction	▪ Intergovernmental Agreement required for projects crossing city boundary
City of Glendale Transportation Department		▪ Transportation Department sets aside funding to address scalloped street issues	▪ On-going process to address scallop streets within city jurisdiction	▪ Intergovernmental Agreements required for projects crossing city boundary

Major Bridge Policy Review

Maricopa County Department of Transportation

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1.0 OVERVIEW

The purposes of this Major Bridge Policy Report are:

- To provide a listing of bridges recently constructed by MCDOT;
- To identify criteria that should be used to determine when to build structures over major water crossings;
- To provide guidance as to when MCDOT should be involved in bridge building in other jurisdictions; and
- To provide guidance regarding funding for both new and wider bridges.

The MCDOT transportation system is linked to the systems of other transportation agencies, including the Arizona Department of Transportation (ADOT) and the cities and towns under the Maricopa Association of Governments umbrella. Through this linkage, MCDOT currently plays a role in bridge building in other jurisdictions by providing monetary and technical assistance. For instance, there have been a number of cases in which MCDOT assumes the responsibility of the design and construction of a bridge that is annexed by a city or town upon completion. Thus, MCDOT acts as a link within unincorporated regions of the county and as a link between cities.

Upon request, MCDOT provides technical review of a design when a city or town wishes to design and construct the bridge structure. The county may also consider projects requested by cities and towns that have completed Candidate Assessment Reports (CAR), Design Concept Reports (DCR) or fully designed projects for inclusion in the county's Transportation Improvement Program (TIP).

2.0 EXISTING AND PLANNED STRUCTURES

Out of the 440 bridge structures built and maintained by MCDOT, 87 have been constructed within the past 10 years. Tables 1 and 2 list the structures, in chronological order, based on the year built, with the most recently constructed structures at the end. The tables display the roadway carried, the location of the structure, and the feature that is intersected by the bridge. Additionally, the structure number and structure length along with the sufficiency rating are listed for each structure. Table 1 is a compilation of the 11 major bridges (over 200 feet) that have been built, and Table 2 lists the other 76 bridges. There are also 13 MCDOT bridge projects in the planning and design stages. These are listed in Table 3.

It is important to note that only structures with a length over 20 feet are listed in this table, due to the fact that the Federal Highway Administration (FHWA) defines a bridge with the criterion. The Sufficiency Rating for the majority of the structures is above 90, which intuitively makes sense, given that the structures are relatively new.

TABLE 1 Major Bridge Structures Constructed from 1995-2004

Roadway Carried	Structure Number	Feature Intersected	Location	Sufficiency Rating	Year Built	Structure Length
New River Rd	10021	Skunk Creek	0.25 mi W/ 7th Ave	96.87	1995	367
I-17 Frontage Rd	10085	New River	1000' S/ New River Rd	87.71	1996	401
New River Road	10083	Cline Creek Wash	350' N/ Circle Mtn Rd	96.08	1996	221
New River Road	10106	New River	0.25 mi E/ I 17	75.57	1997	407
Riggs Road	10101	E. Maricopa Fldwy	1 mi W/ Higley	98.5	1997	334
Avondale Blvd	10163	Gila River	0.75 mi S/ Southern Ave	99.76	1998	2548
Carefree Hwy EB	10162	Cave Creek Wash	1 mi W/ Cave Creek Rd	96.6	1998	354
Power Road	10390	Queen Creek	0.2 mi S/ Queen Creek Rd	96.05	2002	193
Deer Valley Road	10389	New River	W/ of 75th Avenue	96.68	2003	269
Vistancia Blvd NB	10440	Twin Buttes Wash	1/2 Mi S/W of El Mirage R	96.21	2003	194
Agua Fria Blvd	10396	Agua Fria River	E/ Estrella Blvd	99.25	2004	1256

TABLE 2 Minor Bridge Structures Constructed from 1995-2004

Roadway Carried	Structure Number	Feature Intersected	Location	Sufficiency Rating	Year Built	Structure Length
El Mirage Rd	9949	Dysart Drain	0.5 mi N/ Glendale Ave	98.41	1995	73
7th St	10050	Desert Lake Wash	0.2 mi N/ 7th St/Carefree	95.94	1996	122
Circle Mtn Road	10084	Wash	3437’ E/ New River Rd	76.43	1996	49
Cottonwood Rd	10062	Cottonwood Creek	N Entrance Lk Plant Pk	86.09	1996	60
Germann Road	10087	Eastern Canal	0.25 mi W/ Lindsay Rd	94.61	1996	30
Jackrabbit Trail	10088	RID Canal	0.25 mi N/ Yuma	96.96	1996	35
Lone Mountain Rd	10052	Wash	0.75 mi E/ 227th Ave	98.95	1996	52
Lone Mountain Rd	10053	Wash	0.65 mi E/ 227th Ave	98.95	1996	65
New River Rd	10086	Wash	100' E/ I 17 Frontage	86.77	1996	25
Old US 80	10061	Arlington Valley Wash	0.3 mi S/ 331st Ave	88.55	1996	84
Power Road	10107	Drainage Ditch	just S/ Chandler Hts Rd	80.58	1996	24
164th Street	10102	Drainage Ditch	S Riggs Rd 0.5 mi W/ Higley	97	1997	21
Airport Rd	10126	Buckeye Canal	1 mi N/ MC85	98.81	1997	42
Fort McDowell Rd	10104	Wash	just N/ Yavapai Rd	95.66	1997	44
Higley Road	10103	Drainage Ditch	just S/ Riggs Rd	95.68	1997	21
McKellips Road	10105	Granite Reef Wash	0.5 mi W/ SR 101	97.14	1997	23
Meridian Rd	10108	Wash	0.25 mi N/ McKellips Rd	96.16	1997	52
Williams Field Rd	10213	RWCD Canal	E/ Power Road	97	1997	24
Carefree Highway	10158	Wash	W/ 16th Street	97.16	1998	21
Carefree Highway	10159	Wash	0.5 mi W/ 24th Street	97.16	1998	21
Carefree Highway	10160	Wash	0.25 mi E/ 24th Street	97.16	1998	32
Carefree Highway	10161	Apache Wash	0.5 mi E/ 24th Street	97.16	1998	80
Whitman Drive	10369	Wash	600' E/ Galvin Peak Pkwy	96.85	1998	27
Citrus Road	10229	Wash	just N/ Northern Ave	81.85	1999	21
Deer Valley Road	10238	Drainage Ditch	just E/ 83rd Ave	96.23	1999	21
Forest Rd	10366	Large Wash	1.3 mi N/ McDowell Mtn Rd	99.74	1999	65
Forest Rd	10367	Small Wash	1.4 mi N/ McDowell Mtn Rd	99.74	1999	64
Germann Road	10276	Drainage channel	.25 mi E/ Sossaman Rd	96.31	1999	25
Jomax Road	10274	Wash	.25 mi W/ Grand Ave	96.95	1999	32
MC-85	10230	Bullard Wash	0.3 mi E/ Estrella Pkwy	97.71	1999	103

Roadway Carried	Structure Number	Feature Intersected	Location	Sufficiency Rating	Year Built	Structure Length
Meadowbrook Ave	10242	Wash	W/ Jackrabbit Trail	93.25	1999	32
Minnezona Ave	10241	Wash	W/ Jackrabbit Trl	97	1999	32
Chambers Street	10240	Buckeye Feeder Ditch	0.6 mi S/ Broadway Rd	99	2000	34
Estrella Rdwy (SR 303)	10220	Grand Ave & BNSF Rlrd	Grand Ave & BNSF Rlrd	99.25	2000	536
Gavilan Peak Pkwy	10384	Wash	300 ' N. King Drive	96.7	2000	33
Main St - Gila Bend	10245	Wash	W/ 2nd St - Gila Bend	92.42	2000	29
Main St - Gila Bend	10246	Wash	E/ 2nd St - Gila Bend	92.42	2000	22
Memorial Drive	10385	Wash	600' E of Gavilan Pk Pkwy	81.09	2000	37
Memorial Drive	10386	Wash	1700' E of Gavilan Pk Pkw	81.09	2000	32
Memorial Drive	10388	Split Flow Wash	350' E of Republic Way	81.09	2000	43
Roeser Rd	10239	Buckeye Feeder Ditch	0.5 mi S/ Broadway Rd	99	2000	34
129th Avenue	10368	Drainage Channel	N/ Camelback Rd	96.93	2001	26
El Mirage Rd	10277	Drainage channel	N/ Camelback Rd	95.64	2001	32
Anthem Way	10405	Wash	East of I-17	69.89	2002	47
Clearview Rd	10370	Estrella Frwy-303	at Estrella Fwy Loop 303	96.78	2002	185
Gavilan Peak Pkwy	10397	Wash	W/ Navigation Way	77.53	2002	65
Meridian Drive	10442	Wash	0.45 mi N/ Warner Rd	99.29	2002	21
Mountain Road	10445	Wash	1/4 mi N of Warner Road	84.64	2002	27
96th Street	10444	Wash	1/8 mi N/ Broadway Road	-1	2003	28
Cloud Road	10443	Wash	500' W of 32nd Drive	87.5	2003	24
Mountain View Rd	10371	Estrella Frwy-303	at Estrella Fwy Loop 303	96.83	2003	189
Vistancia Blvd	10438	Wash	1.75 mi SW/ El Mirage Rd	83.41	2003	109
Vistancia Blvd	10439	Wash	0.75 mi SW/ El Mirage Rd	92.12	2003	45
107th Avenue	10524	Wash	0.3 mi S of Estrella Rdwy	99.55	2004	34
Agua Fria Blvd	10458	Wash	1.65 mi W/Lake Pleasant Rd	99.25	2004	55
Agua Fria Blvd	10459	Wash	0.2 mi W/Lake Pleasant Rd	99.25	2004	34
Agua Fria Blvd.	10457	Wash	2.06 mi w/ Lake Pleasant Rd	99.25	2004	34
Bethany Home Rd	10512	Wash	200' E of 125th Ave	99.89	2004	28
Clarendon Avenue	10520	Drain Ditch	just W of 195th Avenue	92.38	2004	25
Daisy Mtn Drive	10519	Wash	0.6 mi S of Anthem Way	78.81	2004	60
Estrella Rdwy (SR303)	10446	Wash	2.6 mi NE of Grand Avenue	89.49	2004	21
Estrella Rdwy (SR303)	10452	Wash	2.8 mi NE/ Grand Ave	89.49	2004	21
Estrella Rdwy (SR303)	10453	Wash	3.15 mi NE/ Grand Ave	89.49	2004	21
Estrella Rdwy (SR303)	10454	Wash	4.7 mi NE of Grand Avenue	95.12	2004	119
Estrella Rdwy (SR303)	10455	Wash	0.5 Mi. E/ El Mirage Rd	95.12	2004	42
Estrella Rdwy (SR303)	10456	Wash	1 Mi. E of El Mirage Rd	95.12	2004	24
Hemingway Lane	10518	Wash	just E of Dedication Trail	89.38	2004	26
King Drive	10511	Wash	180' W of Opportunity Way	89.38	2004	36
Missouri Ave	10510	Wash	N of Marshall Ave	84.37	2004	28
Olive Avenue	10516	Wash	160' W of Beardsley Canal	99.81	2004	21
Osborn Road	10517	Drain Ditch	just W of 195th Avenue	92.29	2004	48
Vistancia Blvd	10387	Beardsley Canal	just N/ Jomax Rd	99.21	2004	70
Vistancia Blvd SB	10441	Twin Buttes Wash	1/2 mi S/W of El Mirage R	96.21	2004	114
Wigwam Creek Blvd	10513	Drain Channel	200' SW of 124th Lane	96.89	2004	25
Wigwam Creek Blvd	10514	Drain Ditch	550' NW of Orange Drive	89.38	2004	66
Wigwam Creek Blvd	10515	Drain Ditch	just N of Camelback Rd	89.38	2004	21

Currently there are 13 MCDOT bridge projects in the planning and design stages (see Table 3).

TABLE 3 MCDOT Structures Projects Being Planned

Roadway Carried	Feature Intersected	Status
Riggs Rd	Sonoqui Wash	CAR
Beardsley Road	Agua Fria River	DCR
Deer Valley Road	Agua Fria River	DCR
Desert Hills Dr	Skunk Creek	DCR
Cotton Lane	Gila River	Design
Chandler Heights Rd	Sonoqui Wash	Design
Gilbert Rd	Salt River	DCR
McKellips Rd	Salt River	DCR
Dobson Rd	Salt River	DCR
Olive Ave	Agua Fria River	DCR
Glendale Ave	Aqua Fria River	DCR
Camelback Rd	Aqua Fria River	DCR
Honda Bow Rd	Skunk Creek	DCR

3.0 Decision criteria

There are several factors that should be used to decide when to build structures over major water crossings. The following is a compilation of the decision criteria that should be utilized:

- *Fatal Flaws*:
  - *Regional—Are there jurisdictional issues (e.g. reservation, military) that might preclude construction?*
  - *Local—Are there major issues regarding local connectivity or land use impacts or impacts on public facilities that might preclude construction?*
  - *Site—Are there major issues regarding complex design features (e.g. scour remediation, future loading permit issues, etc) that might preclude a structure at the site?*
- *Consistent with local plans*—Will construction of the structure be consistent with future circulation and land use plans?
- *Construction complexity/feasibility*—Are there undesirable design features or excessive construction constraints (i.e. additional channel work, utility relocation, traffic management, etc)?
- *Improvement of travel continuity for other travel modes*—What improvement will this structure have on improved travel continuity for other travel modes (i.e. pedestrians, cyclists, etc)?
- *Additional right-of-way/land use impact*—Will extensive right-of-way be required to construct the structure?

- *Provides regional travel and mobility*—Does the new structure provide a continuous roadway network for the region?
- *Impact to river channel*—Will there be adverse channelization impacts to the river?
- *Utility impacts*—What level of complexity and cost are associated with relocating or bypassing the impacted utilities?
- *Public support*—What is the level of public support by the local community?
- *Benefit/Cost ratio*—Does the project have a benefit/cost ratio greater than 1.0?
- *Volume/Capacity (V/C) ratio*—Will the surrounding transportation infrastructure (i.e. arterials) handle the increased traffic flow?

4.0 ISSUES AND POLICY OPTIONS

This report aims to provide guidance as to when MCDOT should be involved in bridge building in other jurisdictions, as well as guidance regarding the funding of both new and wider bridges.

In addressing these issues, the following questions should be considered:

Is MCDOT currently involved in building bridges in other jurisdictions?

MCDOT sometimes provides monetary or technical assistance to other jurisdictions. MCDOT has in some cases has assumed the responsibility for the design and construction of a bridge that is annexed by a city or town upon completion. In situations where a city or town has elected to design and construct a bridge, MCDOT has, upon request, provided technical design review.

Is there a need for a governmental agency to become involved in oversight?

The need for oversight by a governmental agency would be clearly established if there were either catastrophic failures of bridges or major maintenance issues that were created due to sub-standard design of the bridge. These problems do not appear to exist, however.

Do the communities want assistance from MCDOT in preparing plans for bridges in their communities?

Looking into the future, there is significant projected growth over the next 25 years with considerable expansion being planned in the communities of Avondale, Buckeye, El Mirage, Glendale, Goodyear, Peoria, Queen Creek, and Surprise, among others. None of these communities have the necessary expertise to provide oversight services for bridge design and construction. Thus, there may be a desire for County assistance.

What would be the impact on MCDOT resources if MCDOT does assume a larger role?

If MCDOT were to provide oversight services for, say, eight bridges per year, additional staff resources would be required (perhaps one person half-time).

If MCDOT were to take on a greater role in the construction of bridges in local jurisdictions, the impact on the Department's budget may be significant, but difficult to quantify. Fewer resources would be available for non-bridge projects, unless new funding sources were secured.

What role have developers played in bridge building?

Most bridges that have been built in the past ten years have been built by developers, who typically hire consultants to design the bridges. Some local communities review developer designs for conformance with applicable code provisions, while others hire a consultant to check the design.

Should MCDOT maintain its current practices regarding bridges?

Currently, MCDOT conducts studies on bridge needs, and funds new bridges and improvements to existing bridges only when demand warrants and local funding partners exist. This practice should continue.

An alternate practice would be to earmark funds specifically for bridge projects in each year's Transportation Improvement Program. Further investigation of this practice may be worthwhile.

Interim Intersection Improvements Policy Review

Maricopa County Department of Transportation

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1.0 INTRODUCTION

The objective of this working paper is to review current MCDOT policy related to the implementation of intersection improvements as an interim measure to provide capacity enhancements on existing roadways. It will review policy options and provide policy options.

2.0 CURRENT POLICY

While there currently are no formal MCDOT guidelines or policies governing the implementation of intersection improvements versus full roadway widening, MCDOT generally recognizes the benefit of increasing capacity at intersections in advance of general roadway widening where intersections act as system bottlenecks and funding is not available for an ultimate roadway improvement. The current MCDOT Traffic Management policy focuses on continuously identifying and addressing problem areas to optimize traffic flow and address safety concerns.

3.0 POLICY DISCUSSION

3.1 Literature Review

A brief literature review showed that there is a lack of widely accepted references addressing the issue of specific benefits of intersection improvements versus general roadway widening. However, transportation agencies do typically provide intersection improvements to increase capacity at congested arterial/arterial intersections.

3.2 Travel Time Benefits Research

Without specific data on the benefits of intersection improvements versus general roadway widening, preliminary research was undertaken to compare the travel time benefits of two improvement alternatives. This research, which is detailed in Appendix A, used the traffic microsimulation tool CORSIM to measure cumulative travel time across a three-mile corridor under six separate cross-section and intersection lane configuration combination scenarios.

The research looked first at a highly congested two-lane corridor. Travel time analysis was performed for the corridor, both with interim intersection improvements and full segment widening, to provide four continuous travel lanes. Corridor travel times and estimated improvement costs for each of the improvement alternatives were compared to the no-build two-lane scenario.

Next, the research looked at a highly congested four-lane corridor. Travel time analysis was performed for the corridor, both with interim intersection improvements and full segment widening, to provide six continuous travel lanes. Corridor travel times and estimated improvement costs for each of the improvement alternatives were compared to the no-build four-lane scenario.

The findings of this preliminary network configuration/alternative improvement analysis suggest that the benefits obtained from "intersection improvements only" on an over-capacity facility could result in significant travel time savings with a relatively modest capital investment. The findings point to a greater potential benefit when intersection improvements are done on a two-lane roadway as compared to a four-lane facility. While these findings provide planning level guidance that is consistent with the MCDOT Traffic Management experience,[1] there are many real world variables, which would vary from site to site, that could not be incorporated into the generalized analysis.

3.3 Additional Variables

While the travel time analysis suggests that interim intersection improvements could be a cost-effective way to add capacity to a deficient corridor, there are numerous variables that differ from case to case, including corridor length, traffic signal settings, major trip generators between intersections, and traffic safety issues. Moreover, intersection improvement cost is heavily influenced by site conditions such as irrigation ditches, utilities, well sites, and right-of-way needs.[2] Any of these variables in combination or alone could tip the balance for or against the efficacy of interim intersection improvements on a given corridor.

Other considerations include the risk of constructing the ultimate intersection footprint without full understanding of whether the profile or other physical improvements will match the ultimate roadway improvement. In some cases, intersection widening improvements may be thrown away when the roadway is eventually widened to its ultimate cross section. Potential cost contributions from future developments to improve an intersection are another factor to weigh.

4.0 SUMMARY AND OPTIONS

Initial research conducted for this policy paper indicates that interim intersection improvements ahead of general roadway improvements are potentially a cost-effective solution to the current and on-going demand for additional network capacity and improved mobility needs. MCDOT Traffic Management experience, combined with this research, clearly demonstrates that, from a policy perspective, where there is a near-term need, the "intersection improvements only" option merits consideration especially where limited funding is available for improvements on multiple corridors.

Therefore, a prudent policy option may be for MCDOT to specify that its design concept reports (DCRs) should consider interim intersection improvements in the matrix of potential capacity solutions together with general segment widening. This would allow the benefit-cost of each potential application to be considered in the context of corridor traffic demand and local site conditions.

[1] Nicolaas Swart, Maricopa County Department of Transportation, Email correspondence, Phoenix, Arizona, 13 April 2006.
[2] Ibid.

Appendix A: Interim Intersection Improvements Travel Time Benefit Analysis

Maricopa County Department of Transportation

June 2006

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Appendix A-1 – Scenario Traffic Flow Assumption

INTRODUCTION

Over the next decade, MCDOT will be faced with the need to provide capacity enhancements to many of its existing roadways. Roadway capacity enhancements can include reconstruction, realignment, roadway widening, intersection improvements, roadway extensions, or construction of new facilities.

This study focuses only on the potential travel time benefits of implementation of intersection improvements, roadway segment widening, or a combination of both. Many times, interim intersection improvements are made to provide temporary relief to an over-capacity roadway in advance of the availability of funding necessary to implement full roadway segment widening. The objective of this policy paper is to quantify the benefits of roadway widening versus implementation of interim intersection improvements and develop options for identifying which type of improvement strategy may be preferred for a given roadway condition.

Roadway widening analysis is limited to the construction of additional lanes on an existing facility and does not include reconstruction of existing travel lanes. The following sections detail the methodology used to assess improvement benefits, the results of the analysis, and a Comparative Travel Time Savings assessment based on the analysis results.

METHODOLOGY

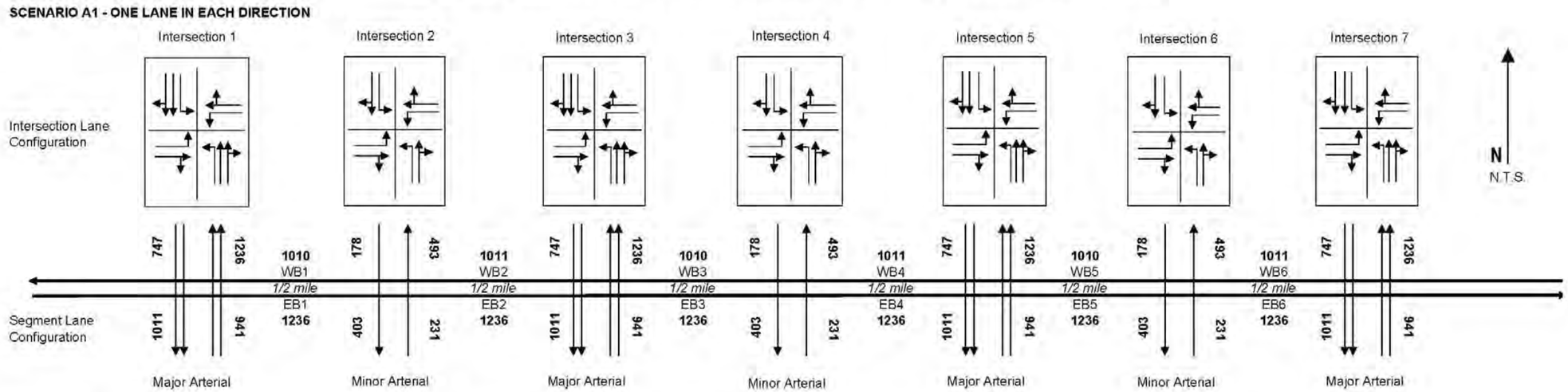
A three-mile sample corridor comprised of both major arterial and minor arterial crossings serves as the basis for the analysis. The corridor contains four major intersections and three minor intersections. For purposes of the analysis, eastbound and northbound have been considered as the peak volume directions. In total, six different scenarios were considered. The scenarios were grouped into two subsets, A and B, each containing three mainline facility configuration scenarios (1-3).

The subset A scenarios were based on an existing two-lane roadway with an ultimate classification as a four-lane arterial, with alternating major and minor street crossings every half mile. A volume of 25,000 vehicles per day was assumed to replicate over-capacity conditions for the existing two-lane major roadways (mainline and crossing), with 9% occurring during the peak hour (2,500 vehicles), and a 55% directional split corresponding to peak direction volume of approximately 1,236 vehicles. Left and right turning movements were each assumed to account for approximately 8-16% of the directional volume on the major street approaches. For the minor two-lane roadway crossings, a volume of 10,000 vehicles per day was assumed, with a 9% peak hour and 55% peak directional split corresponding to 493 vehicles in the peak direction. Left and right turning movements on the minor approaches were each assumed to account for

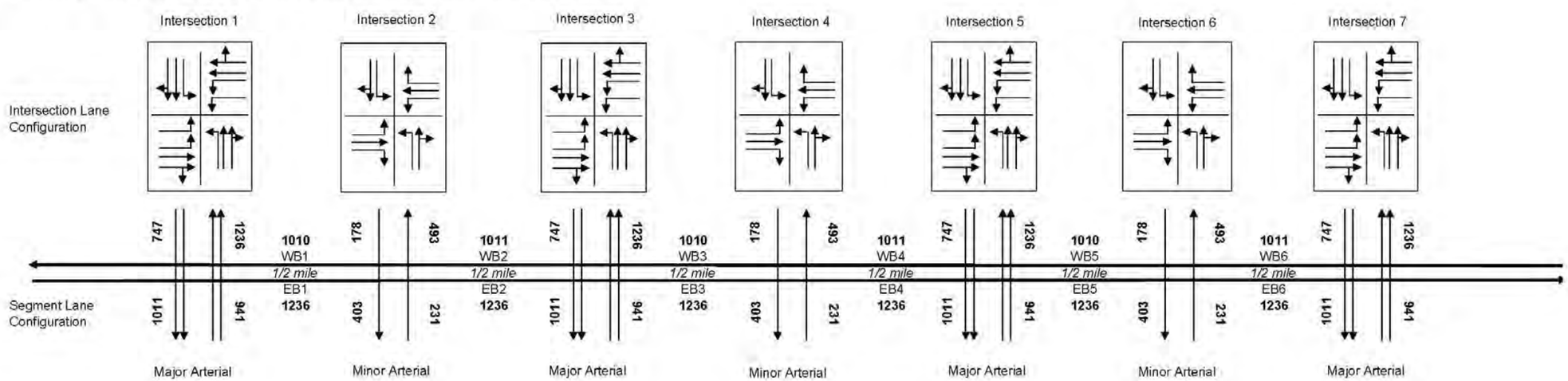
approximately 20-33% of the directional volume. Detailed turn movement assumptions are included in the report Appendix.

Scenario A1 is the existing, base condition with one travel lane per direction and single left turn lanes at the intersections. Scenario A2 includes "improvements to intersections only." Major intersections were improved to an assumed "buildout" geometry, adding a through lane in each of the east and westbound directions of the mainline arterial along with dual left turn lanes on these approaches. Minor intersections were improved by adding a right turn lane in each of the east and west bound directions of the arterial. Scenario A3 consists of both the intersection improvements and the roadway widening. Intersection turn lanes were consistent with the Scenario A2 assumptions, but in Scenario A3 two travel lanes are provided in the east and westbound directions throughout the three-mile corridor. Figure 1 provides a diagram of the assumed geometrics associated with each scenario A1-A3.

FIGURE 1: SCENARIO A1 - A3 GEOMETRIC AND PEAK HOUR VOLUME ASSUMPTIONS



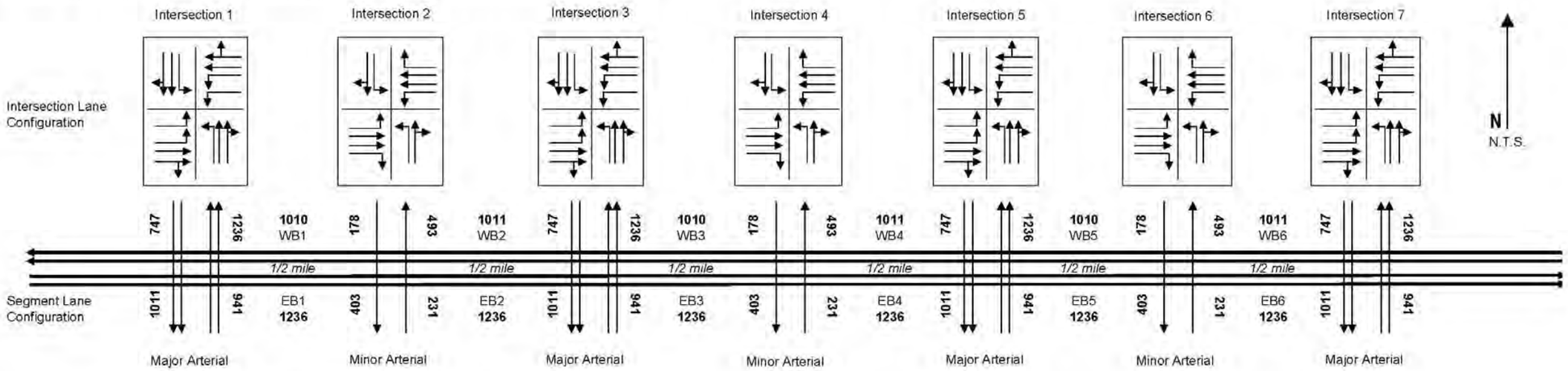
SCENARIO A2 - ONE LANE IN EACH DIRECTION WITH INTERSECTION IMPROVEMENTS ONLY



Source: Wilson Company, January 30, 2006.

FIGURE 1: SCENARIO A1 - A3 GEOMETRIC AND PEAK HOUR VOLUME ASSUMPTIONS (Continued)

SCENARIO A3 - TWO LANES IN EACH DIRECTION WITH INTERSECTION & ROADWAY IMPROVEMENTS



Note: XXX - Peak Hour Directional Segment Volumes

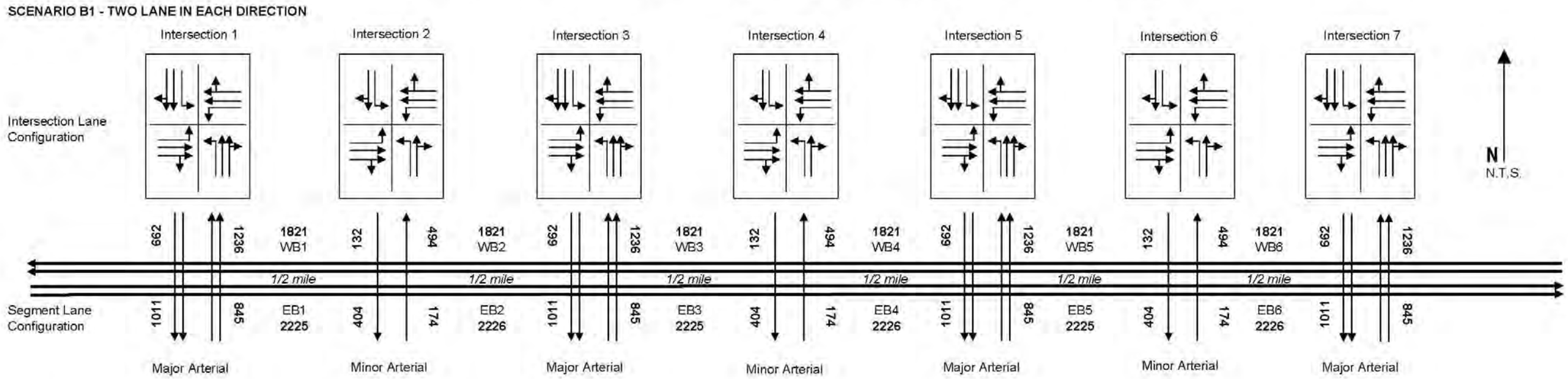
Source: Wilson Company, January 30, 2006.

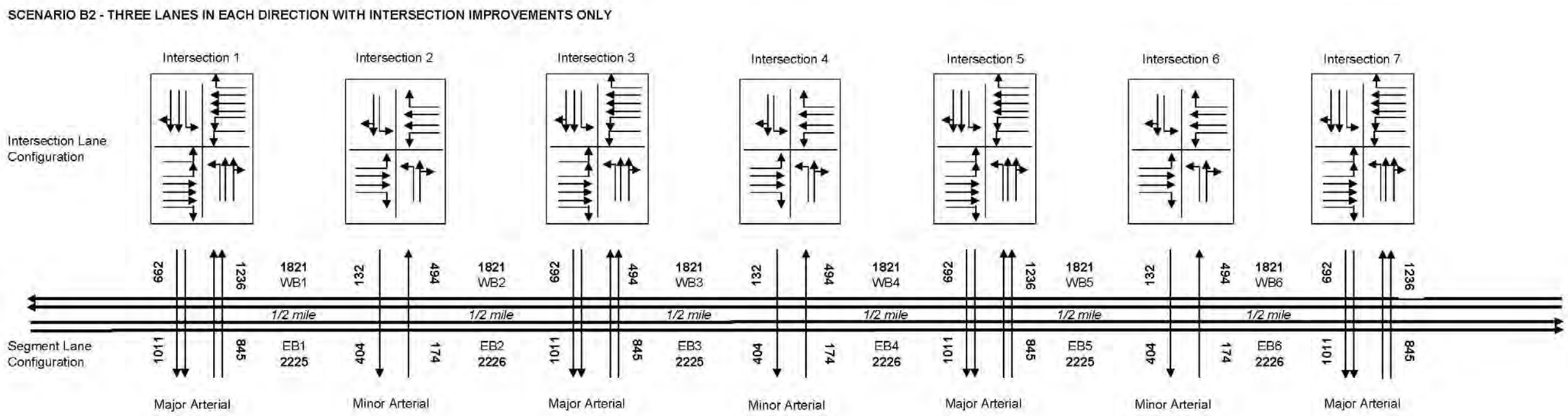
The subset B scenarios were based on an existing four-lane roadway with an ultimate classification as a six-lane arterial, with alternating two-lane major and minor street crossings every half mile. A volume of 45,000 vehicles per day was assumed to replicate over-capacity conditions for the existing four-lane major roadway, with 9% occurring during the peak hour (4,050 vehicles), and a 55% directional split corresponding to peak direction volume of approximately 2,226 vehicles. Left and right turning movements were each assumed to account for approximately 6-11% of the directional volume on the mainline approaches. For the major two-lane crossing roadways a volume of 25,000 vehicles per day was assumed, with a 9% peak hour and a 55% directional split corresponding to a peak direction volume of approximately 1,236 vehicles. Left and right turning movements on the major crossing approaches were each assumed to account for approximately 12-22% of the directional volume. For the minor two-lane roadway crossings a volume of 10,000 vehicles per day was assumed, with a 9% peak hour and 55% peak directional split corresponding to 493 vehicles in the peak direction. Left and right turning movements on the minor approaches were each assumed to account for approximately 24-41% of the directional volume. Detailed turn movement assumptions are included in the report Appendix A.

Scenario B1 is the existing, base condition with two travel lanes per direction and single left turn lanes at the intersections. Scenario B2 includes "improvements to intersections only." Major intersections were improved to their ultimate geometry, adding a through lane in each of the east and westbound directions of the arterial along with a single right turn lane and dual left turn lanes on these approaches. Minor intersections were improved by adding a right turn lane in each of the east and west bound directions of the arterial. Scenario B3 consists of both the intersection improvements and the roadway widening. Intersection turn lanes were consistent with the Scenario B2 assumptions, but in Scenario B3, three travel lanes are provided in the east and westbound directions throughout the three-mile corridor. Figure 2 provides a diagram of the assumed geometrics associated with each scenario B1-B3.

A scenario examining improvements to an existing two-lane roadway with an ultimate classification as a six-lane arterial was considered less practical compared to scenarios A or B. This is largely due to the fact the it does not appear feasible to accommodate a six-lane demand volume on a two-lane facility even with full intersection improvements. Further, the amount of distance required to accommodate the tapers downstream and upstream of the intersections to add and delete lanes could amount to a de facto roadway widening. Finally, this type of treatment may not meet be consistent with typical driver expectancies related to the addition and deletion of travel lanes on an arterial roadway in the vicinity of major signalized intersections. Due to these concerns and potential safety considerations, the scenarios tested focused on conditions that would only add or drop single lanes.

FIGURE 2: SCENARIO B1 - B3 GEOMETRIC AND PEAK HOUR VOLUME ASSUMPTIONS

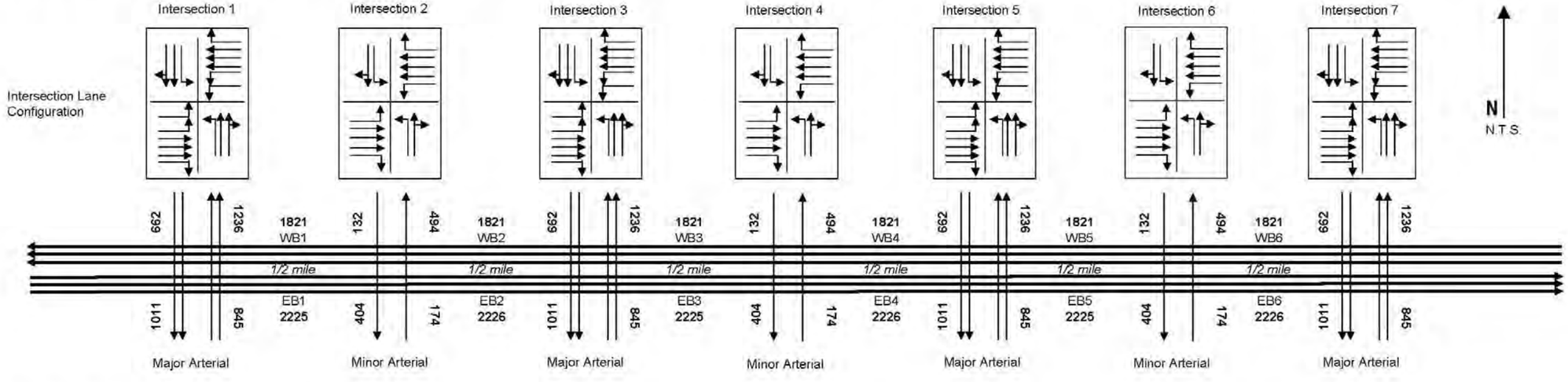




Source: Wilson Company, January 30, 2006.

FIGURE 2: SCENARIO B1 - B3 GEOMETRIC AND PEAK HOUR VOLUME ASSUMPTIONS (Continued)

SCENARIO B3 - THREE LANES IN EACH DIRECTION WITH INTERSECTION & ROADWAY IMPROVEMENTS



Note: XXX - Peak Hour Directional Segment Volumes

Source: Wilson Company, January 30, 2006.

FINDINGS

The intersection signal timings for each scenario were optimized using the SYNCHRO analysis software. Cycle length and signal phasing were kept constant between scenarios. The cycle length for the 'A' scenario was 80 seconds. The cycle length for the 'B' scenario was 100 seconds. The resultant files were then exported to the CORSIM analysis software to simulate the travel conditions under each roadway scenario. Total travel time, total delay, and average speed were derived from the CORSIM output data for each scenario. The resulting measures of effectiveness (MOEs) are summarized in Figures 3 and 4 for the subset A and B scenarios, respectively. MOEs are provided on a segment basis as well as a system basis for each scenario.

Total corridor travel time was selected as the key MOE because it includes the effect of all types of traffic delay. Table 1 summarizes the results of the analysis for Scenarios A1-A3. As indicated in Table 1, the intersection improvements results in roughly a 19% improvement in travel time system-wide. Intersection improvements in combination with roadway widening results in roughly a 68% improvement in travel time system-wide.

Table 1
Summary of Average Travel Time Improvement
Scenarios A1-A3

Scenario	Westbound		Eastbound		System Average	
	Travel Time[1]	% Change[2]	Travel Time[1]	% Change[2]	Travel Time[1]	% Change[2]
A1	1,746	-	2,092	-	1,919	-
A2	1,374	21.3%	1,741	16.8%	1,558	18.8%
A3	597	65.8%	620	70.4%	609	68.3%

Source: Wilson & Company, January 30, 2005

1. Seconds of total travel time per vehicle
2. Percent change as compared to the no-build conditions (A1)

The analysis results of Scenarios B1-B3 are summarized in Table 2. As indicated in Table 2, the intersection improvements results in roughly a 2.5% improvement in travel time system-wide. Intersection improvements in combination with roadway widening results in roughly a 42.5% improvement in travel time system-wide.

Table 2

Summary of Average Travel Time Improvement
Scenarios B1-B3

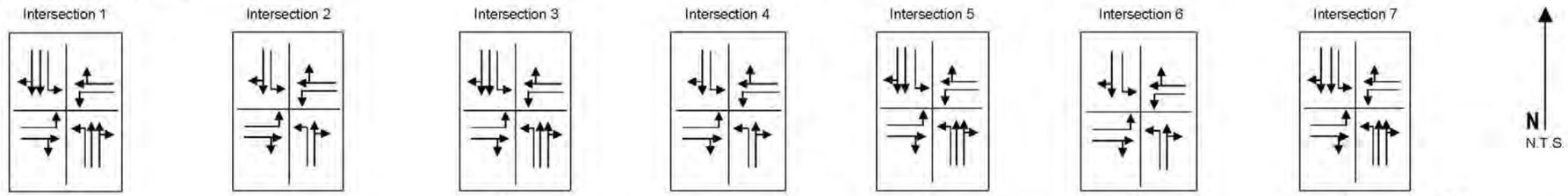
Scenario	Westbound		Eastbound		System Average	
	Travel Time[1]	% Change[2]	Travel Time[1]	% Change[2]	Travel Time[1]	% Change[2]
B1	1,063	-	1,162	-	1,113	-
B2	1,026	3.5%	1,142	1.7%	1,084	2.5%
B3	633	40.5%	647	44.3%	640	42.5%

Source: Wilson & Company, January 30, 2005

1. Seconds of total travel time per vehicle
2. Percent change as compared to the no-build conditions (B1)

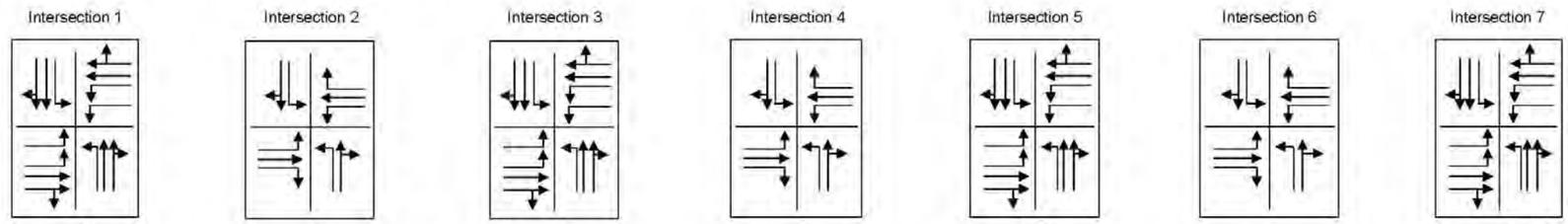
FIGURE 3: SUMMARY OF FINDINGS FOR A1-A3

SCENARIO A1 - ONE LANE IN EACH DIRECTION



	Intersection 1	Intersection 2	Intersection 3	Intersection 4	Intersection 5	Intersection 6	Intersection 7	System Statistics
WB	Average Speed[1] 7.9	Average Speed[1] 5.3	Average Speed[1] 9.4	Average Speed[1] 5.4	Average Speed[1] 9.3	Average Speed[1] 3.9		Average Speed[1] 6.9
	Total Delay Time[2] 169.1	Total Delay Time[2] 284.0	Total Delay Time[2] 134.0	Total Delay Time[2] 279.0	Total Delay Time[2] 134.8	Total Delay Time[2] 402.5		Total Delay Time[2] 1403.4
	Total Travel Time[3] 227.7	Total Travel Time[3] 340.1	Total Travel Time[3] 192.4	Total Travel Time[3] 334.8	Total Travel Time[3] 192.9	Total Travel Time[3] 458.1		Total Travel Time[3] 1746.0
	WB1	WB2	WB3	WB4	WB5	WB6		
	1/2 mile	1/2 mile	1/2 mile	1/2 mile	1/2 mile	1/2 mile		
	EB1	EB2	EB3	EB4	EB5	EB6		
EB	Average Speed[1] 4.3	Average Speed[1] 5.9	Average Speed[1] 4.1	Average Speed[1] 5.9	Average Speed[1] 4.4	Average Speed[1] 8.3		Average Speed[1] 5.5
	Total Delay Time[2] 362.1	Total Delay Time[2] 251.0	Total Delay Time[2] 384.6	Total Delay Time[2] 246.9	Total Delay Time[2] 351.7	Total Delay Time[2] 159.2		Total Delay Time[2] 1755.5
	Total Travel Time[3] 417.2	Total Travel Time[3] 306.9	Total Travel Time[3] 439.9	Total Travel Time[3] 302.9	Total Travel Time[3] 407.5	Total Travel Time[3] 217.3		Total Travel Time[3] 2091.7
	Major Arterial	Minor Arterial	Major Arterial	Minor Arterial	Major Arterial	Minor Arterial	Major Arterial	

SCENARIO A2 - ONE LANE IN EACH DIRECTION WITH INTERSECTION IMPROVEMENTS ONLY

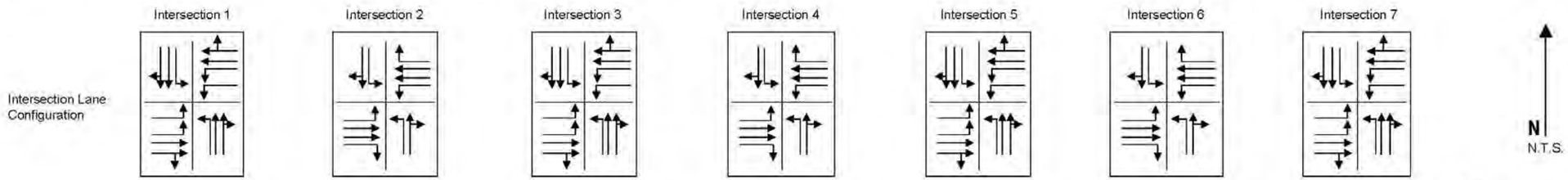


	Intersection 1	Intersection 2	Intersection 3	Intersection 4	Intersection 5	Intersection 6	Intersection 7	System Statistics
WB	Average Speed[1] 17.3	Average Speed[1] 6.7	Average Speed[1] 16.8	Average Speed[1] 6.5	Average Speed[1] 16.6	Average Speed[1] 3.5		Average Speed[1] 11.2
	Total Delay Time[2] 44.9	Total Delay Time[2] 210.1	Total Delay Time[2] 47.7	Total Delay Time[2] 219.8	Total Delay Time[2] 49.3	Total Delay Time[2] 453.9		Total Delay Time[2] 1025.7
	Total Travel Time[3] 104.3	Total Travel Time[3] 267.0	Total Travel Time[3] 107.1	Total Travel Time[3] 276.9	Total Travel Time[3] 108.7	Total Travel Time[3] 510.2		Total Travel Time[3] 1374.1
	WB1	WB2	WB3	WB4	WB5	WB6		
	1/2 mile	1/2 mile	1/2 mile	1/2 mile	1/2 mile	1/2 mile		
	EB1	EB2	EB3	EB4	EB5	EB6		
EB	Average Speed[1] 3.4	Average Speed[1] 11.2	Average Speed[1] 4.4	Average Speed[1] 11.8	Average Speed[1] 4.6	Average Speed[1] 17.6		Average Speed[1] 8.8
	Total Delay Time[2] 466.3	Total Delay Time[2] 102.5	Total Delay Time[2] 354.0	Total Delay Time[2] 94.4	Total Delay Time[2] 335.2	Total Delay Time[2] 42.9		Total Delay Time[2] 1395.4
	Total Travel Time[3] 522.5	Total Travel Time[3] 160.9	Total Travel Time[3] 410.3	Total Travel Time[3] 152.9	Total Travel Time[3] 391.6	Total Travel Time[3] 102.4		Total Travel Time[3] 1740.5
	Major Arterial	Minor Arterial	Major Arterial	Minor Arterial	Major Arterial	Minor Arterial	Major Arterial	

Source: Wilson Company, January 30, 2006.

FIGURE 3: SUMMARY OF FINDINGS FOR A1-A3 (Continued)

SCENARIO A3 - TWO LANES IN EACH DIRECTION WITH INTERSECTION & ROADWAY IMPROVEMENTS

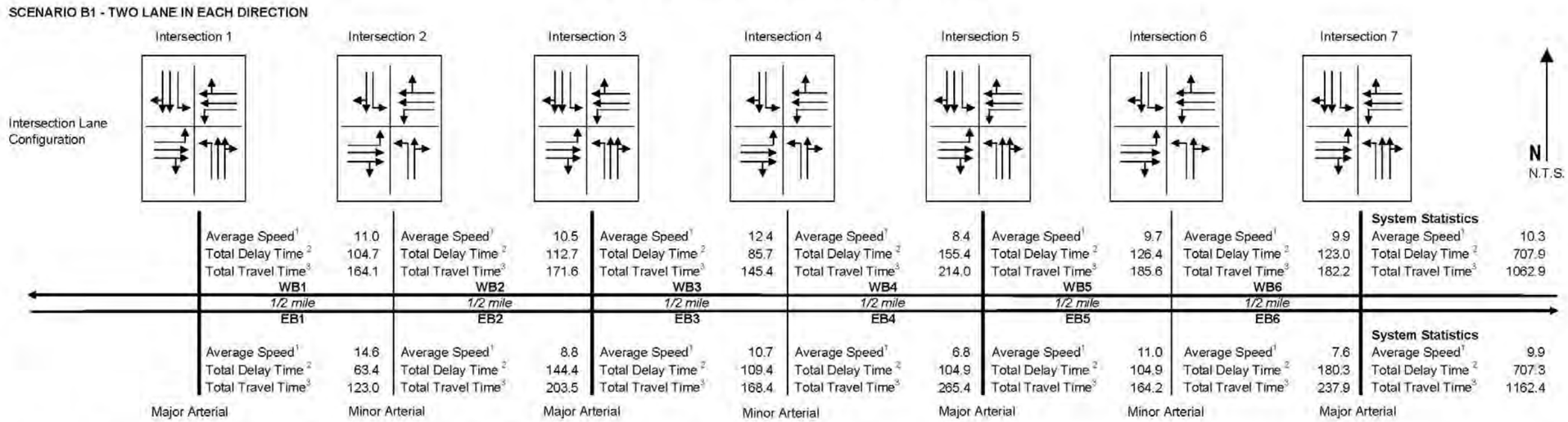


	Intersection 1	Intersection 2	Intersection 3	Intersection 4	Intersection 5	Intersection 6	Intersection 7	System Statistics
Average Speed[1]	17.2	19.6	17.1	19.4	16.6	19.1		18.2
Total Delay Time[2]	45.1	32.86	46.08	33.56	48.92	34.92		241.4
Total Travel Time[3]	104.37	92.01	105.49	92.72	108.3	94.16		597.1
WB1	WB2	WB3	WB4	WB5	WB6			
1/2 mile	1/2 mile	1/2 mile	1/2 mile	1/2 mile	1/2 mile			
EB1	EB2	EB3	EB4	EB5	EB6			
Average Speed[1]	18.4	16.6	18.7	16.3	18.5	16.4		17.5
Total Delay Time[2]	38.47	49.03	36.93	51.02	38.16	50.63		264.2
Total Travel Time[3]	97.66	108.38	96.06	110.36	97.31	109.9		619.7
Major Arterial	Minor Arterial	Major Arterial	Minor Arterial	Major Arterial	Minor Arterial	Major Arterial		

Notes: 1. Average Speed: Miles per Hour. Based on an average of 10 different CORSIM network evaluations.
2. Total Delay Time: Seconds/Vehicle. Total Delay per Segment based on an average of 10 different CORSIM network evaluations.
3. Total Travel Time: Seconds/Vehicle. Total travel time per segment based on an average of 10 different CORSIM network evaluations.

Source: Wilson Company, January 30, 2006.

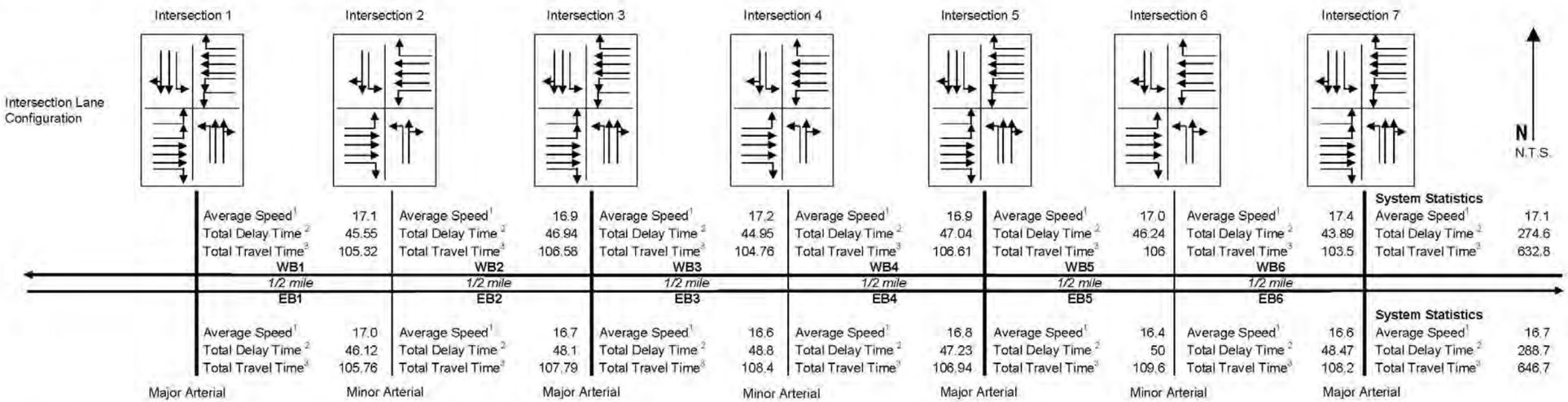
FIGURE 4: SUMMARY OF FINDINGS FOR B1-B3



Source: Wilson Company, January 30, 2006.

FIGURE 4: SUMMARY OF FINDINGS FOR B1-B3 (Continued)

SCENARIO B3 - THREE LANES IN EACH DIRECTION WITH INTERSECTION & ROADWAY IMPROVEMENTS



Notes: 1. Average Speed: Miles per Hour. Based on an average of 10 different CORSIM network evaluations.
2. Total Delay Time: Seconds/Vehicle. Total Delay per Segment based on an average of 10 different CORSIM network evaluations.
3. Total Travel Time: Seconds/Vehicle. Total travel time per segment based on an average of 10 different CORSIM network evaluations.

Source: Wilson Company, January 30, 2006.

A comparison of the results from Tables 1 and 2 indicates that a substantially greater benefit is derived from the combination of intersection improvements and roadway widening, as would be anticipated. It is interesting to note, however, that while the intersection improvements alone result in roughly a 19% improvement in travel time for a two-lane facility; similar improvements to a four-lane facility produce much more marginal results, with only a 2.5% decrease in travel time.

Comparative Travel Time Savings

A planning-level evaluation was conducted to quantify the value of the time savings earned from each improvement concept in the context of the improvement costs. This evaluation is based on two key variables:

- Estimated improvement costs for each scenario
- The value of the time saved for each improvement scenario, as compared to the no action alternative

Estimated Improvement Costs

Roadway unit costs from engineers' estimates from recently completed projects were used to assign an estimated improvement cost for each scenario. The estimated improvement cost in current dollars for each scenario is shown in Table 3. These costs assume only widening of an existing facility in terms of additional lanes, and do not account for reconstruction of existing travel lanes.

Table 3
Estimated Improvement Costs by Scenario*

Scenario	Improvement Costs ($ Thousands)		
	Eastbound	Westbound	Total
A1	-	-	-
A2	$880	$880	$1,760
A3	$8,120	$8,120	$16,240
B1	-	-	-
B2	$1,200	$1,200	$2,400
B3	$8,440	$8,440	$16,880

Source: CK Engineering and Wilson & Company, January 2006.

* Costs are for construction of additional lanes and do not include reconstruction of existing travel lanes.

Key Travel Time Assumptions

The value of the time saved for each improvement scenario is based on several key assumptions:

- Value of an hour of travel time is equivalent to 40% of the mean hourly earnings of all workers in the Phoenix-Mesa Metropolitan Statistical Area. Bureau of Labor Statistics data shows that in 2004 the mean hourly wage in the Phoenix-Mesa area was $18.36. The value of time used for this analysis is $7.34 per hour.
- Peak hour represents 30% of total daily travel time savings.
- Analysis conditions represent average daily conditions for a 250-day year that does not include holidays or weekends.
- Intersection improvements have a 10 year lifespan and segment improvements have a 20 year lifespan.
- All costs represent current dollars (no factoring for inflation).

Travel time savings and estimated improvement costs were compared for each scenario. Table 4 (pg. 16) summarizes the improvement scenarios. Figure 5 (pg. 17) shows a comparison of the average travel time savings and estimated improvement costs for each alternative. Table 5 (pg. 18) summarizes the Comparative Travel Time Savings for each improvement scenario.

Table 4

Summary of Improvement Scenarios

Scenario 'A' - Two-lane roadway to ultimate four-lane arterial	
A2	Improvements to intersections only. Major intersections were improved to an assumed "buildout" geometry. Minor intersections were improved by adding a right turn lane in each of the east and west bound directions of the arterial.
A3	Intersection improvements consistent with Scenario A2 with two travel lanes provided in east and westbound directions on the 3-mile corridor.
Scenario 'B' - Four-lane roadway to ultimate six-lane arterial	
B2	Improvements to intersections only. Major intersections were improved to an assumed "buildout" geometry. Minor intersections were improved by adding a right turn lane in each of the east and west bound directions of the arterial.
B3	Intersection improvements consistent with Scenario B2 with four travel lanes provided in east and westbound directions on the 3-mile corridor.

Source: Wilson & Company, January 30, 2006

Figure 5

Summary of Average Travel Time Improvements And Estimated Improvement Costs

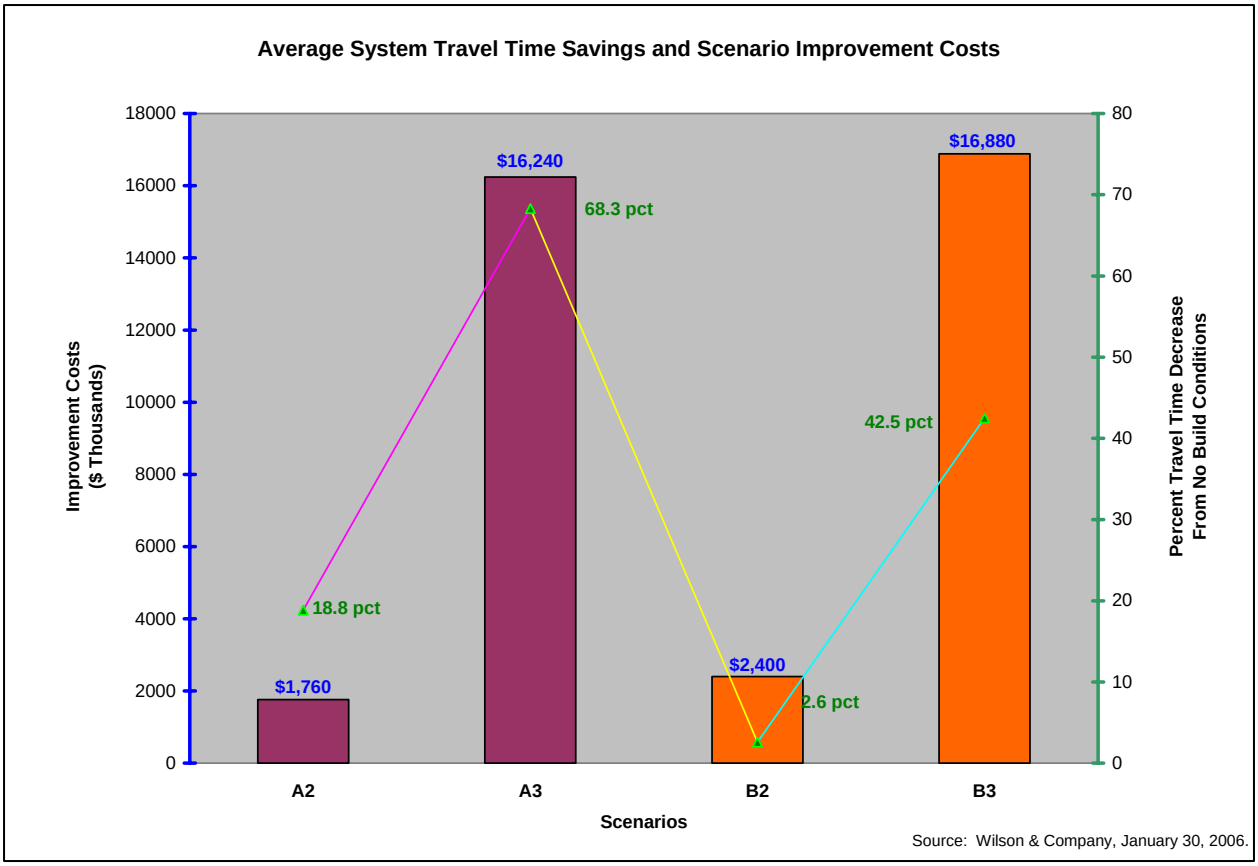


Table 5

Comparative Travel Time Savings Analysis Summary

Variable Description	Scenario			
	A2	A3	B2	B3
Peak Hour Travel Time Savings (Seconds/vehicle)	361	1,310	29	473
Average Daily Traffic Volume	25,000	25,000	45,000	45,000
Peak Hour Volume (9% of daily)	2,250	2,250	4,050	4,050
Total Peak Hour Travel Time Savings (Seconds)	812,250	2,947,500	117,450	1,915,650
Total Peak Hour Travel Time Savings (hours)	226	819	33	532
Peak Hour Savings as Percent of Total	30%	30%	30%	30%
Daily Travel Time Savings (hours)	752	2,729	109	1,774
Annual Travel Time Savings (hours)	188,021	682,292	27,188	443,438
Project Lifetime (years)	10	20	10	20
Lifetime Travel Time Savings (hours)	1,880,208	13,645,833	271,875	8,868,750
Value of Time ($/hour)	7.34	7.34	7.34	7.34
Project Lifetime Savings ($)	13,800,729	100,160,417	1,995,563	65,096,625
Construction Cost ($)	1,760,000	16,240,000	2,400,000	16,880,000
Comparative Travel Time Savings*	**7.8**	**6.2**	**0.8**	**3.9**

Source: Wilson & Company, February 6, 2006

* Comparative Travel Time Savings is the ratio of Project Lifetime Savings to Construction Cost

Findings

Based on observations from Figure 5 and Table 5, under some scenarios phased arterial improvements to "intersections only" could provide potential travel time benefits. For example, Scenario A2, which adds "intersection improvements" only to an existing over-capacity two-lane facility, has the best comparative travel time savings. On the other hand, Scenario B2, which adds intersection improvements to an existing over-capacity four-lane arterial, has the lowest planning-level comparative travel time savings.

4.0 Summary and options

The findings of this preliminary network configuration/alternative improvement analysis suggest that the benefits obtained from "intersection improvements only" on an over-capacity two-lane facility could result in significant travel time savings for MCDOT with a modest capital investment. Conversely, the analysis shows that "intersection improvements only" on a four-lane facility may not provide significant travel time savings as compared to the travel time savings achieved by full segment widening of a four-lane arterial to a six-lane arterial.

While this analysis provides preliminary planning-level guidance, more detailed study would be required to develop the engineering criteria for justifying intersection improvements only. Certain individual roadway situations may preempt strategies for "intersection improvements only." These may include roadways where the proximity of the intersections would result in the overlap of transitions from back-to-back intersection widening, or when forecast volumes of adjacent development projects vastly overwhelm the existing roadway capacity. Therefore, each potential application should be studied on a case-by-case basis to consider such issues as functional classification, future traffic growth potential along the corridor, traffic operations and safety concerns.

The technical analysis documented in this Appendix demonstrates that the potential benefits of implementing intersection improvements at key arterial-arterial intersections could be considered as an interim strategy to increase the carrying capacity of MCDOT facilities. Additional research and evaluation is required on a corridor-by-corridor basis to confirm the amount of travel time savings that could be achieved based "intersection improvements only" option.

From a policy perspective, the analysis clearly demonstrates that where there is a near-term need, the "intersection improvements only" option merits consideration especially where limited funding is available for improvements on multiple corridors.

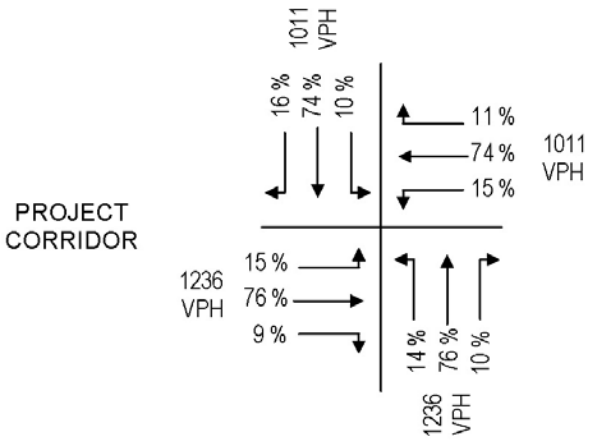
APPENDIX A-1

TRAFFIC FLOW ASSUMPTIONS

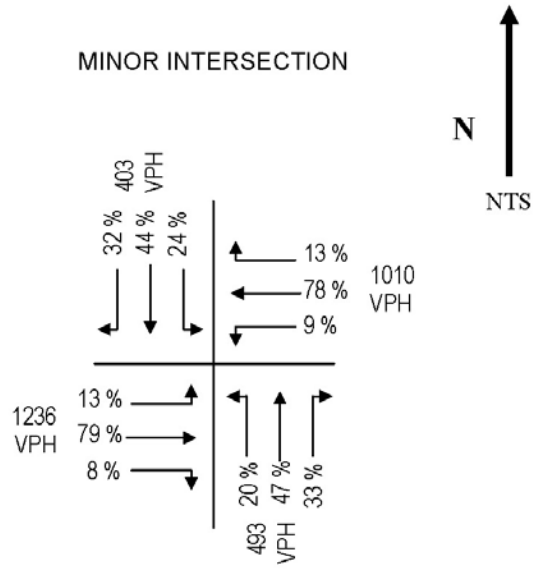
Traffic Flow Assumptions

SCENARIO A

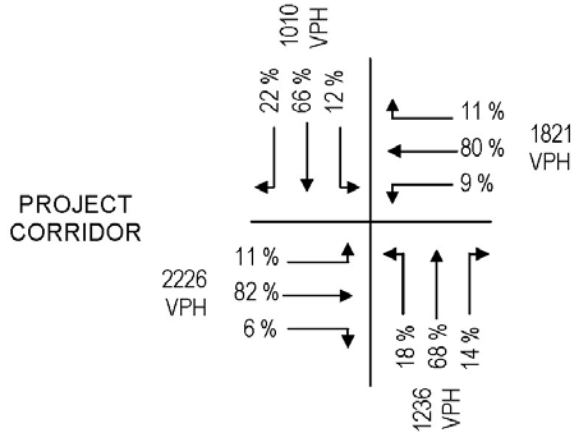
MAJOR INTERSECTION

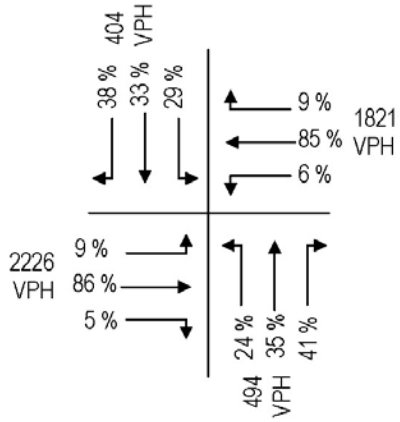


MINOR INTERSECTION



SCENARIO B





MCDOT Role in Regional Transportation Review

Maricopa County Department of Transportation

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1.0 INTRODUCTION

Maricopa County has experienced significant growth over the last 50 years, growing an average of 45 percent per decade from 1960 through 2000. This growth is projected to continue with the population expected to double in the next 25 years.

Through this growth period, MCDOT has found itself operating a dynamic roadway system, constructing new roads and improving old roadways, which, as the area becomes urbanized, are annexed by growing cities and towns in the County. MCDOT has served as a facilitator for the coordinated improvement of arterial streets – e.g. Bell Road – that are located in multiple jurisdictions. Lastly, MCDOT has also served as a protector of right-of-way for a future freeway corridor – Loop 303. MCDOT is responsible for the operations and maintenance of roadway systems located in unincorporated communities around the County – e.g. Sun City and Sun Lakes. With the passage of Proposition 400 in November of 2004, MCDOT has also been thrust into the role of a funding partner on arterial street improvements throughout the region that were included in the Maricopa Association of Governments (MAG) Regional Transportation Plan.

The objective of this paper is to investigate what MCDOTs role in the regional transportation system could be. Questions that have been raised in discussion on this issue include:

- Should MCDOT permanently retain regionally significant corridors in its system? If so, what are the administrative barriers to doing so? What are the associated costs? What corridors would MCDOT want to retain? What criteria should be used to select them? What are the design standards for such corridors? Does the Regional Transportation Plan (RTP) fully identify regional corridors?
- Should a County Highway System be developed? What would that entail? What would be the criteria? Should MCDOT do just Intelligent Transportation Systems or the whole roadway? Would it be the Primary System as currently defined?
- How should MCDOT deal with the issue of retention/annexation of existing roadways?
- What level of investment should MCDOT make in rural unincorporated portions of the County?
- Can the Low Volume Roads (LVR) program process be focused on rural areas?
- What are the regional mobility needs of rural areas?
- Can current rural needs and future urban needs be linked?

2.0 PEER AGENCY REVIEW

To work toward defining MCDOTs role in the region, we contacted other reasonably comparable counties and asked about their role in their respective regions. Summaries of these discussions are presented in this section.

CLARK COUNTY, NEVADA

There appear to be three main differences between Clark County, Nevada and Maricopa County, Arizona:

First, Clark County has a regional gas tax with a Regional Transportation Board that selects and funds roadway projects. Therefore, there are no disputes over annexation and project funding responsibility. The board is comprised of the following members (number of representatives shown in parentheses): Clark County (2), Las Vegas (2), North Las Vegas (1), Henderson (1) and Boulder City (1).

Secondly, there are cooperative annexation agreements between Clark County and Las Vegas. The Strip is unincorporated and the city agrees not to try to annex it, while the County agrees to let the City freely annex to the north.

Finally, Nevada allows townships, which function as taxing districts, to be formed in unincorporated areas. The townships can do certain things such as form flood control districts, or other special districts without being incorporated or annexed. This limits the need for annexation into a city to get city like services.

Given these differences, and the low probability that a Regional Transportation Board will be formed within Maricopa County, it does not appear the Clark County, Nevada experience provides significant guidance in the role that Maricopa County could assume.

CLARK COUNTY, WASHINGTON and WASHINGTON COUNTY, OREGON

The role of counties as providers of "regional" services is fairly well understood within the State of Washington because of their Growth Management Act. Cities are expected to annex urban areas and provide local services. Transportation has both a regional and a local level of service provided to the citizens. The state law automatically transfers jurisdiction of roadways from the county to the appropriate city with annexation. There is some concern that may run counter to the regional nature of transportation.

In contrast, the Washington County, Oregon model requires cities to annex local streets, but leaves the regional facilities - the principal arterial system in the county's hands. In the Portland area, there is an elected regional government known as Metro. Metro has the authority to plan, design, build, and maintain the transportation facilities that serve a regional function -- like the roadways that are not state highways but tie the counties within the region together. The Metro region in the Portland area, as it exists now, is a jurisdictional “patchwork” with respect to control of the roadway system. For example, Washington County which is located on the west side of the region, has played a regional transportation role by effectively retaining control over regional roadways regardless of land use jurisdiction. In the northeast portion of Metro, Multnomah County has transferred transportation responsibilities to the City of Portland or the City of Gresham where annexation has occurred but has retained responsibility for the bridge crossings of the Willamette River which divides downtown Portland. The situation in the third county, Clackamas, is less clear. In Clackamas County, the majority of the development activity has occurred in unincorporated urban areas under the county’s land use jurisdiction so the county is both a provider of local and regional transportation facilities. The Clackamas County situation best resembles that in Clark County, Washington.

Clark County, Washington, has a non-elected planning organization, the Regional Transportation Council (RTC). There was recently a discussion at the RTC Board of Directors about a new regional corridor (that may lead to a "third" or "fourth" Columbia River crossing between Washington and Oregon). While such a regional transportation discussion could be hosted by Clark County, that discussion occurs at the RTC level and not at the county level because the cities do not feel comfortable with the county having the coordinating role in those discussions -- the county acts too much like a local service provider, especially with respect to land use decisions, to be seen by the cities as a regional service provider for transportation.

Clark County has gone back and forth over the years about whether or not the "threat" of annexation is a valid transportation improvement programming criterion (i.e., choosing not to invest transportation dollars in areas where annexation was likely). In one instance, the county staff seriously considered asking the Board of County Commissioners to bond for an improvement when the City of Vancouver was discussing an annexation that would occur shortly after the scheduled completion of those improvements -- the thought being that the debt would transfer proportionally to the city with the assessed value being annexed.

PIMA COUNTY, ARIZONA

Pima County is subject to the same growth issues and development pressure as Maricopa County, and is governed by the same statutes. Major differences occur in the number of municipalities within the County (only five), the role of the County in facilitating regional development, and the level of cooperation between jurisdictions. Pima County has been a trendsetter in constructing major corridors. Many of these corridors were annexed after they were improved, and funded through development exactions and development impact fees. The County provides rural transit services that connect outlying areas with Sun Tran (the local transit service provided by the City of Tucson) and ADA services. Pima County's rural transit service interconnects with Maricopa County's in Ajo, making it possible – for example- to travel from Sells to Phoenix via the interconnection.

In discussions with Pima County, Tucson, and the Pima Association of Governments senior staff, it is apparent that several mutual issues still need to be addressed. These include changes in state law to: (a) simplify the establishment of improvements districts; (b) better control of wildcat development and lot splitting; (c) defining if/how impact fees are transferred between jurisdictions due to annexations and incorporation of unincorporated areas; and (d) the use of community facility districts by Arizona counties.

Maricopa County and now Pima County have been successful in funding roadway and transit improvements through countywide and municipal sales taxes. With the passage of the Regional Transportation Authority (RTA) plan in Pima County, the relationship between the County, other local jurisdictions, and the RTA staff will be evolutionary as the region will need to scramble to accomplish its commitments to the voters. This will also change the role of Pima County by placing the RTA in a position of championing many projects that might otherwise be exclusively County projects. The County recognizes that the passage was critical because the State Legislature is unlikely to raise the gas tax or increase transportation funding for local jurisdictions. Local agencies have already adopted as many funding sources as they can, and there are no viable alternatives to the sales tax option.

Regardless of what happens with annexations, one of the County's major on-going roles will be preservation and advanced acquisition of road right-of-way. This is a particularly onerous task because the location of future corridors has not been defined. As development occurs, it may be possible to exact right-of-way as a rezoning condition, but only when the location is known. This is not an issue along section lines, but many of the new corridors in Pima County are constrained by topography or other physical, cultural, or environmental factors, which takes them off the section line.

Pima County needs to catch up with planning for infrastructure in several areas including the Southwest/Avra/Altar Valley, Green Valley, and the Village of Catalina. These areas are not targeted for near-term annexation, and so the County cannot defer these municipal planning issues for much longer. Pima County is now approaching ADOT for planning support through the Small Area Transportation Studies program for partial funding.

Pima County looks forward to better cooperation from ADOT on issues of urban growth and development. ADOT typically is involved in land use and access issues at the driveway permitting stage, which is far too late in the process. To truly enhance the interaction, changes in state law and State Board of Transportation Policies may be needed.

Like Maricopa County, Pima County and the other jurisdictions are extremely concerned about the implications of suburbanization in the adjacent rural counties. Pima County is being squeezed by development in southern Pinal and northwest Cochise County, and to some degree by northern Santa Cruz County. New residents in these evolving fringe communities will use local arterials to access jobs, employment, and shopping in Pima County. There is no funding from the fringe growth to build new capacity created by the external demand. Cooperation between the counties and MPOs, in additions to new legislation, may be needed to address and resolve the extraterritorial implications of suburbanization.

COUNTY OF SAN DIEGO

Within the County of San Diego, the Department of Public Works (DPW) has responsibility for maintaining and improving the roadway system in the unincorporated portions of the County. The Department of Planning and Land Use (DPLU) is responsible for preparing the Circulation Element of the County's General Plan which identifies the future roadway system, including functional classification, rights-of-way and related design standards.

The unincorporated portions of the County of San Diego include a diverse mix of urban, suburban, and rural communities. For a number of these communities, incorporation remains an option, but is often a volatile local issue. As a result, the County roadway system ranges from lower volume rural collectors to high volume urban arterials.

The San Diego Association of Governments (SANDAG) is the regional planning agency with responsibilities for planning, funding, and implementing regional transportation improvements. The County of San Diego is one of 26 jurisdictions comprising SANDAG and is the primary voice for the unincorporated communities in the County. For the most part, the County is focused on issues within their jurisdiction and participates regionally through SANDAG on broader regional transportation issues. SANDAG is responsible for distributing the region's half-cent sales tax (TransNet), with a portion of that distributed to the County based upon an index which considers population and roadway miles.

As far as involvement in other modes of transportation, up until a couple years ago the County included a Transit Division with responsibilities for planning and implementing rural and suburban transit services. The County no longer performs this role, having relegated the planning responsibilities to SANDAG and operations to the two transit districts in the region – Metropolitan Transit System (MTS) and North County Transit District (NCTD).

The County of San Diego recently implemented a Transportation Impact Fee (TIF) Program to assist in funding needed transportation improvements, with a focus on mitigating the impacts of new growth and development. This TIF varies by subregion, with three separate fee calculations tailored to local conditions.

3.0 MCDOT STAFF INTERVIEWS

In preparing this paper, three members of MCDOT staff were interviewed. Their thoughts, broken into governance and corridor comments, are listed below. This is followed by roles that were identified as roles that MCDOT could fulfill:

GOVERNANCE COMMENTS

The Board of Supervisors would like to be a regional leader in transportation.

Annual MCDOT budget is around $100M, with about half for construction; $1M per lane-mile for design/construction.

Maricopa County (and MCDOT) has the power that the State gives it; Cities are regulated differently and may have sales tax authority.

Cities' attitude toward the County seems to be "give me the money and then go away."

MCDOT should be more flexible in its design standards when dealing with the county/city interface and in county islands in order to facilitate orderly transition; become a cooperative/desirable partner.

MCDOT should be a little freer with money to better serve the people (e.g. aesthetics, additional ROW purchase for access management).

MCDOT should focus on three roles: unincorporated areas, serve smaller communities, contribute to region.

MCDOT needs to develop a "sense of urgency" to complete basic roles.

MCDOT staff needs to take ownership of consultant projects.

MCDOT is a caretaker, not a regional leader.

MCDOT not set up to maintain Sun City type developments.

MCDOT can participate on "enhanced arterial corridors", but does not have the authority to control land use and access – cities have that control.

CORRIDOR COMMENTS

Loop 303 - MCDOT served as a caretaker on 303L in the county areas by preserving the arterial corridor for a future freeway; Some communities felt that MCDOT should be spending less on 303L and more in other areas of the County.

Northern Avenue Super Street – Glendale did DCR; MCDOT will be doing design/construction; maintenance/operations responsibility has not been determined.

Meridian – MCDOT did a corridor study; Mesa will do design/construction.

New Freeway Corridors (e.g. Hassayampa corridors) - MCDOT does not have the expertise nor the funding to conduct freeway location and environmental studies – ADOT does and should take the lead in all freeway corridors. Location/DCR responsibility for freeway corridors could be financially draining on MCDOT.

Bell Road – MCDOT took the lead and helped resolve issues.

Hassayampa Freeways - MCDOT can try to protect alignments in county areas after MAG/ADOT determines location.

Arterial Street Corridors - MCDOT should continue role in corridor planning on arterial streets.

OPTIONS FOR COUNTY ROLE

Serve as a transition agency for rural to urban roadways, constructing and then transferring arterial streets after annexation.

Manage large, multi-jurisdictional arterial projects.

Focus on County's statutory role first, i.e. take care of unincorporated areas in the County.

Ensure adequate service from the State System to smaller communities.

Develop a County Highway system of selected routes that cross jurisdictional boundaries based upon the Roads of Regional Significance system.

Build/maintain/operate County roads in areas that will not incorporate – Sun City, Sun City West, Anthem, Rio Verde, etc.

Conduct location/DCR studies for new freeway corridors.

Provide mobility for Pinal County residents traveling into Maricopa County.

4.0 OTHER JURISDICTIONS STAFF COMMENTS

During our research, we contacted staff at cities and towns in Maricopa County, ADOT, and MAG. Thoughts received from these individuals were:

Work more cooperatively with the cities to jointly fund improvements on County island streets with the goal of the city or town annexing them after improvements are completed; cost share agreement could possibly be based on difference in roadway standards.

Bury the Roads of Regional Significance concept – it will never be implemented.

Identify future high-capacity arterial streets in unincorporated areas and preserve adequate right-of-way and access.

Participate financially (to some undefined extent) in bridges over rivers, major washes, and the CAP canal.

Compliments to MCDOT on outstanding professional and financial support on arterial roadway projects through planning, design, and construction.

Should MCDOT spend less on corridors that are going to be annexed and more on roadways that will remain under its jurisdiction for some time?

Focus on: (1) roads not yet in urbanizing areas of the County; (2) roads in urbanized areas that will probably remain unincorporated; and (3) roads which cross multiple jurisdictions.

Need to move into a transit-provider role, beyond specialized transit.

5.0 MCDOT ROLE DISCUSSION

Before proceeding with what the consultant's perception of what options MCDOTs role in regional transportation should be, we thought it would be beneficial to reflect on the history of transportation in the Valley.

Traditionally the roles for providing the street transportation system in the region have been defined as follows:

Regional freeway planning has historically been done by the Maricopa Association of Governments (MAG) and its predecessor, the Valley Area Traffic and Transportation Study (VATTS). VATTS put together the initial transportation plan for the Valley in 1960. In 1983, MAG undertook a series of studies to update the Regional Transportation Plan (RTP), which resulted in the implementation of the initial one-half cent sales tax in 1986 to fund transportation improvements (primarily freeways) in the region. In 2004, MAG updated the RTP, which is now being funded through an extension of the sales tax. MAG has policy authority over the expenditure of funds generated by the tax. Today MAG is taking the lead to do small area planning throughout the west valley to identify the roadway framework (both arterial and freeway needs) for this area. These studies will identify the first new freeway alignments since some of the studies that were done in the 1960's and 1970's.

Freeway location, construction, and maintenance have historically been the responsibility of ADOT, and its predecessor, the Arizona Highway Department.

The cities and towns in the region have traditionally planned, constructed, and maintained all of the surface streets within their jurisdictions. Some cities have supplemented regional sales tax funds to provide enhancements, such as additional landscaping or traffic interchanges, to the freeway segments traversing their community or, on a loan basis, to provide funding to expedite completion of freeway segments. Before the advent of the sales tax, the City of Phoenix constructed SR-51 from its junction with I-10 to Glendale Avenue before turning the completed freeway over to the State.

The MCDOT, and its predecessor, the County Highway Department, have primarily focused on constructing and maintaining streets in unincorporated areas of the county. Major exceptions have been coordination of the design and construction of Bell Road, and preserving the right-of-way for Loop 303 when regional funding was not available. The rapid pace of growth in the region has resulted in a dynamic system of County roadways with new County or developer constructed roadways entering the County's system as fast as existing roadways are annexed by cities and towns.

The region has gone through some tumultuous times over the years. MAG has been viewed at times with suspicion by the cities and towns, who wanted to make their own transportation decisions without MAG oversight, and by the federal government, which had questioned whether a Regional Council made up of locally-elected officials could truly have a regional perspective. The State Legislature has stepped in and taken an oversight role in the implementation of the RTP because of the slow pace of progress during the early years of the initial sales tax and concerns over whether sales tax dollars are being spent on the most beneficial mode. Maricopa County has at times felt that it provides a more regional representation than any of the cities and towns and thus should take a more active role in regional transportation planning.

It is the opinion of the consultant team, the existing governing system, despite its flaws, has progressed to the point where it has and continues to deliver a regional transportation system that, with the available level of funding, provides for mobility in one of the fastest growing regions in the country.

With this as a background, the consultant team's responses to the seven specific questions raised at the beginning of this paper are presented below:

1. *Should MCDOT permanently retain regionally significant corridors in its system? If so, what are the administrative barriers/costs to doing so? What corridors would MCDOT want to retain? What criteria should be used to select them? What are the design standards for such corridors? Does the RTP fully identify regional corridors?*

The RTP does not identify regional arterial corridors or the Roads of Regional Significance (RRS) concept. The RRS have never progressed beyond the original planning phase. There appears to be little interest in establishing such corridors. In addition, cities and towns control land use and access to the roadway. Unless the municipalities are willing to allow the County to enforce access control or to at least participate in those decisions, allocating limited County funds to just design and construct regionally significant roadways does not make sense.

2. *Should a County Highway System be developed – What would that entail? What would be criteria? Should MCDOT do just ITS or the whole roadway? Would it be the Primary System as currently defined?*

As stated above, there seems to be little interest in establishing regional roads or a County Highway System in urbanized areas. If a County Highway System is developed, it should be developed in unincorporated areas of the County where annexation would seem to be many years away.

3. *How should MCDOT deal with the issue of retention/annexation of existing roadways?*

MCDOT does accept the fact that its roadways are going to be annexed, and encourages annexation in most cases as the area becomes urbanized. MCDOT should thus adopt standards that would provide ROW for an ultimate six-lane roadway, but construct only four lanes unless the annexing jurisdiction is willing to participate in funding the additional two lanes. County roadway standards should be flexible and conform to the city or town standards where the roadway is likely to be annexed.

4. *What level of investment should MCDOT make in rural unincorporated portions of the County?*

In the near term, MCDOT should work closely with cities and towns with a goal of transferring ownership of all County Island roadways to cities and towns. Then the majority of MCDOT funds should be allocated to rural unincorporated areas.

5. *What are the regional mobility needs of rural areas?*

Mobility needs in the rural areas are the need to reach employment, schools, recreational opportunities, and services through a coordinated system of freeways and arterial streets for

motorized vehicles and paved shoulders and bike lanes for bicyclists. In most rural areas, the distances do not support pedestrian travel.

6. *Can current rural needs and future urban needs be linked?*

Yes, through the development of coordinated transportation and land use plans, a rural system of roadways can be planned, sufficient right-of-way for urbanized uses can be preserved, and, within that right-of-way, a transportation system to serve current rural needs can be provided.

6.0 MCDOT ROLE OPTIONS

MCDOT role options in providing the regional transportation system could be as follows:

1. Continue to build, maintain, and operate roads in unincorporated Maricopa County
2. Transition rural roads to urban roads by constructing the right road, at the right time, and at the right cost, and then transfer these streets to the cities and towns.
3. At the request of, and in cooperation with, cities and towns, manage large multi-jurisdictional arterial street projects through the DCR, design, and/or construction.
4. Identify and preserve major street corridors in unincorporated areas of the county to serve regional travel.
5. Continue to identify bridge needs on major waterways, and build partnerships in the design and construction of these bridges.
6. Preserve right-of-way for identified high capacity corridors (enhanced arterials roadways, super streets, parkways, and freeways).

Needs Assessment Based Upon Levels of Service D and E

Maricopa County Department of Transportation

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Needs Assessment Based Upon Levels of Services D and E

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1.0 INTRODUCTION

The Needs Assessment analysis compares projected revenues with projected costs for the years 2006 through 2026. Costs were divided into three categories: Capital Improvement Costs, Operation and Maintenance Costs, and Personnel Services Costs. Capital improvement costs include roadway costs and other capital costs (bridges and other structures, bicycle lanes, etc.). Levels of costs are established based upon needs, not upon available revenues or what MCDOT has spent in the past.

Chapter 4, "Needs Assessment and Options for Securing Additional Revenues," projected Capital Improvement Costs, based upon an assumption of a system-wide Level of Service C. This paper presents the recalculation of the Needs Assessment, based upon achieving and maintaining system-wide Levels of Service of D and E, which changes the projected Capital Improvement Costs. It is assumed that Revenues, Operation and Maintenance Costs, and Personnel Costs remain the same as presented in Chapter 4.

Revenue Estimates

Exhibit 1 reproduces the Revenue Estimates from Chapter 4, Table 4-1. Over the period under review, MCDOT can expect revenues from existing sources of $4.1 billion; $1.5 billion between 2006 and 2015 and almost $2.8 billion between 2016 and 2026. State Shared Revenues, specifically HURF revenues, are the preeminent sources of revenues, accounting for almost $3.7 billion (90%) of projected revenues.

Exhibit 1 MCDOT Revenue Projections, 2006 – 2026

Revenue Source	2006-2015	2016-2026	Total
State Shared Revenues			
State Shared HURF	1,225,400,000	2,164,400,000	3,389,800,000
State Shared Vehicle License Tax	106,400,000	176,500,000	282,900,000
Subtotal State Shared Revenues	1,331,800,000	2,340,900,000	3,672,700,000
Other IGA Revenues	103,680,000	123,750,000	227,430,000
Maricopa County Controlled Revenues			
Licenses/Permits Revenues	19,800,000	22,000,000	41,800,000
Miscellaneous Revenues	16,345,000	19,800,000	36,145,000
Interest Income Revenues	6,230,000	7,150,000	13,380,000
Gain on Fixed Assets Revenues	3,125,000	3,575,000	6,700,000
Subtotal Maricopa County Controlled Revenues	45,500,000	52,525,000	98,025,000
Grant Revenues			
Federal Grant Revenues	40,000,000	44,000,000	84,000,000
Private Revenues			
Developer Contributions Revenues	8,850,000	9,900,000	18,750,000
Total Revenues	1,529,830,000	2,571,075,000	4,100,905,000

Operation and Maintenance Costs and Personnel Services Costs

The Needs Assessment in Chapter 4 assumes average annual Operation and Maintenance Costs of $30,000 per mile of paved road and a net of 2,000 miles of paved roads in the MCDOT maintenance system, translating into annual costs of $60 million per year.

Personnel Costs are assumed to be $30 million per year for the period of 2006 through 2026, to support a staff of 480 people.

Exhibit 2 summarizes these projected costs for 2006 through 2026.

Exhibit 2 Operation and Maintenance/Personnel Services Costs, 2006 - 2026

Cost Category	2006 - 2015	2016-2026	Total
Operations and Maintenance	600,000,000	660,000,000	1,260,000,000
Personnel Services	300,000,000	330,000,000	630,000,000
Total	900,000,000	990,000,000	1,890,000,000

Capital Costs for Levels of Services D and E

The Needs Assessment assumes capital costs of $1,270,000 per lane-mile of construction, plus an additional 25% in costs for "other (non-roadway) capital costs."

Exhibit 3 presents the estimated lane-mile needs for 2006 - 2026 to construct for system-wide LOS D and E. To achieve a system-wide LOS of D would require construction of 2,530 lane-miles, 1,240 lane-miles by 2015 and 1,290 lane-miles by 2026. Achieving LOS E would require 2,180 lane-miles of improvements, 1,010 by 2015 and 1,170 by 2026.

Exhibit 3 Lane-Mile Needs for LOS D and E, 2006 – 2026

	LOS D			LOS E		
Type of Capacity Improvement	2,015	2,026	Total	2,015	2,026	Total
New Arterials	430	380	810	430	370	800
Reconstructed/Rewidening	780	830	1,610	570	750	1,320
Widening	30	80	110	10	50	60
Total lane Miles	1,240	1,290	2,530	1,010	1,170	2,180

Exhibit 4 presents the estimated Capital Costs to achieve LOS D and E, based upon the assumption of $1,270,000/lane-mile and an adjustment in costs of 25% for non-roadway capital needs. Total Adjusted Capital Costs for LOS D are $4.0 billion and are almost $3.5 billion for LOS E.

Exhibit 4 Estimated Capital Costs for LOS D and E, 2006 – 2026

		LOS D		LOS E	
Period	Cost Categories	Lane-Miles/Costs	Adjusted Capital Costs	Lane-Miles/Costs	Adjusted Capital Costs
2015	Lane-Miles Need	1,240		1,010	
	Capital Costs	1,574,800,000	1,968,500,000	1,282,700,000	1,603,375,000
2026	Lane-Miles Need	1,290		1,170	
	Capital Costs	1,638,300,000	2,047,875,000	1,485,900,000	1,857,375,000
Total	Lane-Miles Need	2,530		2,180	
	Capital Costs	3,213,100,000	4,016,375,000	2,768,600,000	3,460,750,000

Exhibit 5 presents total projected costs based upon LOS D and E. based on LOS of D and E, total costs for 2006 – 2026 are estimated at $5.9 billion and $5.4 billion respectively.

Exhibit 5 Total Projected Costs for LOS D and E, 2006 – 2026

	LOS D			LOS E		
Cost Categories	**2006-2015**	**2016-2026**	**Total**	**2006-2015**	**2016-2026**	**Total**
Operations and Maintenance	600,000,000	660,000,000	1,260,000,000	600,000,000	660,000,000	1,260,000,000
Capital Improvement Costs	1,968,500,000	2,047,875,000	4,016,375,000	1,603,375,000	1,857,375,000	3,460,750,000
Personnel Services Costs	300,000,000	330,000,000	630,000,000	300,000,000	330,000,000	630,000,000
Total Needs	**2,868,500,000**	**3,037,875,000**	**5,906,375,000**	**2,503,375,000**	**2,847,375,000**	**5,350,750,000**

Comparative Needs Assessments for LOS D and E

Exhibit 6 presents the Needs Assessments for LOS D and E, and includes the assessment for LOS C for comparative purposes. For the entire period, there is a revenue shortfall of $1.8 billion (30.6%) for LOS D and $1.2 billion (23.4%) for LOS E. These compare to the much larger revenue shortfall for LOS C of $2.9 billion (41.5%).

In all three scenarios, the revenue shortfalls are much larger in the immediate period of 2006 – 2105: $1.3 billion (46.7%) for LOS D and $973.5 million (38.9%) for LOS E. There are revenue shortfalls for the period 2016 to 2026, but they are smaller, 15.4% and 9.7% respectively.

Exhibit 6 Needs Assessments for LOS D, E, and C, 2006 – 2026.

LOS D			
Needs	**2006-2015**	**2016-2026**	**Total**
Operations and Maintenance	600,000,000	660,000,000	1,260,000,000
Capital Improvement Costs	1,968,500,000	2,047,875,000	4,016,375,000
Administrative Costs	300,000,000	330,000,000	630,000,000
Total Needs	**2,868,500,000**	**3,037,875,000**	**5,906,375,000**
Total Revenues	**1,529,830,000**	**2,571,075,000**	**4,100,905,000**
Shortfall (Revenues Less Costs)	**-1,338,670,000**	**-466,800,000**	**-1,805,470,000**
Shortfall (% of Total Needs	-46.7%	-15.4%	-30.6%
LOS E			
Needs	**2006-2015**	**2016-2026**	**Total**
Operations and Maintenance	600,000,000	660,000,000	1,260,000,000
Capital Improvement Costs	1,603,375,000	1,857,375,000	3,460,750,000
Administrative Costs	300,000,000	330,000,000	630,000,000
Total Needs	**2,503,375,000**	**2,847,375,000**	**5,350,750,000**
Total Revenues	**1,529,830,000**	**2,571,075,000**	**4,100,905,000**
Shortfall (Revenues Less Costs)	**-973,545,000**	**-276,300,000**	**-1,249,845,000**
Shortfall (% of Total Needs	-38.9%	-9.7%	-23.4%
LOS C			
Needs	**2006-2015**	**2016-2026**	**Total**
Operations and Maintenance	600,000,000	660,000,000	1,260,000,000
Capital Improvement Costs	2,574,925,000	2,541,587,500	5,116,512,500
Administrative Costs	300,000,000	330,000,000	630,000,000
Total Needs	**3,474,925,000**	**3,531,587,500**	**7,006,512,500**
Total Revenues	**1,529,830,000**	**2,571,075,000**	**4,100,905,000**
Shortfall (Revenues Less Costs)	**-1,945,095,000**	**-960,512,500**	**-2,905,607,500**
Shortfall (% of Total Needs	-56.0%	-27.2%	-41.5%

Options for Additional Revenues

Chapter 4 examined closely two options for securing additional revenues: a development impact fee ordinance; and three strategies for increasing the statewide gasoline and use fuel taxes.

Impact fee revenues will depend upon the level of the fees and the percent of growth that occurs in unincorporated Maricopa County prior to annexation. Exhibit 7 displays how an impact fee program could reduce or eliminate the projected revenue shortfalls based on these two factors. If the percent of shortfall covered meets or exceeds 100%, the revenue shortfall would be covered by the assumed fee amount ($3,000, $5,000, or $10,000) and percent of growth before annexation (100, 75, 50, or 25 percent).

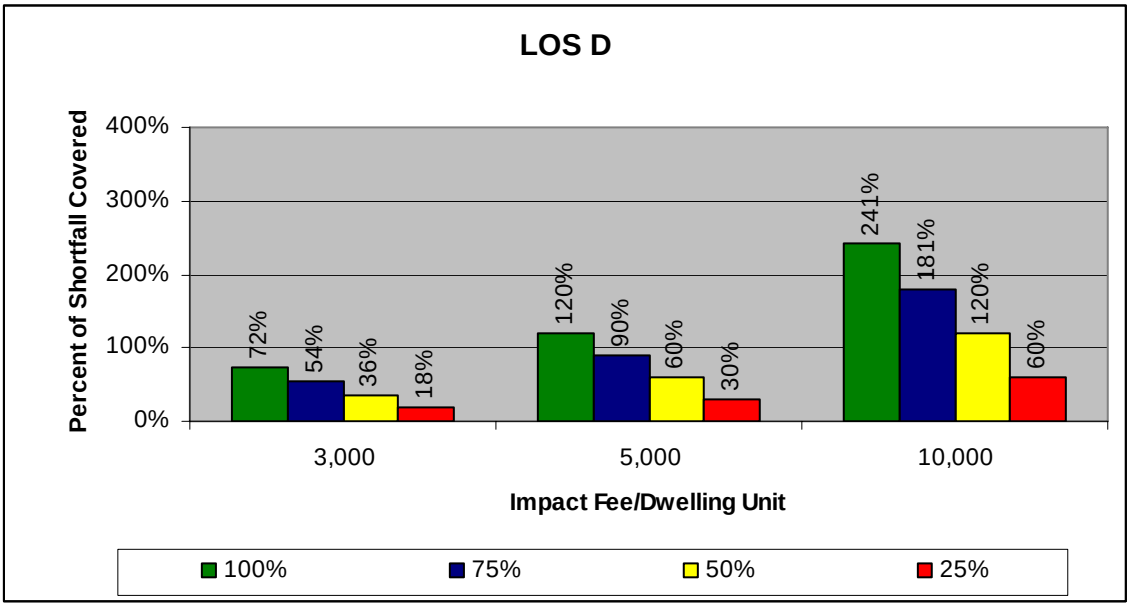
Summarizing the results as shown in the exhibit:

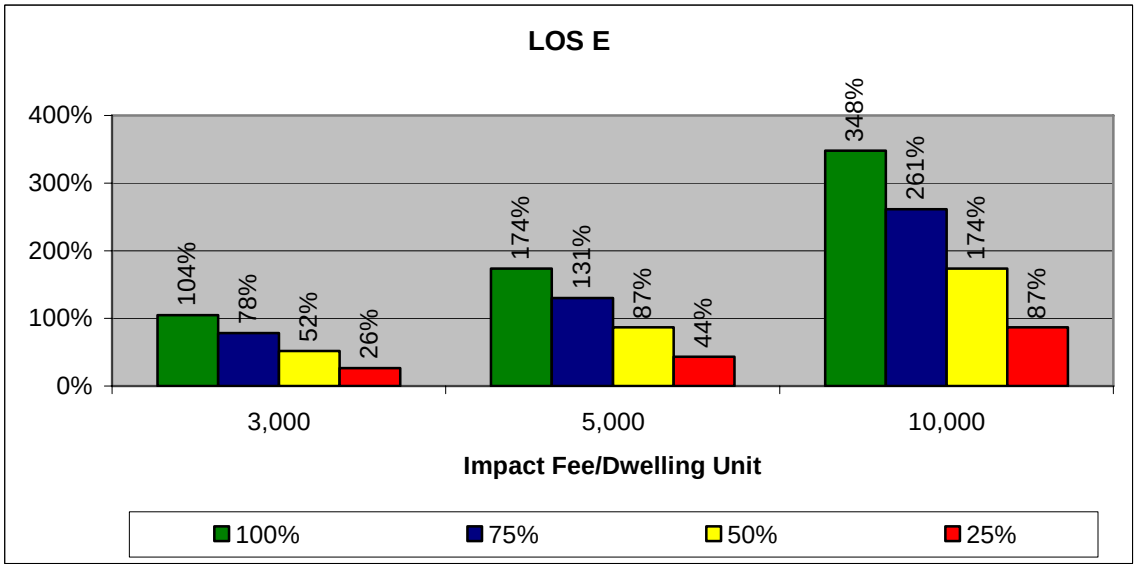
An impact fee of $3000 would only cover the shortfall at LOS E assuming 100% of the growth occurs before annexation

An impact fee of $5000 would cover LOS D revenue shortfall at 100% and LOS E at 75% or 100% growth before annexation.

An impact fee of $10,000 would cover both LOS D and LOS E revenue shortfall at 50%, 75%, or 100% growth before annexation.

Exhibit 7 Percent of Revenue Shortfall Covered by Impact Fee Options, Depending on Impact Fee/Dwelling Unit and % of Growth in Unincorporated County Before Annexation





Chapter 4 also reviewed three options for increasing statewide gas and use fuel taxes:

Option 1 would increase the gas tax to 20 cents per gallon and leave the use fuel tax at its current rate. This option would increase MCDOT HURF revenues by $335.6 million from 2006 through 2026.

Option 2 would index both gas and use fuel taxes to inflation, starting at the current tax rates. This option would increase MCDOTs HURF revenues through 2026 by $553.0 million.

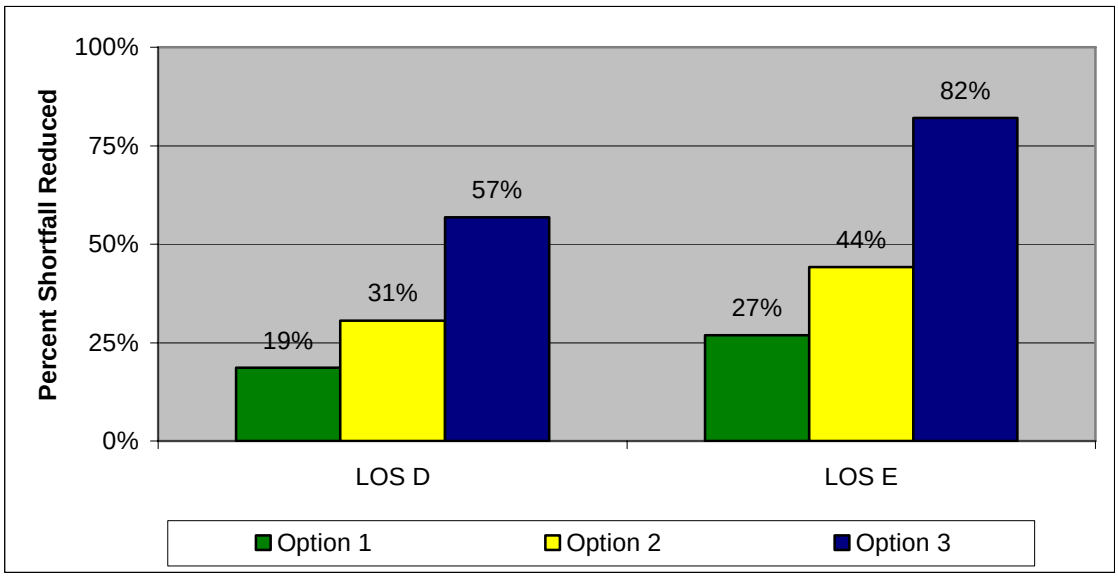
Option 3 would also index the two tax rates, but would start with the gas tax rate at 20 cents per gallon. This option would increase MCDOTs HURF revenues by $1.0 billion.

Exhibit 8 presents the impacts of these options for reducing the revenue shortfalls for LOS D and E.

For LOS D, the shortfall would be reduced by between 19% and 57%.

For LOS E, the shortfall would be reduced by between 27% and 82%.

Exhibit 8 Shortfall Reductions Achieved by Increasing Statewide Gas and Use Fuel Taxes



Development Impact Fee Potential

Maricopa County Department of Transportation

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This paper estimates the revenue potential for MCDOT of implementing a County Development Impact Fee (DIF) program. The "Analysis of the Potential for Development Impact Fees and Improvement Districts for Providing New Revenues" paper spent a considerable amount of focus on the regional, intergovernmental ramifications of a County DIF program, especially on the value of structuring it to achieve the goal of a net increase in regional transportation revenues. This section acknowledges the importance of that regional focus, but is more concerned with how MCDOT could benefit from a County DIF program.

Precise and complete estimates of the revenue potential for both DIFS are beyond the scope of the TSP update, because of the many policy questions that need to be addressed before setting fees. This report does portray the potential revenues for MCDOT from a county Development Impact Fee program. The analysis will focus only on impact fees for residential development, since there is no readily available basis for projecting non-residential development, except for the sure knowledge that such development will follow the residential development. The analysis looks at the range of potential revenues.

1.0 Patterns of Growth in Maricopa County

The central considerations in discussing population projections for Maricopa County are the Municipal Planning Areas (MPAs), current corporate boundaries and the pace of annexation. There are twenty-four MPAs, which identify the projected ultimate corporate boundaries of each jurisdiction. In some instances, MPA boundaries and corporate boundaries are identical (Scottsdale, for example), while in other MPAs, there currently are significant swaths of unincorporated areas (Buckeye and Surprise, for example). Those portions of the County outside of the MPAs are expected to remain unincorporated.

The impact fee paper identified four roadway circumstances facing MCDOT: MPAs with potential for growth in unincorporated areas; county islands adjacent to high growth areas; county area with potential for growth; and county areas with low projected growth. The first three circumstances provide opportunities for a roadway development impact fee program. A county roadway development impact fee program has a potential for generating revenues from almost 435,000 new homes projected from 2006 through 2026.

2.0 Revenue Potential of a County Roadway Development Impact Fee

How much revenue would be generated by a County roadway development impact fee program will depend upon: 1) how much growth occurs in unincorporated areas, with fees collected, prior to annexation; and 2) the level at which impact fees are set. Table 1 reports various potential impact fee revenues, assuming that 100%, 75%, 50%, and 25% of growth in housing units occurs prior to annexation and rates are set at $3,000, $5,000 or $10,000 per housing unit. Potential revenues by 2026 range from $326.3 million (25% growth prior to annexation and fee at $3,000 per unit) to $4.4 billion (100% growth prior to annexation and a fee of $10,000 per unit).

TABLE 1

REVENUE POTENTIAL OF A COUNTY ROADWAY DEVELOPMENT IMPACT FEE

% Growth in Unincorporated Areas Prior to Annexation	New Housing Units	$3,000/Dwelling Unit		$5,000/Dwelling Unit		$10,000/Dwelling Unit	
		$3,000	% of Shortfall	$5,000	% of Shortfall	$10,000	% of Shortfall
100%	435,000	1,305,000,000	45%	2,175,000,000	75%	4,350,000,000	150%
75%	326,250	978,750,000	34%	1,631,250,000	56%	3,262,500,000	112%
50%	217,500	652,500,000	22%	1,087,500,000	37%	2,175,000,000	75%
25%	108,750	326,250,000	11%	543,750,000	19%	1,087,500,000	37%

An impact fee at $10,000 per dwelling unit would generate revenues in excess of the projected shortfall if 75% or 100% of growth occurred before annexation. A $10,000 impact fee would close the shortfall by 75% if 50% of growth occurred prior to annexation and by 37% if 25% of growth was before annexation.

Depending upon the extent of growth occurring before annexation, a fee of $5,000 per dwelling unit would close the shortfall by 19% at 25% of growth before annexation. A $5,000 fee would reduce the shortfall by 75% at 100% of growth before annexation.

3.0 Targeted Improvement Districts

The 1999 Needs Study reported that Maricopa County used improvement districts for repaving projects, construction of roadways or sidewalks, and installation of landscaping. The 1999 study assumed that revenues from improvement districts would continue through the year 2020, at an average rate of $200,000 per year. While not conceiving of improvement districts as a major source of funding

for MCDOT, the 1999 study did recommend an increased use of improvement districts. The 1999 study also noted that formation of a county improvement district was subject to more restrictions than a municipal improvement district.

The study suggested that simplification of the formation requirements could enhance their potential for increasing the Department's revenue base, but pointed out that the Arizona Association of County Engineers tried unsuccessfully to revise the enabling statute.

The county operates improvement districts for streets primarily on local, rural streets serving a limited number of property owners. The county and MCDOT can continue with the current practices, serving targeted, “niche markets” with funding outside of the MCDOT budget. Under this scenario, recommendations regarding the use of improvement districts would not be germane to the TSP update.

However, other Arizona counties use improvement districts in ways that MCDOT and the county, might wish to look at more closely. Improvement districts might provide a funding source for improvements in the county areas, though parts of the county not expected to be annexed or incorporated, where projected growth through 2026 is low. Improvement districts could be used to help fund horizontal and/or vertical capacity improvements to roadways already in the county maintenance system or that existing residents or businesses are requesting be brought into the system. As distinct from impact fees, improvement districts provide an option for financing improvements to meet existing roadway deficiencies.

4.0 Increasing Statewide Gasoline/Use Fuels Taxes

Roadway development impact fees and targeted use of improvements districts are the two options potentially available to the county and within its authority to implement. On the other hand, the State Legislature controls a source of potential increased revenues – gasoline and use fuel taxes – that could help to significantly reduce revenue shortfalls throughout the state. This section explores the revenue potential for changes in the State's gasoline and use fuel taxes. The revenue potentials are so significant that Maricopa County and the rest of the state should continue to participate in the dialogue surrounding this subject.

5.0 Impact of Inflation on Arizona's Effective Gasoline and Use Fuel Taxes

Arizona's gasoline tax rate has been set at 18 cents per gallon since 1990 and the use fuel tax rate has been at 26 cents per gallon since 1996, having been raised from the 18 cents per gallon that was collected previously. (It should be noted the use fuel tax “increase” to 18 cents per gallon was intended to compensate, at lease partially, for the revenues lost when the motor carrier tax, “weight-distance tax,” was repealed at the urging of the trucking community.) Figure 1 charts how inflation has eroded the effective gas tax and use fuel tax rates since 1990 and what the current rates would have to be to have kept pace with inflation.

Since 1990, the 18 cents per gallon tax rate is the equivalent of a rate of 11.6 cents per gallon in 2005, while the use fuel tax rate eroded in value from 18 cents to 16.5 cents between 1990 and 1994, when the Legislature raised it to 26 cents. Since 1994, the effective use fuel tax rate has declined from 26 cents to 18.8 cents per gallon.

Conversely, to have kept pace with inflation, the respective tax rates in 2005 would have to have been 28 cents for gasoline and 36 cents for use fuel.

6.0 Impacts of Three Options for Increasing Gasoline and Use Fuel Tax Rates

This section does not recommend any strategy for raising gas and use fuel taxes, looking instead at the revenue impacts of three options for raising the taxes:

Option 1: Just increase the gas tax to 24 cents per gallon, leaving the use fuel tax at 26 cents per gallon;

Option 2: Index gas and use fuel tax rates to inflation, starting in 2006 with the current tax rates of 18 cents and 26 cents per gallon; and,

Option 3: Index gas and use fuel tax rates to inflation, starting in 2006 with the gas tax at 24 cents per gallon and use fuel tax at 26 cents per gallon.

Tables 2, 3 and 4 present the revenue impacts of each option for raising gasoline and use fuel taxes statewide. This analysis assumes that: 1) the statutory formulas for distributing HURF revenues remain the same; and 2) Maricopa County's share of statewide unincorporated population remains at its current 19.7%.

The results of this analysis are that:

Under Option 1, the average annual increase in MCDOT HURF revenues would be $16.0 million and the total increase through 2026 would be $336.6 million.

With Option 2, the average annual increase in revenues would be $26.3 million and the total increase through 2026 would be $553.0 million

Under Option 3, the average annual increase would be $48.9 million and the total increase would be just over $1.0 billion.

FIGURE 1 *IMPACTS ON GASOLINE AND USE FUEL TAX RATES AS A RESULT OF INFLATION: 1990 TO 2005*

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1.

TABLE 2

ADDITIONAL MCDOT HURF REVENUE UNDER OPTION 1

Fiscal Year	Revised Estimates				Original MC HURF	Difference
	Total HURF	Net HURF	County HURF (19% Net)	MCDOT HURF		
2006	1,483.0	1,482.0	281.6	112.8	99.1	13.7
2007	1,551.7	1,540.7	292.7	117.2	104.0	13.2
2008	1,617.7	1,606.7	305.3	122.2	109.0	13.3
2009	1,686.8	1,675.8	318.4	127.5	114.2	13.3
2010	1,755.2	1,744.2	331.4	132.7	119.0	13.8
2011	1,829.2	1,818.2	345.5	138.3	124.4	14.0
2012	1,904.8	1,893.8	359.8	144.1	129.7	14.4
2013	1,986.6	1,975.6	375.4	150.3	135.7	14.6
2014	2,069.9	2,058.9	391.2	156.7	141.6	15.1
2015	2,159.8	2,148.8	408.3	163.5	148.2	15.3
2016	2,254.1	2,243.1	426.2	170.7	155.1	15.6
2017	2,352.9	2,341.9	445.0	178.2	162.3	15.9
2018	2,456.6	2,445.6	464.7	186.1	169.8	16.2
2019	2,565.3	2,554.3	485.3	194.4	177.8	16.6
2020	2,679.4	2,668.4	507.0	203.0	186.0	17.0
2021	2,799.1	2,788.1	529.7	212.1	194.7	17.5
2022	2,924.8	2,913.8	553.6	221.7	203.7	18.0
2023	3,056.8	3,045.8	578.7	231.7	213.2	18.5
2024	3,195.3	3,184.3	605.0	242.3	223.1	19.2
2025	3,340.8	3,329.8	632.7	253.3	233.5	19.9
2026	3,493.4	3,482.4	661.7	265.0	244.3	20.6
Total	49,163.2	48,942.2	9299.2	3723.8	3388.4	335.7
					Average Annual Increase	
					16.0	

TABLE 3

ADDITIONAL MCDOT HURF REVENUE UNDER OPTION 2

Fiscal Year	Revised Estimates				Original MC HURF	Difference
	Total HURF	Net HURF	County HURF (19% Net)	MCDOT HURF		
2006	1,314.2	1,313.20	249.50	99.90	99.1	0.8
2007	1,395.5	1,384.50	263.10	105.30	104.0	1.3
2008	1,475.9	1,464.90	278.30	111.50	109.0	2.5
2009	1,561.3	1,550.30	294.50	118.00	114.2	3.8
2010	1,648.1	1,637.10	311.00	124.60	119.0	5.6
2011	1,742.8	1,731.80	329.00	131.80	124.4	7.4
2012	1,841.7	1,830.70	347.80	139.30	129.7	9.6
2013	1,949.4	1,938.40	368.30	147.50	135.7	11.8
2014	2,061.8	2,050.80	389.60	156.00	141.6	14.5
2015	2,183.9	2,172.90	412.90	165.30	148.2	17.2
2016	2,314.2	2,303.20	437.60	175.20	155.1	20.2
2017	2,452.9	2,441.90	464.00	185.80	162.3	23.5
2018	2,600.8	2,589.80	492.10	197.00	169.8	27.2
2019	2,758.5	2,747.50	522.00	209.10	177.8	31.3
2020	2,926.8	2,915.80	554.00	221.90	186.0	35.8
2021	3,106.4	3,095.40	588.10	235.50	194.7	40.8
2022	3,298.2	3,287.20	624.60	250.10	203.7	46.4
2023	3,503.1	3,491.10	663.50	265.70	213.2	52.5
2024	3,722.0	3,711.00	705.10	282.40	223.1	59.2
2025	3,956.1	3,945.10	749.60	300.20	233.5	66.7
2026	4,206.4	4,195.40	797.10	319.20	244.3	74.9
Total	52,020.00	51,798.00	9841.7	3,941.3	3,388.4	553.0
					Average Annual Increase	
					26.3	

TABLE 4

ADDITIONAL MCDOT HURF REVENUE UNDER OPTION 3

Fiscal Year	Revised Estimates				Original MC HURF	Difference
	Total HURF	Net HURF	County HURF (19% Net)	MCDOT HURF		
2006	1,483.1	1,482.1	281.6	112.8	99.1	13.7
2007	1,573.2	1,562.2	296.8	118.9	104.0	14.8
2008	1,663.1	1,652.1	313.9	125.7	109.0	16.7
2009	1,758.3	1,747.3	332.0	132.9	114.2	18.8
2010	1,855.4	1,844.4	350.4	140.3	119.0	21.4
2011	1,961.1	1,950.1	370.5	148.4	124.4	24.0
2012	2,071.4	2,060.4	391.5	156.8	129.7	27.1
2013	2,191.3	2,180.3	414.2	165.9	135.7	30.2
2014	2,316.4	2,305.4	438.0	175.4	141.6	33.8
2015	2,452.0	2,441.0	463.8	185.7	148.2	37.6
2016	2,596.3	2,585.3	491.2	196.7	155.1	41.6
2017	2,749.9	2,738.9	520.4	208.4	162.3	46.1
2018	2,913.5	2,902.5	551.5	220.8	169.8	51.0
2019	3,087.6	3,076.6	584.6	234.1	177.8	56.3
2020	3,273.2	3,262.2	619.8	248.2	186.0	62.2
2021	3,471.1	3,460.1	657.4	263.3	194.7	68.6
2022	3,682.1	3,671.1	697.5	279.3	203.7	75.6
2023	3,907.2	3,896.2	740.3	296.4	213.2	83.2
2024	4,147.4	4,136.4	785.9	314.7	223.1	91.6
2025	4,403.9	4,392.9	834.6	334.2	233.5	100.7
2026	4,677.8	4,666.8	886.7	355.1	244.3	110.7
Total	58,235.3	58,014.3	11022.6	4,414.0	3,388.4	1,025.7
					Average Annual Increase 48.9	

ANALYSIS OF THE POTENTIAL OF DEVELOPMENT IMPACT FEES AND IMPROVEMENT DISTRICTS FOR PROVIDING NEW REVENUES

Maricopa County Department of Transportation

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1.0 INTRODUCTION

This report analyzes the potential of development impact fees and improvement districts to generate significant new revenues for MCDOT. Maricopa County currently does not impose development impact fees, while MCDOT does make limited use of improvement districts. This report demonstrates that both programs could significantly enhance the MCDOT revenue base and suggests that MCDOT consider these two options to address very different challenges the department will face over the next twenty-five years.

As is discussed below and in more detail later in this report, MCDOT can be seen as facing four different circumstances:

Currently unincorporated areas within MPA boundaries where very large population increases are projected between 2005 and 2030 and where there the possibility exists that significant development could be completed in these unincorporated areas prior to annexation;

County Areas that will persist as "islands" inside Municipal Planning Areas, eventually to be surrounded by incorporated jurisdictions, and which are projected to experience some level of significant population increase;

County Areas that are adjacent to those areas within MPAs that should experience the largest amount of growth, with some of that growth spilling over into the adjacent County Areas; and

County Areas on the west and northeast sides of the County that will experience very low rates of population increase and that will remain essentially rural in nature.

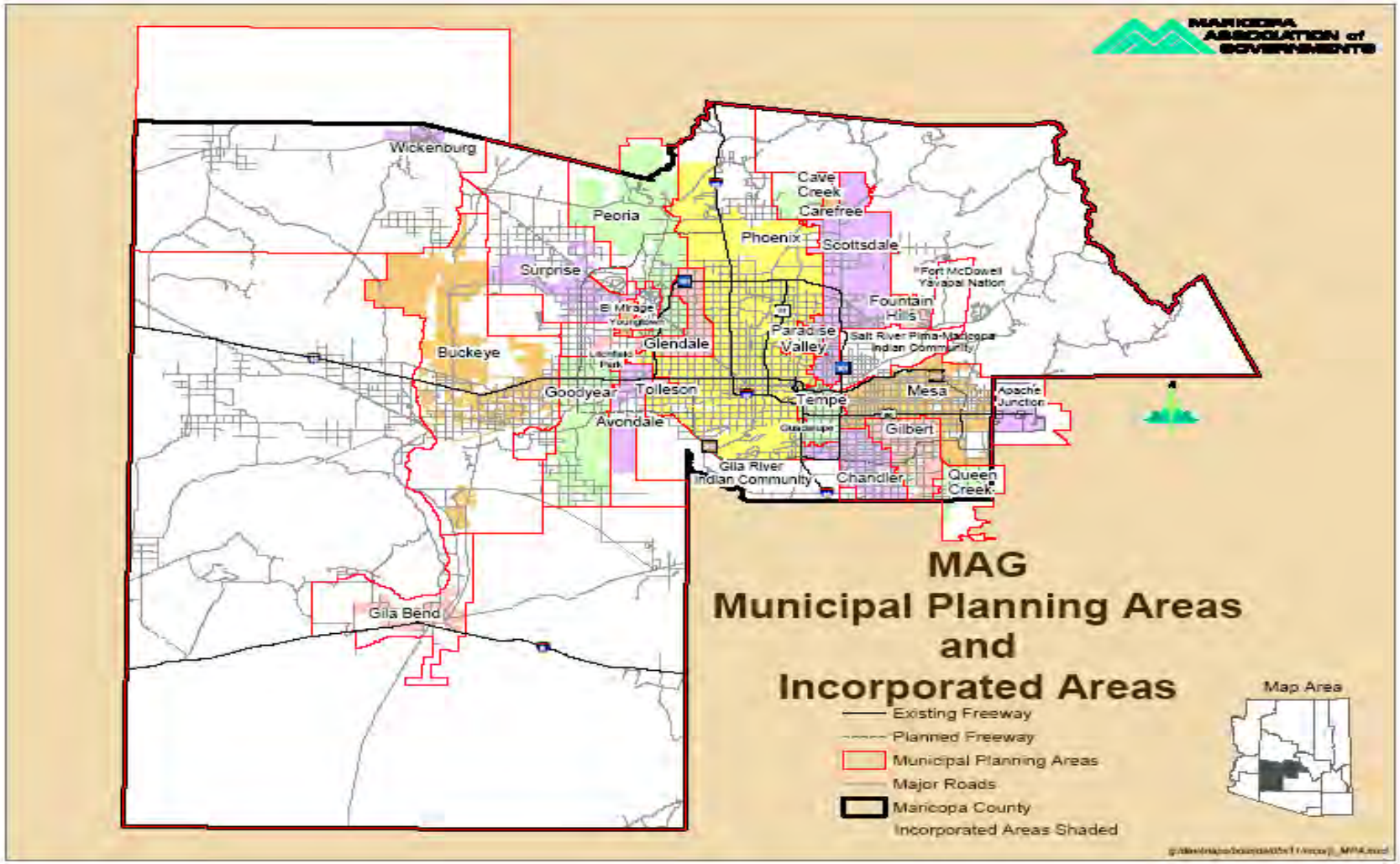
The first two circumstances, where population increase and development will be most significant, would clearly be candidates for development impact fees. The third circumstance could benefit from some combination of impact fees and targeted improvement districts. The fourth circumstances, with little growth and probably the need for targeted roadway capacity improvements, could benefit most from an improvement district program.

<u>Patterns of Growth in Maricopa County</u>

Maricopa County population is projected to grow to 6,129,255 by 2030, an increase of 2,521,576 (70%) over the 2005 population of 3,605,649. The central facts in discussing population projections for Maricopa County are the Municipal Planning Areas (MPAs), current corporate boundaries and the pace of annexation, and County Areas, as shown in Exhibit 1.

There are twenty-four MPAs, which identify the projected ultimate corporate boundaries of each jurisdiction, as identified the red lines demarcating the boundaries of each MPA. Those portions of the County outside of the MPAs is identified as County Areas, those areas expected to remain unincorporated. The shaded areas identify the current corporate boundaries of the incorporated jurisdictions. In some instances, MPA boundaries and corporate boundaries are identical (Scottsdale, for example), while in other MPA there currently are significant swaths of unincorporated areas (Buckeye and Surprise, for example).

Exhibit 1 MPA Boundaries and Corporate Boundaries



The information in Exhibit 2 provides a basis for quantifying the four roadway circumstances facing MCDOT: MPAs with Potential for Growth in Unincorporated Areas; County Islands Adjacent to High Growth Areas; County Area with Potential for Growth; and County Areas with Low Projected Growth.

MPAs with Potential for Growth in Unincorporated Areas

Based upon the information in Exhibit 2, the ten MPAs with the greatest potential for development in currently unincorporated areas are Phoenix, Buckeye, Surprise, Mesa, Peoria, Avondale, Queen Creek, Gila Bend, Cave Creek, and Wickenberg. The first seven of these MPAs are among the nine MPAs with the most projected growth. Each of these ten MPAs show significant areas that are not shaded, indicating that they are currently unincorporated.

It is possible, though admittedly imprecise, to translate the MPA unincorporated areas into Regional Analysis Zones and use MAGs interim population projections to determine the potential for development in each RAZ. Exhibit 2 shows the 2000 Occupied Housing Unit counts and the projected 2030 Occupied Housing Units, which is used here because housing units are the basis of residential impact fees. This analysis suggests that almost 425,000 (43.6%) of the projected growth in occupied housing units will occur in those RAZs with the highest potential for development in unincorporated areas. The potential of a development impact fee program in these high growth areas is apparent in these numbers.

As is discussed more fully in Section 2.4, the revenue potential for a MCDOT impact fee program will be influenced by the timing of development and annexation. If development is completed before annexation, MCDOT would realize the full revenue potential of an impact fee program; if annexation occurs at any point prior to the completion of development, the revenue potential of MCDOT impact fees would be proportionally lessened.

Exhibit 2 Potential For Population Growth in MPA Unincorporated Areas

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County Islands Adjacent to High Growth Areas

Exhibit 3 identifies three "County Islands," relatively small areas not included in an MPA, but surrounded by MPAs, suggesting that they will never be annexed. Furthermore, these County Islands are surrounded by, or at least adjacent to, RAZs identified in Exhibit 2 as MPA Unincorporated Areas with high growth potential. Each of these County Islands are discrete RAZs:[3]

Area 1 - # 220, 221, and 237 are surrounded by the Surprise MPA, Peoria MPA, and El Mirage MPA, as well as being surrounded by MPA Unincorporated Area RAZs;

Area 2 - #252 is surrounded the Surprise MPA, Buckeye MPA, and Glendale, as well as being surrounded by MPA Unincorporated Area RAZs, and is identified on one map as the White Tank Park;

Area 3 - #301 is surrounded by the Buckeye MPA and Goodyear MPA, as well as being adjacent to MPA Unincorporated Area RAZs.

Three of the four RAZs that comprise these County Islands are projected for some level of development between 2000 and 2030 (see Exhibit 3). In Area 1, RAZ #221 and 237 are apparently built out, with increases of only 141 units, to 12,151 units, in #221 and 424 units, to 23,550, in #237.

The other three RAZs, however, show projected grow by a total of 7,908 occupied housing units by 2030. This rate of growth is modest compared to projections for the surrounding areas, but it is significant beyond its size because it is surrounded by high growth MPA Unincorporated RAZs. Residential development impact fees appear appropriate for these County Islands.

Exhibit 3 Projected Growth in Occupied Housing Units for County Islands

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County Area with Potential For Growth

Only four County Area RAZs show projected growth grater than 2000 occupied housing units by 2030. Three of those RAZs are those in the County Islands reported in Exhibit 3. The fourth RAZ is # 346, which is directly west of the center of the Buckeye MPA. RAZ # 346 is projected to experience a growth in occupied housing units of 3,101 by 2030, increasing from 1,051 in 2000 to 4,152 in 2030. This RAZ is directly to the west of #277 and #340, in the Buckeye MPA, which are projected to experience an increase of 11,024 and 24,083 occupied housing units respectively. A residential impact fee program, especially for that growth occurring closest to that in the Buckeye MPA appears appropriate.

[3] There is a final, very small County Island, RAZ #326, which is surrounded by Chandler and the Gila River Indian Community, which shows a projected increase of 911 occupied housing units, to 5,507, by 2030.

County Areas with Low Projected Growth (Exhibit 4)

The MPA areas effectively divide Maricopa County down its middle, with the County Areas located to the northeast and on the entire western and southern parts of the County. It seems appropriate to divide the County Areas into four sub-regions:

Northeast Area – RAZ # 336, 345, 231, and 337, this is the area north of the Pinal County line and of Mesa and east of the Salt River-Maricopa Indian Community, Fort McDowell Yavapai Nation, Scottsdale, Cave Creek, and the northern end of the Phoenix MPA;

Northwest Area – RAZ #347, 334, and 335, which is the area west the Surprise MPA, and County Area growth RAZ #346, outside of the Wickenburg MPA, and north of I-10;

West Central Area – RAZ#333, which is the area between I-10 and I-8, west of RAZ#346, and the Buckeye and Gila Bend MPAs;

South Area – RAZ # 330 and 332, which is west of the southern portion of the County line, north of the southern most portion of the County line, east and south of the Gila Bend MPA, with I-8 forming a border with the West Central Area.

Together, the County Areas are projected to experience an increase in occupied housing units of 5,445, from 2321 to 7,766. The Northeast Area (increase of 2,011) and Northwest Area (increase of 1,716) account for most of the projected growth in occupied housing units. This rate of development will not generate very much need for additional horizontal capacity, nor would this growth generate very much development impact fee revenues. Improvement districts, however, might be an appropriate option for funding vertical capacity improvements, whether current or future, such as roadway paving or bringing roads up to County standards prior to accepting them into the County's roadway maintenance system.

Exhibit 4 Projected Growth in County Areas

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Section 2.0 provides a detailed discussion about Development Impact Fees and Section 3.0 on Improvement Districts.

2.0 ANALYSIS OF THE POTENTIAL OF DEVELOPMENT IMPACT FEES FOR PROVIDING NEW REVENUES

2.1 INTRODUCTION

The 1999 Transportation System Plan documented that Maricopa County had not implemented a development impact fee program. The study recommended that Maricopa County move to implement a roadway development impact fee assessed on both residential and non-residential development. The study estimated that a fee of $1,550 per equivalent demand unit would raise $110 million through the year 2020; if development in very rural areas were excluded, the study estimated revenues through 2020 of $73 million. To date, no action has been taken to implement a roadway development impact fee for Maricopa County.

A review of the research literature suggests that communities with successful development impact fee programs typically have a large population base; are experiencing moderate to rapid growth; are already facing infrastructure financing constraints; and have a large capital investment to maintain.[4] These are all characteristics of Maricopa County, whether defined as the whole county or by reference to the unincorporated area. From the perspective of the research literature, a development impact fee program for Maricopa County seems eminently reasonable and justifiable.

This report will explore the legal considerations that must be addressed in developing a development impact fee program. The review will then look at the incidence of development impact fee programs in Arizona and in more detail for cities and towns inside Maricopa County. The final section will identify several major policy issues that would need to be addressed and decided upon in the formation of a development impact fee program.

2.2 LEGAL CONSIDERATION

Development impact fees are generally defined by common characteristics that include: "(1) they are charged only to new development, (2) they are standardized fees as opposed

[4] Carrión, Carmen and Libby, Lawrence W., "Development Impact Fees: A Primer," page 2; at "www – agecon.agohio-state.edu/programs/Swank/pdfs/dif.pdf"

to *ad hoc*, negotiated payments, and (3) they are designed and used to fund capital improvements needed to serve growth."[5]

Development impact fees are defended as exercise of local government police powers – to protect health, safety and welfare; they are a form of regulation and not as exercise of government's power of taxation. Limits on and requirements for development impact fees have largely been set by U.S. Supreme Court decisions and lower court case law.[6] In general, there are three constitutional tests that have been applied to development impact fee programs and a set of "nexus" tests that flow from the constitutional considerations.

CONSTITUTIONAL TESTS

There are three constitutional tests that apply to development impact fees, tests that have been applied to the constitutionality of all forms of local regulations. FOOTNOTE

"Substantive due process" test

Does the local government have the authority to assess, collect and spend impact fees for a determined public facility and has the local government qualified the payment as a fee rather than as a tax? This test is met by the state statutes that enable counties and municipalities to have development impact fee programs.

"Equal protection" test

Are the development impact fees applied to all similar parties on the same basis? There must be no discrimination between parties in the application of development impact fees.

"Takings" test

Is the local government's objective sufficiently close to the method chosen to accomplish the stated objectives, such that there is no taking of property? If it is determined that the development impact fee program involves a taking of property, then either property owners must receive just compensation or the fee program must be either redesigned or abandoned.

These constitutional tests, especially the "takings test," lead to what are generally referred to the "nexus tests," of which there are three.

"**Reasonable relationship" nexus**

Is there a reasonable connection between the fee charged to the developer and the needs generated by that development?

---

[5] Mullen, Clancy, "2005 National Impact Fee Survey," prepared by Duncan Associates, February 13, 2005, page 1; at "www.impactfees.com/pdfs_all/2005%20impact%fee%survey.pdf"

[6] Carrión and Libby, ibid, page 6 - 7

"Specifically and uniquely attributable" nexus

Is the fee charged attributable to the development that is paying the fee?

"Rational" nexus

Is there proportionality between the amount of the fee charged and the costs of the type and amount of demand generated by the development paying the fee?

In short, development impact fees must be used to meet demands generated by new development and cannot be used to meet existing needs or for operation and maintenance expenditures.

STATE STATUTORY ENABLING LEGISLATION

State statutes contain specific language enabling counties and municipalities to have development impact fee programs. The statute for counties is ARS § 11-1102; for cities and towns the statute is ARS § 9-463.05 (see Exhibit 5). (See Attachment 1 for the full text of both statutes.) The statutes provide for the kind of fees a local government may collect; requirements for the operation of the program; requirements for public notice; and for municipalities, a requirement for annual reports. While the enabling statutes are similar for both types of local governments, they are more restrictive for counties than they are for municipalities.

Exhibit 5 Comparisons of Enabling Statutes for Development Impact Fees

Issue	County Enabling Statute	Municipal Enabling Statute
Kind of Fees	ARS § 11-1102(A) If a county has adopted a CIP, it may assess development fees within a covered planning area for water, sewer, streets, parks and public safety facilities"	ARS §9-463.05(A) May impose development fees to cover the costs to the municipality associated with providing necessary public services to a development
Requirements	ARS § 11-1102(B): 1. beneficial use to development 2. maintain separate accounts 3. prescribe schedule of payments; residential development shall be	ARS §9-463.05 (B) Same as County

	at building permit 4. reasonable relationship 5. non-discriminatory 6. community facilities districts	
Public Notice	ARS §11-1102© 1. 120 days advance notice 2. written report documenting fees 3. public hearings after 120 days over and with 14 days notice	ARS §9-463.05(C) 1. 60 days advance notice 2. written report documenting fees 3. public hearing after 60 days over and with 14 days notice
Annual Report	No Provision	ARS §9-463.05(D) to (F) Requires an annual report

ARS §9-463.05(A) provides municipalities with very broad powers to impose development impact fees "to cover the costs to the municipality associated with providing necessary public services to a development." ARS § 11-1102(A), on the other hand, requires that a county have an adopted capital improvement plan and restricts impact fees to "within a covered planning area for water, sewer, streets, parks and public safety facilities."

Furthermore, counties must provide at least one hundred twenty days advance notice of its intent to assess a new or increased impact fee. For municipalities, the public notice requirement is only sixty days.

The enabling legislation for both counties and municipalities do not set forth any specific methodology for the calculation of fees, which is important. ARS § 11-1102(B) and ARS §9-463.05 (B) only require that the fees provide a "beneficial use" to the development; bear a "reasonable relationship" to the "burden of costs" of additional services to the development; and assessed in a "non-discriminatory manner," all of which are statements of the nexus tests.

The statutes require that the local government prepare and release "a written report including all documentation that supports the assessment of a new or increased development impact fee." The methodology for assessing fees and meeting the requirements of the enabling legislation would be documented in this report. Policy issues that would need to be addressed in this written report are discussed in Section D of this report. This report, of course, is in no way intended to fulfill the requirements of ARS §11-1102(C)(2).

Included in the Growing Smarter legislation from 1998 were significant changes to the enabling statute for county development impact fees, as summarized in Exhibit 6. The

new statutes require that residential impact fees be collected when construction permits are issued, but it is silent on when commercial impact fees are to be collected.

The earlier statute required that impact fees must directly provide capacity to the new development; the new statute requires that the improvements paid for with impact fees provide a "beneficial use" to the development paying the fees.

The earlier statutes required that fees be expended or encumbered within five years of their collection or they had to be returned to the property owner, with interest. The new statute makes no provision for when fees collected must be expended or encumbered.

Exhibit 6 Results of Statutory Changes Related to Growing Smarter Legislation

Issue	Previous Statute	Amended Statute
When Fees Collected	Any time between construction permits and certificate of occupancy	Residential development fees shall be paid at time of construction permit No provision for non-residential development
Use of Fees	New development capacity	Beneficial use to development
When Fees Spent/Encumbered	Within 5 Years of Collection	No Provision
Affordable Housing Waiver	County may waive	No Provision
Appeal Process	Provided for Appeal to Board of Supervisors	No Provision
Overriding Public Interest Waiver	County may waive	No Provision

OTHER AUTHORITY IN THE COUNTY ENABLING STATUTE

The county enabling statutes provide other authorities other than county development impact fees through which counties could generate revenue for paying for infrastructure demands of new development.

ARS §11-1101 Development Agreements

This provision allows counties, by resolution or ordinance, to enter into development agreements with "a landowner or any other person having an interest in real property" that is located outside of the incorporated area of a city or town. These development agreements may relate to issues such as permitted uses, density and intensity of use, dedication of land for public uses, preservation and restoration of historic structures, and phasing of construction.

In addition, ARS §11-1101(B)(7) permits the agreements to set "conditions, terms, restrictions, **financing** and requirements for **public infrastructure** and subsequent **reimbursements** over time. ARS §11-1101(B)(8), in turn, permits the agreements to set "conditions, terms, restrictions and requirements relating to the **County's intent to form a special taxing district** pursuant to title 48" i.e., improvement districts).

Development agreements clearly provide an alternate source of revenue for paying for infrastructure needs generated by new development. Revenues could be collected either through direct financing and reimbursements from the developer or through improvement districts. Furthermore, development agreements and improvement districts would offer the County more flexibility is the types of infrastructure that would be funded through the agreements.

ARS §11-1103 Development fees; intergovernmental agreements

This section states that "A county may enter into an intergovernmental agreement to accept or disperse development fees for construction of a public facility pursuant to a benefit area plan, including an agreement with a city or special taxing district for the joint establishment of a needs assessment, the adoption of a benefit area plan and the imposition, collection and disbursement of development fees to implement a joint plan for development." This authority would appear to anticipate the need for public facilities of "regional" significance, namely projects that cross jurisdictional boundaries.

2.3 Incidence Of Impact Fees In Arizona: Who Has Fees; Types Of Fees: And Range Of Fees

Development impact fees programs are becoming very prevalent, across the nation and in Arizona. This section will provide a brief glance at data from a 2005 national survey of development impact fees and then look at Arizona data: which counties have development impact fees; what municipalities outside of Maricopa County have impact fees; and then what municipalities inside Maricopa County have impact fees.[7] The review will report on not only which jurisdictions have impact fees, but what types of fees are they collecting, and what is the range of fees assessed.

NATIONAL SURVEY DATA

In 2005, Clancy Mullen, Director of Infrastructure Finance, with Duncan Associates, collected and reported on a national survey of impact fee programs.[8] The Mullen survey found that 245 local jurisdictions impose impact fees and 191 of these impose impact fees for roads. For single family residential development, the average roadway development fee was $2,027 and the average total of all fees collected was $7,669. Because some California communities have very high fees, the Mullen data reported that the average single family residential roadway development fee, excluding California, was $1,602 and the average of all fees collected was $5,361.

[7] Reference the PDOT and MAG studies of 2002; did not do updates or original survey
[8] Mullen, Clancy, ibid

ARIZONA COUNTIES

Only two counties in Arizona currently assess development impact fees: Pima County and Yavapai County. Three other counties – Pinal, Cochise, and Santa Cruz – are considering impact fees. Pinal County has used the authority provided by ARS §11-1101 to collect voluntary donations from developers for residential and non-residential development through development agreements. In 2002, voluntary donations for residential development averaged $883, while those for non-residential development have varied. Pinal County has retained Paul Tischler and Associates to conduct the studies necessary to assess development impact fees pursuant to ARS §11-1102.

Cochise County reports that it will consider development impact fees, but probably not until 2006 or later. Santa Cruz County reports that it also will consider development impact fees, maybe in the current fiscal year or next.

Pima County and Yavapai County only assess roadway development fees. Pima County assesses residential and commercial impact fees, while Yavapai assesses fees only for residential dwelling units, but also includes "each time share and each room to be occupied in a hotel, motel or resort."

Both Pima County and Yavapai County have created benefit areas: Pima County has ten benefit areas, all located in eastern Pima County, where growth is the heaviest. Yavapai County has two benefit areas: the "East" area includes Sedona and the "West" area includes Prescott. Pima County's impact fees are assessed uniformly across all benefit areas, while Yavapai set separate impact fees for its two benefit areas, of $1,100 and $1,200 per dwelling unit.

Pima County assesses residential impact fees based upon density and whether the development is occurring inside a retirement community. As of July 1, 2005, the County's residential impact fee schedule ranged from a low of $2,067 for High Density/Retirement Community development to a high of $3,692 Low-Medium/Standard Development (see Exhibit 7).

Exhibit 7 Pima County Residential Impact Fees as of July 1, 2005

Location	Density	Fees
Standard	High (6 or more residences per acre)	$2,768
	Low/Medium (Less than 6 residences per acre	$3,692
Retirement Community	High (6 or more residences per acre)	$2,067
	Low/Medium (Less than 6 residences per acre	$2,768

Yavapai County sets its fees for units in a hotel, motel or resort at one-half those per dwelling unit in the effected benefit area.

Pima County also assesses non-residential fees, for retail, office, and industrial development, with fees assessed per 1,000 square feet (Exhibit 8). Pima County distinguishes among fourteen categories of retail development and assesses fees that range between $1,112 and $13,325 per 1,000 square feet. Pima County assesses fees of, or greater than, $4,000 per 1,000 square feet for seven categories of retail development: "

Convenience Store/Gas Station at $13,235;
Bank With Drive-Through at $8,067;
Fast Food With Drive Through at $5,431;
Restaurant at $5,000;
Fast Food without Drive Through at $4,427;
Mega "Big Box" Retail-Freestanding >150,000 square feet" at $4,360; and,
Mega Shopping Center > 300,000 square feet at $3,976.

The remaining retail development fees are between $1,112 for "Home Improvement Superstore" and $2,359 for "Supermarket."

Exhibit 8 Range of Pima County Non-Residential Development Impact Fees, Per 1,000 Square Feet

Retail Development		Office Development		Industrial Development	
Lowest Fee	Highest Fee	Lowest Fee	Highest Fee	Lowest Fee	Highest Fee
$1,112	$13,235	$1,339	$1,339	$1,063	$1,697

Pima County provides for an automatic adjustment of its development impact fee schedule based upon inflation, as measured by the Consumer Price Index-Urban, reported by the U.S. Department of Labor Statistics.

CITIES AND TOWNS OUTSIDE MARICOPA COUNTY WITH IMPACT FEES

Fifteen cities and towns outside of Maricopa County assessed impact fees, for transportation and other purposes, but only ten of these jurisdictions included transportation impact fees in their program (Exhibit 9).[9] In 2002, Camp David, Clarkdale, and Eloy were reported to be studying development impact fee programs.

Some jurisdictions only charge a single or a narrow array of impact fees. The Town of Marana assesses only residential impact fees and only for transportation purposes, while Sierra Vista is only for Parks, Wilcox and Winslow only for sewer. Seven jurisdictions collect several development impact fees. The City of Tucson is the most recent jurisdiction to develop a development impact fee program.

Eleven of these jurisdictions assess residential and non-residential fees, while four do not assess non-residential fees. The Town of Marana, however, levies a construction sales tax that covers non-residential development and the Town of Oro Valley utilizes development agreements to collect revenues for non-residential development. The City of Tucson has created non-residential development impact fees, but delayed the beginning of collection until January 2008, when it will begin to assess 50 percent of the fee and then January 2011, when it will begin collecting the full fee.

[9] Based upon PDOT 2002 study

The lowest residential impact fees were assessed by Wilcox and Winslow, which assess fees only for sewers. Several of these jurisdictions have fee schedules that range around $2,000 and $2,500. The City of Tucson is alone in assessing residential and non-residential fees based on a square foot basis. The City also distinguishes rates between its Central Benefit Area and the rest of the City, establishing the rates in the former at a lower rate.

The City of Tucson included an automatic adjustment of its fees for inflation, as measured by the Engineering News – Record Construction Cost Index. This automatic adjustment will begin as of January 15, 2008.

Exhibit 9 Cities and Towns Outside of Maricopa County With Development Impact Fee Programs

Jurisdiction	What are they used for?	Price range for Residential?	Price range for Commercial?
Apache Junction	Library, Municipal Parks, Roads, Police		
Casa Grande	Fire, Police, EMS, Sanitation, Streets, Parks, Sewers, Transportation		
Chino Valley	Public Building, Parks, Library, Police, Roads		
Prescott	Library, Fire, Parks, Police, Street Services, Public Buildings		
Sedona	Transportation, Drainage, Government, Police, Parks		
Show Low	Parks, Library, Water, Sewer		
Sierra Vista	Parks & Rec.		
Tucson	Transportation and Regional Parks		
Marana	Transportation		
Oro Valley	Roadway Improvements		
Payson	Water, Parks, Streets		
Prescott Valley	Parks & Rec., Public Safety, Streets, Civic & Culture		

CITIES AND TOWNS INSIDE MARICOPA COUNTY WITH IMPACT FEES

Eighteen cities and towns within Maricopa County assess development impact fees, with ten of these jurisdictions including roadway development impact fees in their programs (Exhibit 10).[10] Three jurisdictions have no impact fee programs and there was no data in 2002 on another three jurisdictions.

[10] Maricopa Association of Governments, "Development Impact Fees, Best Practices Paper # 3: Growing Smarter Implementation Project

Exhibit 10 Cities and Towns Inside of Maricopa County With Development Impact Fee Programs

Jurisdiction	Have Transportation Impact Fees	Have Other Impact Fees
Avondale	Yes	Yes
Buckeye	No	Yes
Carefree	No	Yes
Cave Creek	Yes	Yes
Chandler	Yes	Yes
El Mirage	No	N
Fountain Hills	Yes	Yes
Gila Bend	No	N
Gilbert	Yes	Yes
Glendale	Yes	Yes
Goodyear	Yes	Yes
Guadalupe	No Data	No Data
Litchfield Park	No	Yes
Mesa	No	Yes
Paradise Valley	No	No
Peoria	Yes	Yes
Phoenix	Yes	Yes
Queen Creek	No	Yes
Scottsdale	No	Yes
Surprise	No	Yes
Tempe	No	Yes
Tolleson	Yes	Yes
Wickenburg	No Data	No Data
Youngtown	No Data	No Data

The ten jurisdictions that impose transportation impact fees also assess impact fees for several other public infrastructure needs. Exhibit 11 reports on the transportation impact fees and total impact fees for these jurisdictions. Transportation impact fees as a percent of total impact fees range from a low of 2% in Gilbert and 3% in Goodyear to a high of 32% in Peoria North, revealing differences in priorities placed upon supplementing available transportation revenues in these jurisdictions.

Exhibit 11 Transportation and Total Residential Impact Fees in Ten Maricopa County Jurisdictions

Jurisdiction	Single Family Residential Fee Transportation	Total Single Family Residential Fee	Transportation Fee as % of Total Fee
Avondale	$400	$6,545	6%
Cave Creek	$250	$2,945	8%
Chandler	$1,537	$8,178	19%
Fountain Hills	$638	$3,275	19%
Gilbert	$148	$6,946	2%
Glendale	$542	$9,360	6%
Goodyear	$148	$4,896	3%
Peoria North	$4,028	$12,680	32%
Phoenix High (North Black Canyon)	$2,700	$12,160	22%
Tolleson	$644	$3,114	21%

Exhibit 12 reports on transportation impact fees in these ten jurisdictions that collect fees for both residential and non-residential development. In each case, residential impact fees are per unit, while the non-residential fees are based upon 1,000 square feet.

Exhibit 12 Residential and Non-Residential Transportation Impact Fees in Maricopa County

Jurisdiction	Single Family Residential	Retail	Office	Industrial
Avondale	$ 400	$ 1,879	$ 732	$ 385
Cave Creek	$ 250	$ 250	$ 250	$ 250
Chandler	$ 1,537	$ 3,880	$ 2,260	$ 1,630
Fountain Hills	$ 638	$ 2,020	$ 580	$ 580
Gilbert	$ 148	$ 550	$ 200	$ 140
Glendale	$ 542	$ 50	$ 1,440	$ 398
Goodyear	$ 148	$ 418	$ 168	$ 48
Peoria North	$ 4,028	$ 16,645	$ 5,586	$ 2,934
Phoenix High (North Black Canyon)	$ 2,700	$ 5,508	$ 4,266	$ 552
Tolleson	$ 644	$ 2,182	$ 2,182	$ 384

Exhibit 13 reports on total impact fees assessed by the ten Maricopa County jurisdictions that collect transportation impact fees, with residential fees per dwelling unit and non-residential fees per 1,000 square feet.

Exhibit 13 Comparison of Total Impact Fees Collected For Residential and Non-Residential Property in Maricopa County

Jurisdiction	Residential	Retail	Office	Industrial
Avondale	$ 6,545	$ 3,505	$ 2,281	$ 1,640
Cave Creek	$ 2,945	$ 2,945	$ 2,945	$ 2,945
Chandler	$ 8,178	$ 4,780	$ 3,160	$ 2,530
Fountain Hills	$ 3,275	$ 2,350	$ 910	$ 910
Gilbert	$ 6,946	$ 2,049	$ 1,699	$ 1,639
Glendale	$ 9,360	$ 2,049	$ 4,367	$ 2,247
Goodyear	$ 4,896	$ 2,110	$ 1,929	$ 1,052
Peoria North	$ 12,680	$ 18,648	$ 7,357	$ 4,224
Phoenix High (North Black Canyon)	$ 12,160	$ 5,927	$ 4,739	$ 1,310
Tolleson	$ 3,114	$ 3,162	$ 1,505	$ 864

None of the Maricopa County jurisdictions have provisions for automatic adjustments in their impact fee schedules to account for inflation.

2.4 Basic Policy Issues

In order to implement a development impact fee program, Maricopa County will need to provide for a detail study, resulting in a written, public report that supports the assessment of the fees (see ARS §11-1102(C)(2)). There are several policy issues that will need to be identified as needing to be explored in the kind of detailed written report required by enabling legislation. These policy issues have been sorted into two primary categories: Regional Cooperation and Technical Issues.

Under Regional Cooperation are: Timing of Development and Annexation; Drawing Benefit Areas; Setting Development Impact Fees; and Residential and Non-Residential Impact Fees.

Under Technical Issues are: Roadway Development Impact Fees Only; Automatic Adjustment of Fees for Inflation; Timing of Collection of Impact Fees; Credits and Adjustments of Impact Fees; and Affordable Housing Waivers.

<u>Regional Cooperation</u>

Section 1.0 established four “circumstances” MCDOT will encounter between 2005 and 2030:

MPAs with Potential for Growth in Unincorporated Areas;

County Islands Adjacent to High Growth Areas;

County Area With the Potential for Growth;

County Areas with Low Projected Growth

The first three circumstances, most notably the first circumstance, all present MCDOT with the opportunity for generating new revenues through a development impact fee program and all three circumstances present opportunities for regional cooperation.[11] Exhibit 14 summarizes the potential for growth in occupied housing units under these three circumstances. In unincorporated areas within MPAs, growth in occupied housing units is projected to be 423,865, with an additional 7,908 in County Islands and 3,101 in the County Area adjacent to Buckeye, for potential new housing through 2030 of 434,874.

Exhibit 14 Potential Growth in Occupied Housing Units in Unincorporated Areas

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With growth of this magnitude, regional cooperation in establishing a Maricopa County development impact fee program would appear to be of paramount importance. Regional cooperation will be influenced by four policy issues:

The timing of development and annexation
Drawing benefits areas
Setting development impact fees
Residential and non-residential impact fees

Timing of Development and Annexation

For those MPAs with significant unincorporated areas, the timing of development and annexation will crucially impact the revenue potential of a County development impact fee program. Annexations can take place either before or after development has occurred and/or a capital improvement has been completed. The issue is not whether the annexation will eventually occur, that has been the dominant pattern of development in Maricopa County. The issue is when the annexation occurs and how that timing affects the County's ability to impose, collect, and expend impact fees on roadway improvements, as shown in .

As the following simple matrix shows, the timing of annexations will affect whether or not Maricopa County can assess and collect impact fees (see Exhibit 15).

Maricopa County cannot assess or collect impact fees on any property after it has been annexed into a city or town. There is anecdotal evidence that developers are getting their zonings or rezoning from Maricopa County and then getting themselves immediately annexed. In these instances, a Maricopa County impact fee program would be irrelevant.

[11] The January 2002 MAG report on impact fees addresses this issue as well. For example, the report suggests that "Jurisdictions could plan and finance one or several different kinds of facilities jointly through locally collected fiscal impact fees by establishing a joint area of benefit. This could be done by two or more jurisdictions."[11] Later, the report says, "In the MAG Region, there is no provision for regional infrastructure impact fees."[11] Since MCDOT already partners, and will continue to partner, with incorporated jurisdictions on roadways of regional significance, partnering on impact fees would seem to be a small step conceptually.

Maricopa County can assess and collect impact fees on property that has not been annexed yet. The amount of impact fees collected, however, would depend upon the timing of annexation in relation to construction of capital improvements funded with impact fees. In the instance where development and completion of an impact fee project occur before annexation, then Maricopa County fees would be totally applicable. When development occurs before annexation, but the improvement project is started or completed after annexation, intergovernmental agreements, between the County and annexing jurisdiction would be necessary.

Exhibit 15 Relationship Of Timing Of Development, Capital Improvements And Annexations

		Timing of Capital Improvements	
		Before Annexation	After Annexation
Timing of Development	Before Annexation	Maricopa County could assess and expend development impact fees for all property developed and relevant capital improvements that occur before the property is annexed	Maricopa County could assess development impact fees on this property before it is annexed; expenditure of impact fees collected on capital improvements constructed after annexation would require an IGA
	After Annexation	Maricopa County cannot assess impact fees on development after property is annexed; these capital improvements would have been completed before the specific development	Maricopa County cannot assess impact fees on development after property is annexed; these capital improvements would be covered by any development fees assessed by the municipality

Drawing Benefit Areas

While some jurisdictions are small enough, and compact enough, to draw one benefit area for the entire jurisdiction. The circumstances in Maricopa County are far more complex and geographically dispersed to allow for a reasonable use of a single benefit area. Exhibit 16 presents a map of the RAZs that are (1) most likely to be currently unincorporated areas inside of the ten affected MPAs; (2) County Islands most surrounded by MPAs and high growth areas; (3) the County Area TAZ with growth potential adjacent to the Buckeye MPA. Exhibit 16 is not a recommendation for specific benefit areas, but an example of how benefit areas could drawn, based upon a cursory examination of geographical proximity.

Exhibit 16 suggests some common sense demarcation of perhaps as many as eleven benefit areas:

Exhibit 16 Potential Benefit Areas Map

Benefit Area	Area Description	RAZs Included
1	Phoenix MPA North	203, 206, 218
2	Mesa/Queen Creek MPA	294, 295, 300, 321, 322, 339
3	Phoenix MPA South	283, 284, 304
4	Avondale MPA	282, 303
5	Gila Bend MPA	331
6	Buckeye MPA South, with County Island RAZ 301	343, 277, 301, 279, 278
7	County Area RAZ 346	346
8	Buckeye MPA North, with County Island RAZ 252	253, 252, 340, 341
9	Surprise/Peoria MPA South, with County Islands RAZ 220	211, 212, 233, 213,215, 220
10	Surprise/Peoria MPA North	344, 202, 204
11	Wickenburg MPA	201

Exhibit 17 reports on the potential growth in occupied housing units by 2030 in each of the eleven conceptual benefit areas. There would be considerable variation in the rates of growth of these conceptual benefit areas. The benefit area with the largest growth would be # 9 (Surprise/Peoria MPA South, with a potential of 118,090 new occupied housing units. Five benefit areas (#2, 3, 6, 8, and 10) would be somewhat uniform in the amount of growth in each, ranging from a low of 48,561 to a high of 64,251. Two benefit areas would experience growth in new housing units of just under 25,000 new units, areas #1 and 4. Finally, The Gila Bend MPA (#5), County Area (#7), and Wickenburg MPA (11) would experience the lowest amount of growth, suggesting that they might be better served rolled into a large benefit area.

To reiterate, the purpose here is not to recommend precise benefit areas, but to demonstrate the type of detailed analysis that could be used in drawing multiple benefit areas.

Exhibit 17 Summary of Benefit Area Growth in Housing Units

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Setting Development Impact Fees

One important goal of a Maricopa County roadway impact fee program could be to achieve a net increase, or at least avoid a net decrease, in regional transportation funding. This goal would look at the potential of a County roadway impact fee program to increase revenues for MCDOT, but also at how such a program could be structured achieve net revenue increases for other jurisdictions, depending upon how annexations occur, as discussed earlier. The following section reviews the potential for a Maricopa County impact fee program to increase net regional transportation revenues, assuming all other transportation funding variable are held constant.

While virtually all incorporated jurisdictions in Maricopa County have development impact fees, not all jurisdictions impose fees for roadway improvements (see Exhibit 18). Six of the jurisdictions in targeted MPAs do not have roadway development impact fees, most notably Buckeye, Mesa, Queen Creek, and Surprise. Three jurisdictions in targeted MPAs, however, do collect roadway development impact fees, most notably Avondale, Peoria, and Phoenix.

Exhibit 18 Jurisdictions in Targeted MPAs with and without Roadway Development Impact Fees

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In the MPA areas, however, the situation is more complex. If no annexations occurred until after development is finished and all roadway impact fees were collected, a Maricopa County impact fee program would generate a net increase to regional transportation revenues. The timing of annexations, however, could produce complicated impacts on net regional revenues. There are four impact scenarios if annexation were to

occur prior to completion of development, depending upon whether or not Maricopa County and the other incorporated jurisdictions have roadway impact fees.

There are four possible scenarios regarding impact fees:

County NO/Incorporated Jurisdiction NO
County YES/Incorporated Jurisdiction NO
County NO/Incorporated Jurisdiction YES
County YES/Incorporated Jurisdiction YES

Each scenario creates its own opportunities and needs for achieving the goal of increasing regional transportation funding.

NO/NO Regardless of the timing of annexation, this scenario would not increase regional transportation revenues, because neither jurisdiction is collecting an impact fee. This would be the status quo option for six jurisdictions in targeted MPAs (Buckeye, Gila Bend, Mesa, Queen Creek, Surprise, and Wickenburg), with projections for significant growth in the next twenty-five years. the potential for population growth of 760,605 and new households of 304,242. The preferable alternative is for one or both jurisdiction to impose roadway impact fees.

YES/NO If Maricopa County collected a roadway impact and the six incorporated jurisdiction continued to not collect a fee, there would be a net increase in regional transportation revenues, but only until annexation, regardless of when it occurred. After annexation, there would be a decrease in regional transportation revenues, since no impact fees would be collected after annexation, which would be an undesirable outcome. This outcome could be avoided in one of two ways. First, there could be an agreement between the County and the jurisdiction that annexation would not occur until after the County had collected all potential roadway impact fees. Second, the incorporated jurisdiction could impose a roadway impact fee that was equal to or greater than the County's, so that fees are collected regardless of annexation.

NO/YES Under this scenario, there would be an increase in regional transportation as soon as annexation occurred, because the four incorporated jurisdiction would begin to collect impact fees on all development that occurs after annexation. Under this scenario, the earlier that annexation took place, the higher would be the net increase in regional revenues.

YES/YES This is the more complicated of the scenarios. With Maricopa County starting to collect a roadway impact fee, there would be a net increase in regional revenues. With annexation, however, the impacts on regional revenues clearly will depend upon how the two fees compare to one another.

If impact fees in the incorporated jurisdiction were higher than those collected by Maricopa, then annexation would further increase regional revenues and the earlier that annexation occurred, the higher the increase in revenues.

If Maricopa County set its impact fees at the level equivalent to what the incorporated jurisdiction would collect, then the gain realized by the County's impact fee program would be preserved, regardless of when annexation occurred.

If, however, the County's fees were higher then those that the incorporated jurisdiction would impose, then annexation could be seen as decreasing regional revenues. Like the YES/NO scenario, this outcome could be avoided by an agreement to delay annexation or by the incorporated jurisdiction raising its fees.

The enabling legislation does not prescribe a methodology for setting impact fees, only requiring that they be reasonable and nondiscriminatory (ARS §11-1102(B)(4) and (5)). Therefore, Maricopa County has considerable flexibility in developing policies for implementing an impact fee program and harmonizing its program with those of incorporated jurisdictions in the County. The Recommendations section presents some estimates of the potential development impact fee revenues, depending upon assumptions of timing of annexation and the level of the fees.

Residential And Non-Residential Development Impact Fees

All of the incorporated jurisdictions in Maricopa with impact fees collect them for residential and non-residential development. Non-residential development will certainly follow residential development of the scale anticipated through 2030, generating its own travel demand. For the reasons discussed above, Maricopa County would want to also collect non-residential impact fees and to harmonize those fees with the adjacent incorporated jurisdictions.

Some jurisdictions also impose construction sales taxes or use development agreements for commercial development. The County will need to decide whether it will assess fees on both residential and commercial development, or only on residential development. The County might also want to look at the authorities provided by ARS11-1101 to use development agreements tied to improvement districts as a mechanism, especially for commercial development.

Technical Issues

There are other policy issues that would be addressed in developing a Maricopa County development impact fee program. These issues tend to be more technical in nature, but they would also have regional revenue impacts. The five issues discussed below include (1) whether to collect fees for other capital needs in addition to roadway; (2) whether to adjust fees for inflation; (3) when to collect fees; (4) whether to provide credits and adjustments to fees based upon other contributions from the development; and (5) whether to grant waivers from fees for affordable housing.

Roadway Development Impact Fees Only

The Arizona counties that currently have development impact fees assess them only for transportation, but the legislation (ARS §11-1102(A)) allows counties to assess impact

fees for water, sewer, parks and public safety facilities. All of the incorporated jurisdictions in Maricopa County that collect impact fees do so for needs beyond roadways and several do not include roadways in their fee programs. Whether Maricopa County would assess fees for more than transportation is a matter for the Board of Supervisors and not Maricopa DOT, but it is a question that would need to be reviewed in the impact fee study.

Automatic Adjustment For Inflation

Most local jurisdictions provide for periodic review of their fee programs and allow adjustment of fees by legislative action. Pima County and City of Tucson, however, provide for automatic adjustments of fees to account for inflation. No other jurisdiction was found to provide for automatic adjustments for inflation, but all jurisdictions do provide for adjustments to fees based upon legislative action of the governing body. Maricopa County will want to explore the option of providing for automatic inflation adjustments, to keep fees consistent with increasing costs or of providing for fee increases based upon the discretion of the governing body.

If the County were to opt for automatic adjustments for inflation, the County would need to decide on a measure of inflation. Pima County uses the Bureau of Labor Statistics Consumer Price Index –Urban (CPI-U) to measure the inflation adjustment; the City of Tucson uses the Engineering News – Record Construction Cost Index (CCI) as its measure. Both are respected indexes that are widely used and readily available. Technically, the CCI seems more related substantively to the issue at hand, financing infrastructure improvements, than does a measure of goods and services purchased by the average urban household. Since 1990, both indexes have roughly tracked one another and the average annual increase of the CCI has been slightly higher than the CPI-U. Furthermore, the CCI has shown more volatility than the CPI-U, especially at the upper range of increases. Over the past two years, the CCI has grown considerably faster than the CPI-U, a factor of the dramatically increasing prices of cement and structural steel.

Timing Of Collection Of Impact Fees

ARS§11-1101(B)(3) requires that fees for residential impact fees shall be paid "when construction permits for the dwelling units are issued," but otherwise provides that the county "shall prescribe the schedule for paying the development fees." No instances were found of a jurisdiction that did not require both residential and non-residential fees to be paid at the time of construction permits. Ultimately, the timing of non-residential fees is a matter of the jurisdiction having the leverage to compel payments of fees. Development agreements would provide both the County and the developer with more flexibility on the timing of payment of contributions for public infrastructure, permitting a schedule for reimbursements, or the creation of an improvement district.

Credits And Adjustments Of Impact Fees

The statute provides for credits and adjustments for donations at ARS §11-1102(B)(3):

- "The county shall provide a credit toward the payment of the fee for the required dedication of public sites and improvements provided by the developer for which that fee is assessed."

There appears to be variation in how credit provisions are structured, with some jurisdictions being more restrictive in the scope of credits than others. This is an issue that would be explored in more detail in a formal impact fee study.

Affordable Housing Waivers

The County enabling statute used to provide explicit, permissive authority for counties to provide waivers in impact fees for affordable housing. With the Growing Smarter amendments, however, language relating to affordable housing waivers was deleted from the statute. Pima County continues to offer an affordable housing waiver, limited to one waiver per household, based upon total annual income limits of $28,200 for a one person household to $36,300 for a three person household up to $53,200 for an eight person household. No attempt was made to determine if other jurisdictions provide for affordable housing waivers or otherwise provide for income-related reductions in fees.

2.5 Conclusion

Development impact fee programs are ever more common and relatively easy to administer. Over the next twenty-five years, MCDOT and several jurisdictions will be responsible for providing significant new capacity for a population increase of approximately 2.5 million people, much of which growth will occur in currently unincorporated areas of the County slated for eventual annexation. A Maricopa County roadway development impact fee, structured and administered to consistently enhance regional roadway revenues, would provide needed revenues to meet the challenges of this growth.

3.0 ANALYSIS OF THE POTENTIAL OF IMPROVEMENT DISTRICTS FOR PROVIDING NEW REVENUES

3.1 Introduction

The 1999 Needs Study reported that Maricopa County used improvement districts for repaving projects, construction of roadways or sidewalks, and installation of landscaping The 1999 study reported as MCDOT revenues the following revenues from improvement districts between Fiscal Year 1993/94 and 1996/97.

Exhibit 19 Improvement District Revenues from 1999 Needs Study

Fiscal Year	Revenues
FY 1994	270,000
FY 1995	191,000
FY 1996	198,000
FY 1997	170,000
Total	829,000
Average	207,250

The 1999 study assumed that revenues from improvement districts would continue through the year 2020, at an average rate of $200,000 per year.

While not conceiving of improvement districts as a major source of funding for Maricopa County DOT, the 1999 study did recommend an increased use of improvement districts. The 1999 study also noted that formation of a county improvement district was more restrictive than for forming a municipal improvement district. The study suggested that simplification of the formation requirements could enhance their potential for enhancing the Department's revenue base, but pointed out that efforts by the Arizona Association of County Engineers tried unsuccessfully to revise the enabling statute.

The 2005 TSP has established that the information from the 1999 report is no longer accurate today. While the County continues to operate improvement district programs, no revenues or expenditures for these districts are included under the MCDOT budget. In fact, the State Auditor General recently ruled that the County cannot continue to use HURF revenues to defray administrative costs of improvement districts. Furthermore, the uses to which Maricopa County applies improvement districts are significantly different than originally reported, and, where the uses relate to streets, they focus primarily on local rather than arterial streets.

Maricopa County has extensive experience with improvements districts, with the Superintendent of Streets office playing a direct, or at least instrumental role in the formation of districts, as well as with billing and collecting assessments. Under current practices, however, improvement districts for streets are primarily focused on local, rural streets serving a limited number of property owners. The County and MCDOT can continue with the current practices, which are serving targeted, "niche markets" with alternative funding that would not otherwise be available. Under this scenario, recommendations regarding the use of improvement districts would not be germane to the 2005 TSP.

MCDOT, and the County, might wish to look more closely at a basic policy question: can, and should, improvement districts be used to help fund major capacity improvements, both horizontal and vertical/structural, to roadways that are already in the County's maintenance system or that existing residents or businesses are requesting be brought into the maintenance system? As distinct from impact fees, improvement districts provide an option for financing improvements to meet existing roadway deficiencies. Section 1.0 discussed four sub-regions of the County Areas, where improvement districts might be an effective option for generating additional, targeted revenues. As noted in Exhibit 4, the Northeast and Northwest sub-regions have the greater potential for growth (2,011 and 1,716 new occupied housing units respectively), while the West Central and

South sub-regions will experience relatively little growth (833 and 885 new occupied housing units respectively). While development impact fees would not be relevant to these areas, improvement districts could be used to help finance improvements that are of importance to the residents in the areas.

After a brief discussion of how Maricopa County currently utilizes improvement districts, this white paper examines some key issues that could help inform a policy discussion of this question. This discussion touches upon the difficulties of forming districts under current state statutes; do other Arizona counties use districts to fund larger roadway improvements; should the County explore cost sharing as an incentive to the formation of districts; should the County more aggressively market improvement districts; should Maricopa County consider linking development agreements and improvement districts; and what options does Maricopa County have if an improvement district fails or defaults.

3.2 Maricopa County Improvements District Program: Some Background Information

Report

Maricopa County has a fairly extensive experience with improvement districts, dating back several decades.[12] (See Attachment 3.1 for Frequently Asked Questions on improvement districts provided on the Maricopa County web page.[13] The County operates three categories of improvement districts: K Districts, L Districts, and Street Lighting Districts (see Exhibit 20).

Exhibit 20 Improvement Districts Operated by Maricopa County

K Districts	K Districts are one time improvement districts formed to make specific improvements. Typically bonds are sold to finance the improvements. The Superintendent of Streets bills and collects the property assessments.
L Districts	L Districts are perpetual districts, typically established to finance on-going maintenance, of streets or water systems, and one HOA Park. Billing is collected on the property tax roll. The Superintendent of Streets reports the existence of twelve L Districts.
Street Lighting Districts	Street lighting districts are established to cover the costs of operating and maintaining street lighting within the district. These districts are typically established as part of a subdivision development, with the developer paying for installation of the system. The Superintendent of Streets helps with

[12] This discussion relies exclusively on information provided by staff in the Superintend of Streets office.

[13] . See www.mcdot.maricopa.gov/divisons/ops/improve.htm and click on the link under Question 2, "What is a Maricopa County Improvement District."

creation of the district and with approval of the lighting layout. The utility bills the Finance Department and property owners pay through secondary assessments on their property tax bill. The Superintendent of Streets reports the existence of over 500 street lighting districts.

The Consultant reviewed data in an Excel spreadsheet provided by the Superintendent of Streets on K Districts (see Attachment 3.2). The spreadsheet identified seventy-eight districts, but only sixty-two districts provided useable data. Thirteen districts were not used because of their status and three districts did not include data on costs (see Exhibit 21).

Exhibit 21 Reasons for Excluding Improvement Districts from Analysis

Category	Number of Districts
Rescinded/Denied	5
Not Organized/To Be Barred	3
No Assessments	1
Annexed	2
Done by Community Developmei	1
Pending	1
No Cost Data	3
Total	16

Exhibit 22 describes the remaining sixty-two K Districts for which useable data was provided. The total reported costs of these districts, going back to the late 1970's, were $11.2 million, with an average cost per district of $186,178. The total number of reported assessments was 3,285 properties, with an average number of assessments per district of fifty-six.

Districts for street paving, at forty-four, were the most common occurrences. The total reported costs of these districts were just under $6.0 million, with an average cost per district of $135,554. The average number of assessments per district was forty-four.

Exhibit 22 Data on Sixty-Two K Districts

District Type	Number of Districts	Reported Costs: Total Reported Costs	Reported Costs: Average Reported Costs	Reported Number of Assessments: Total Number Assessments	Reported Number of Assessments: Average Number Assessments
Paving	44	5,964,377	135,554	1,873	44
Paving/Curbs/Gutters	7	1,386,171	198,024	522	75
Chip Seal	1	26,795	26,795	15	15
Sewer/Water	10	3,843,387	384,339	875	88
Total	62	11,220,730	186,178	3,285	56

There were seven districts formed to fund paving, curbs, and gutters, with total reported costs of $1.4 million and an average cost per district of $198,024. These districts were larger than those just for paving, with an average of 75 assessments per district.

There was one district formed to fund chip sealing, with a total reported cost of only $26,795 and fifteen assessments.

(Ten districts were formed to fund sewer or water improvements (five districts for each), with an average reported cost per district of $384,339 and an average number of assessments per district of eighty-eight.)

Comments

This data establishes that K type improvement districts are typically formed to provide improvements to local, probably rural streets, at low costs and serving a limited number of property owners. The 2005 TSP Update assumes that the L Districts (for on-going maintenance) serve a similar type of street and population.

The Superintendent of Streets office clearly has longstanding experience with improvement districts, which they manage with a high degree of competence and professionalism. The office maintains a webpage on improvement districts, with instructions on how to petition to establish one and description of the uses for which a district can be formed.[14] Improvement districts are used to serve "niche markets" and provide a useful source of funding for these niches. The County most assuredly should continue to provide this option.[15]

3.3 Should MCDOT Use Improvement Districts To Help Fund Horizontal And/Or Vertical Capacity Improvements On Roadways?

Whether Maricopa County should use improvement districts to fund horizontal and/or vertical capacity improvements on roadway is a complex question, not all aspects of which will be reviewed in this analysis. Strategic questions that are addressed in this analysis include:

Are current state statutes enabling county improvement districts too limited and cumbersome?

[14] See http://www.mcdot.maricopa.gov/diivisions/ops/improve

[15] MCDOT has proposed seeking legislative changes to the enabling statutes for county improvement districts to permit formation at the county's initiative of districts to address street paving to meet federally mandated air quality requirements. To date, these recommendations have not been included in the County's annual legislative agendas.

How do other Arizona counties use improvement districts?

Should Maricopa County consider cost sharing with improvement districts?

Should Maricopa County more aggressively "market" improvement districts?

Should Maricopa County consider using development agreements linked to improvement districts?

What options does Maricopa County have if an improvement district fails or defaults?

Are current state statutes enabling county improvement districts too limited and cumbersome?

Report

With its extensive experience with improvement districts, the Superintendent of Streets office in MCDOT is well aware of the issues raised here. These issues, however, might not be as well understood throughout all of MCDOT with an interest in the potential use of improvement districts. Most certainly, the further removed from MCDOT, the less likely it would be that a reader would have extensive awareness of these issues. It was decided, therefore, to provide a somewhat detailed discussion of the administrative procedures involved with improvement districts.

Arizona counties are not allowed to initiative formation of improvement districts, as is the case with cities and towns, but must await petitions from property owners. In addition, formation and operation of improvement districts, for counties as well as cities and towns, are very time consuming, providing extensive due process and notification rights to property owners. The Superintendent of Streets noted that improvement districts entail very cumbersome administrative procedures (in particular the public notice requirements), and, as a result, they were not inherently faster, more efficient or cheaper options for financing public improvements.

The formation and operation of county improvement districts are governed by Title 48, Chapter 6, §48-901 to 48-1070, which impose restrictions on formation of county improvement districts and detailed administrative and procedurals rules for their governance. (See Attachment 3 for a Step-by-Step analysis of Title 48, Chapter 6 provided on its web site by Coconino County[16].)

Formation of County Improvement Districts by Petition Only

ARS §48-903 requires that county improvement districts can only be formed pursuant to a petition signed by either a majority of persons owning property in the proposed district or by owners of fifty-one percent or more of the real property within the proposed district. Procedurally, property owners initiate the process of improvement district formation, but counties are ready to provide citizens with support services to facilitate the development of legal petitions. The Superintendent of Streets reported that his office constantly receives requests for information about formation of improvement districts, but that very few districts are actually formed.

Administrative Steps Prior to Final Plans, Specifications and Engineers Estimate

[16] See "http://co.coconino.az.us/uploadedFiles/RoadImpDist/Step_By_Step.pdf"

Regardless of restrictions on how county improvement districts can be formed, the steps to get from formation to final plans, specifications and engineer's estimate are complicated and time consuming. Before any construction is begun, there are at least five formal actions that the Board of Supervisors must take, including:

1. After a petition has been received and deemed sufficient, the Board must hold a public hearing on the petition not later than forty-five days after the petitions have been presented. The county must publish two public notices in newspapers of general circulation, one week apart, with the first publication not less than ten days before the hearing date. In addition, the county must mail the notice by first class to all property owners of record in the proposed district not less than twenty days prior to the public hearing. If all property owners (100%) in the proposed district have signed the petition, the Board may automatically order formation of the district (ARS §48-905).

   If the petitions are deemed sufficient and it is determined that the public convenience, necessity or welfare will be promoted, the Board shall order formation of the district and the Board sits as Board of Directors for the district (ARS §48-906).
2. The Board appoints a district engineer and fixes his compensation (ARS §49-913) and the district engineer prepares plans and specifications, with estimates of the cost and expenses, which are then filed with the clerk (ARS §48-914).
3. After receiving the district engineer's plans and cost estimates and before ordering any improvement, the Board must adopt a resolution of intention to order improvements (ARS §48-912). The Board provides all property owners in the district notice of the adoption of the resolution of intention; a description of the work to be performed and the property to be assessed; the total amount of the engineer's estimate of costs and expenses of the work; and description of the board's intention to levy assessments and issue bonds, as applicable (ARS §48-916).
4. The statutes also require that before incurring any expenses for which the district would be liable and that will result in assessments against property in the district, the board shall require a petition to incur expenses signed by sufficient property owners that must be filed with the clerk (ARS §915).
5. If all legal requirements have been met, the board may order the proposed improvements by resolution and the "superintendent" then publishes the resolution and invites bids (ARS §48-919). In this instance, "superintendent" means the person designated by the board to act as street superintendent for all improvement districts.

<u>From Engineers Estimate to Start of Construction</u>

Coconino County's website provides a tentative schedule of events that estimates the process from final plans, specifications and engineers estimate to the start of construction will take 195 days (see Attachment 4)[17]. This schedule begins after the process of petitions, establishment, appointment of district engineer, and engineer's preparation of

[17] See "http://co.coconino.az.us/uploadedFiles/RoadImpDist/Events.pdf"

construction plans and engineer's estimate of costs, which will add several more months to the process leading to the start of construction.

Comments

In contrast to restrictions placed on counties, state statutes (ARS, Title 48, Chapter 4, Municipal Improvement Districts) enable cities and towns to "order" the formation of improvement districts, rather than being required to wait solely on petitioner initiatives.[18] MC DOT has proposed legislation to enable counties to order formation of improvement districts for paving roadways as part of the County's federal air quality requirements, but to no effect as of yet. While the legislative road to any legislation freeing counties to initiate action on improvement districts involves considerable heavy lifting, it seems obvious that there would be considerable benefits for counties to have such authority. At the very least, there would seem to be little or no rationale for the legislature to continue distinguishing between counties and incorporated jurisdictions in this matter, especially in light of the recent legislation that harmonizes municipal and county statutes on development impact fees.

As Coconino County demonstrates, there are a wide range of procedures and responsible parties involved in the formation and operation of a county improvement district (see Attachment 5[19]). These procedures and the range of responsible parties, however, are far less daunting than appearances make it out to be. Most of the most important procedural requirements are routinely contracted out, from preparation of resolutions and legal documents, bond counsel, financial advisors, and the district engineer. The clerk of the board will know how to handle setting routine matters like petitions and resolutions on the board agenda. The treasurer is organized to manage deposit of bonds and billing for assessment payments.[20] Most of the procedures are fairly standardized and routine, but the process is very time consuming.

How Are Other Arizona Counties Using Improvement District?

Report

The permitted uses of county improvement districts, set forth at ARS §48-909, are quite extensive, including streets; street lighting; fire protection; wastewater management; delivery of water for domestic use; levee and riverbank protection; and community centers, parks, and recreation areas. In addition, a county improvement district can provide transportation services.

Other Arizona counties that aggressively use improvement districts include Coconino, Mohave, Pima, and Yavapai. The question is whether these other counties use improvement districts to finance capacity improvements to arterial roadways.

Coconino County has thirteen active improvements district: six for roadway improvements and seven for maintenance. In several instances, the roadway maintenance

[18] It is worth noting that ARS § 48, 501 to 558, grants counties as well as cities and towns to order the formation of improvement districts for the purposes of "opening, widening closing public ways" needed for "any water course, irrigation ditch, pipe line, water main or sewer for sanitary or drainage purposes."

[19] See "http://co.coconino.az.us/uploadedFiles/RoadImpDist/process.pdf"

[20] In Maricopa County, this function is managed by the Superintendent of Streets.

district follows upon completion of construction of a roadway. No cost data was provided for three of these districts. Six of the districts had total construction costs of between $138,000 and $305,000, serving anywhere between 14 and 66 parcels.

Four improvement districts were significantly larger. Two districts are located in the Mountainaire section of the County, two of four districts formed as road maintenance district for dust control purposes. These districts had total costs and assessments of $528,392/210 parcels and $626,931/233 parcels. A third district, $621,883/96 parcels was formed to pave a dirt road and install associated drainage improvements. The fourth district, $5,340,612/710 parcels, was formed to improve all the roads in the Kachina Village area south of Flagstaff as well as drainage improvements.

Mohave County has been active with improvement districts since 1990, usually with one or two districts being formed per year. The County reports that it currently manages approximately 21,000 assessments. Fifteen improvement districts, have been formed since 1990, seven for water and eight for roadway paving. Seven of the eight districts involved paving of county-maintained dirt roads, three of which involved roads within subdivisions. Four of these districts were relatively large undertakings, as shown in Exhibit 23. Costs ranged from a high of almost $6.0 million to $1.1 million, averaged $2.8 million, and totaled $11.1 million. The number of miles improved ranged from a high of 22.3 to a low of 9.5 miles, with an average of 13.1 miles. The number of property assessments ranged from 3,118 to 1,077, averaging 1,814. The Scenic Road/Bridge was a major project, with total costs of almost $6.0 million, which included a new 485-foot bridge over the Virgin River and 10.5 miles of new roadway.

Exhibit 23 Summary Information on Four Mohave County Roadway Improvement Districts

District	Costs	Miles of Road Paved	Number of Assessments
Scenic Road and Bridge	5,966,650	10.5/485' Bridge	1,077
Egar/Estrella Roads	2,186,036	9.5	1,811
Butler #1	1,850,524	22.3	3,118
Butler #2	1,141,612	10	1,249
Average	2,786,206	13.1	1,814
Total Costs	11,144,822		

The most recent improvement districts were formed in 2000 and 2001. Bonds have been retired for nine districts and assessments are still active in the remaining six. All work has been completed in the fifteen districts. The County reports that “several petitions are being circulated by property owners” for roadway paving, water, and sanitary projects. No effort was made to determine the status of these petitions.

Pima County uses improvement districts and street light improvement districts. The improvement district (also referred to as “special assessment districts) is typically used for paving or drainage work and the billings are separate, not appearing on the property tax bill. The County reports three special assessment districts: La Cholla Boulevard (commercial property only), two Cimmaron Foothills districts, and Tucson Country Club Estates.

The La Cholla Boulevard ID was formed to supplement funding of a project in Pima County's 1997 HURF Revenue Bond program, La Cholla, River Rd to Magee Rd. This project entailed widening La Cholla to six-lanes, with associated landscaped medians, drainage improvements, sidewalks, and ADA access improvements. The improvement district was formed to finance a joint-use Foothills Mall/Wal-Mart entrance. Total costs to the district were $1,980,204 and involved assessments to sixteen commercial properties.

The two Cimmaron Foothills IDs were formed to install asphaltic concrete overlays on existing street pavement and to street shoulders, and to provide erosion controls. Total costs to the district were $573,124 and involved assessments to 40t properties.

The Tucson Country Club Estates district involved paving improvements to existing streets, a potable water system, a storm sewer system, a sanitary sewer system, and a reclaimed water system. Total costs to the district were $4,102,217 and involved assessments to 283 properties (including the Country Club).

Yavapai County reports using seven types of county special districts: for road/street improvement and then for street lighting, wastewater, sanitary, domestic water, fire, and a miscellaneous category[21]. The County reports six road/street improvement districts that have been formed and dissolved after assessments have been retired. Another four road/street improvement districts are reported. Two of these districts date back to 1996 and 1999, with the work completed and the assessments on-going: one will be paid off in 2006 and the second in 2022. A third street improvement district was established in 1993 and the engineering study was completed, but there was not enough assessed value in the district to sell bonds. The district, however, has not been dissolved. Finally, a fourth district was formed in 2005, involving 953 acres and approximately 270 parcels. Design of this project is at 30%.

Yavapai County reports that their road/street improvement districts have not made improvements to arterial roadways. The districts are typically in rural areas, have included include rural, residential collector roads. These areas are experiencing growth and residents wish to bring the roads into the county maintenance system The County's policy is that no roads can be included in their maintenance system until they are brought up to County standards, at no cost to the County. This typically is the purpose of formation of the improvement district.

<u>Comments</u>
These counties provide four examples of uses of improvement districts that could provide targeted financing options for MCDOT:

Mohave	Paving county-maintained dirt roads in rural areas
Coconino	Paving roads for dust control
Pima	Improvements to un incorporated areas within the urban area, involving a major commercial development and two high end residential subdivisions

[21] Under "Miscellaneous" special districts, the County includes a hospital district, an irrigation district, and the free library, flood control, and jail districts.

Yavapai	Rural areas experiencing growth and residents demanding roads be brought into the county-maintenance system

These uses of improvement districts are more extensive than MCDOTs current practices, would generate more revenues, and presumably would justify bringing at least some portion of the improvement district program back into the MCDOT budget.

Should the County Use Cost Sharing With Improvement Districts?

Report

MCDOT currently does not offer to cost share with improvement districts. Of the other Arizona counties reviewed, Coconino and Pima do participate in cost-sharing arrangements. In the nine improvement districts with construction cost information provided on its web site, Coconino County provided a cost share contribution in every instance, ranging from $27,000 to $1,478,722. On the average, the County contributed 38% of the total construction costs, ranging from a low of 9% to as much as 71%. In three instances where there was a large County contribution (50% or more), the contribution included the costs of drainage improvements.

In Pima County, the $5.3 million costs of the La Cholla Improvement District were born entirely by the commercial property owners, but these improvements were part of a much larger project from the County's 1997 HURF Revenue Bond Program, La Cholla – River Road to Magee Road. The improvement district was constructed in conjunction with Phase 1 of this bond project, which was completed at a cost of another $9.8 million. Pima County did not cost share directly with either Cimarron Hills or Tucson Country Club Estates.

Yavapai County has traditionally used road/street improvement districts to finance reconstructing private roads to county-standards, prior to accepting the roads into the County maintenance system, and requires that the reconstruction entails no cost to the County.

Comments

Maricopa County should consider an option for cost sharing with improvement districts. Cost sharing would provide an incentive to property owners to form improvement districts. The Superintendent of Streets reports that he believes cost sharing would be a good idea.

Should the County More Aggressively Market County Improvement Districts?

Report

The Superintendent of Streets reports that the County does not actively market roadway improvement districts. While Arizona Revised Statutes permit formation of county improvement districts only upon petition by property owners, however, this statute does not require that the County sit back passively waiting for petitioners to show up. If the County were to choose to expand its use of improvements districts to cover larger

projects, such as capacity improvements on arterial roadways, it might want to consider a more active, aggressive marketing of the availability of districts.[22]

One approach to more aggressive marketing could be to heighten and clarify the profile of improvement districts and special districts. For example, Coconino County has a special districts coordinator; Mohave County has an Improvement Districts Division in its Public Works Department; and Yavapai County has an office of Special Districts Administration, located in the Clerk of the Board's office. Pima County has recently transferred management of improvement districts into the Finance Department, raising its profile from an office in the Real Property Division. In contrast, Maricopa County assigns it improvement districts as a responsibility in the Department of Transportation, Engineering Division, Superintendent of Streets. [23]

While this office is very competent and professional, If Maricopa County decided to make more extensive use of improvement districts, beyond those for streets, it might want to raise the profile of county staff responsible for districts and expand their duties. Even if the County decided to focus solely on street related districts, the function of improvement district coordination could be expanded and placed in a more visible position in the organizational structure of MCDOT.

The County might also want to create a new, more visible, and user friendly web page to market improvement districts. Coconino, Mohave, and Yavapai counties all maintain web pages for improvement districts, and other special districts, that provide detailed information on how districts are formed and offering county staff services to support their formation.

Coconino County has very extensive information on its "County Road Improvement Districts" web page. The site provides links to general information on districts, on the differences between road improvement and road maintenance districts, a brochure on improvement districts, a tentative schedule of events and step-by-step work sheet on events, frequently asked questions, and their county road improvement district petition form. The web site also has links describing all active and proposed improvement districts.

Mohave County has an "Improvement Districts Division" web site that provides a short history of improvement districts in the county; a detailed outline of the steps from the petition to establish a district to assessments and billings; and a detailed description of what citizens need to do to get a district formed (see Attachment WHAT).

Finally, the Yavapai County "Special Districts Administration" web site includes a handbook on special districts, detailed descriptions of what is required to form a district, guidelines for maps related to formation of improvement districts, and summary descriptions of all special districts in the County (see Attachment WHAT).

These three counties provide web sites that are easier to access, more informative and professional, and more user friendly than what Maricopa County currently provides on its web site.

<u>Comments</u>

[22] This option assumes that state statutes continue to restrict formation of county improvement districts by petition. If statutes were amended to enable counties to order the formation of districts

[23] Pima County assigns responsibility for improvement districts to an office within its Real Property Division of Public Works.

If the County were to pursue a more aggressive marketing of improvement districts, raising the profile of district staff and improving the quality of the web page would be easily achievable goals.

Should Maricopa County Consider Linking Development Agreements to Improvement Districts?

Report

Maricopa DOT should also give serious thought to the funding opportunities presented by linking the authorities given by ARS §11-1101 relating to development agreements and the authorities in Title 48, Chapter 6, to form improvement districts.

ARS §11-1101 permits the county to enter into an agreement with a landowner or others with interest in real property. The agreement would establish the permitted uses of property; the density and intensity of uses and the maximum heights and size of proposed buildings; reservation or dedication of land for public purposes and provisions to protect environmentally sensitive lands; preservation or restoration of historic structures; and the phasing or time of construction or development.

In addition, to these agreements on use and development of the land, ARS §11-1101(B)(7) provides in a development agreement for setting "conditions, terms, restrictions, financing and requirements for public infrastructure and subsequent reimbursements over time" (emphasis added). Furthermore, ARS §11-1101(B) provides for setting "conditions, terms, restrictions and requirements relating to the county's intent to form a special taxing district pursuant to title 48" (emphasis added).

Comments

Using improvement districts in conjunction with development that is about to occur would seem to be a creative method for financing development related infrastructure needs, with more flexibility on what can be financed than what is offered by the county development fee statute (ARS §11-1102).

Maricopa County Options if Development Agreement and/or Improvement District Fails or Defaults

Report

At the January 5, 2006 meeting of the County Advisory Committee for the Transportation System Plan Update 2005, committee members asked the risks faced by the County is improvement districts fail or there are delinquencies on required assessment payments. The County's fact sheet on improvement districts provides the following answer to this question:

> "14. **What if I can't make the payments?**
> If an assessment becomes delinquent, the district is obligated to sell the property covered by that assessment to pay the special assessment bonds. The buyer is

required to hold the lien for a minimum of one year before applying for a Superintendent of Streets deed of the property. During that period, the assessment lien must be paid in full, plus penalties. Once a deed is issued, the buyer has control of its redemption value."

Comment

It would appear that the County's risk due to delinquencies or defaults can be addressed legally, though the process of obtaining judgments and compensation for losses is time consuming and unpleasant for all parties.

3.4. Conclusions

Maricopa County has extensive experience with improvement districts, but the experiences of other Arizona counties demonstrate that MCDOT could make significantly more use of improvement districts. Pima County has demonstrated that districts can be used profitably in urban settings, for commercial development and with suburbanized, high density residential developments. In instances where the needs exist already rather than being growth generated, improvement districts are a viable option. Also, in the County Areas where the existing population is demanding that their roads be upgraded and/or brought into the County system, improvement districts would also be a viable option.

Improvement districts will never generate large revenues, but they can generate revenue streams that are commensurate with much targeted needs that the County will encounter and wish to address.

ATTACHMENT 2.1

State Statutes Governing County and City/Town Development Impact Fees

11-1102. County development fees

A. If a county has adopted a capital improvements plan, the county may assess development fees within the covered planning area in order to offset the capital costs for water, sewer, streets, parks and public safety facilities determined by the plan to be necessary for public services provided by the county to a development in the planning area.

B. Development fees assessed under this section are subject to the following requirements:

1. Development fees shall result in a beneficial use to the development.

2. Monies received from development fees shall be placed in a separate fund and accounted for separately and may only be used for the purposes authorized by this section. Interest earned on monies in the separate fund shall be credited to the fund.

3. The county shall prescribe the schedule for paying the development fees. The county shall provide a credit toward the payment of the fee for the required dedication of public sites and improvements provided by the developer for which that fee is assessed. The developer of residential dwelling units shall be required to pay the fees when construction permits for the dwelling units are issued.

4. The amount of any development fees must bear a reasonable relationship to the burden of capital costs imposed on the county to provide additional necessary public services to the development. In determining the extent of the burden imposed by the development, the county shall consider, among other things, the contribution made or to be made in the future in cash by taxes, fees or assessments by the property owner toward the capital costs of the necessary public service covered by the development fee.

5. Development fees shall be assessed in a nondiscriminatory manner.

6. In determining and assessing a development fee applying to land in a community facilities district established under title 48, chapter 4, article 6, the county shall take into account all public infrastructure provided by the district and capital costs paid by the district for necessary public services and shall not assess a portion of the development fee based on the infrastructure or costs.

C. Before assessing or increasing a development fee, the county shall:

1. Give at least one hundred twenty days' advance notice of intention to assess a new or increased development fee.

2. Release to the public a written report including all documentation that supports the assessment of a new or increased development fee.

3. Conduct a public hearing on the proposed new or increased development fee at any time after the expiration of the one hundred twenty day notice of intention to assess a new or increased development fee and at least fourteen days before the scheduled date of adoption of the new or increased fee.

D. A development fee assessed pursuant to this section is not effective for at least ninety days after its formal adoption by the board of supervisors.

E. This section does not affect any development fee adopted before the effective date of this section.

9-463.05. Development fees; imposition by cities and towns; annual report

A. A municipality may assess development fees to offset costs to the municipality associated with providing necessary public services to a development.

B. Development fees assessed by a municipality under this section are subject to the following requirements:

1. Development fees shall result in a beneficial use to the development.

2. Monies received from development fees assessed pursuant to this section shall be placed in a separate fund and accounted for separately and may only be used for the purposes authorized by this section. Interest earned on monies in the separate fund shall be credited to the fund.

3. The schedule for payment of fees shall be provided by the municipality. The municipality shall provide a credit toward the payment of a development fee for the required dedication of public sites and improvements provided by the developer for which that development fee is assessed. The developer of residential dwelling units shall be required to pay development fees when construction permits for the dwelling units are issued.

4. The amount of any development fees assessed pursuant to this section must bear a reasonable relationship to the burden imposed upon the municipality to provide additional necessary public services to the development. The municipality, in determining the extent of the burden imposed by the development, shall consider, among other things, the contribution made or to be made in the future in cash or by taxes, fees or assessments by the property owner towards the capital costs of the necessary public service covered by the development fee.

5. If development fees are assessed by a municipality, such fees shall be assessed in a non-discriminatory manner.

6. In determining and assessing a development fee applying to land in a community facilities district established under title 48, chapter 4, article 6, the municipality shall take into account all public infrastructure provided by the district and capital costs

paid by the district for necessary public services and shall not assess a portion of the development fee based on the infrastructure or costs.

C. A municipality shall give at least sixty days' advance notice of intention to assess a new or increased development fee and shall release to the public a written report including all documentation that supports the assessment of a new or increased development fee. The municipality shall conduct a public hearing on the proposed new or increased development fee at any time after the expiration of the sixty day notice of intention to assess a new or increased development fee and at least fourteen days prior to the scheduled date of adoption of the new or increased fee by the governing body. A development fee assessed pursuant to this section shall not be effective until ninety days after its formal adoption by the governing body of the municipality. Nothing in this subsection shall affect any development fee adopted prior to July 24, 1982.

D. Each municipality that assesses development fees shall submit an annual report accounting for the collection and use of the fees. The annual report shall include the following:

1. The amount assessed by the municipality for each type of development fee.

2. The balance of each fund maintained for each type of development fee assessed as of the beginning and end of the fiscal year.

3. The amount of interest or other earnings on the monies in each fund as of the end of the fiscal year.

4. The amount of development fee monies used to repay:

(a) Bonds issued by the municipality to pay the cost of a capital improvement project that is the subject of a development fee assessment.

(b) Monies advanced by the municipality from funds other than the funds established for development fees in order to pay the cost of a capital improvement project that is the subject of a development fee assessment.

5. The amount of development fee monies spent on each capital improvement project that is the subject of a development fee assessment and the physical location of each capital improvement project.

6. The amount of development fee monies spent for each purpose other than a capital improvement project that is the subject of a development fee assessment.

E. Within ninety days following the end of each fiscal year, each municipality shall submit a copy of the annual report to the city clerk. Copies shall be made available to the public on request. The annual report may contain financial information that has not been audited.

F. A municipality that fails to file the report required by this section shall not collect development fees until the report is filed.

ATTACHMENT 3.1

Frequently Asked Questions

Improvement Districts

11. **What is an Improvement District?**
An improvement district is designed to provide neighbors a method of accomplishing local improvements and distributing the cost among all property owners who benefit.

12. **How do I go about getting one organized?**
To initiate an improvement district, a request for a petition must be submitted, in writing, to the Office of the Superintendent of Streets, outlining the extent of the improvements desired. A petition, which includes the district boundary and a cost estimate, will then be returned to obtain signatures of either a majority of persons owning real property within the district or the owners of fifty-one percent (51%) or more of the real property owners within the district.

Upon receipt of a petition with sufficient signatures, the Superintendent of Streets will proceed with formation of the district. Proceedings and hearings as required by state law will be conducted with the Maricopa County Board of Supervisors serving as the Board of Directors of the district. This process, from start to finish, takes a minimum of eight (8) months to complete, depending on design and construction time requirements.

13. **How do I pay for the improvements?**
The total cost of the improvement is either financed by special assessment bonds purchased through public bid or collected annually on the tax roll (for street lights and road maintenance).

Once the improvements are complete, an assessment is placed on every lot and/or parcel within the district. For districts financed with bonds, the assessment may be paid for:
a) In cash, during the time provided, normally 30 days, or'
b) By semiannual installment of principal and interest (May and November), for a period not to exceed 25 years.

If, after an assessment has gone to bond and an early payoff is desired, the payoff will include the unpaid principal balance PLUS interest to the next payment period PLUS a five percent (5%) penalty on the unpaid balance (premium to bond holder).

14. **What if I can't make the payments?**
If an assessment becomes delinquent, the district is obligated to sell the property covered by that assessment to pay the special assessment bonds. The buyer is required to hold the lien for a minimum of one year before applying for a Superintendent of Streets deed of the property. During that period, the assessment lien must be paid in full, plus penalties. Once a deed is issued, the buyer has control of its redemption value.

15. **Who can I talk to for more information?**
For further information on improvement districts within unincorporated areas of Maricopa County, contact the Office of the Superintendent of Streets at (602)506-8798.

16. **I don't want to have my road paved but I would like to have my road graded.**
Due to current legal restrictions, we are not accepting any new roads for grading. Only roads that have been paved to county standards will be accepted for maintenance by MCDOT.

17.**How often is the road graded?**
The road is graded approximately six times per year.

18 **How can I discontinue maintenance of a dirt road improvement district?**
Maintenance established by this proposed improvement district shall not be terminated until an alternate form of perpetual maintenance is approved by the Board of Directors or until the district incorporates into a municipality or the district is annexed by a municipality.

ATTACHMENT 3.2

Numerical K District Listing

Numerical K District Listing

K Number	District Name	Type	Total Cost	Date Warrant Recorded	Dkt/Pg(s)	Date Organized	Lien Filed	No. of Assmnts	Comments/Collecting
K 17	Casa Shadows	S	$116,202.00	7/18/1978				61	
K 18	Carefree Drive	S	$63,270.13	7/18/1978				66	
K 19	Lehi	W	$64,734.40	11/21/1977				14	
K 20	Pendergast	P	$248,385.93	7/2/1979				61	
K 21	131st Street	P	$54,329.16	9/26/1977				21	
K 22	Queen Creek	W						430	
K 23	Villa Paradise	S	$30,346.45	5/1/1981	15206/336-340		2/23/1981	18	
K 24	Thunderbird Acres	P	Rescinded 4/7/80						
K 25	Tonto			4/7/1982	15942/1231-1234		2/22/1982	48	
K 26	Desert Foothills	S	$297,606.62	4/7/1980				206	
K 27	Cashion Terrace	P	Done By Community Development						
K 28	Range Rider	W	$953,940.82	9/17/1979				128	
K 29	Utopia		Rescinded 11/5/79						
K 30	Hidalgo-Pecan	P	$73,078.00	1/7/1981	14941/53-57		11/17/1980	25	
K 31	Circle City	P							
K 32	Miami Road		Dissolved 3/16/81						
K 33	Eastern Pacific	W	$156,215.75	1/7/1981	14941/37-47		11/17/1980	33	
K 34	Granada	P	Annexed by City of Glendale						
K 35	Carefree Water	W	Dissolved						
K 38	Desert Lane	P	$51,525.25	1/7/1981	14941/48-52		11/17/1980	23	
K 39	Saddleback	P	$251,684.59	8/17/1983	83-329808		6/27/1983	128	
K 41	Golden Crest	P	$57,480.00	1/7/1981	14941/42-47		11/17/1980	36	
K 42	Vista Del Valle	P	$77,347.23	5/1/1981	15206/330-335		2/23/1981	37	
K 43	Mary Francis	P	$56,678.44	6/29/1981	15346/1173-1178		5/18/1981	28	
K 45	Superstition III	PCG	$438,094.06	6/29/1981	15346/1178-1194		5/18/1981	230	
K 46	Luke Field South	PCG	$65,946.40	9/9/1981	15505/34-38		7/20/1981	34	
K 47	97th Street	P	$287,846.60	1/22/1982	15783/344-357		12/14/1981	170	
K 48	Tremaine Park	P	$247,022.96	3/17/1982	15897/5-12		2/9/1982	86	

K Number	District Name	Type	Total Cost	Date Warrant Recorded	Dkt/Pg(s)	Date Organized	Lien Filed	No. of Assmnts	Comments/Collecting
K 49	Superstition IV	P	$243,957.29	12/9/1981	15690/850-860		10/26/1981	133	
K 51	4th Avenue	P	$75,446.10	4/12/1982	15951/1136-1141		8/15/1983	38	
K 52	Suburban I	P	$249,417.00	9/28/1983	83-390970		6/27/1983	62	
K 53	Golden Crest II	P	$174,532.70	1/17/1983	83-016940		12/6/1982	81	
K 54	80th Avenue	P	$28,947.00	1/19/1983	83-021678		12/13/1982	6	
K 55	Surrey Hills	P	$20,184.56	8/11/1983	83-321294		2/22/1982	10	
K 56	Cave Creek	S	Denied	11/15/1982					
K 57	Ivanhoe	P	$371,646.80	6/7/1984	84-247237		4/16/1984	107	
K 58	Mobile Gardens	W	$323,206.92	1/17/1985	85-022603	5/23/1984	11/26/1984	270	Tax Roll
K 59	Emerald	P	$44,212.00	10/24/1985	85-506396		9/16/1985	17	
K 60	Thunderbird North	P	$399,918.10	11/23/1987	87-706876			87	
K 61	91st Place	P	$42,474.60	3/9/1988	88-111222		10/5/1987	8	
K 62	Tierra Madre	P	$194,474.60	9/3/1986	86-475600		1/25/1988	32	
K 63	Creedance	P	$47,740.60	8/25/1986	86-454194		7/21/1986	9	
K 64	Ranchitos Verdes 5	P	$132,098.60	10/22/1986	86-579211		9/15/1986	16	
K 65	Butte Street	P	$46,900.00	9/3/1986	86-475599		7/21/1986	13	
K 66	98th Street	P	$65,014.37	11/10/1987	87-683237		7/21/1986	32	
K 67	Highland	P	Annexed by Town of Cave Creek						
K 68	98th Place	P	$65,788.25	5/27/1987	87-332507		3/16/1987	20	
K69	Pecos-McQueen	S	$1,438,458.81	12/8/1987	87-729279		1/19/1987	79	
K70	99th Place	P	$65,198.25	5/27/1987	87-329391		3/16/1987	24	
K72	Whetten	P	$235,416.80	5/21/1987	87-321988		4/6/1987	87	
K73	Valencia	P	$118,387.50	11/16/1989	89-530893		10/2/1989	76	
K74	99th Street	P	$65,349.12	3/9/1988	88-111223		1/25/1988	19	
K75	98th Way	P	$64,705.74	3/9/1988	88-110245		1/25/1988	15	
K76	Vine	P	$47,892.87	11/8/1988	88-551727		9/26/1988	15	
K77	Inland	P	$347,687.35	1/28/1987	87-054186		12/15/1986	57	
K78	Foothills		Not Organized						
K79	97th Place	PCG	$84,086.50	3/28/1989	89-137882		2/6/1989	19	
K80	Del Witt	P	$121,954.00	11/16/1989	89-530894		10/2/1989	22	
K81	5th Avenue	P	$76,242.00	1/31/1995	90-068898		1/8/1990	26	
K83	Boulder	P	$55,543.36	2/5/1992	92-061813		1/16/1992	8	
K89	158th Street	P	$77,931.40	9/23/1992	92-0530836		9/10/1992	28	
K90	Grandview Manor	PCG	$366,840.10	1/31/1995	95-0055974	12/7/1992	1/12/1995	129	
K91	Queen Creek Water	W	$399,404.94		Bonds closed 01/12/98	8/2/1993			X
K92	Fairview Lane	P	$107,936.10	10/23/1995	95-0647344	6/22/1994	10/13/1995	35	
K93	Fairview Lane East	P	$128,265.40	10/4/1996	96-0709834	9/7/1994	9/27/1996	28	X
K94	White Fence Farms	PCG	$310,870.60	10/30/1996	96-0767135	5/17/1995	10/25/1996	54	X
K95	104th Place	PCG	$102,444.40	9/25/1997	97-0664809	1/17/1996	9/2/1997	32	FH, X

K Number	District Name	Type	Total Cost	Date Warrant Recorded	Dkt/Pg(s)	Date Organized	Lien Filed	No. of Assmnts	Comments/Collecting
K96	Central Avenue	P	$397,307.75	3/4/1999	99-0208821		3/1/1999	100	X
K97	96th Place	P	$41,250.00			1/29/1997		15	
K98	Billings Street	PCG	$17,888.76	8/27/1998	98-0757196	1/29/1997	8/25/1998	24	X
K99	Mercury Drive	Chip Seal	$26,795.00			6/16/1999		15	
K100	Marguerite Drive	P	$92,790.00	10/19/2001	2001-0972707	2/2/2000	9/5/2001		X
K102	Desert Hills Sanitary	Sewer	Pending						
K103	20th Street	P	$108,500.00	7/2/2004	2004-0769323		5/5/2004	11	Tax Roll
K104	Casitas Bonitas	Sewer	No assessments						
K106	7th Street North	P	$203,889.00	4/8/2004	2004-0369247		2/4/2004	21	X
K107	31st Avenue	P	To be Barred						
K108	Mapleweood St	P	Dissolved						

ATTACHMENT 3.3

Step-by-Step Analysis of ARS Title 48, Chapter 6

COUNTY IMPROVEMENT DISTRICT
County Improvement District
Scheduling Worksheet

(A.R.S. Title 48, Chapter 6, Article 1)

Response.	Task
Step 1	
Citizens	Citizen(s) initiate project request with County Special District Staff
	County Staff will supply citizens with information packet as well as conduct community meeting to exchange information for the formation of the possible District. Citizens will be required to obtain the required signatures on the petition.
Step 2	
Citizens	File petitions with Clerk of tie Board.
Special Dist.	Petition is sent to Assessor for verification.
Step 3	
Special Dist.	Hearing must be set not later than 40 days after filing.
Special Dist.	Staff initiates hearing on petition to establish the District and incur expense for funding **(Resolution to Form District)** of improvements authorized pursuant to A.R.S. 48-986.01 and presents **to Board of Supervisors if project qualifies**.
Citizens	May participate in hearing to form.
Clerk	Mail Notice of Hearing on petition to property owners (more than 20 days prior to the hearing).
Clerk	Publish Notice of Hearing twice in a newspaper of general circulation within the County - the publications shall be one week apart and the first publication shall not be less than ten(10) days prior to the date of the hearing.
Board	Adopt Resolution to form District.
Special Dis.	Notify~ Department of Revenue of new taxing authority.

Step 4

Appointing District Engineer, Attorney and Financial Consultant - RFP's for:

Special Dis. Appoint Attorney (Bond Counsel) and Financial Consultant **(NECESSARY ONLY IF FUNDING IS NOT APPROVED PURSUANT TO A.R.S. 48-986.0 1).**

Public Works Appoint District Engineer.

Agreement for:

Special Dis. Attorney (Bond Counsel) Services **(NECESSARY ONLY IF FUNDING IS NOT APPROVED PURSUANT TO A.R.S. 48-986.01)**

Public Works Engineering Services

Special Dis. Financial Consultant Services **(NECESSARY ONLY IF FUNDING IS NOT APPROVED PURSUANT TO A.R.S. 48-986.01)**

Public Works Right-of-Way acquisition consultant (if necessary)

Step 5

Resolution of Intention to Order Improvement

Dist. Eng Submit final plans, specifications and Engineer's estimate to clerk.

Special Dist. Present to Board **Resolution of Intention** and assessment Diagram showing all lots and parcels to be assessed after reviewing the final plans, specifications and Engineer's estimate submitted by the District Engineer to the Clerk of the Board.

Board Adopt Resolution of Intention.

Clerk Mail to the owners of all real property within the area to be assessed a notice that contains the following:

a) Notice of passage of the Resolution of Intention with the date of the Resolution of Intention;
b) The total amount of the Engineer's estimate of costs and expenses of the work;
c) A description of the Board's intention to levy assessments and issue bonds.

Clerk Comment (protest) period - written protests will be received up to a maximum of 20 days after the date of the mailing of the notice of the passage of the **Resolution of Intention**

Step 6

Special Dist.	Conduct hearing on objections to proposed improvement District and/or extent of assessment District (if protests are received). Staff Report is required.

Step 7

Special Dist.	Present **Resolution Ordering the Work** / Request for Bids to the Board.
Board	Adoption of Resolution Ordering the Work and call for bids (in conjunction with Hearing if needed).
ClerklPur	Publish Resolution Ordering Work and inviting sealed bids two (2) times in one or more daily papers
Clerk	Post a copy of the Resolution to Order Work / call for bids for five (5) days on or near door of meeting place of Board of Directors

Step 8

Bid Proceedings

Purchasing	Advertise for bids
Purchasing	Filing deadline for sealed bids to the Clerk of the Board of Directors
Purchasing	Open Bids at Public session conducted at Board of Directors meeting. Review and analysis bids for completeness.

Step 9

Special Dist.	Present **Resolution to Award** construction Contract and approve the Assessment Diagram.
Board	Adopt Assessment Diagram and Resolution to award the contract.
Clerk	Publish Notice of Award of Bid twice (2) in daily paper of general circulation within the County
Clerk	Comment (protest) period on Award of Bid - lasts a maximum of 15 days from the first publication date of the notice

Step 10

Special Dist.	Conduct hearing on objections to award of contract if needed.
Purch./PW	Contract signed by bidder within 20 days after date of first publications, if no objections have been filed. In addition obtain payment and performance bonds and insurance certification.

Step 11 Assessments

Special Dist.	Present **Resolution to Record Assessment Diagram** with Superintendent of Streets, can also require that Cash Demand letters are sent to owners of property.

	Notify Board that assessment is recorded
	Notice of Recording of Assessment Diagram
	Board sets Hearing on Assessment Diagram
Clerk	Publish Notice of Hearing on Assessment Diagram five (5) times in a daily newspaper of general circulation within the County
Special Dist	Demand letters / Notice of Hearing on assessments mailed at least 20 days prior to the hearing
Special Dist.	If required will begin preparation of documents for Revolving Loan fund.
Finance	Pre-payment period begins (40 days total)

Step 12

Special Dist.	Conduct hearing on Assessment Diagram and present **Resolution to Board to Approve Assessment Diagram**
Board	Approve Assessment Diagram.

Step 13

Special Dist.	Close cash collection period and prepare Treasurer's return.
Special Dist.	Certify list of unpaid assessments. File certified assessment with Clerk and unpaid assessment with Superintendent of Streets. No Board action is Required.

Step 14

Bonds	**If Required**
Treasurer	Treasurer disburses funds pursuant to evidence of indebtedness and sends copy to Budget Department.
Financial Ad.	Circulate notice inviting proposals and official statement regarding sale of the bonds (initiate after Notice of Hearing on the Assessment Diagram is mailed and before the Hearing on the Assessment Diagram) **(NECESSARY ONLY IF FUNDING IS NOT APPROVED PURS UANT TO A.R.S. 48-986.01)**
Special Dist.	Present **to Board Resolution to Sell Bonds and opening of bond bids,** sale of bonds - at Board of Directors Meeting
Board	Adopt Resolution **(NECESSARY ONLY IF FUNDING IS NOT APPROVED PURSUANT TO A.R.S. 48-986.01)**
Financial Ad.	Bond closing / deposit of funds in District account with County Treasurer ***(NECESSARY ONLYIF FUNDING ISNOTAPPROVEDPURSUANTTO A.R.S. 48-98601)***

Step 15

Public Works Notice to Proceed

Step 16

Contractor Begin Construction

Step 17

Finance	Finance department initiates spread of levy and bills assessment. Payments are forwarded to the treasurer.
Treasurer	Treasurer credits payments submitted by Finance department to the revolving fund.
Special Dist.	Special Districts staff completes the annual disclosure statements for the improvement District and submits to the District Board of Directors.

ATTACHMENT 3.4

TENTATIVE SCHEDULE OF EVENTS
Special Districts

PROJECT PHASE (DISTRICT BOARD)

Item No.	Action	Estimated to be completed on Day
1	Final plans, specifications and engineer's estimate filed with the clerk.	
1		
2	Adopt Resolution of Intention.	
3	Mail notice of proposed improvement .	2
4	Receive objections and protests. Any objection or substantial protests require a hearing which will delay the schedule. Insufficient protests do not require a hearing.	20
5	Adopt Resolution ordering the work. (Calling for construction bids.)	20
6	Publish advertisement for proposals.	34
7	Post advertisement for proposals at or near the door of the board meeting room.	36
8	Receive construction bids. Open and declare the bids.	42
9	Award construction contract.	56
10	Approve assessment diagram showing all lots and parcels to be assessed with their assigned assessment number. Also must show location of work.	56
11	Publish notice of award of contract.	63
12	Sign contract, obtain payment and performance bonds and insurance certificate.	73
13	Prepare and record assessment including summary of costs and list of amounts assessed to each lot.	80
14	Notify Board that assessment is recorded	80
15	Notice of recording of assessment.	80
16	Receive objections to the award.	87
17	Board sets hearing on assessment.	101
18	Mail notice of hearing to all property owners.	108
19	Mail cash demand letters to property owners.	115

Item No.	Action	Estimated to be completed on Day
20	Begin preparation of documents for the revolving loan fund	115
21	Publish notice of hearing.	115
22	Hold hearing on assessment.	129
23	Approve assessment.	129
24	Close cash collection period and prepare Treasurer's Return. Shows amount collected.	136
25	Certified list of unpaid assessments. Shows which assessments go to bond.	143
25	Adjust issue size for cash collection. Information must be made available to underwriter.	150
26	Adopt Resolution authorizing the sale of bonds	150
27	Adopt resolution authorizing the sale of bonds	150
28	Price bonds and set interest rates	157
29	Execute documents necessary for closing	I 64
30	Notice to proceed is issued to contractor.	185
31	Begin Construction	195

ATTACHMENT 3.5

Procedures and Responsible Parties

Process Work Sheet and Resonsibilites	Citizens	Special District Staff	Board of Supervisors	Board of Directors	Treasurer	Purchasing	F
ESTABLISHMENT							
Citizen(s) initiate project request with county special district staff	X	X					
Citizens circulate petitions (petitions provided by staff)	X						
Petitions are filed with the Clerk of the Board (hearing must be set not later than 40 days after filing)	X	X					
Set Petitions for Public Hearing at a Board of Supervisors Meeting		X	X				
Staff initiates request for funding of improvements through the revolving fund authorized by A.R.S. 48-986.01 and request is forwarded to Board of Supervisors if project qualifies		X	X				
Notice of Hearing on petitions is mailed to property owners (must be mailed more than 20 days prior to the hearing)		X					
Notice of hearing on petitions is published twice in a newspaper of general circulation within the county (the publications shall be one week apart and the first publication shall not be less than ten days prior to the date of the hearing)		X					
Hearing on formation petitions and petition to incur expense is conducted - Resolution is adopted ordering formation of the district (Resolution drafted by Special District staff and forwarded to Clerk of Board for BOS consideration)		X	X				

Process Work Sheet and Resonsibilites	Citizens	Special District Staff	Board of Supervisors	Board of Directors	Treasurer	Purchasing	F
ESTABLISHMENT							
Board of Supervisors considers request from district for funding through the revolving fund, initiates evidence of indebtedness and forwards to the Treasurer		X	X		X		
Staff notifies the Department of Revenue of the new taxing authority after formation is approved		X	X				
APPOINTMENT OF DISTRICT ENGINEER, BOND COUNSEL AND FINANCIAL CONSULTANT							
RFP issued for District Engineer		X				X	
RFP issued for Bond Counsel (necessary only if funding is not approved pursuant to A.R.S. 48-986.01)		X				X	
RFP issued for Financial Advisor (necessary only if funding is not approved pursuant to A.R.S. 48-986.01)		X				X	
CONTRACTS SIGNED WITH:							
District Engineer		X		X		X	
Bond Counsel (necessary only if funding is not approved pursuant to A.R.S. 48-986.01)		X		X		X	
Financial Advisor (necessary only if funding is not approved pursuant to A.R.S. 48-986.01)		X		X		X	
Right-of-Way acquisition consultant (if necessary)		X		X		X	
ENGINEER PREPARES CONSTRUCTION PLANS AND ENGINEER'S ESTIMATE (variable time period - dependent upon time needed to complete construction plans)							

Process Work Sheet and Resonsibilites	Citizens	Special District Staff	Board of Supervisors	Board of Directors	Treasurer	Purchasing	F
RESOLUTION OF INTENTION TO ORDER IMPROVEMENT							
After reviewing the final enginering plans, specifications and engineer's estimates prepared by the District Engineer, the Board of Directors adopts the Resolution of Intention		X		X			
The District mails to each property owner in the district a notice that contains: a) Notice of passage of the Resolution of Intention with the date of the Resolution of Intention; b) the total amount of the engineer's estimate of costs and expenses		X					
Protest period - written protests will be received up to a maximum of 20 days after the date of the mailing of the notice of the passage of the Resolution of Intention	X						
Board of Directors holds hearing on objections to proposed improvement and/or extent of assessment (if protests are received)	X	X		X			
RESOLUTION ORDERING WORK / REQUEST FOR BIDS							
The Board of Directors adopts the Resolution Ordering Work and call for bids		X		X		X	
Publish Resolution Ordering Work and inviting sealed bids two times in one or more daily papers		X				X	
Post a copy of the Resolution Ordering Work and call for bids for 5 days on or near the door of meeting place for the Board of Directors		X					
The Board of Directors approves the Assessment Diagram showing all lots and parcels to be assessed with the assigned assessment number		X		X			

Process Work Sheet and Resonsibilites	Citizens	Special District Staff	Board of Supervisors	Board of Directors	Treasurer	Purchasing	F
BID PROCEEDINGS							
Advertise for construction bids		X				X	
Bid opening and Notice of Award of Bid are conducted at a Board of Directors meeting		X		X		X	
Award construction Contract		X		X		X	
Publish Notice of Award of Bid twice (2) in daily paper of general circulation within the County		X				X	
Protest period on Award of Bid - lasts a maximum of 15 days from the first publication date of the notice	X					X	
Contract signed by bidder within 20 days after date of first publications, if no objections have been filed		X	X			X	
ASSESSMENTS							
The Assessment Diagram is recorded with the Superintendent of Streets		X					
The Board of Directors is notified that the Assessment Diagram is recorded		X		X			
Notice of Recording of Assessment Diagram is completed by staff		X					
The Board of Directors sets the Hearing on the Assessment Diagram		X		X			
Demand letters and Notice of Hearing on assessments mailed to property owners at least 20 days prior to the hearing		X					
Notice of Hearing on Assessment Diagram is published 5 times in a daily newspaper of general circulation within the county		X					
Pre-Payment period on assessments begins (40 days total)	X	X			X		

Process Work Sheet and Resonsibilites	Citizens	Special District Staff	Board of Supervisors	Board of Directors	Treasurer	Purchasing	F
ASSESSMENTS							
The Board of Directors holds the Hearing on the Assessment Diagram		X		X			
The Board of Directors approves the Assessment Diagram				X			
BONDS							
The cash collection period is closed and Treasurer's Return is prepared		X			X		
The Treasurer disburses funds pursuant to evidence of indebtedness and sends a copy to the Finance and Planning & Budget departments					X		
The Board of Directors certifies the List of Unpaid Assessments				X			
The notice inviting proposals and the official statement regarding the sale of the bonds is circulated (initated after the Notice of Hearing on the Assessment Diagram is mailed and before the hearing on the Assessment Diagram)(necessary		X					
Bond bids are opened and bonds are sold by the Board of Directors (necessary only if funding is not approved pursuant to A.R.S. 48-986.01)		X		X			
Bond closing occurs; funds are deposited in district account with Treasurer (necessary only if funding is not approved pursuant to A.R.S. 48-986.01)		X			X		
CONSTRUCTION							
Notice to Proceed is issued to the contractor		X					
Construction begins		X					

Process Work Sheet and Resonsibilites	Citizens	Special District Staff	Board of Supervisors	Board of Directors	Treasurer	Purchasing	F
PAYMENT OF ASSESSMENTS							
The Finance department initiates the spread of levy and bills assessments; payments are forwarded to the Treasurer		X			X		
Treasurer credits payments submitted by the Finance department to the revolving fund		X			X		
Special Districts staff completes the annual disclosure statements for the improvement district and submits to the district Board of Directors		X		X			

MCDOT Revenues: Actual and Budgeted Revenues for FY 1993/94 to 2005/06 and Estimated Revenue for FY 2006 to 2026

2005 Transportation Needs and Funding Options Study

Prepared for
Maricopa County Department of Transportation

Prepared By

Curtis Lueck & Associates
5460 West Four Barrel Ct
Tucson, AZ 85743

June 8, 2006

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5460 West Four Barrel Ct
Tucson, AZ 85743

(520) 743-8748
FAX (520) 743-4210
Project No. 2005.63

Curtis Lueck, P.E., Principal
Cheryl Rader, Senior Planner/Analyst

June 8, 2006

NOTICE

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INTRODUCTION

CLA was tasked to (1) develop estimates of MCDOT revenues for the period of FY 2006 to 2026 and (2) discuss options for increasing revenues to meet estimated needs. This report addresses estimates of MCDOT revenues through FY 2026. The first section reports on actual MCDOT revenues from FY 1994 to 2005 and budgeted revenues for FY 2006. The second section presents the revenue estimates, based upon the trends observable for the period of FY 1994 to 2006.

For this analysis, MCDOT revenues are classified in four categories:

State Shared Highway User Revenue Fund (HURF) and Vehicle License Tax (VLT) Revenues

Other Intergovernmental Agreement (IGA) Revenues

Maricopa County Controlled Revenues

- Licenses and Permits
- Interest Earnings
- Miscellaneous Revenues
- Gain on Fixed Assets
- Other Charges for Services

Grant Revenues

- Federal Grants (including the AZTech Grant)
- State Grants
- MAGTPO Grant

Private Revenues

- Private Cash
- Development Contributions

As is well known, State Shared HURF/VLT Revenues is the major source of funding for MCDOT. For the entire period of FY 1994 to 2006, these revenues accounted for 83.9% of total revenues. Since implementation of the "MCDOT Cost Participation Guidance" in FY 1999, "Other IGA Revenues" have grown substantially and, as a result, accounted for 7.6% of total revenues in that period. The other categories accounted for smaller shares of total MCDOT revenues: Grant Revenues were 4.3%; Maricopa County Controlled Revenues were 4.0%; and Private Revenues were only 0.22%.

This analysis does not take into account how annexation will reduced the unincorporated population of Maricopa County by 2026. A de facto assumption that the unincorporated population will remain must cause overestimation of certain revenues. For example, the forecast of HURF revenues assumes that Maricopa County's unincorporated population will remain at 19.7 of the statewide population. Any decrease in the percentage will reduce MCDOT's HURF revenues, assuming no changes to the statutory distribution formulas.

ACTUAL AND BUDGETED REVENUES FOR FY 1994 to 2006

Attachment 1 reports revenues for MCDOT for each of the thirteen years between Fiscal Year 1994 and 2006.[24] This data provides the basis for the exhibits in this section.

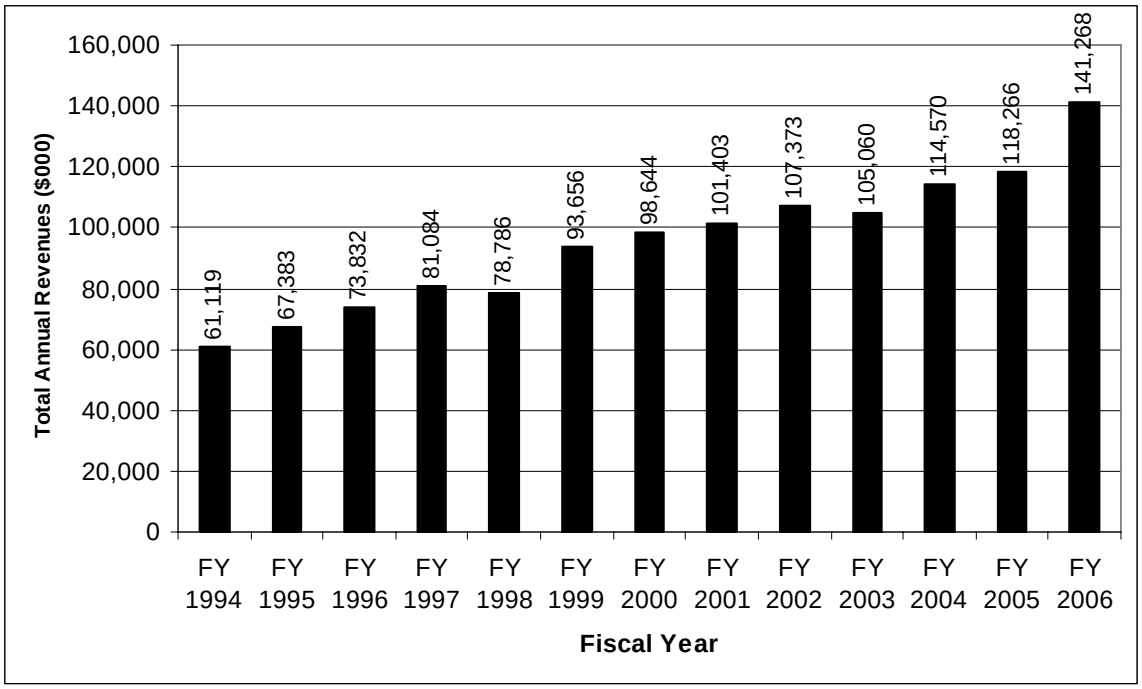
The section begins with some summary data on revenues received, rates of growth in revenues year-by-year, and revenues sources. Following the summary, each revenue source is analyzed individually

SUMMARY OF REVENUES RECEIVED

Total Annual Revenues Received

Exhibit 1 reports on MCDOT annual revenues for the thirteen years from FY 1994 to 2006. In FY 1994, total annual revenues were $61.1 million, which increased to the $141.3 million budgeted for FY 2006. Total revenues for the entire thirteen year period were $1.24 billion.

Exhibit 9: Annual MCDOT Revenues, FY 1994 to 2006



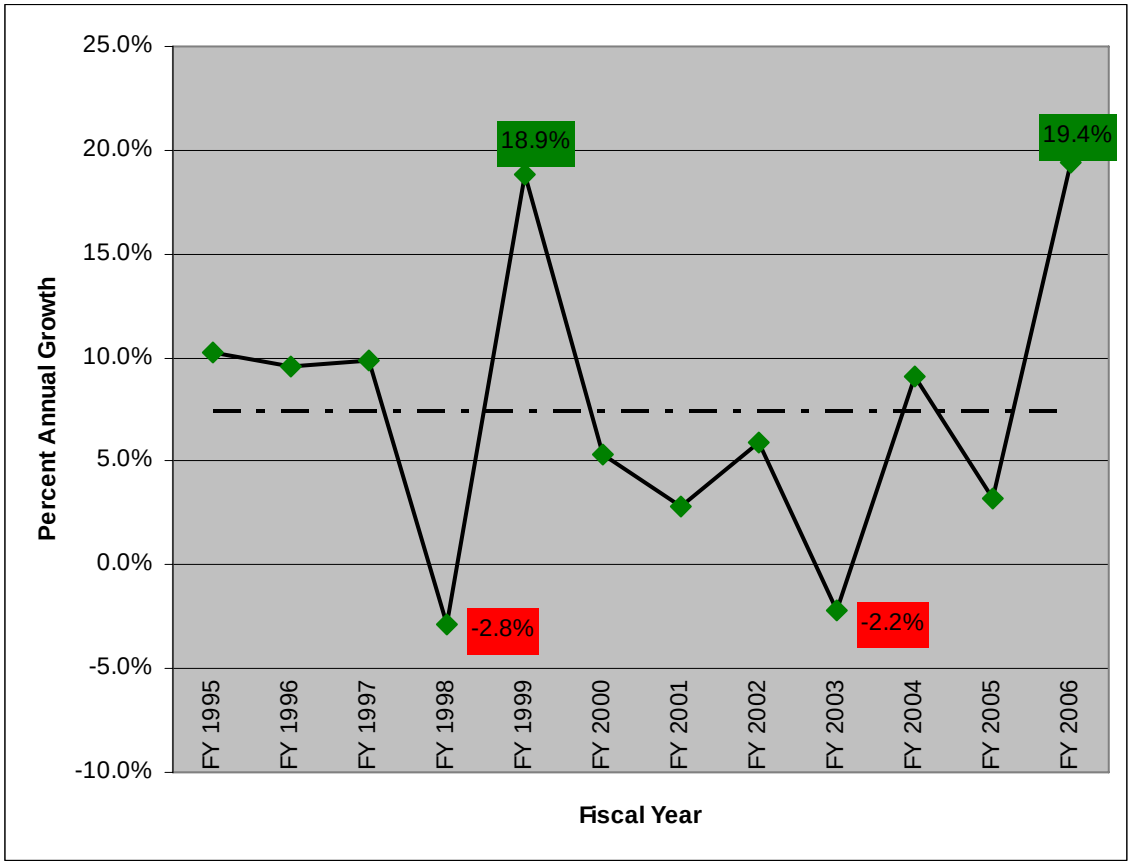
Year-by-Year Growth in Total Annual Revenues

Exhibit 2 charts the year-by-year growth in total MCDOT revenues, in percentage terms, over this thirteen year period. The trend line (black, dashed line) shows that total revenues increased on an average of 7.5% per year. In eight of these years, the annual percentage growth in revenues hovered closely to the trend line. In two years, however, annual revenues declined from the year before: from FY 1997 to FY 1998 by -2.8% ($81.1 million to $78.8 million) and FY 2002 to FY 2003 by-2.2% (from $107.4 million to $105.1

[24] Revenues for FY 1993/94 to 1997/98 were provided in the 1999 Needs Study and revenues for FY 1998/99 to 2005/06 were supplied by MCDOT.

million).[25] In two other years, however, the annual increase in total revenues was just under 20%: In Fiscal Year 1999, following the decline in the previous year, annual revenues increased by 18.9%, from $78.8 million to $93.7 million and budgeted revenues for FY 2006, at $141.3 million is a 19.4% increase over FY 2005 ($118.3 million).[26]

Exhibit 10: Annual Percentage Change in MCDOT Revenues – FY 1994 to 2006



Summary of Revenue Sources

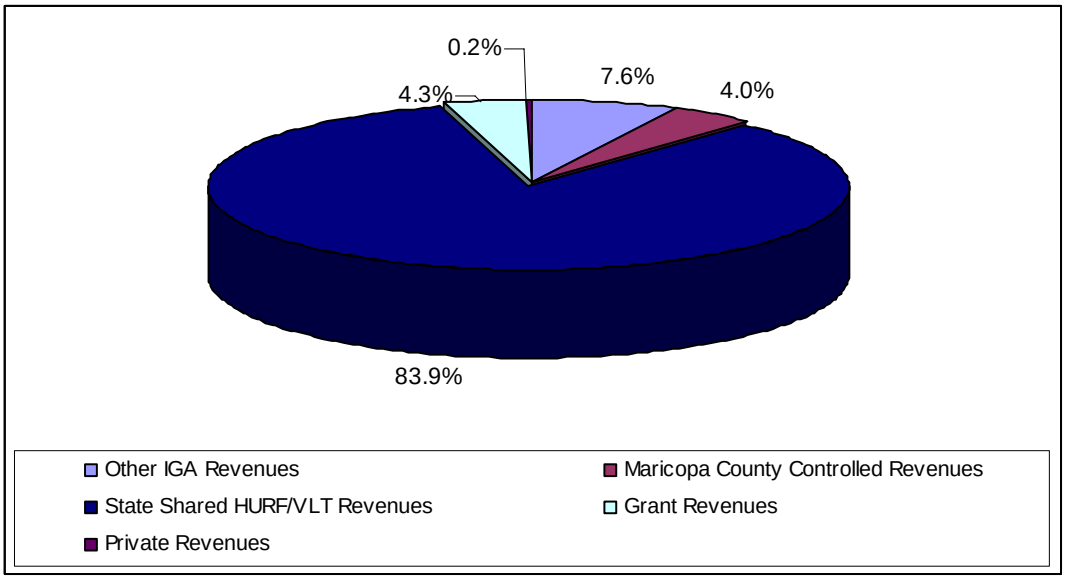
Exhibit 3 summarizes MCDOT revenue sources for the entire thirteen year period. As would be expected, State Shared HURF/Vehicle License Tax Revenues provided 83.9% ($1.04 billion) of MCDOT revenues between FY 1994 and 2006. "Other IGA Revenues" revenues provided 7.6% ($95.1 million) of total revenues over this period, primarily since FY 1999. Two categories of revenues each provided approximately 4% of total revenues. Grant Revenues (federal, state, and Maricopa Association of Governments) accounted for 4.3% ($53.3 million) of total revenues. A category of revenues designated as Maricopa County Controlled Revenues (Licenses and Permits, Interest Earnings, Miscellaneous Revenue, Gain on Fixed Assets, and Other Charges for Services) accounted for 4.0% ($49.2 million).

[25] The decline in total revenues in FY 1997/98 was the result of a decline in statewide HURF revenues. The decline in FY 2002/03 was largely the result of a reduction in Other IGA Revenues from the previous year. These occurrences are discussed in more detail in the sections discussing each revenue source individually.

[26] The increase in FY 1998/99 was the result of the rebound in HURF revenues and an increase in Other IGA Revenues. The increase in the FY 2005/06 budget is largely the result of a dramatic increase in Other IGA Revenues, from $9.2 million to $29.4 million. These occurrences are discussed in more detail in the revenue specific sections.

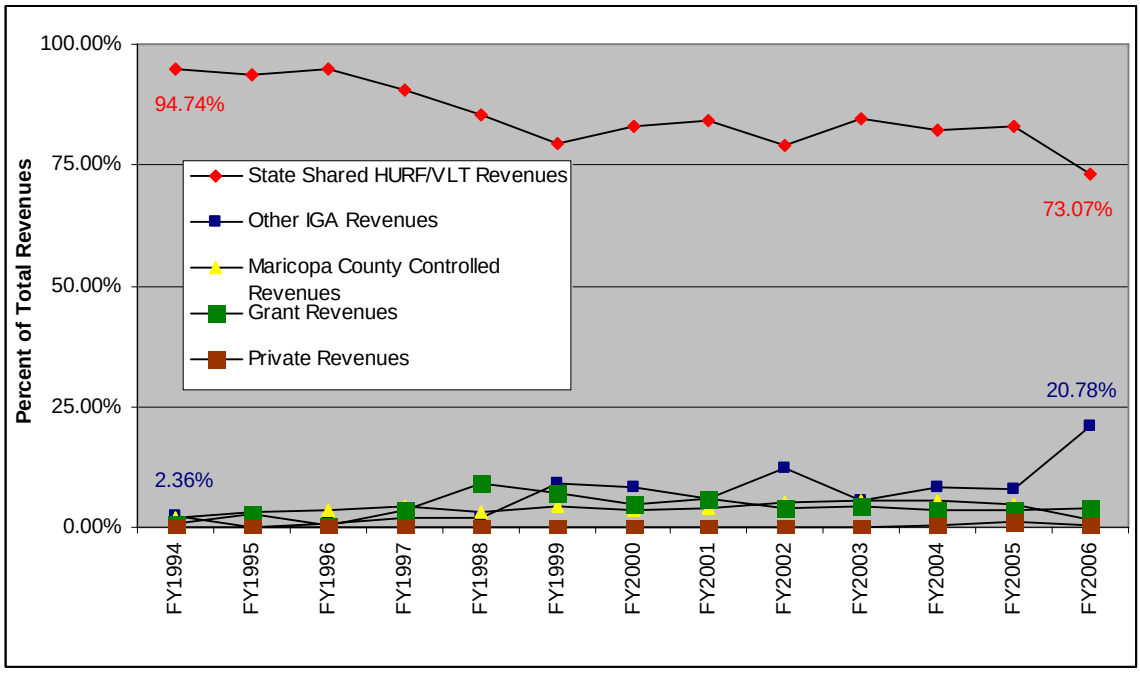
Finally, Private Revenues (Private Cash and Development Contributions) provided 0.2% ($2.8 million).

Exhibit 11: Summary of MCDOT Revenue Sources for FY 1994 to 2006 (Percent)



As Exhibit 4 reveals, State Shared HURF/VLT Revenues have been the dominant revenue sources throughout the entire thirteen year period. For the entire period, State Shared HURF/VLT Revenues accounted for 83.90% of total revenues. Over this period, however, State Shared HURF/VLT Revenues, while they have grown significantly in every year but one, account for a declining share of overall MCDOT revenues, from a high of 94.7% in FY 1994 to a low of 73.07% in FY 2006. The declining percentage share of these revenues is accounted for by MCDOT's greater success at obtaining other revenues, especially Other IGA Revenues, which increased from a 2.36% share in FY 1994 to a 20.78% share in FY 2006, and a 7.6% share for the entire period.

Exhibit 12: Revenue Sources by Percent, FY 1994 to 2006



DISCUSSION OF INDIVIDUAL REVENUE SOURCES

This section discusses each individual MCDOT revenue source for the period of FY 1994 to 2006 in the following order: State Shared HURF/VLT Revenues; Other IGA Revenues; Maricopa County Controlled Revenues; Grant Revenues; and Private Revenues.

Information from the 2005 TSP Update is compared with information from the 1999 Needs Study, to permit a "reality check" on methodology and to identify recent trends in revenues that were not apparent in 1999.

Data for FY 1999 to 2006 was derived from an Excel spreadsheet provided by MCDOT, as well as from annual reports for the period available on the Arizona Department of Transportation web page. Data for FY 1994 to 1998 was borrowed from the 1999 Needs Study.

STATE SHARED HURF/VLT REVENUES

As noted above, State Shared HURF/VLT Revenues continue to be the largest single source of revenue for MCDOT. The 1999 Needs Assessment combined HURF and VLT into a single category of State Shared Revenues. The 2005 TSP will treat with each revenue source separately, as individual components of State Shared Revenues, but also combine them for comparison purposes with the 1999 Needs Study.

In order to report on HURF and VLT revenues separately, much of the information in this section is taken from Arizona Department of Transportation annual reports from FY 1999 to 2005, rather than on the information provided in the MCDOT Excel spreadsheet, which also combined the two revenues into a single category. Of the two revenue sources, HURF is the larger revenue source, by a factor of 11 times larger.

State Shared HURF Revenues

HURF is comprised of two major components: (1) the inflow of revenues into HURF that are derived from several sources and (2) the outflow of revenues from HURF by statutory formulas for distribution to the State Highway Fund, cities and towns, and counties. Since FY 1998, there have been changes to HURF since FY 1998 that affected both revenue collections and revenue distributions. (Attachment 2 depicts collections and distributions into and out from HURF as of FY 2005.[27]) This section reviews on HURF collections and distributions, then reporting on MCDOT HURF collections for FY 1999 to 2005.

HURF Collections

According to the ADOT "Highway User Revenue Fund: Fiscal Year 2005 Year-End Report," "HURF collections have averaged an annual growth rate of 4.2 percent over the last ten years," increasing from $859.6 million in FY 1996 to $1,245.6 million in FY 2005.

HURF revenues are collected from several sources, including the gas tax, use fuel tax, vehicle license tax, registration fees, motor carrier fees, and other fees (see Exhibit 5).[28]

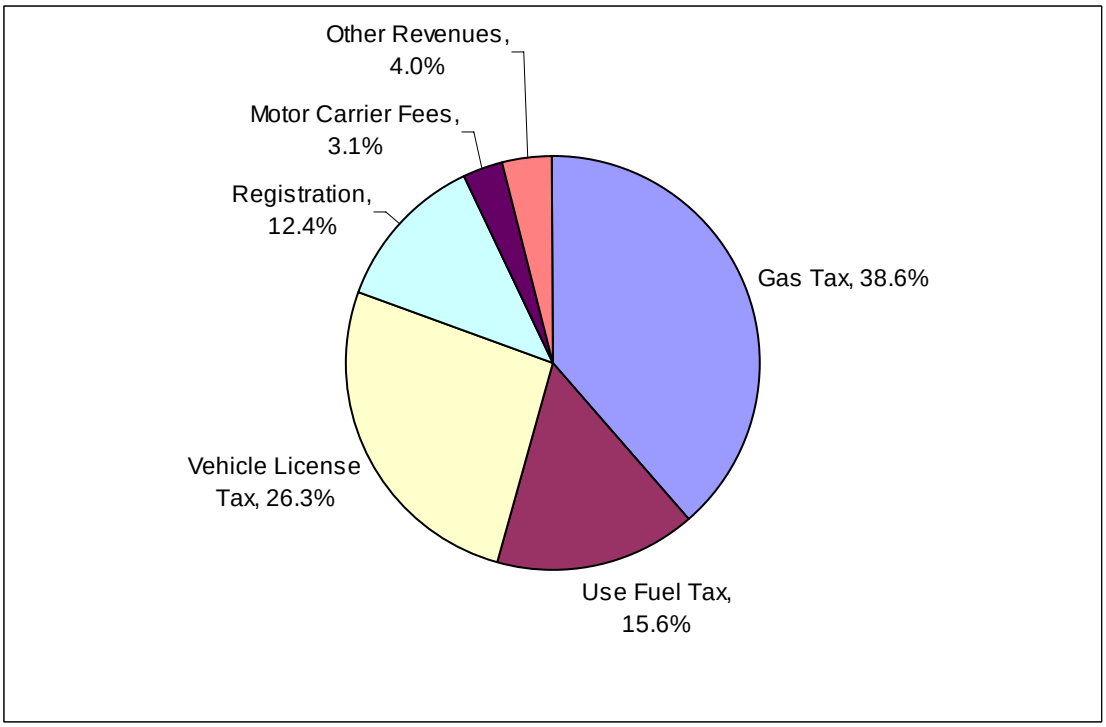
The largest single source is the gas tax, which accounted for 38.6% of HURF revenues in FY 2005, which is a decline from 41.8% in FY 1996. The second largest source of revenues is the Vehicle License Tax, which accounted for 26.3% of HURF revenues in FY 2005, a strong increase from approximately 18% in FY 1996. Vehicle License Tax revenues have benefits from the strong inflationary pressure on new cars over time, even though the

[27] Source: Arizona Department of Transportation – "Highway User Revenue Fund Fiscal Year 2005 Year End Report"

[28] ibid

tax rates were lowered since the 1999 Needs Assessment. Use Fuel Taxes (15.6%) and Registration (12.4%) are the next largest sources of HURF revenues in FY 2005.

Exhibit 13: HURF Revenue Sources for FY 2005



It is important to note that the taxes on fuels have been static since 1990 on gasoline ($0.18 per gallon) and since 1994 on fuel taxes ($0.26 per gallon). If these fuel taxes had been indexed to inflation, HURF collections would have been much higher, protecting the purchasing power of the HURF revenues.

HURF Distributions

HURF revenues are distributed to the State Highway Fund, cities and towns, and counties, pursuant to statutory formulas. By statute, counties receive 19% of HURF revenues. In fact, counties receive 19% of "Net HURF" revenues, after allocations for other purposes. Since FY 1996, HURF revenues have been allocated to the Arizona Department of Public Security (a total of $297.5 million) and the Economic Strength Project Fund ($10 million), as shown in Exhibit 6.[29] During this period, a total of $10,290.4 million was collected in HURF revenues, with $297.5 allocated to DPS and $10 million to Economic Strength Project Fund, with a resultant total "Net HURF" of $9,982.9 million. Of this "Net HURF," $1,887.0 million (19%) was distributed to counties.[30]

[29] ibid

[30] Total HURF revenues declined from $987.0 million in FY 1997 to $887.5 million in FY 1998. The FY 1998 annual report from ADOT attributes this decline in revenues to four legislative and policy factors: (1) Motor Carrier and Fuel tax legislative changes from the previous year; (2) changes stemming from MVD revenue acceleration program and VLT accounting changes; (3) changes to a staggered registration program for commercial vehicles; and (4) a policy change to utilize a more conservative revenue forecast. These factors cause FY 1998 revenues to decline, but had no similar impact in future years. The decline in total HURF revenues, of course, resulted in a decline in MCDOT HURF revenues in the same year.

Exhibit 14: HURF Allocations to Counties, FY 1996 to 2005

Fiscal Year	Total HURF	DPS	ESPF	Net HURF	Counties Share of Net HURF
1996	859.6	20.0	1.0	838.6	151.8
1997	897.0	17.5	1.0	878.5	166.9
1998	887.5	15.0	1.0	871.5	165.6
1999	982.8	12.5	1.0	969.3	183.4
2000	1019.6	12.5	1.0	1006.1	191.1
2001	1031.0	12.5	1.0	1017.5	192.2
2002	1076.4	52.1	1.0	1023.3	194.4
2003	1111.3	54.5	1.0	1055.8	200.5
2004	1179.6	48.7	1.0	1129.9	214.6
2005	1245.6	52.2	1.0	1192.4	226.5
Total	10290.4	297.5	10.0	9982.9	1887.0

The County HURF pie is further allocated to individual counties by statute, based upon (1) county origins of gasoline and use fuel sales as a percentage of total gallons sold statewide and (2) county unincorporated population as a percentage of statewide unincorporated population. Pursuant to the so-called "HURF Equity" legislation from 1996, the county-by-county distribution of County HURF revenues is shown in Exhibit 7. Since FY 2000, 72% of County HURF revenues are allocated according to the gasoline and use fuel gallons sold in the county as a percent of all fuel sold statewide, while 28% is allocated by the county unincorporated population as a percent of statewide unincorporated population.

Exhibit 15: Statutory Allocations for County HURF Revenues

Fiscal Year	Percent by Fuel Sales	Percent by Unincorporated Population
1997	85%	15%
1998	80%	20%
1999	76%	24%
2000 and After	72%	28%

MCDOT HURF Revenues FY 1999 to 2005

The Highway User Revenue Fund is by far the largest single source of MCDOT annual revenues, accounting for almost 80 percent of total revenues between FY 199 and 2005 (see Exhibit 8).[31]

Exhibit 8 suggests that there was a slight decline in total HURF receipts for MCDOT between FY 2001 and 2002, which is probably a result of the economic downturn falling the 9/11 attacks. In every year since Fiscal Year 1999, except for Fiscal Year 2002, MCDOT HURF receipts have increased, by an average of 3.2% per year.

[31] The data for Table 4 was taken from the ADOT Highway user Revenue Fund Year End Reports for Fiscal Years 1999 to 2005. The data for Fiscal Years 2002 to 2005 differ from information provided by MCDOT slightly. The decision was made to use the ADOT information.

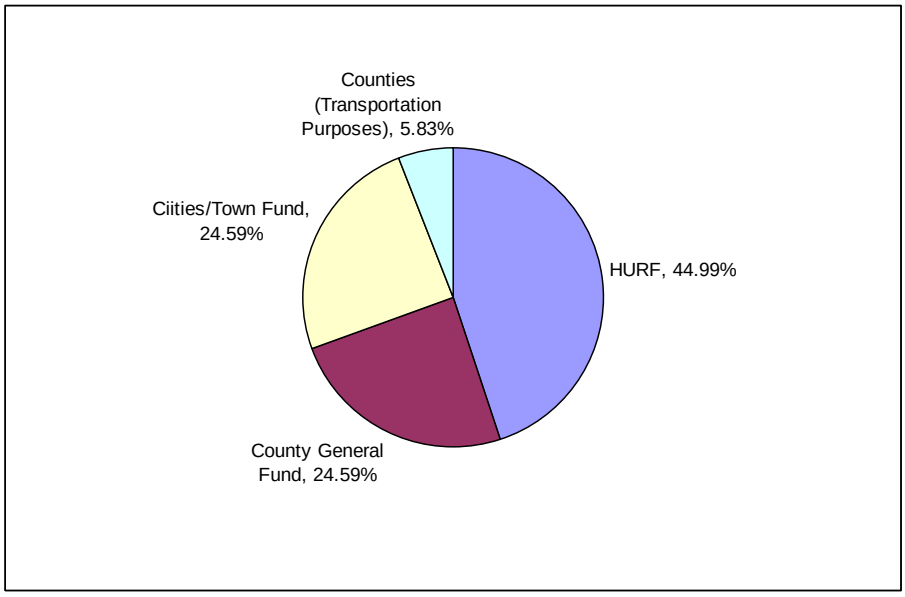
Exhibit 16: State Shared HURF Revenues Received by MCDOT: FY 1999 to 2005

Fiscal Year	Actual HURF Revenues
1999	72,233
2000	76,955
2001	78,350
2002	78,141
2003	81,524
2004	86,519
2005	90,029

State Shared Vehicle License Taxes

Since Fiscal Year 2002, Vehicle License Tax revenues have been distributed by statute to the Highway User Revenue Fund (44.99%); to Cities and Towns and to County General Funds (24.59% to each); and to Counties for Transportation Purposes (5.83%) (see Exhibit 10).[32] The distribution to Counties (Transportation Purposes) increased between FY 1999 and 2001, from 2.45% to 5.12% to 5.71% and has been at 5.83% since FY 2002. This section briefly describes how VLT revenues are distributed and then reports on MCDOT VLT revenues for FY 1999 to 2005.

Exhibit 17: Distribution of Vehicle License Tax, FY 2002 to 2005



County VLT Distributions To MCDOT, FY 1999 To 2005

Exhibit 10 reports on the distribution of the Vehicle License Tax between Fiscal Year 1999 and 2005, first to County VLT and then to MCDOT. In Fiscal Year 1999, MCDOT received $2.9 million in County VLT, which has grown each year to $8.2 million in FY 2005. The increase from FY 1999 to 2000 was especially large, which was primarily related to the

[32] Data in this section on Vehicle License tax revenues is derived from ADOT annual reports on Vehicle License Tax Distribution for Fiscal Year 1999 to 2005. Prior to Fiscal Year 2002, VLT revenues were also distributed to the State Highway Fund, State General Fund for School Aid, and the State Highway Fund. In the subsequent years, negligible amounts were so transferred, except for Fiscal Year 2005, when a total of $135.1 million was transferred to the State General Fund for School Aid.

fact that the distribution to County VLT increased from 2.45% to 5.12% (($14 million to $30 million).

Over this period, the percentage of County VLT distributions going to MCDOT has declined, from 20.7% in FY 1999 to 19.2% in FY 2005, averaging 19.6% per year over this seven year period.

Exhibit 18: Vehicle License Tax Distributions, FY 1999 to 2005 ($million)

Fiscal Year	Total VLT	County VLT	Distribution to MCDOT	% MCDOT of County VLT
1999	594.9	14.0	2.9	20.7%
2000	583.0	30.0	6.1	20.3%
2001	570.8	32.6	6.6	20.2%
2002	601.6	35.1	6.8	19.4%
2003	628.2	36.7	7.1	19.3%
2004	695.3	40.6	7.8	19.2%
2005	747.0	42.7	8.2	19.2%
Total	4,420.8	231.7	45.5	19.6%

Total State Shared HURF/VLT Revenue: FY 1994 to 2006

Exhibit 11 reports on total State Shared HURF/VLT Revenues for FY 1994 to 2006. This data is derived from the 1999 Needs Study and the Excel spreadsheet provided by MCDOT.[33] Total State Shared HURF/VLT revenues increased from $57.9 million in FY 1994 to $103.5 million budgeted in FY 2006. For this period, State Shared revenues totaled just over $1.0 billion.

Exhibit 19: Total State Shared HURF/VLT Revenues Received by MCDOT: FY 1994 to 2006 ($000)

Fiscal Year	State Shared HURF/VLT Revenues
FY 1994	57,902
FY 1995	63,227
FY 1996	70,135
FY 1997	73,250
FY 1998	67,408
FY 1999	74,532
FY 2000	82,323
FY 2001	85,473
FY 2002	85,029
FY 2003	89,225
FY 2004	94,482
FY 2005	98,339
FY 2006	103,479
Total Revenues	1,044,804

[33] Total State Shared HURF/VLT Revenues in Exhibit 11 for FY 1999 to 2005 were $609.2 million. Total revenues for these years derived by adding HURF and VLT revenues from Exhibit 8 and 10 were $609.5 million.

OTHER INTERGOVERNMENTAL AGREEMENT (IGA) REVENUE

Data on "Other IGA Revenue" is derived from information provided by the 1999 Needs Study for FY 1994 to 1998 and from the Excel spreadsheet provided by MCDOT for FY 1999 to 2006.

Between FY 1994 and 2006, MCDOT recorded $95.1 million in Other IGA Revenue (see Exhibit 12).

Exhibit 20: Revenues From Other IGA Revenues: FY 1994 to 2006 ($000)

Fiscal Year	Annual Revenues
FY 1994	1,445
FY 1995	0
FY 1996	582
FY 1997	1,535
FY 1998	1,511
FY 1999	8,691
FY 2000	8,383
FY 2001	6,136
FY 2002	12,988
FY 2003	5,703
FY 2004	9,528
FY 2005	9,151
FY 2006	29,430
Total Revenues	95,083

Other IGA Revenues after FY 1999 are considerably higher than what was reported in the 1999 Needs Assessment, ranging from a low of $5.7 million in FY 2003 to a high of $29.4 million budgeted in FY 2006. In these eight years, Other IGA Revenues totaled $90.0 million and averaged $11.3 million per year. Between FY 1994 and 1998, Other IGA Revenue averaged just over $1.0 million per year, fluctuating between $0 in FY 1995, $582,000 in FY 1996, and $1.5 million in FY 1997 and 1998.

The difference in the magnitude of Other IGA Revenue after FY 1999 is a result of the successful implementation of the department's "MCDOT Cost Participation Guidance," which was effective as of December 29, 1999. The guidance commits MCDOT to "seek financial participation on all projects from jurisdictions adjacent to or benefiting from the roadwork."[34] The guidance provides that "final cost sharing agreements will be negotiated on a case by case basis."[35] but further provides that "MCDOT's funding shall not exceed 75% participation for the projects in the five year TIP for which there are partnerships."[36]

MARICOPA COUNTY CONTROLLED REVENUES

Maricopa County Controlled Revenues include revenues from Licenses and Permits, Interest Earnings, Miscellaneous Revenues, Gain on Fixed Income, and Charges for Other Services. Over the period of FY 1994 to 2006, MCDOT received a total of $49.2 million from these revenue sources. As reported in Exhibit 3, these revenues, combined, accounted for

[34] MCDOT Cost Participation Guidance, page 1
[35] ibid
[36] Ibid, page 10

4.0% of total MCDOT revenues. Interest Earnings was the largest source of Maricopa County Controlled Revenues ($19.9 million or 40.3%), followed by Miscellaneous Revenue ($14.2 million) and License and Permits ($12.7 million). Gain on Fixed Assets and Other Charges for Service were very small revenue sources.

Exhibit 21: Total Maricopa County Controlled Revenues for FY 1994 to 2006

Revenue Source	Total Revenues	%
Interest Earnings	19,855	40.3%
Miscellaneous Revenue	14,213	28.9%
License and Permits	12,732	25.9%
Gain on Fixed Assets	2,173	4.4%
Other Charges for Service	271	0.6%
Total	49,244	100.0%

Each of these revenue sources are discussed in moiré detail below.

Interest Earnings

The 1999 Needs Study defined Miscellaneous Revenues as primarily composed of Interest Earnings. The MCDOT data for FY 1999 to 2006 provides a line item for Interest Earnings. To eliminate the danger of using data that is not comparable, the 2005 TSP Update only reports on the data for Interest Earnings for the period from FY 1999 onward.

Interest Earnings declined in every year from FY 1999 to 2004, climbed in FY 2005, and then declined again in FY 2006 (see Exhibit 14). Over the eight year period, Interest Earnings averaged $1.2 million, but since FY 2002 annual average revenues declined to $631,000.

Exhibit 22: Interest Earnings, FY 1999 to 2006 ($000)

Fiscal Year	Annual Revenues
FY 1999	3,223
FY 2000	2,185
FY 2001	1,345
FY 2002	755
FY 2003	667
FY 2004	306
FY 2005	1,046
FY 2006	380
Total Revenues	9,907

Miscellaneous Revenue

In the 1999 Needs Study, this category was titled Miscellaneous (Interest Income) and was defined as comprising primarily the interest earned from fund balances that are carried over from year-to-year. As noted above with regard to Interest Earnings, the 2005 TSP Update only reports Miscellaneous Revenue for FY 1999 to 2006.

MCDOT distinguishes Miscellaneous Revenue in the Operating and Capital budgets, which are defined as follows:

> "Miscellaneous Revenues in the Operating Budget generally include "building rental, equipment rental, insurance recoveries, sale of fixed assets, and other revenues that are not categorized much smaller than those in the Capital Budget. Additionally, Miscellaneous Revenues in the Capital budget include property rental, sale of land/property, or private contributions. These amounts could fluctuate from year-to-year, depending on the cost-share agreements, property sales, and other variables."[37]

Miscellaneous Revenue have been very volatile, increasing in FY 2001 to $2.1 million from $758,000 in the previous year; continuing to increase over the next three fiscal years, to a high of $4.0 million in FY 2004; and then declining precipitously in the next two years, to $687,000 and then $145,000 (see Exhibit 15). Over this eight year period, Miscellaneous Revenue averaged just under $1.8 million per year.

Exhibit 23: Miscellaneous Revenue, FY 1999 to 2006 ($000)

Fiscal Year	Annual Revenues
FY 1999	242
FY 2000	758
FY 2001	2,064
FY 2002	2,713
FY 2003	3,564
FY 2004	4,040
FY 2005	687
FY 2006	145
Total Revenues	14,213

Licenses and Permits

Data for Licenses and Permits is derived from the 1999 Needs Study and the MCDOT Excel spreadsheet, covering the entire period from FY 1994 to 2006.

License and Permits revenue increased substantially after FY 2002, increasing each year through FY 2005 and then declining for FY 2006 (see Exhibit 16). Over the thirteen year

[37] See "MCDOT FY 1999 – FY 2006 Annual Revenues (in thousands)," Note 2. Based on other data provided by MCDOT, it is clear that Miscellaneous Revenues in the Operating Budget were much lower than those in the Capital budget ("FY 2002-2005 Operating and Capital Budgets," dated August 23, 2005.

period, Licenses and Permits totaled $12.7 million, an average of $979,000 per year. Since FY 2002, Licenses and Permits Revenues averaged $1.9 million per year.

Exhibit 24: Licenses and Permits: FY 1993/94 to 2005/06 ($000)

Fiscal Year	Annual Revenues
FY 1994	117
FY 1995	258
FY 1996	240
FY 1997	276
FY 1998	340
FY 1999	664
FY 2000	585
FY 2001	672
FY 2002	1,451
FY 2003	1,563
FY 2004	1,719
FY 2005	3,047
FY 2006	1,800
Total Revenues	12,732

Gain On Fixed Assets

MCDOT notes that "Gain on Fixed Assets" was reported as part of Miscellaneous Revenue prior to FY 2002. "Gain on Fixed Assets" are generally revenues from the sale of construction vehicles and equipment. Proceeds from the sale of all other assets are reported as Miscellaneous Revenues."[38] To remain consistent with this definition, the 2005 TSP Update only reports on the data for FY 2002 to 2006. The 1999 Needs Study identified "Sale of Fixed Assets" as a separate revenue category, but this data does not appear to be compatible with the definition of "Gain on Fixed Assets" and, therefore, is not included in this analysis.

Between FY 2002 and 2006, MCDOT shows a total for "Gain on Fixed Assets" of $1.6 million (see Exhibit 17). The annual revenues have fluctuated very significantly in each year, with a low of $99,000 in FY 2003 and a high of $742,000 in FY 2005. Budgeted revenues for FY 2006 are $200,000. The average annual revenues for the period were $325,000 per year.

[38] "MCDOT FY 1999 – FY 2006 Annual Revenues," Note 3.

Exhibit 25: Gain on Fixed Assets, FY 2002 to 2006

Fiscal Year	Annual Revenues
FY 2002	452
FY 2003	99
FY 2004	130
FY 2005	742
FY 2006	200
Total Revenues	1,623

Other Charges for Services

Data for Other Charges for Service is derived from the 1999 Needs Study and the MCDOT Excel spreadsheet, covering the entire period from FY 1994 to 2006.

The 1999 Needs Study reported minimal revenues in each year from FY 1994 to 1998, totaling $271,000 (see Exhibit 18). The MCDOT Excel spreadsheet reported no revenues under this category for FY 1999 to 2006. As a result, no estimate is made for Other Charges for Service for FY 2007 to 2026.

Exhibit 26: Other Charges for Service: FY 1994 to 2006 ($000)

Fiscal Year	Annual Revenues
FY 1994	16
FY 1995	18
FY 1996	121
FY 1997	36
FY 1998	80
FY 1999	0
FY 2000	0
FY 2001	0
FY 2002	0
FY 2003	0
FY 2004	0
FY 2005	0
FY 2006	0
Total	271

GRANT REVENUES: FEDERAL, STATE AND MAGTPO

The 1999 Needs Study described four separate revenue sources: “Federal,” “State Grants,” “MAGTPO Grant,” and the “AZTech Grant.” The 2005 TSP Update combines

presents these four revenues sources under one category, titled "Grant Revenues." Over the thirteen year period, Grant Revenues totaled $50.6 million (see Exhibit 19). The largest single revenue source was Federal Grants, at $38.0 million, followed by the AZTech Grant (also a Federal Grant), at just under $9.0 million. State Grants over this period totaled $2.3 million and the MAGTPO Grant totaled $1.2 million. Over this period, total average annual grant revenues have been $4.2 million.

Exhibit 27: Federal, State, and MAG Grants: FY 1994 to 2006 ($000)

Fiscal Year	Federal Grants	AZTECH Grant	State Grants	MAGTPO Grant	Total
FY 1994	425	0	0	110	535
FY 1995	1,834	0	0	115	1,949
FY 1996	0	0	197	120	317
FY 1997	2,559	0	171	125	2,855
FY 1998	3,901	2,900	350	132	7,283
FY 1999	3,666	2,277	361	0	6,304
FY 2000	3,666	579	165	0	4,410
FY 2001	3,666	1,617	430	0	5,713
FY 2002	3,666	200	119	0	3,985
FY 2003	3,666	74	499	0	4,239
FY 2004	3,666	0	34	165	3,865
FY 2005	3,666	46	0	102	3,814
FY 2006	3,666	1,285	0	333	5,284
Total Revenues	38,047	8,978	2,326	1,202	50,553

Each of these separate grant sources are discussed below.

Total Federal Grants

Data on Federal Grants and the AZTech grant for FY 1994 to 1998 is derived from the 1999 Needs Study. Data for FY 1999 to 2006 for the AZTech Grant is derived from the MCDOT Excel spreadsheet. Data for Federal Grants for FY 1999 to 2006 is derived from two reports also provided by MCDOT in Excel spreadsheets: (1) "Federal Aid 1998 to 2011" and (2) "Transportation Enhancement (TE) Funds". Neither spreadsheet reports revenues by fiscal year, though the Federal Aid spreadsheet does report on the date of authorization and whether the revenue grant is closed or open. As reported below, Federal Grants were averaged for the eight years between FY 1999 and 2006 and that average figured was inserted in Exhibit 19.

Federal Grants

In this analysis, Federal Grants revenue is comprised of Transportation Enhancement grants and Federal Aid grants.

MCDOT reports three Transportation Enhancement grants: two for Bush Highway Bike Lane of $250,000 and $500,000 (that latter of which is still open) and one for Usury Road, Mesa City Limits to Salt River Recreation Site for $300,000. Total of reported Transportation Enhancement grants was $1,050,000. This analysis assumes these grants were available at some time between FY 1999 and 2006.

MCDOT reported on thirty-three Federal Aid grants. Four were AZTech grants and eight were reported to be for FY 2007 to 2011. The remaining twenty-one grants are reported in Exhibit 20, which sorts the grants by Larger Projects (federal grants greater than $1.5

million); Smaller Projects (federal grants of less than $1.0 million); and PM 10 Paving Roads, and further sorted by Authorization Date within each category.

Total federal funds reported were $28.3 million, with $14.5 million allocated for Larger Projects; $10.3 million allocated for PM 10 Paving Roads; and $4.2 million for Smaller Projects.

Exhibit 28: MCDOT Federal Aid 1999 to 2006

Project	Description	Auth Dte	Fed Funds	Status
MMA0018	115TH AVE @ GILA RV., MARICOPA CO., CONST NEW BRID	08 1997	2,000,000	Closed
MMA0018	115TH AVE @ GILA RV., MARICOPA CO., CONST NEW BRID	08 1997	2,627,000	Closed
MMA0017	MCCLINTOCK RD,RED MTN FRWY TO MCKELLIPS, 4R-WIDEN/	01 1998	2,200,000	Closed
MMA0001	BELL RD,49TH TO 64TH ST IN PHX, 4R-WIDEN/RECONST S	09 1998	3,435,851	Closed
MMA0016	POWER RD @ QUEEN CRK WASH IN MARICOPA CO., BRIDGE	08 2001	1,500,000	Closed
MMA0032	Gilbert Rd, McDowell Rd to SR-87 (Beeline Hwy)4R	08 2003	2,000,000	Closed
		Subtotal Larger Projects	14,537,851	
MMA0001	BELL RD,49TH TO 64TH ST IN PHX, 4R-WIDEN/RECONST S	09 1998	433,149	Closed
MMA0021	PEORIA AVE BR @ NEW RVR, ADD SIDEWALKS TO BR	08 1999	59,570	Closed
MMA0020	OLD US-40 @ GILA RVR, BRIDGE INSPECTION	03 1999	41,116	Closed
MMA0024	MC85 @ AVONDALE WASH, BRIDGE REPLACEMENT	04 2000	157,622	Closed
MMA0031	MC85 Bridge at Agua Fria RiverFailing Pier Cap Re	03 2003	680,000	Closed
MMA0029	Loop 303 at Olive AvenueIntersection Improvement	04 2003	531,000	Closed
MMA0030	Loop 303 at Northern AvenueIntersection Improveme	04 2003	531,000	Closed
MMA0044	Bell Road Incident Management in Surprise	09 2004	986,000	Open
MMA0041	Bell Road ITS Grand Av to Loop 101	04 2005	775,000	Open
		Subtotal Smaller Projects	4,194,457	
MMA0023	PM 10 Paving Roads	09 1999	471,500	Closed
MMA0025	PM 10 Paving Roads	05 2001	800,000	Closed
MMA0026	PM 10 Paving Roads	09 2002	3,970,000	Closed
MMA0027	PM 10 Paving Roads	07 2003	2,147,500	Closed
MMA0042	PM 10 Paving Roads	09 2004	250,000	Closed
MMA0043	PM 10 Paving Roads	08 2005	2,680,000	Open
		Subtotal PM 10 Paving Roads	10,319,000	
		Total All Projects	28,276,308	

This analysis assumes that all of these federal grant revenues should be applied to the eight year period from FY 1999 to 2006. Three of the Larger Projects grants were authorized in FY 1998, totaling $6.8 million. This analysis assumes that the actual grant revenues were available between FY 1999 and 2006. The 1999 Needs Study reported Federal Grants of $4.9 million in FY 1998 and that figure is used in the 2005 TSP Update.

All of the Larger Projects grants are listed as Closed, but two of the Smaller Projects grants and one PM 10 Paving Roads grant are listed as Open, totaling $4.4 million. Grants that are listed as Open could conceivably have expenditures in FY 2007 or later, but, for the

sake of this analysis, it is assumed that these revenues also be expend prior to the end of FY 2006.

Total Federal Grants for the eight years from FY 1999 to 2006 are calculated at $29.3 million ($28.3 million in Federal Aid plus $1.0 million in Transportation Enhancement grants). This analysis calculated the annual average of Federal Grants at $3,666,000 per year, which average was inserted into Exhibit 19.

AZTech Grant

Data on the AZTech grant is derived from the 1999 Needs Study and the MCDOT Excel spreadsheet.

The AZTech grant refers to a $7.5 million grant from the Federal Highway Administration (FHWA) as one of four grants nationwide under the "Intelligent Transportation System Model Deployment Initiative." The grant was signed by USDOT Secretary Federico Pena on October 24, 1996. The program was described as a "seven-year project (two-year implementation and five-year operation) to develop an integrated Intelligent Transportation System for the Phoenix metropolitan area."[39] As the 1999 Needs Study noted, "MCDOT teamed up with ADOT, various MAG-area municipalities, and private companies to create a partnership called AZTech."[40] MCDOT received a second grant for AZTech of $3.0 million, so total AZTech Grant revenues are $10.5 million, with the final expenditure of grant funds ($1.35 million) scheduled for FY 2007. MCDOT has submitted an application for an additional $1.5 million, but has received no word on the status of the application as of this time.

A Note on Total Federal Grants

MCDOT's Transportation Improvement Program for FY 2006 – 2010 states that "Maricopa County frequently receives Federal Highway Administration (FHWA) funds for the improvement of eligible County roadways and bridges," but that "These funds usually make up less than 3% of the total funds received and are primarily used to extend local funds."[41] The data in Exhibit 19 for Federal Grants of $38.0 million is 3.1% of total reported revenues for FY 1994 to 2006; the AZTech Grant (at just under $9.0 million) is 0.7% of total revenues; combined the two revenue sources are 3.8% of total revenues.

State Grants

The 1999 Needs and MCDOT Excel spreadsheet report that the department received $2.3 million in State Grants between FY 1994 and 2006 (see Exhibit 19). Over that period, MCDOT did not receive any State Grants in four of the thirteen years, but did receive them in every year between FY 1996 and FY 2004; in those nine years, the department received an average of $258,000 per year in State Grants. The highest year was FY 2003, at $499,000, but that declined to $34,000 in FY 2004 and there were no reported State Grants in FY 2005 or 2006.

The 1999 Needs Study noted that:

> "Maricopa County periodically obtains State grants for roadway purposes. The grant program is competitive, and the County has to show an economic benefit provided by the projects. State grants equaled nearly

[39] See "www.aztech.org/about.htm"

[40] 1999 Needs Study, Page 30. The AZTech web site claims that "AZTech is working with over 75 public and private agencies," ibid

[41] MCDOT Transportation Improvement Program and Accomplishments: Fiscal Years 2006 to 2010," Page 21. The TIP also notes that the "FHWA funds" are administered by MAG and ADOT, which would explain why the revenues do not appear in MCDOT revenues.

> $240,000 per year between 1996 and 1998. However, this type of funding is rarely available and MCDOT staff does not budget on this funding in their long-term projections."[42]

The 1999 Needs Study did not include a projection of State Grants in its FY 20020 forecast and the 2005 TSP Update also does not include an estimate of future State Grant revenues.

MAGTPO Grant

The MAGTPO Grant was described in the 1999 Needs Study as a grant from MAG to MCDOT to cover salaries of two MCDOT employees. The grant was expected to average "$132,000 per year through 2008 or upon retirement of the two employees."[43]

The MCDOT Revenue report for FY 1998/99 to 2005/06 reports no revenues under the MAGTPO Grant for the period of FY 1998/99 to 2002/03 and then revenues in each of the subsequent three years: $165,000, $102,000, and $333,000, for a total of $600,000. The 2005 TSP Update assumes that these revenues will end and does not include an estimate of MAGTPO Grant revenues for FY 2007 to 2026.

PRIVATE REVENUES

The 1999 Needs Study included data on "Private Cash" contributions, though they only totaled to $70,000 for the period of FY 1994 to 1998. MCDOT did not report any Private Cash revenues since FY 1998/99 onward. Therefore, the category of Private Cash has not been utilized in the 2005 TSP Update.

MCDOT did include a category labeled "Development Contributions," with the following note:

> "'Development contributions' is a new category that was added to the table. These contributions are not tracked on a fiscal year basis. These contributions are not tracked on an annual basis; therefore, the information shown is only for the last two fiscal years and the current fiscal year. FY 2003/04 is an approximation for the $500,000. The amount shown for FY 2005/06 is a receivable."[44]

Total revenues from Development Contributions were $2.7 million (see Exhibit 21). In the three year period, these revenues fluctuated considerably, jumping from $500,000 in FY 2004 to $1.4 million in FY 2005, and then declining to $750,000 in FY 2006. Over the three year period, the average of Private Revenues per year was $896,667.

Exhibit 29: Development Contribution Revenues, FY 2004 to 2006

Fiscal Year	Annual Revenues
FY 2004	500,000
FY 2005	1,440,000
FY 2006	750,000
Total Revenues	2,690,000

[42] Ibid, Page 29
[43] Ibid, Page 24 and Exhibit 12 on Page 32
[44] "MCDOT FY 1999 – FY 2006 Annual Revenues," Note 5.

ESTIMATED REVENUES FOR FY 2006 TO 2026

SUMMARY OF REVENUE FORECAST: FY 2006 TO 2026

This section provides estimates of MCDOT revenues for FY 2006 to 2026. Except for State Shared HURF and VLT Revenues and Federal Grant Revenues, the forecasts use MCDOT budgeted data for FY 2006 and estimates thereafter. After this summary, the methodologies for each individual revenue source forecast are discussed.

The 2005 TSP Update forecasts total MCDOT revenues for the period of FY 2006 to 2026 of $4.1 billion (Exhibit 22). As would be expected, MCDOT will continue to rely almost entirely on State Shared Revenues. Estimated State Shared HURF Revenues will be almost $3.4 billion, 82.7% of total forecast revenues. State Shared VLT Revenues will account for another $282.9 million, 6.9% of total forecast revenues. Other IGA Revenues are estimated to generate $227.4 million in revenues, 5.5% of total revenues. Maricopa County Controlled Revenues are estimated to raise $98.0 million; Grant Revenues to raise $84.0 million; and Private Revenues $18.8 million. These revenue forecasts are in real, not deflated, dollars.

Exhibit 30: Summary of Estimated Revenues for FY 2006 to 2026

Revenue Source	2006-2015	2016-2026	Total Estimated Revenues	% of Total
State Shared Revenues				
State Shared HURF	1,225,400,000	2,164,400,000	3,389,800,000	82.7%
State Shared Vehicle License Tax	106,400,000	176,500,000	282,900,000	6.9%
Subtotal State Shared Revenues	1,331,800,000	2,340,900,000	3,672,700,000	89.6%
Other IGA Revenues	103,680,000	123,750,000	227,430,000	5.5%
Maricopa County Controlled Revenues				
Licenses/Permits Revenues	19,800,000	22,000,000	41,800,000	1.0%
Miscellaneous Revenues	16,345,000	19,800,000	36,145,000	0.9%
Interest Income Revenues	6,230,000	7,150,000	13,380,000	0.3%
Gain on Fixed Assets Revenues	3,125,000	3,575,000	6,700,000	0.2%
Subtotal Maricopa County Controlled Revenues	45,500,000	52,525,000	98,025,000	2.4%
Grant Revenues				
Federal Grant Revenues	40,000,000	44,000,000	84,000,000	2.0%
Private Revenues				
Developer Contributions Revenues	8,850,000	9,900,000	18,750,000	0.5%
Total Revenues	1,529,830,000	2,571,075,000	4,100,905,000	

Error! Not a valid link. The 2005 TSP Update revenue estimates suggests that MCDOT will be even more dependent on State Shared HURF/VLT Revenues between FY 2006 and 2026 than it was between FY 1994 to 2006 (see Exhibit 23). Between FY 1994 and 2006, State Shared HURF/VLT Revenues accounted for 83.9% of revenues, but would account for 89.6% of revenues in the period of FY 2006 to 2026. Other IGA Revenues would decline from 7.6% to 5.5% of revenues, while Maricopa County Controlled Revenues would decline from 4.0% to 2.4% of revenues. In this forecast, Federal Grant Revenues, which were 3.1% of total revenues between FY 1994 and 2006, would decline to 2.0% of revenues for the forecast period.

Exhibit 31: MCDOT Revenue Sources (Percent) for FY 1994-2006 and 2006-2026

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It is important to note these changes in the composition of projected MCDOT revenues. One likely explanation for the differences is that the forecasts for revenues other than State Shared Revenues are conservative. As explained below, estimating State Shared HURF and VLT Revenues is more straight forward than projecting the other revenue sources.

DISCUSSION OF INDIVIDUAL REVENUE FORECASTS

As was done in the previous section, revenue forecasts are presented for State Shared HURF/VLT Revenues, Other IGA Revenues, Maricopa County Controlled Revenues, Grant Revenues, and Private Revenues.

State Shared HURF And Vehicle License Tax Revenues

This section presents estimates for State Shared HURF Revenues and State Shared VLT Revenues separately. Then the separate estimates are combined into a single forecast for State Shared Revenues. Because of the importance of these revenues to MCDOT, the section also includes a relatively detailed discussion of the similarities and differences between the estimates from the 1999 Needs Study and 2005 TSP Update, primarily to provide some assurances as to the validity of the estimates and methodology.

State Shared HURF Revenues

Exhibit 24 presents estimates of MCDOT HURF Revenues for FY 2006 to 2026. The estimate is for $3.4 billion in HURF Revenues.[45] The estimate shows $99.1 million in FY 2006, growing to $244.4 million in FY 2026. Between 2006 and 2015, MCDOT HURF receipts are estimated at $1.2 billion and at $2.2 billion for 2016 to 2026.

Exhibit 32: Estimated HURF Revenues, FY 2006 to 2026 ($millions)

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These estimates are based upon the following data and assumptions.

1. The estimates for Total HURF Revenues are taken from ADOT's "Arizona Highway User Revenue Fund: Forecasting Process & Results, FY 2005-2014." Projections for Total HURF Revenues for FY 2015 to 2026 assume that HURF revenue collections will increase at an annual rate 4.7%, the average annual increase forecast by ADOT for FY 2005 to 2014.
2. ADOT's forecasts of HURF distributions assumes that $10 million annually will be transferred from HURF to the Department of Public Safety and $1 million transferred to the Economic Strength Project Fund through FY 2014; this forecast assumes that the transfer will continue for FY 2015 to FY 2026. It should be noted that the state's FY 2006 budget does not include a transfer to DPS, but does for the Economic Strength Fund, which is reflected in the estimate for FY 2006. The estimates for

[45] In these calculations, the combined HURF and VLT revenues for FY 2006 are $107.2 million, which is $3.7 million more than the MCDOT budget for this year.

each year from FY 2007 to 2026, however, do assume the full transfer of $11 million from Total HURF Revenues. If the transfer does not occur in subsequent years, this analysis will underestimate MCDOT's State Shared HURF Revenues MCDOT by approximately $18.3 million.

3. The estimate assumes that counties will continue to receive 19% of Net HURF Revenues.

4. The estimate assumes that the current statutory allocation of County HURF to counties will continue to use the 72% for origin of fuel sales and 28% for unincorporated population.

5. ADOT published a report on fuel gallonage by county, for FY 1990 to 2005. For FY 1997 to 2005, Maricopa County accounted for an average of 47.969% of all fuel sales in the state and this percent was used to estimate Maricopa County HURF receipts based upon origin of fuel sales. The 1999 Needs Assessment reported that the unincorporated Maricopa County population was 19.67% of the total statewide unincorporated population and this percent was used to estimate MCDOT HURF receipts based upon population.

State Shared Vehicle License Taxes

Exhibit 25 estimates what MCDOT will receive in County VLT revenues from Fiscal Year 2006 to 2026. The MCDOT distribution of County VLT is estimated to grow from $8.9 million in FY 2006 to $19.3 million in FY 2026, and to total $282.9 million over the twenty year period.

Exhibit 33: Estimated Vehicle License Tax Distributions to MCDOT, FY 2006 to 2026

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These estimates are based upon the following data and assumptions.

1. Between FY 1999 and 2005, total Vehicle License Tax revenues increased by an average of 3.97% per year and Total VLT for FY 2006 to 2026 was assumed to grow at the same average annual rate through FY 2026.

2. It is assumed that the 5.83% distribution of Total VLT Revenues to County VLT that prevailed from FY 2002 to 2005 will continue through FY 2026.

3. It is assumed that MCDOT will receive for Fiscal Year 2006 to 2026 the same 19.6% of County VLT Revenues that it received on the average from Fiscal Year 1999 to 2005 (see Exhibit 26).

Exhibit 34: MCDOT Share (Percent) of County VLT For Transportation

Fiscal Year	Total VLT	County VLT	Distribution to MCDOT	% MCDOT of County VLT
1999	594.9	14.0	2.9	20.7%
2000	583.0	30.0	6.1	20.3%
2001	570.8	32.6	6.6	20.2%
2002	601.6	35.1	6.8	19.4%
2003	628.2	36.7	7.1	19.3%
2004	695.3	40.6	7.8	19.2%
2005	747.0	42.7	8.2	19.2%
Total	4,420.8	231.7	45.5	19.6%

Combined State Shared Revenues (HURF And VLT)

Total combined State Shared Revenues are estimated at just under $4.9 billion. In FY 2006, total State Shared Revenues are estimated at $107.9 million, which is $4.4 million higher than what the department budgeted for the year. By FY 2020, combined State Shared Revenues is estimated to grow to $315.6 million.

Exhibit 35: Combined State Shared Revenues: FY 2006 to 2026 ($Millions)

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Comparing 2005 HURF Estimates With 1999 Needs Study Estimates

Because of the great significance of State Shared Revenues to MCDOT, it is important to have a high "comfort level" with the methodology and assumptions. One way to test the methodology and assumptions is to compare estimates from the 1999 Needs Study and 2005 TSP Update for years of overlap. The 1999 estimates can be compared to actual revenues for FY 1999 to 2005, while the 1999 and 2005 estimates can be compared for the years FY 2006 to 2020. These comparisons are made for State Shared HURF Revenues and VLT Revenues separately, and then for combined State Shared Revenues.

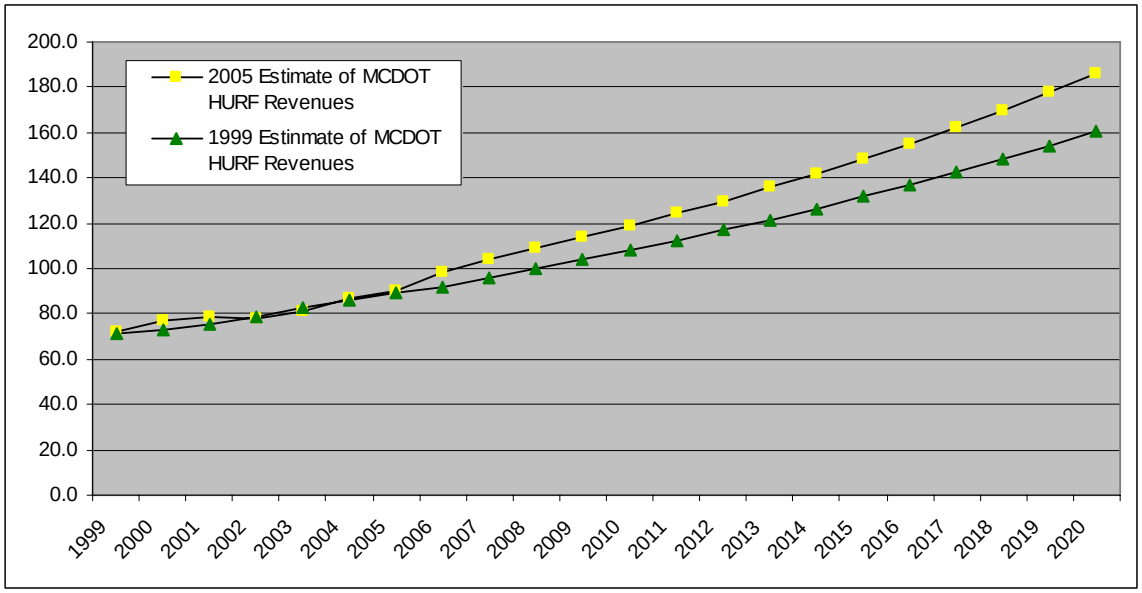
The 2005 projection of HURF revenues were $231.5 million higher than the 1999 Needs Study projections, while the 2005 projections for VLT revenues were $66.6 million lower. Looking at total State Shared Revenues (HURF and VLT), the two projections are nearly identical.

State Shared HURF Revenues - Exhibit 28 compares State Shared HURF Revenue estimates from the 1999 Needs Study with actual revenues reported by ADOT for Fiscal Year 1999 to 2005 and the 2005 estimates for FY 2006 through 2020, which is the period of overlap from the two estimates. The 1999 Needs Study estimates were relatively close to the actual revenues for Fiscal Year 1999 to 2005, with the actual revenues for 2000 and 2001 somewhat higher comparatively than for the other years. Over these seven years, the actual revenues were an average of $1 million higher than the 1999 Needs Study estimates.

Starting with Fiscal Year 2006 and thereafter, the 2005 HURF revenues estimates are significantly higher than those from the 1999 Needs Study. The 2005 estimate for FY 2006 is $6.1 million higher than the 1999 estimate, growing to $25.7 million by FY 2020. For the twenty-two year period of overlapping estimate, the 2005 estimate is a total of $231.5

million higher than the 1999 estimate, most of which difference is in the 2006 to 2020 estimates.

Exhibit 36: 2005 and 1999 Estimates of MCDOT HURF Revenues, FY 2006 to 2020 ($million)



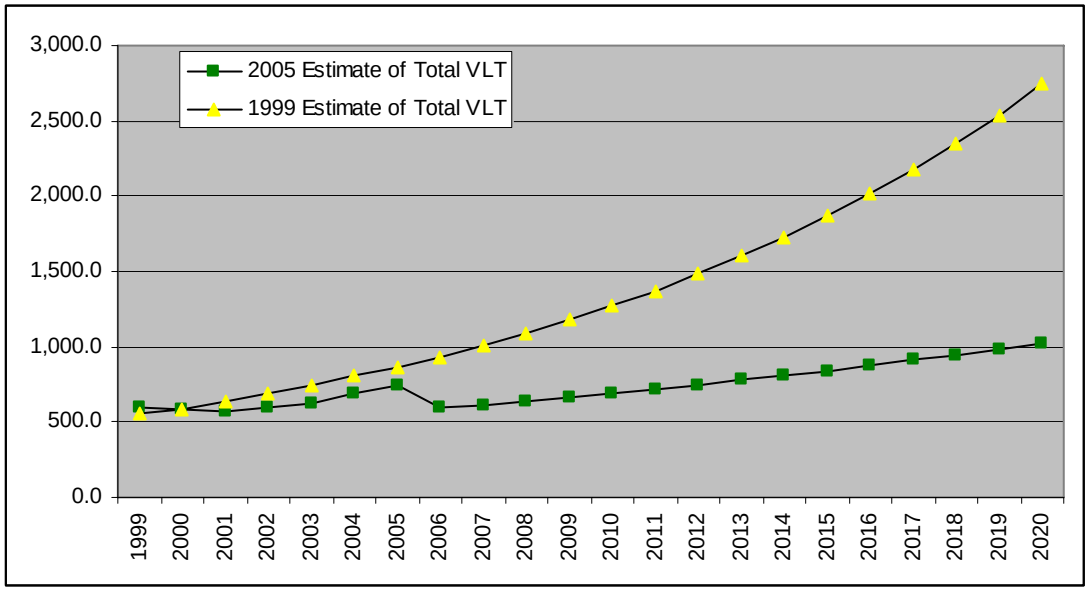
The differences between the 2005 and 1999 estimates of MCDOT State Shared HURF Revenues from Fiscal Year 2006 on are largely a factor of higher estimates from ADOT of Total HURF Revenues (see Exhibit 29).. Both estimates assumed a transfer to DPS of $10 million and to Economic Strength Project of $1 million. The ADOT 2005 estimate of Total HURF for FY 2006, however, is $69.6 million higher than the 1999 estimate. Over this fifteen year period, the ADOT 2005 estimate projects $2.7 billion more in Total HURF Revenues than the 1999 estimates. These higher estimates of Total HURF Revenues, of course, translate into higher estimates of Net HURF Revenues.

Exhibit 37: 2005 and 1999 Estimates of Total HURF Revenues, DPS/ESP Transfer and Net HURF Revenues, FY 2006 to 2020 ($million)

	ADOT 2005 Estimates			1999 Needs Assessment Estimates			
Fiscal Year	Estimates of Total HURF	Less DPS/ESP Transfer	Net HURF	Estimates of Total HURF	Less DPS/ESP Transfer	Net HURF	Difference in Overall HURF
2006	1,303.1	11.0	1,292.1	1,233.5	11.0	1,222.5	69.6
2007	1,378.1	11.0	1,367.1	1,282.9	11.0	1,271.9	95.2
2008	1,443.4	11.0	1,432.4	1,334.2	11.0	1,323.2	109.2
2009	1,511.8	11.0	1,500.8	1,387.6	11.0	1,376.6	124.2
2010	1,574.4	11.0	1,563.4	1,443.1	11.0	1,432.1	131.3
2011	1,645.5	11.0	1,634.5	1,500.8	11.0	1,489.8	144.7
2012	1,715.4	11.0	1,704.4	1,560.8	11.0	1,549.8	154.6
2013	1,794.3	11.0	1,783.3	1,623.4	11.0	1,612.4	170.9
2014	1,871.7	11.0	1,860.7	1,688.2	11.0	1,677.2	183.5
2015	1,958.4	11.0	1,947.4	1,755.7	11.0	1,744.7	202.7
2016	2,049.1	11.0	2,038.1	1,825.9	11.0	1,814.9	223.2
2017	2,144.0	11.0	2,133.0	1,899.0	11.0	1,888.0	245.0
2018	2,243.3	11.0	2,232.3	1,974.9	11.0	1,963.9	268.4
2019	2,347.2	11.0	2,336.2	2,053.9	11.0	2,042.9	293.3
2020	2,455.9	11.0	2,444.9	2,136.1	11.0	2,125.1	319.8
Total	27,435.5	165.0	27,270.5	24,700.0	165.0	24,535.0	2,735.5

State Shared VLT Revenues - For Fiscal Years 1999 to 2006, the 1999 Needs Study and 2005 VLT Revenue estimates were fairly close (Exhibit 30). For the period of 1999 to 2006, the difference between the two estimates was only $800,000, or about $100,000 per year. Starting in Fiscal Year 2007, the 1999 estimates were $500,000 higher than the 2005 estimates and grew each year thereafter, reaching $11.2 million in Fiscal Year 2020. For the entire period, the 1999 estimates were $66.6 million higher than the 2005 estimates.

Exhibit 38: 2005 and 1999 Estimates of MCDOT County VLT Revenues, FY 2006 to 2020 ($Million)

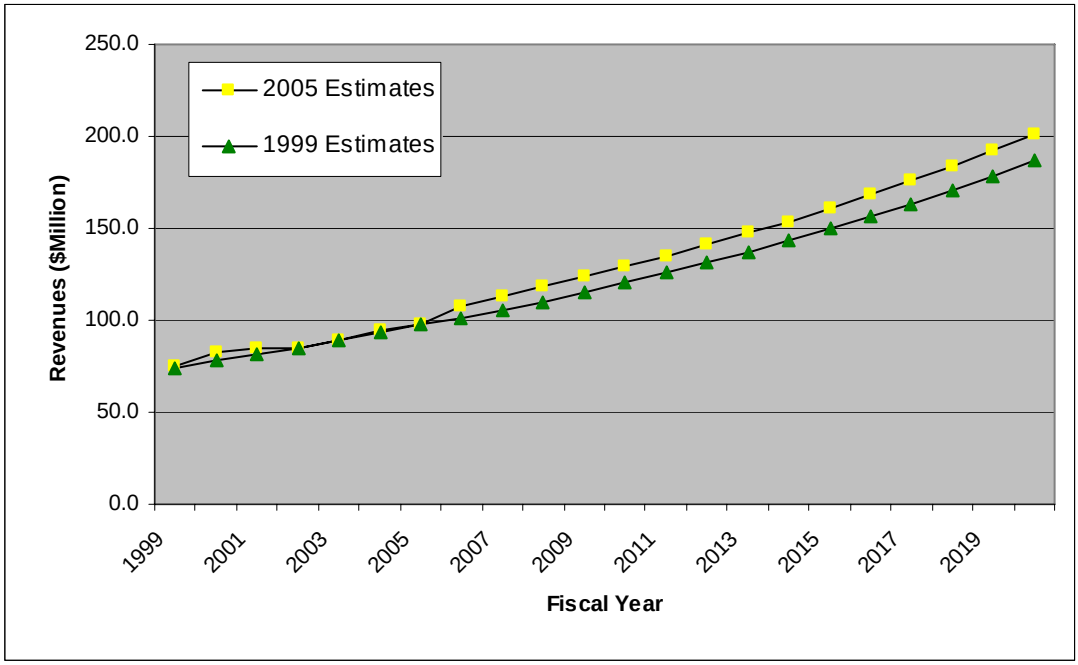


The differences between the 2005 and 1999 estimates appear to be due to much higher estimates of total VLT revenues in the 1999 estimates (see Exhibit 31). In Fiscal Year 1999, actual VLT revenues were $35.2 million higher than the 1999 estimates. Beginning in Fiscal Year 2000, however, actual VLT revenues became ever lower than the 1999 estimates, from $3.2 million less in Fiscal Year 2000 to $118.0 million less in Fiscal Year 2005.

Exhibit 39: Estimates of Total Vehicle License Tax Revenues: FY 1999 to 2020

Combined State Shared Revenues - Exhibit 32 compares the 2005 and 1999 estimates of Combined State Shared HURF/VLT for Fiscal Year 1999 to 2020. The estimates of combined State Shared revenues are almost identical, with the 2005 estimates showing slightly higher combined revenues starting in Fiscal Year 2007. The difference in estimates, however, by Fiscal Year 2020 is only $14.5 million out of total estimated revenues of $201.3 million. Obviously, the higher 2005 estimates of HURF revenues balance out the lower 2005 estimates of VLT revenues.

Exhibit 40: Comparison of 2005 and 1999 Estimates of Total State Shared HURF/VLT Revenues, FY 1999 to 2020



This congruity between the two estimates, added to the fact that that the 1999 estimates were very accurate for the period of Fiscal Year 1999 to 2005, provides a good measure of confidence in the 2005 estimates. At the very least, it would seem that the combined estimate of State Shared HURF/VLT revenues, which accounts for as much as 90% of the department's known revenues.

Other Intergovernmental Agreement (IGA) Revenue

In FY 1999, MCDOT instituted the "MCDOT Cost Participation Guidance policy, with the result of significantly increasing Other IGA Revenues. Since this policy went into effect, MCDOT has realized $90.0 million in revenues, of the total of $95.1 million realized for the entire period of FY 1994 to 2006.

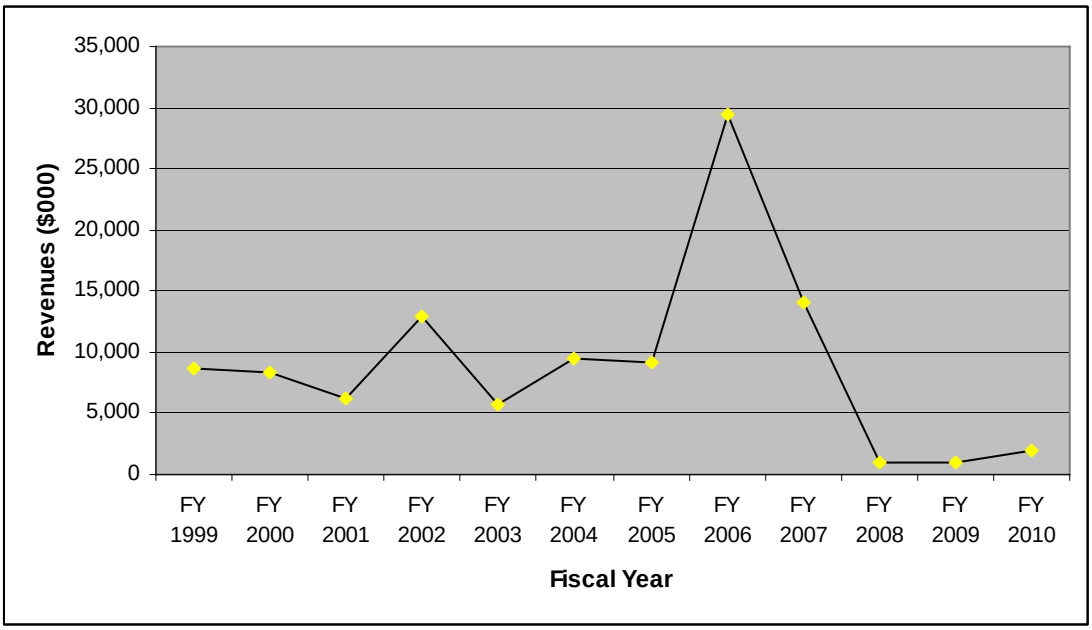
MCDOT's FY 2006-2010 Transportation Improvement Program shows a total of $47.4 million in Other IGA Revenues (the TIP refers to this as "TIP Partner Revenue") over the next five years.

Exhibit 41: Other IGA Revenues in MCDOT FY 2006 – 2010 TIP ($000)

Fiscal Year	Annual Revenues Shown in TIP
FY 2006	29,430
FY 2007	14,100
FY 2008	1,000
FY 2009	900
FY 2010	2,000
Total	47,430

While the department has received significantly higher revenues under this policy since FY 1999, actual revenues have been very volatile, rising and falling in subsequent fiscal years and are projected to do so over the next five years as well (see Exhibit 34).

Exhibit 42: Other IGA Revenues: FY 1999 to 2010



Because of this volatility, it is not possible to assume a straight line projection of future revenues, based upon an assumption of typical annual increases. The 2005 TSP Update, therefore, assumes that the department will realize annual average revenues over the period FY 2006 to 2026. This issue revolves around what annual averaged should be assumed. Because of the effectiveness of the 1999 cost sharing policy, estimated annual average revenues should be based upon revenues realized since its implementation. For the period of FY 1999 to 2006, average annual revenues were $11,251,000. For the period of FY 19999 to 2007, after which the TIP projects much lower Other IGA Revenues, the annual average is $11,568,000. The average annual revenues, based upon FY 1999 to 2010, would be $9,000,000.

The 2005 TSP Update assumes that Other IGA Revenues will continue to fluctuate annually, but that an estimate of annual average revenues of $11,250,000 would be

reasonable, but uses the revenue estimates in the FY 2006 – 2010 TIP for those years. This estimate assumes that the drop-off of Other IGA Revenues for FY 2008 to 2010 does not indicate a trend, but is a function of the episodic timing of when major projects involving other jurisdictions will be in the MCDOT 5-Year TIP.

Exhibit 35 presents an estimated of Other IGA Revenues for FY 2006 to 2026 of $227.4 million.

Exhibit 43: Estimated Other IGA Revenues, FY 2006 to 2026

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Maricopa County Controlled Revenues

Maricopa County Controlled Revenues are estimated for Licenses and Permits, Miscellaneous Revenues, Interest Earnings, and Gain on Fixed Assets. The 2005 TSP Update estimates Maricopa County Controlled Revenues will generate a total of $98.0 million between FY 2006 and 2026, 2.4% of total revenues over the period. Because MCDOT reported no revenues for Other Charges for Service between FY 1999 and 2006, this revenue source has been deleted from the estimate of revenues. As noted below, because of the volatility of these revenue sources, the estimates are based upon assumptions regarding average annual revenues.

Licenses And Permits

Licenses and Permits Revenues increased substantially in FY 2001/02 and thereafter, compared to revenues for the years between FY 1993/94 and 2000/01. These revenues increased each year from FY 2001/02 to 2004/05, but the budgeted amount for FY 2005/06 represents a decline in revenues, to $1.8 million from $3.0 million in the preceding year. Because of this decline in budgeted revenues, it is not possible to do a straight line projection, based upon an assumed annual rate of growth. Since FY 2001/02, the average annual revenues have been $1,916,000. The 2005 TSP Update assumes that annual Licenses and Permits Revenues will continue to fluctuate, but around an average of $2.0 million. Exhibit 36 presents an estimate of Licenses and Permits Revenues through FY 2026 of $41.8 million, based upon $1.8 million budgeted for FY 2006 and $2.0 million for FY 2006 to 2026.

Exhibit 44: Estimated Licenses and Permits Revenues, FY 2006 to 2026

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Miscellaneous Revenue

Annual Miscellaneous Revenues were reported for FY 1998/99 to 2005/06, to remain consistent with data provided by MCDOT. Annual revenues increased each year from FY 1998/99 to 2003/04, then declined steeply through FY 2005/06. The budgeted amount for FY 2005/06 is only $145,000, while the average annual revenues for this period were $1,777,000. The 2005 TSP Update assumes that these fluctuations in revenues will continue each year through FY 2026, but also that the pattern will more resemble the earlier years rather than the decline of the last two year. For this estimate, the 2005 TSP Update assumed average annual revenues of $1,800,000 per year from FY 2007 to 2026 and the budgeted $145,000 for FY 2006. Exhibit 37 shows estimated revenues for this period of $36.1 million.

Exhibit 45: Estimated Miscellaneous Revenues, FY 2006 to 2026

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Interest Earnings

For the same reasons of definitional consistency, Interest Earnings were only reported for FY 1998/99 to 2005/06. It was noted that, consistent with MCDOT's stated aim to reduce fund balances and therefore Interest Earnings, these revenues have declined every year since FY 1998/99, except for an increase in FY 2004/05 to just over $1.0 million from the preceding year's $306,000. Budgeted Interest Earning Revenues for FY 2005/06 declined again, to $380,000.

Average annual revenues for the period since FY 1998/99 were $1.2 million, but had declined to an average of $631,000 since FY 2001/02. Because it is MCDOT's stated goal to keep fund balances low, the 2005 TSP Update will use the lower average annual figure, $650,000, as an estimator of annual revenues from FY 2007 through FY 2026 and the budget amount of $380,000 for FY 2006.

Exhibit 38 shows estimated Interest Earnings through FY 2026 of $13.4 million.

Exhibit 46: Estimated Interest Earning, FY 2006 to 2026

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Gain On Fixed Assets

"Gain on Fixed Assets" have been reported as a separate revenue item only since FY 2001/02. In the five years since FY 2001/02, these revenues only totaled $1.6 million and fluctuated considerably from year to year, with average annual revenues in the period of $325,000. The MCDOT FY 2005/06 budget shows revenues of $200,000 for the year. The 2005 TSP Update assumes that these revenues will continue to ebb and flow yearly through FY 2026

Exhibit 39 shows estimated Gain of Fixed Assets revenues of $8.0 million through FY 2026based upon $200,000 for FY 2006 and average annual revenues of $325,000 for each subsequent year.

Exhibit 47: Estimated Gain on Fixed Assets, FY 2006 to 2026

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Grant Revenues

The 1999 Needs Study assumed that "Federal Revenues, which varied considerably in the mid-1990's due to special project allocations, are assumed to decline from $3.9 million in 1998 to approximately $300,000 in 1999," and would average $300,000 each year through FY 2020, or $10.5 million for FY 1998 to 2020.[46] As Exhibit 19 demonstrated, MCDOT has been much more successful in obtaining Federal Grants than the 1999 Needs Study assumed. the assumption of $300,000 per year was not realized in the period of FY 1998 to 2006

Based on the record of Grant Revenues for FY 1994 to 2006, the 2005 TSP Update does not include estimates for State Grants or the MAGTPO Grant. The 1999 Needs Study assumed AZTech Grant revenues would total $8.4 million, with $2.9 million in FY 1998 and $5,5 million in FY 1999, and would end in that year, with no further revenues through FY

[46] 1999 Needs Study, Page 36 – 37.

2020.[47] In fact, AZTech Grant revenues will continue through FY 2007, with a total expenditure of $10.5 million.[48] MCDOT has submitted an application for an additional $1.5 million for AZTech, but has no word on the status of the application at this time. The 2005 TSP Update does not include this $1.5 million in its forecast of Federal Grant Revenues, assuming that AZTech funding will end as of FY 2007. The 2005 Update assumes that FY 2007 will be the last year of the AZTech Grant.

Because MCDOT demonstrated success in getting Federal Grant Revenues, especially in the years of FY 1998 to 2006, the 2005 Update does include an estimate of Federal Grant Revenues for FY 2006 to 2026.

MCDOT reports Federal Grant Revenues totaling $6.5 million for the period of FY 2007 to 2011 (see Exhibit 40).[49]MCDOT shows $1.4 million for AZTech and $2.0 million for PM 10 Paving Roads in FY 2007. All of the other grants would be for what the 2005 Update characterizes as "Smaller Projects."

Exhibit 48: MCDOT Federal Grant Revenues for FY 2007 to 2011

Description	Fed Funds	Date
McDowell Mountain Road Bike Lanes	494,870	FFY2007
Bell Road Loop 303 to Grand Ave Construct ITS	500,000	FFY2007
Rio Verde Drive: 136 Street to Forest Road	507,200	FFY2009
MCDOT TMC Upgrade	735,000	FFY2010
Bell Road Loop 303 to 75 Ave Construct ITS	382,200	FFY2011
Five Intersections: Signalization & Modernization	100,000	FFY2011
Forest Road from McDowell Mtn to Rio VerdeDr	400,000	FFY2011
PM 10 Paving Roads	2,032,400	FFY2007
AzTech Smart Corridor	1,350,000	FFY2007
Total	6,501,670	

The 2005 Update assumes that MCDOT will continue to pursue Federal Grant Revenues, especially for the "Larger Projects" and that the department will be successful in obtaining such grants. In the period of FY 1999 to 2006, MCDOT obtained just over $28.0 million in Federal Grant Revenues, an average of almost $3.7 million per year. The 2005 Update acknowledges that obtaining Federal Grant Revenues is unpredictable and cannot be budgeted on an annual basis. For the purposes of estimating Federal Grant Revenues for FY 2006 to 2026however, it was assumed that MCDOT would receive an average of $4.0 million per year, slightly better than what they did between FY 1999 and 2006 (see Exhibit 41). Over twenty years, this would amount to $84 million in Federal Grant Revenues.

Exhibit 49: Estimated Federal Grant Revenues: FY 2006 to 2026

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[47] Ibid, Page 37

[48] "Federal Aid 1998 to 2011 reports an AZTech grant for FY 2007, but not for any further years through FY 2011.

[49] "Federal Aid 1998 to 2011

This can be considered a conservative estimate of revenues, since Federal Grant Revenues were 3.1% of total revenues for FY 1994 to 2006, but $84.0 million would be only 2.0% of total estimated revenues for FY 2006 to 2026.

Private Revenues

Since MCDOT does not track Development Contributions on an annual basis and there is only data for the last three fiscal years, estimating these revenues through FY 2026 is problematic. The average annual revenues for those three years were $987,000. The 2005 TSP Update assumes that Development Contributions will continue to ebb and flow annually through FY 2026, but that $900,000 is a reasonable, conservative estimate of these revenues over time.

Exhibit 42 shows that Development Contributions could produce revenues of $22.4 million through FY 2026, assuming revenues of $750,000 in FY 2006 and $900,000 in each subsequent year.

Exhibit 50: Estimated Development Contributions, FY 2006 to 2026

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CONCLUSION

For the period of 2006 – 2026, MCDOT total revenues are projected to be $4.1 billion, a substantial amount of revenues but an amount that will be seen to fall short of projected needs over the same period. These projections demonstrate MCDOT's dependence on the decisions of others to generate their revenues. The State Legislature controls distribution of State Shared Revenues, which, over the period of 2006 to 2026 should account for 90% ($3.7 billion) of total MCDOT revenues. The second most important source of revenues, Other IGA Revenues, at $227.4 million (5.5%), will be episodic in nature and dependent upon the willingness of other jurisdictions to enter into intergovernmental agreements. In fact, revenues that Maricopa County controls will provide only $98 million (2.4%) of MCDOT's revenues between 2006 and 2026.

The actual revenues that MCDOT receives will be heavily influence by the pace and timing of annexations that will occur through 2026 in the Municipal Planning Areas. For example, if aggressive annexation reduced Maricopa County's share of statewide unincorporated population to 15% (from the current 19.7%) over the period of 2006 to 2026, MCDOT's share of HURF revenues would decrease by approximately $150 million; if it was reduced to 10%, MCDOT would lose approximately $300 million in HURF revenues. This is an issue that cannot be quantified at this time, but is worth noting with the expectation that MCDOT would regularly review these revenue projections against the actual circumstances "on the ground."

Attachment 1 MCDOT Revenues by Fiscal Year: FY 1994 to 2006 ($000)

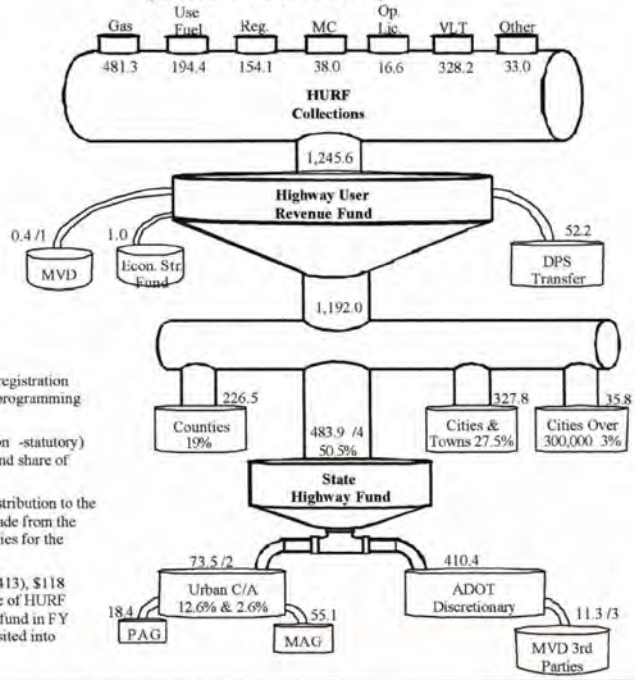
Revenue Source	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	Total Revenues
State Shared HURF/VLT	57,902	63,227	70,135	73,250	67,408	74,532	82,323	85,473	85,029	89,225	94,482	98,339	103,479	1,044,804
Other IGA	1,445		582	1,535	1,511	8,691	8,383	6,136	12,988	5,703	9,528	9,151	29,430	95,083
Maricopa County Controlled Revenues														
License and Permits	117	258	240	276	340	664	585	672	1,451	1,563	1,719	3,047	1,800	12,732
Interest Earnings	954	1,781	2,231	2,982	2,000	3,223	2,185	1,345	755	667	306	1,046	380	19,855
Miscellaneous Revenue	0	0	0	0	0	242	758	2,064	2,713	3,564	4,040	687	145	14,213
Gain on Fixed Assets	150	150	150	150	150	0	0	0	452	99	130	742	0	2,173
Other Charges for Service	16	18	121	36	80	0	0	0	0	0	0	0	0	271
Grant Revenues														
Federal	425	1,834	0	2,559	3,901	3,666	3,666	3,666	3,666	3,666	3,666	3,666	3,666	38,047
AZTECH Grant	0	0	0	0	2,900	2,277	579	1,617	200	74	0	46	1,285	8,978
State Grants	0	0	197	171	350	361	165	430	119	499	34	0	0	2,326
MAGTPO Grant	110	115	120	125	132						165	102	333	1,202
Private Revenues														
Private Cash	0	0	56	0	14	0	0	0	0	0	0	0	0	70
Development Contributions	0	0	0	0	0	0	0	0	0	0	500	1,440	750	2,690
Total Revenues	61,119	67,383	73,832	81,084	78,786	93,656	98,644	101,403	107,373	105,060	114,570	118,266	141,268	1,242,444

Attachment 2

Arizona Highway User Revenue Fund

FY 2005 Actual Revenue Distribution Flow

(Dollars in Millions)



NOTES:

/1. Appropriation to MVD for vehicle registration enforcement program ($383,300) and programming for legislative mandate ($37,000).

/2. The 12.6% (statutory) and 2.6% (non -statutory) allocations from the State Highway Fund share of HURF distributions.

/3. With the elimination of the VLT distribution to the state highway fund, a distribution is made from the state highway fund to MVD Third Parties for the collection of VLT.

/4. Per Laws 2004, Chapter 282 (SB 1413), $118 million of the state highway fund share of HURF VLT is transferred to the state general fund in FY 2005. The $118 million was not deposited into HURF before the transfer.

Needs Assessment and Recommendations for Securing Additional Revenues

2005 Transportation Needs and Funding Options Study

Prepared for
Maricopa County Department of Transportation

Prepared By

Curtis Lueck & Associates
5460 West Four Barrel Ct
Tucson, AZ 85743

June 8, 2006

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Curtis Lueck & Associates
5460 West Four Barrel Ct
Tucson, AZ 85743

(520) 743-8748
FAX (520) 743-4210
Project No. 2005.63

Curtis Lueck, P.E., Principal
Cheryl Rader, Senior Planner/Analyst

June 8, 2006

NOTICE

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INTRODUCTION

This report presents a Needs Assessment and Recommendations for Securing Additional Revenues for Maricopa County Department of Transportation. The Needs Assessment compares Projected Revenues and Projected Costs for the period 2006 to 2026. Projected Costs in excess of Projected Revenues result in a revenue shortfall. The second section of the report presents recommendations for closing, or at least narrowing, the revenue shortfall.

Projected Costs are heavily dependent on the Level of Service (LOS) Maricopa County intends to provide on its roadway system. This issue is especially a factor with establishing the capital needs and costs through 2026. This analysis investigated needs and costs for LOS C, D, and E: LOS C would be the best of the three and LOS E the worst. As the LOS increases, the needs for capacity improvements and the costs of those improvements will increase. Projected Costs are measured as Capital Improvement Costs, Operation and Maintenance Costs, and Personnel Costs. The analysis reveals the capital cost implications of providing a system at differing LOS, but assumes that O and M Costs and Personnel Costs are the same, regardless of LOS.

This report concludes that:

MCDOT faces a twenty-year revenue shortfall of between $1.3 billion to provide a transportation system operating only at LOS E, to $1.9 billion for a system at LOS D, and to $2.9 billion for a system at LOS C; and,

The only truly viable option for securing additional revenues that is within the County's control is a roadway development impact program. The report "Analysis of the Potential of Development Impact Fees and Improvement Districts for Providing New Revenues" describes in detail the many decisions that would need to be made in instituting a development impact fee program. This report makes no attempt to precisely project the revenue potential of an impact fee program, but does present a range of revenue scenarios that show such a program could substantially reduce, if not eliminate, the projected revenue shortfall. Depending upon the configuration of variables discussed in this report, a County roadway development impact fee could generate revenues of between $326.3 million under the most constrained assumptions to $4.4 billion under the least constrained assumptions. These numbers represent large amounts of revenues, which is simply a reflection of the projected growth in the housing market in Maricopa County over the next twenty to twenty-five years.

An expanded improvement district program has a low overall potential for generating new revenues, but any new revenues could be specifically targeted to "niches" in the MCSDOT system, especially for rural areas where existing residents and businesses are demanding that the County pave their roads and include them in the County's maintenance system.

The State Legislature exerts total control over the one revenue source with great potential for generating needed new revenues: the statewide gasoline and use fuel taxes. While the Legislature has exhibited no willingness to raise these taxes, their revenue potentials warrant exploration of scenarios for adjusting these taxes, simply to demonstrate, first, their revenue potential and, second, to remind everyone that a battle to raise these taxes is still worth waging. Three options for raising these taxes were reviewed, with projections of additional HURF revenue for MCDOT ranging from $326.3 million to $1.03 billion.

The next section presents the Needs Assessment. The following section presents the Recommendations for Securing Additional Revenues.

The timing of annexation of currently unincorporated areas with Municipal Planning Areas and the schedule for constructing roadway improvements within these areas will greatly affect MCDOT's twenty-year forecast of needs and revenue. Every lane mile of new capacity that goes to construction after annexation would be the responsibility of the annexing jurisdiction, not MCDOT, unless the County voluntarily assumed responsibility for its construction. The projected costs presented in this report assumes that MCDOT will have total responsibility for constructing all of the necessary lane-miles of additional capacity, Annexation prior to this construction presumably would lower MCDOT's projected costs.

Additionally, annexation will influence MCDOT's projected O and M costs. This report assumes that the profile of the MCDOT roadway system will remain unchanged between 2006 and 2026. Over time, annexation will change the configuration of MCDOT's roadway system, reducing the more expensive to maintain urban/suburban roads and leaving the less expensive to maintain rural roads. This report assumes that average annual O and M costs will be $35,000/mile, which is a reasonable estimate of these costs, based upon the department's current roadway responsibilities.

On the revenue side, annexation could reduce the County's share of statewide population, thereby reducing its share of HURF revenues. Furthermore, if the County establishes a development impact fee program, annexation will affect MCDOT's revenues from this new source, depending upon whether annexation occurs before or after the development occurs and the County has collected the fees.

The issue of annexation and its timing raises a central policy issue for MCDOT: the possibility of a serious imbalance between costs and revenues – shouldering the responsibilities for costs while annexation erodes revenues. How this issue will play out is beyond the scope of this report, but the report can identify some of the dimensions of the issue, so that MCDOT can consider their impacts and possible permutations.

NEEDS ASSESSMENT

INTRODUCTION

This section reviews projected revenues and costs, to determine the extent of the revenue shortfalls facing MCDOT between 2006 and 2026. First, the section shows again the projected revenues through 2026. Next, the section reviews projected costs of capital improvements, O and M, and personnel. Finally, the section reports on the range of revenue shortfalls, depending upon the LOS to which MCDOT will construct the future roadway network. As noted, MCDOT faces a twenty-year revenue shortfall of between $1.3 billion to provide a transportation system operating only at LOS E, to $1.9 billion for a system at LOS D, and to $2.9 billion for a system at LOS C.

PROJECTED REVENUES

Exhibit 1 provides the revenue estimates for 2006 to 2026. The 20-year projection is for $4.1 billion in revenues, with $1.5 billion between 2006 and 2015 and $2.6 billion from 2016 to 2026. State Shared Revenues, HURF and Vehicle License Tax, are the principal source of revenues, constituting $3.7 billion (almost 90%) of total revenues. The next largest source of revenues is Other IGA Revenues, at $227.4 million. Exhibit 1 assumes that the statutory formulas for distributing HURF revenues will not change and that the County's share of unincorporated population will remain the same.

Exhibit 51: MCDOT Revenue Projections, 2006 - 2026

Revenue Source	2006-2015	2016-2026	Total
State Shared Revenues			
State Shared HURF	1,225,400,000	2,164,400,000	3,389,800,000
State Shared Vehicle License Tax	106,400,000	176,500,000	282,900,000
Subtotal State Shared Revenues	1,331,800,000	2,340,900,000	3,672,700,000
Other IGA Revenues	103,680,000	123,750,000	227,430,000
Maricopa County Controlled Revenues			
Licenses/Permits Revenues	19,800,000	22,000,000	41,800,000
Miscellaneous Revenues	16,345,000	19,800,000	36,145,000
Interest Income Revenues	6,230,000	7,150,000	13,380,000
Gain on Fixed Assets Revenues	3,125,000	3,575,000	6,700,000
Subtotal Maricopa County Controlled Revenues	45,500,000	52,525,000	98,025,000
Grant Revenues			
Federal Grant Revenues	40,000,000	44,000,000	84,000,000
Private Revenues			
Developer Contributions Revenues	8,850,000	9,900,000	18,750,000
Total Revenues	1,529,830,000	2,571,075,000	4,100,905,000

PROJECTED COSTS

This report projects costs through 2026 in three categories: Capital Improvement Costs, Operation and Maintenance Costs, and Personnel Costs. This report is attempting to establish levels of costs based upon needs, not upon available revenues or what MCDOT has spent in the past. The report assumes that MCDOT, like every other transportation agency in the nation, has needs in excess of revenues.

The 2005 Transportation System Update produced detailed projections of roadway capital needs (new lane-miles of capacity) through 2026, based upon the County providing a system at different LOS. No direct estimates of cost to provide these different new lane-mail scenarios were made. In addition, the 2005 TSP Update did not generate estimates of needs for 1) new bridges and other new capacity improvements (i.e., sidewalks, bike lanes, intersection improvements, and signalization) or 2) for O and M, both of which need to be included in a full accounting for projected costs. This section suggests methodologies for estimating projected costs of these elements of total needs. Furthermore, the report believes that these methodologies do not provide for estimates of the costs of personnel services and suggests that the adopted FY 2007 budget for personnel services be used as an assumed annual expenditure.

The Projected Capital Improvement Costs are based primarily on assumptions of new lane-miles of capacity needs in the current unincorporated area. The projected costs assume that MCDOT will be responsible for all of these improvements and their costs. If the affected roadways were annexed prior to construction of the new lane-miles, the annexing jurisdiction presumably would assume responsibility for the associated costs of their construction. The report also estimates Projected O and M Costs based upon the current configuration of the MCDOT roadway system. As annexation reconfigures this system to more of a rural system, average annual O and M costs will decline. Finally, Projected Personnel Costs assume the same level of current staffing through 2026. If MCDOT's responsibilities were reduced, one would expect staff size to be lowered as well.

Projected Capital Improvement Costs

Capital Improvement Costs include capacity enhancements to existing improvements and new facilities. The Needs Assessment was provided with information on lane-miles needed for roadway improvements, as well as an estimated from MCDOT of the average cost per lane-mile of roadway construction. Roadway costs do not include needs for bridges and structures, among other capacity improvement needs. After discussing the projected roadway needs, the Needs Assessment proposes an adjustment to the estimate cost/lane-mile to account for other capital improvement needs.

Estimated Roadway Needs

Exhibit 2 shows the projected lane-miles needed, by Level of Service (LOS), for 2006 – 2015 and 2016 – 2026.[50] Lane-mile calculations assume that all new roads and existing roadway widening that go from 2-lanes or 3-lanes will involve total reconstruction of the roadway; widening of existing roadways of 4-lanes or greater will require construction of the new lanes only.

To achieve LOS C by 2015 would require construction of 1,622 lane-miles and 1,601 by 2026, for 3,223 lane-miles of construction. LOS D would require construction of 1,300 lane-miles by 2015 and 1,280 by 2026; for LOS E, the respective numbers are1, 050 and 1,170.

Exhibit 52: Lane-Miles Needed by Level of Service, 2006 – 2015 and 2016 - 2026

Level of Service	2015	2,026	Total
LOS C	1,622	1,601	3,223
LOS D	1,300	1,280	2,580
LOS E	1,050	1,170	2,220

[50] Data provided by HDR

Estimated Capital Improvement Costs for Roadway Needs

Exhibit 3 presents projected Capital Improvement Costs for roadways, by LOS, and for 2006 – 2015 and 2016 – 2026, assuming an average cost/lane-mile of $1,270,000. This estimate of cost/lane-mile was provided by MCDOT, based upon their methodology for calculating improvement costs for the Highway Economic Requirements System (HERS) Model, a methodology developed by the Federal Highway Administration to help with estimates of future investment requirements in roadway systems. When MCDOT last compiled data for HERS, the average cost/lane-mile was just over $1.26 million. This estimate has been rounded up to $1.27 million/lane-mile, to take into account inflation of costs since MCDOT's last input into the HERS Model.

For LOS C, roadway Capital Improvement Costs by 2015 would be $2.1 billion and for 2016 – 2026 $2.0 billion; for total roadway Capital Improvement Costs of $4.1 billion. For LOS D, the Capital Improvement Costs would be $1.7 billion by 2015 and $1.6 billion for 2016 – 2026, with total costs of just over $3.3 billion. The respective numbers for LOS E are $1.3 billion, $1.5 billion, and $2.8 billion.

Exhibit 53 Estimated Capital Improvement Costs for Roadways Only, by LOS and Period

Cost/Mile	2015 Lane Miles Needed	2015 Capital Costs for Roadways	2026 Lane Miles Needed	2026 Capital Costs for Roadways	Total Costs for Roadways
1,270,000	1,622	2,059,940,000	1,601	2,033,270,000	4,093,210,000
1,270,000	1,300	1,651,000,000	1,280	1,625,600,000	3,276,600,000
1,270,000	1,050	1,333,500,000	1,170	1,485,900,000	2,819,400,000

Adjusting Projected Capital Improvement Costs

The Capital Improvement Costs estimated above are for roadways only. MCDOT, however, will encounter other costs for capacity improvements. The AACE's "Year 2004 Roadway Needs Study Update," for example, reports on $116.9 million in needs for "New Bridges on Existing Roads" in Maricopa County between 2005 and 2014. The 1999 Needs Study lists several "capacity enhancement" needs in addition to those on roadways, including bridge capacity enhancements, bike lanes, signalization capacity enhancements, capacity-related safety projects, system wide capital projects, and capital expenditures for AZTech model deployment. Together, these needs accounted for $382.2 million of 25.2% of the total $1.52 billion in "Capacity Enhancement Needs." Based on these sources, relying only on costs of roadway capacity needs will understate actual total capital capacity costs. Exhibit 4 presents adjusted estimates of capacity needs, assuming that non-roadway capital needs would add an additional 25% to total costs. For LOS C, the 2015 costs would increase to $2.6 billion; 2026 costs to $2.5 billion; and total Capital Improvement Costs to $5.1 billion. For LOS D, the respective costs would be increased to $2.1 billion, $2.0 billion, and $4.1 billion. For LOS E, the costs would increase to $1.7 billion, $1.9 billion, and $3.5 billion.

Exhibit 54: Adjusted Estimate of Capital Capacity Costs

2015 Capital Costs for Roadways	Adjusted 2015 Capital Costs	2026 Capital Costs for Roadways	Revised 2026 Capital Costs	Revised Total Costs for Roadways
2,059,940,000	2,574,925,000	2,033,270,000	2,541,587,500	5,116,512,500
1,651,000,000	2,063,750,000	1,625,600,000	2,032,000,000	4,095,750,000
1,333,500,000	1,666,875,000	1,485,900,000	1,857,375,000	3,524,250,000

Projected Operations and Maintenance Costs

In addition to estimates of the costs of new roads and capacity enhancements on existing roads, the Needs Assessment must include an estimate of Operations and Maintenance Costs (O and M) through 2026. The 2005 TSP Update did not make direct estimates of O and M Costs, so this section makes an estimate of annual O and M Costs per mile, in 2005 dollars.

The 1999 Needs Study did make direct, detailed estimates of O and M Costs, which the Needs Study defined as including:

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Exhibit 5 reports on the estimated twenty-year costs of Operations and Maintenance from the 1999 Needs Study. Total estimated costs are just over $1.0 billion, with O&M Expenses accounting for almost 90% of these costs, at $873.5 million.

Exhibit 55 20-Year Estimated O&M Costs, From 1999 Needs Study

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In its benefit-cost analyses, MCDOT estimates O and M costs at $12,100/lane-mile. The average number of lanes for all paved roads is 2.18, which translates into average O and M Costs/mile of approximately $26,400.

This estimate does not include an estimate of what the Arizona Association of County Engineer's "Year 2004 Roadway Needs Study Update" identified as "operating expenses for system support efforts that include administrative costs, upkeep and expansion of maintenance yards, education programs, citizen involvement and transportation planning … and other system wide projects" that represent 10% of O&M costs. Applying the AACE 10% to the estimated annual O&M Costs of $26,400, would increase estimated annual O&M costs to $29,040, which has been rounded up to $30,000/mile of paved road.

The 2005 TSP Update "Existing Conditions" report identified 1,893 miles of paved road in the MCDOT maintenance system, and 719 miles of unpaved roads, for a total existing system of 2,612. It is assumed that the inventory of unpaved roads will continue to decline, as MCDOT completes paving programs needed for air quality compliance. The Needs Assessment assumes that 100 miles of unpaved roads will be converted into paved roads, increasing the paved road inventory to 1,993 miles. The Needs Assessment further assumes that, with construction of new roads and the conversion of County broads through annexations, that the net MCDOT paved roadway system through the 20-year period to 2026 will remain at 1,993, rounded to 2,000 miles of paved roads.

Exhibit 6 projects an estimated 20-Year O&M Needs, assuming average annual costs/mile of $30,000 and a net of 2,000 paved miles in the County maintenance inventory. The estimate of total 20-Year O&M Needs is $1.26 billion, with $600 million in the period of 2006 to 2015 and $660 million for 2016 to 2026. This estimate is approximately $250 million higher than the 1999 Needs Study estimate.

Exhibit 56 Estimated 20-Year O&M Needs, 2006 to 2026

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Projected Personnel Costs

This report believes that the methodologies described above to estimate capital need costs and O and M need costs do not ensure an accounting of personnel services costs, and an estimate of these costs are included here. The County's Fiscal Year 2007 budget includes

recommend expenditures for personnel services of $29.9 million, for a staff of approximately 480 employees. This report rounds up the recommended expenditure to $30 per year and assumes an average annual expenditure of that amount through 2026. That results in Projected Personnel Services Costs of $300 million for the period through 2015 and $330 million for the period through 2026, for total costs of $630 million.

Total Projected Costs

Total Projected Costs range from a low of $5.4 billion for LOS E to a high of $7.0 billion for LOS C. Total costs for the second period through 2026, total costs are slightly higher than those for 2006 – 2015.

Exhibit 57: Combined Projected Costs, 2006 to 2026

NEEDS LOS C	2006-2015	2016-2026	Total
Operations and Maintenance	600,000,000	660,000,000	1,260,000,000
Capital Improvement Costs	2,574,925,000	2,541,587,500	5,116,512,500
Personnel Services Costs	300,000,000	330,000,000	630,000,000
Total Needs LOS C	**3,474,925,000**	**3,531,587,500**	**7,006,512,500**
NEEDS LOS D	**2006-2015**	**2016-2026**	**Total**
Operations and Maintenance	600,000,000	660,000,000	1,260,000,000
Capital Improvement Costs	2,063,750,000	2,032,000,000	4,095,750,000
Personnel Services Costs	300,000,000	330,000,000	630,000,000
Total Needs LOS D	**2,963,750,000**	**3,022,000,000**	**5,985,750,000**
NEEDS LOS E	**2006-2015**	**2016-2026**	**Total**
Operations and Maintenance	600,000,000	660,000,000	1,260,000,000
Capital Improvement Costs	1,666,875,000	1,857,375,000	3,524,250,000
Personnel Services Costs	300,000,000	330,000,000	630,000,000
Total Needs LOS E	**2,566,875,000**	**2,847,375,000**	**5,414,250,000**

CALCULATION OF PROJECTED REVENUE SHORTFALLS

Exhibit 8 reports on the projected revenue shortfalls, at each Level of Service, assuming the revenue forecasts and costs of operations and maintenance needs, total capital capacity needs, and personnel services costs identified in Exhibit 8 before.

As would be expected, revenue shortfalls decline as the Level of Service declines, from a total shortfall of $2.9 billion (41.5%) for LOS C; $1.9 billion (31.5%) for LOS D; and $1.3 billion (24.3%) for LOS E. Under all three Levels of Service, MCDOT faces its most severe revenue shortfalls in the upcoming ten-year period, 2006 – 2015: $2.1 billion (58.0%) for LOS C; $1.4 billion (48.4%) for LOS D; and $1.0 billion (40.4%) for LOS E. Each scenario results in revenue shortfalls in the period 2016 – 2026, but the projected shortfalls are considerably smaller than the shortfalls for 2006 to 2015.

Exhibit 58: Estimated Revenue Shortfall, by Level of Service

NEEDS LOS C	2006-2015	2016-2026	Total
Operations and Maintenance	600,000,000	660,000,000	1,260,000,000
Capital Improvement Costs	2,574,925,000	2,541,587,500	5,116,512,500
Personnel Services Costs	300,000,000	330,000,000	630,000,000
Total Needs LOS C	**3,474,925,000**	**3,531,587,500**	**7,006,512,500**
REVENUES			
State Shared Revenues	1,331,800,000	2,340,900,000	3,672,700,000
Other IGA Revenues	103,680,000	123,750,000	227,430,000
Licenses/Permits Revenues	19,800,000	22,000,000	41,800,000
Miscellaneous Revenues	16,345,000	19,800,000	36,145,000
Interest Income Revenues	6,230,000	7,150,000	13,380,000
Gain on Fixed Assets Revenues	3,125,000	3,575,000	6,700,000
Federal Grant Revenues	40,000,000	44,000,000	84,000,000
Developer Contributions Revenues	8,850,000	9,900,000	18,750,000
Total Revenues	**1,529,830,000**	**2,571,075,000**	**4,100,905,000**
Shortfall (Revenues Less Costs)	**-1,945,095,000**	**-960,512,500**	**-2,905,607,500**
Shortfall (% of Total Needs	-56.00%	-27.20%	-41.50%
Needs LOS D	**2006-2015**	**2016-2026**	**Total**
Operations and Maintenance	600,000,000	660,000,000	1,260,000,000
Capital Improvement Costs	2,063,750,000	2,032,000,000	4,095,750,000
Personnel Services Costs	300,000,000	330,000,000	630,000,000
Total Needs LOS D	**2,963,750,000**	**3,022,000,000**	**5,985,750,000**
REVENUES			
State Shared Revenues	1,331,800,000	2,340,900,000	3,672,700,000
Other IGA Revenues	103,680,000	123,750,000	227,430,000
Licenses/Permits Revenues	19,800,000	22,000,000	41,800,000
Miscellaneous Revenues	16,345,000	19,800,000	36,145,000
Interest Income Revenues	6,230,000	7,150,000	13,380,000
Gain on Fixed Assets Revenues	3,125,000	3,575,000	6,700,000
Federal Grant Revenues	40,000,000	44,000,000	84,000,000
Developer Contributions Revenues	8,850,000	9,900,000	18,750,000
Total Revenues	**1,529,830,000**	**2,571,075,000**	**4,100,905,000**
Shortfall (Revenues Less Costs)	**-1,433,920,000**	**-450,925,000**	**-1,884,845,000**
Shortfall (% of Total Needs	-48.40%	-14.90%	-31.50%
Needs LOS E	**2006-2015**	**2016-2026**	**Total**
Operations and Maintenance	600,000,000	660,000,000	1,260,000,000
Capital Improvement Costs	1,666,875,000	1,857,375,000	3,524,250,000
Personnel Services Costs	300,000,000	330,000,000	630,000,000
Total Needs LOS E	**2,566,875,000**	**2,847,375,000**	**5,414,250,000**
REVENUES			
State Shared Revenues	1,331,800,000	2,340,900,000	3,672,700,000
Other IGA Revenues	103,680,000	123,750,000	227,430,000
Licenses/Permits Revenues	19,800,000	22,000,000	41,800,000
Miscellaneous Revenues	16,345,000	19,800,000	36,145,000
Interest Income Revenues	6,230,000	7,150,000	13,380,000
Gain on Fixed Assets Revenues	3,125,000	3,575,000	6,700,000
Federal Grant Revenues	40,000,000	44,000,000	84,000,000
Developer Contributions Revenues	8,850,000	9,900,000	18,750,000
Total Revenues	**1,529,830,000**	**2,571,075,000**	**4,100,905,000**
Shortfall (Revenues Less Costs)	**-1,037,045,000**	**-276,300,000**	**-1,313,345,000**
Shortfall (% of Total Needs	-40.40%	-9.70%	-24.30%

RECOMMENDATIONS FOR SECURING ADDITIONAL REVENUES

INTRODUCTION

MCDOT faces a twenty-year revenue shortfall of between $1.3 billion to provide a transportation system operating only at LOS E, to $1.9 billion for a system at LOS D, and to $2.9 billion for a system at LOS C. The 1999 Needs study projected a revenue shortfall for the period of 1998 to 2020 of $1.1 billion. As is true for transportation departments throughout the country and at all levels of government, MCDOT's transportation revenue picture has not improved, and might have worsened, over the decade since the 1999 study. Facing a future of increases, some probably dramatic, in the Construction Cost Index, revenue constraints will continue to worsen, unless MCDOT can take steps to find additional revenues.

This section briefly reviews recommendations for increased revenues from the 1999 Needs Study and what actions were taken to implement any of them. The section then narrows the current recommendations for increased revenues to two – implementation of a roadway development impact fee program and expanded use of improvements districts. Finally, the section demonstrates the capacity for increased revenues, for MCDOT and all other transportation agencies in the state, if the Legislature were to increase the statewide gasoline/use fuel taxes and index both of them to inflation in the future.

REVIEW OF THE 1999 NEEDS STUDY RECOMMENDATIONS

What Did the 1999 Needs Study Recommend

The 1999 Report to MCDOT identified twenty-five "funding options potentially available to Maricopa County" (Exhibit 9). The 1999 Needs Study classified these funding options as: Current Sources; Authorized Sources, not Currently Used; New Sources (requiring authorization); and three Cost Reduction Strategies. The funding options included "modifications to some of the current sources …. as well as sources that would require new legislation prior to their use."[51]

[51] 1999 Needs Study, Page

Exhibit 59: "Revenue Source Summary Matrix" From 1999 Needs Study

1: Current Sources	Description	Recommended Action
ıent Exactions	Increase use of development exactions	Do Anyway
Federal Funds	Increase share of federal funds	Do Anyway
ıtrol Taxes	Increase Flood Control District tax	Reserve
Flat	Increase Gas Tax (Flat)	Consider
	Obtain more grant funding	Do Anyway
ıent Districts	Increase use of improvement districts	Do Anyway
es	Expand permit and inspection fees	Do Anyway
on Fees	Increase Vehicle Registration Fees	Reserve
es	Expand utility right-of-way fees	Reserve
icense Tax	Increase Vehicle License Tax	Reserve
2: Authorized Sources, not Currently Used		
Development Impact Fees	Implement development impact fees	Do Anyway
General Funds	Use general funds for transportation	Reserve
Private Contributions	Pursue private sector contributions	Do Anyway
Property Tax	Implement transportation property tax	Consider
Special Allocations	Obtain special allocations from State Legislature	Reserve
Toll Roads	Implement toll roads	Reserve
Traffic Fines	Increase traffic enforcement and fines	Reserve
Transportation Sales Tax	Impose up to half cents sales tax for transportation	Reserve*
3: New Sources (requiring authorization)		
Community Facilities Districts	Utilize community facilities districts	Reserve
Discretionary Sales Tax	Implement County discretionary sales tax	Reserve
Gas Tax, Indexed	Implement gas tax indexed to inflation	Consider
Gas Tax, Sales Tax	Apply sales tax on gasoline purchases	Consider
4: Cost Reduction Strategies		
Growth Management	Increase growth management	Reserve
TDM/TSM	Increase travel reduction and travel demand management	Reserve
Turnbacks	Increase use of turnbacks	Consider

*During the initial phase of the study, the recommendation was to Reserve the transportation sales tax. .Later, members of the Steering Committee wanted it considered because of its high revenue potential.

These twenty-five funding options covered the known spectrum of reasonably conceivable revenue sources. These options included:

Sources typically used for specifically transportation purposes, such as the statewide gasoline tax and vehicle related fees, toll roads, traffic fines, federal and state transportation allocations, a property tax for transportation purposes, transportation specific development exactions and private contributions, and a transportation sales tax;

Sources available for multiple purposes that can include transportation, such as Flood Control District taxes, improvement districts, development impact fees, general funds, and a county wide half-cent sales tax; and,

three strategies that would help to control costs, especially for new capacity investments, including growth management and transportation demand management/transportation system management, as well as a strategy to "turnback" county-maintained roadways to municipalities that surround them.

The 1999 Needs Study rated each of these twenty-five funding options as to their feasibility, distinguishing between "Do Anyway" (the most feasible), "Consider," and "Reserve"

(the least feasible). Twelve options were rated as "Reserve" and were not recommended for further action. As noted, one option – "Transportation Sales Tax" – was rated as "Reserve" in an initial phase of the study, but was included as a recommendation to follow up on because of its high revenue potential. The twelve options listed as "Reserve" were Flood Control Taxes, Registration Fees, Utility Fees, Vehicle License Tax, General Funds, Special Allocations, Toll Roads, Traffic Fines, Community Facilities Districts, Discretionary Sales Tax, Growth Management, and TDM/TSM.

That left thirteen potential funding options that were recommended: seven options as "Do Anyway" and six options as "Consider" (Exhibit 10). The total revenue potential of these thirteen options was estimated to be $1,377,000,000. The 1999 Needs Study originally excluded the $480 million from a Transportation Sales Tax, resulting in an estimate of $897 million in additional revenues, as shown in Exhibit 10. Later, members of the Steering Committee for the study wanted the Transportation Sales Tax included in the analysis because of its high revenue potential. The "Do Anyway" revenue sources were estimated to generate $987 million.

Exhibit 60: "Revenue Forecast Summary" from 1999 Needs Study

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Exhibit 11 sorts the estimated revenue potential, first by the "Do Anyway" and "Consider" categories, and then by the size of the estimated revenues.

Exhibit 61: Revenue Estimates From 1999 Needs Study, Sorted By "Do Anyway" and "Consider"

Do Anyway		Consider	
Recommendation	Estimated Revenue (Millions 1998$)	Recommendation	Estimated Revenue (Millions 1998$)
Development Impact Fees	$73	Transportation Sales Tax	$480
Improvement Districts	$10	Gas Tax, Indexed	$319
Development Exactions	$5	Turnbacks	$138
Federal Funds	$2	Gas Tax, Flat	$136
Grants	$4	Gas Tax, Sales Tax	$109
Permits	$2	Property Tax	$97
Private Contributions	$2		
Total	$98		$1,279

The "Do Anyway" options, the most feasible options, had an estimated revenue capacity of $98 million over twenty years, three-quarters ($73 million) of which would come from a development impact fee program.

Clearly, the "Consider" options, the more difficult options, were estimated to have the most significant potential for generating new revenues.

A Transportation Sales Tax was estimated to generate $480 million for MCDOT over twenty years.

Increasing the statewide gas tax by 5-cents per gallon (Gas Tax, Flat) would generate an estimated $136 million, while then indexing the gas tax to

inflation (Gas Tax, Indexed) would generate an additional $$319 million for MCDOT, for total new revenues of $455 million.

The 1999 Needs Study recommended an approach of combining a transportation Property Tax ($97 million) and cost savings on maintenance from a Turnback program (savings of $138 million), for a combined revenue impact of $235 million.

Finally, applying a sales tax on gasoline sales would generate an estimated $109 million for MCDOT over twenty years.

What Has Been Done to Implement These Recommendations since 1999?

Based upon the currently available information, none of these recommendations has been acted upon, at least to the extent of generating new revenues for MCDOT (Exhibit 12). The possible exception to this statement is Licenses and Fees, which did show substantial increases between FY 1994 – 1998 and FY 2002 – 2005, but there is no information about whether the added revenues are the result, in any measure, of higher rates.

Exhibit 62: Summary of Progress on 1999 Needs Study Thirteen Recommendations

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Increasing Revenues and Who Controls the Revenue

The 1999 Needs Study highlights the dilemma facing MCDOT and all other transportation agencies: those options that would generate the most additional revenues are the hardest to accomplish, while those options that are more readily available have much smaller revenue potential. Exhibit 13 prioritizes the 1999 Needs Study recommendations, first by where does control over implementation of the recommendation reside, and second by revenue potential of options within these categories, while retaining the 1999 Needs Study categories of "Do Anyway Scenario," "Turnback Scenario," "Gas Tax Increase Scenario," and "Sales Tax Scenario 1 and 2." Five options would be under Maricopa County Control; four would require intergovernmental cooperation, but are currently authorized; and four would require action by the State Legislature.

Exhibit 63: Prioritizing Recommendations from the 1999 Needs Study

1999 Recommendations		1999 Revenue Estimates
MARICOPA COUNTY CONTROL		
Do Anyway Scenario		
Implement Development Impact Fees		$73M
Increase Use of Improvement Districts		$10M
Increase the Use of Development Exaction		$5M
Expand Permit and Inspection Fees		$2M
Pursue Private Sector Contributions		$2M
	Sub-Total	**$92M**
REQUIRES INTERGOVERNMENTAL COOPERATION		
Do Anyway Scenario		

Obtain More Grant Funding		$4M
Increase Share of Federal Funding		$2M
Turnback Scenario		
Increase Use of Turnbacks		($138M)
Implement Transportation Property Tax		$97M
	Sub-Total	**$241M**

STATE LEGISLATURE CONTROLS

Gas Tax Increase Scenario		
Gas Tax Indexed to Inflation		$319M
Gas Tax Increase Flat		$136M
Sales Tax Scenario 1 and 2		
Countywide 1/2-Cent Sales Tax for Transportation (not limited access)		$480M
Impose a Sales Tax on the Sale of Gasoline		$109M
	Sub-Total	**$1,044M**
	TOTAL	**$1,377M**

2005 TSP UPDATE RECOMMENDATIONS FOR INCREASING MCDOT REVENUES

The 2005 TSP Update does not repeat several recommendations from the 1999 Needs Study, including Transportation Sales Tax, Turnback/Transportation Property Tax, Grants, and Private Contributions. These recommendations are not continued because their revenue potentials are small; neither MCDOT nor the County has shown any appetite for pursuing them; or the Legislature is unlikely to act positively on them.

The 2005 TSP Update notes that MCDOT did experience substantial increases in Federal Funds and Licenses and Permit Fees and has started to track developer contributions. The 2006 – 2026 Revenue Estimates includes all three of these revenue sources and it is expected that MCDOT will continue to receive revenues commensurate with the Update's forecasts. Therefore, the 2005 Update does make recommendations for increasing these revenue sources.

The 2005 Update does recommend that MCDOT and the County pursue two revenue sources that are entirely within its control: a roadway development impact program and targeted use of improvement districts.

While the Legislature shows no inclination to raise the statewide gasoline/use fuel taxes, their revenue potentials are significant. The 2005 Update, therefore, explores the revenue implications for MCDOT if the Legislature were to 1) raise the gasoline tax to $0.24 per gallon; 2) index gasoline and use fuel taxes to inflation, starting with their current levels; and 3) indexing gasoline taxes starting at $0.24 cents per gallon and use fuel from its current levels.

Roadway Development Impact Fees

This section estimates the revenue potential for MCDOT of implementing a County Development Impact Fee program. The "Analysis of the Potential for Development Impact Fees and Improvement Districts for Providing New Revenues" paper spent a considerable amount of focus on the regional, intergovernmental ramifications of a County DIF program, especially on the value of structuring it to achieve the goal of a net increase in regional transportation revenues.

This section acknowledges the importance of that regional focus, but is more concerned with how MCDOT could benefit from a County DIF program.

Precise and complete estimates of the revenue potential for both DIFS are beyond the scope of the 2005 TSP Update, because of the many policy questions that need to be addressed before setting fees. This report does wish to portray the potential revenues for MCDOT from a county Development Impact Fee program. The analysis will focus only on impact fees for residential development, since there is no readily available basis for projecting non-residential development, except for the sure knowledge that such development will follow the residential development. The analysis looks at the range of potential revenues.

Patterns of Growth in Maricopa County

Maricopa County population is projected to grow to 6,129,255 by 2030, an increase of 2,521,576 (70%) over the 2005 population of 3,605,649. The central facts in discussing population projections for Maricopa County are the Municipal Planning Areas (MPAs), current corporate boundaries and the pace of annexation. There are twenty-four MPAs, which identify the projected ultimate corporate boundaries of each jurisdiction. In some instances, MPA boundaries and corporate boundaries are identical (Scottsdale, for example), while in other MPAs, there currently are significant swaths of unincorporated areas (Buckeye and Surprise, for example). Those portions of the County outside of the MPAs are expected to remain unincorporated.

The impact fee paper identified four roadway circumstances facing MCDOT: MPAs with Potential for Growth in Unincorporated Areas; County Islands Adjacent to High Growth Areas; County Area with Potential for Growth; and County Areas with Low Projected Growth. The first three circumstances provide opportunities for a roadway development impact fee program.

The ten MPAs with the greatest potential for development in currently unincorporated areas are Phoenix, Buckeye, Surprise, Mesa, Peoria, Avondale, Queen Creek, Gila Bend, Cave Creek, and Wickenberg. The first seven of these MPAs are among the nine MPAs with the most projected growth. The paper developed estimates of potential increases in housing units for those Regional Analysis Zones that are most likely to be currently unincorporated. Exhibit 14 shows that almost 425,000 (43.6%) of the projected growth in occupied housing units in these ten MPAs will occur in those RAZs with the highest potential for development in unincorporated areas.

The white paper also identified a potential for growth through 2030 in housing units of 7,908 in “County Islands” adjacent to high growth MPAs, as well as another 3,101 new housing units in a County area directly adjacent to the Buckeye MPA.

Together, Exhibit 14 shows that a County Roadway Development Impact Fee program has a potential for generating revenues from almost 435,000 new homes projected between 2006 and 2026.

Exhibit 64: Potential for Population Growth in MPA Unincorporated Areas

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The potential of a development impact fee program in these high growth areas is apparent in these numbers.

The revenue potential for a MCDOT impact fee program will be influenced by the timing of development and annexation. If development were completed before annexation, MCDOT would realize the full revenue potential of an impact fee program; if annexation occurs at any point prior to the completion of development, the revenue potential of MCDOT impact fees would be proportionally lessened. As noted earlier in this report, Projected Capital Improvement Costs assume that MCDOT will be responsible for 100% of lane-mile capacity improvements.

Revenue Potential of a County Roadway Development Impact Fee

How much revenue would be generated by a County roadway development impact fee program will depend upon 1) how much growth in unincorporated areas occurs, with fees collected, prior to annexation and 2) at what level impact fees are set. Exhibit 15 reports various potential impact fee revenues, assuming that 1005, 75%, 50%, and 25% of growth in housing units occurs prior to annexation and at rates set at $3,000, $5,000, or $10,000 per housing unit. Potential revenues by 2026 range from $326.3 million (25% growth prior to annexation and fee at $3,000/unit) to $4.4 billion (100% growth prior to annexation and a fee of $10,000/unit).

Exhibit 65: Revenue Potential of a County Roadway Development Impact Fee

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The projected revenue shortfall for providing a system at LOS D is $1.9 billion. Exhibit 15 demonstrates that several scenarios for an impact fee program could generate impact fees sufficient to cover, or exceed, that shortfall:

At $10,000/dwelling unit, impact fees would generate revenues in excess of the estimated LOS D shortfall under any percent of growth in unincorporated population prior to annexation except 25%; at 100% of growth prior to annexation, fees of $5,000 or $10,000/dwelling unit would also generate revenues in excess of the estimated shortfall.

At 75% of growth prior to annexation, an impact fee of $5,000/dwelling unit would come close to eliminating the shortfall.

Fees set at $5,000/dwelling unit would reduce the shortfall by $1.1 billion (58%) at 50% unincorporated growth and by $543.7 million (29%) at 25% unincorporated growth.

Fees set at $3,000/dwelling unit would reduce this $1.7 billion shortfall by $326.3 million (17%) at 25% unincorporated growth and by $652.5 million (28%), $978.8 million (58%), or $1.3 billion (68%) depending upon the percent of unincorporated growth prior to annexation.

The development impact fee paper makes clear that specific revenue forecasts for a county roadway development impact fee program require much more detailed study and analysis than the 2005 TSP Update can provide. This data, however, clearly demonstrates the significant revenue potential for an impact fee program.

Targeted Improvement Districts

The 1999 Needs Study reported that Maricopa County used improvement districts for repaving projects, construction of roadways or sidewalks, and installation of landscaping. The 1999 study assumed that revenues from improvement districts would continue through the year 2020, at an average rate of $200,000 per year. While not conceiving of improvement districts as a major source of funding for Maricopa County DOT, the 1999 study did recommend an increased use of improvement districts. The 1999 study also noted that formation of a county improvement district was more restrictive than for forming a municipal improvement district. The study suggested that simplification of the formation requirements could enhance their potential for enhancing the Department's revenue base, but pointed out that efforts by the Arizona Association of County Engineers tried unsuccessfully to revise the enabling statute.

The 2005 TSP paper on improvements districts established that, while the County continues to operate improvement districts for streets primarily on local, rural streets serving a

limited number of property owners. The County and MCDOT can continue with the current practices, serving targeted, "niche markets" with funding outside of the MCDOT budget. Under this scenario, recommendations regarding the use of improvement districts would not be germane to the 2005 TSP.

The paper on improvement districts, however, suggested other Arizona counties use improvement districts in ways that MCDOT, and the County, might wish to look at more closely. The paper suggested that improvement districts might provide a funding source for improvements in the County Areas, though parts of the County not expected to be annexed or incorporated, where projected growth through 2026 is low. Improvement districts could be used to help fund horizontal and/or vertical capacity improvements to roadways already in the County maintenance system or that existing residents or businesses are requesting be brought into the system. As distinct from impact fees, improvement districts provide an. option for financing improvements to meet existing roadway deficiencies.

Examples of Use of Improvement Districts From Other Counties

The paper identified four Arizona counties whose use of improvement districts MCDOT could emulate.

Mohave	Paving county-maintained dirt roads in rural areas
Coconino	Paving roads for dust control
Pima	Improvements to unincorporated areas within the urban area, involving a major commercial development and two high end residential subdivisions
Yavapai	Rural areas experiencing growth and residents demanding roads be brought into the county-maintenance system

The paper documented several improvement districts with significant budgets and a large number of benefiting parcels. Mohave County worked with four districts that averaged $2.8 million, 13.1 miles of street improvements, and 1,814 assessments. Coconino worked with an improvement districts with costs of $5.3 million and 710 benefiting parcels. Pima County had an improvement district with costs of $4.1 million and 283 parcels.

These uses of improvement districts are more extensive than MCDOT's current practices, would generate more revenues, and presumably would justify bringing at least some portion of the improvement district program back into the MCDOT budget.

If MCDOT decided to proceed with an expanded use of improvement districts, the paper suggests some policy and administrative issues that ought to be addressed.

Changing the Statutes on Formation of County Improvement Districts

In contrast to restrictions placed on counties, state statutes (ARS, Title 48, Chapter 4, Municipal Improvement Districts) enable cities and towns to "order" the formation of improvement districts, rather than being required to wait solely on petitioner initiatives.[52] MC DOT has proposed legislation to enable counties to order formation of improvement districts for paving roadways as part of the County's federal air quality requirements, but to no effect as of yet. While the legislative road to any legislation freeing counties to initiate action on improvement districts involves considerable heavy lifting, it seems obvious that there would be considerable benefits for counties to have such authority. At the very least, there would seem to be little or no rationale for

[52] It is worth noting that ARS § 48, 501 to 558, grants counties as well as cities and towns to order the formation of improvement districts for the purposes of "opening, widening closing public ways" needed for "any water course, irrigation ditch, pipe line, water main or sewer for sanitary or drainage purposes."

the legislature to continue distinguishing between counties and incorporated jurisdictions in this matter, especially in light of the recent legislation that harmonizes municipal and county statutes on development impact fees.

Cost Sharing with Improvement Districts

Maricopa County should consider an option for cost sharing with improvement districts. Cost sharing would provide an incentive to property owners to form improvement districts.

More Aggressive Marketing of the Improvement District Option

If the County were to pursue a more aggressive marketing of improvement districts, raising the profile of district staff and improving the quality of the web page would be easily achievable goals.

Improvement Districts and Development Agreements

Using improvement districts in conjunction with development that is about to occur would seem to be a creative method for financing development related infrastructure needs, with more flexibility on what can be financed than what is offered by the county development fee statute (ARS §11-1102).

Increasing Statewide Gasoline/Use Fuels Taxes

Roadway development impact fees and targeted use of improvements districts are the two viable options available to the County and within its authority to implement. On the other hand, the State Legislature controls a source of potential increased revenues – gasoline and use fuel taxes – that could help to alleviate most revenue shortfalls throughout the state. This section explores the revenue potential for changes in the State's gasoline and use fuel taxes. The revenue potentials are so significant that Maricopa County and the rest of the state should never give up the effort to get them increased.

This section reviews the recommendations regarding gas taxes from the 1999 Needs Study; compares Arizona's gas taxes with those in the other states and District of Columbia; reviews the impact of inflation on Arizona's gas and use fuel taxes since 1990; and closes with an analysis of the revenue potentials of three scenarios for increasing gas and use fuel taxes.

What Did The 1999 Needs Study Recommend

The 1999 Needs Study recommended that MCDOT (1) undertake an effort to persuade the State Legislature to raise the statewide gasoline tax rate, from 18-cents per gallon to 24-cents per gallon and (2) consider an effort to persuade the legislature to index the statewide gasoline tax rate to inflation. Both ideas are periodically floated, but the bills, if filed, seldom get out of committee. The 1999 Needs Study warned of the legislative hurdles and anti-tax sentiments that these proposals would encounter.

The 2005 TSP Update does not believe that legislative changes to the statewide gasoline tax have much chance of success. The fact that MCDOT, however, is so dependent on HURF revenues, and VLT revenues, it is important to acknowledge how significantly legislative relief on the tax front would be.

This section compares Arizona's gas tax to that in other states as of December 31, 2005; discusses how inflation has eroded the effective tax rate since 1990; and illustrates the impacts on MCDOT revenues from three optional approaches to increasing tax revenues. Where the 1999 Needs Study only considered the gasoline tax rate, the 2005 TSP Update also looks at options for increasing the use fuel tax rate.

Comparing Gasoline Tax Rates in Other States

Exhibit 16 presents a state-by-state comparison of gasoline tax rates, as of December 31, 2005.[53]

Thirty-one states, plus the District of Columbia, have statewide gasoline tax rates that are higher than Arizona's, ranging from a high of $0.33 per gallon in Wisconsin to $0.19 per gallon in Illinois, Michigan and Vermont. For the states with higher tax rates, the average statewide gasoline tax rate is $0.24 per gallon.

Six states impose a statewide gasoline tax in the $0.18 per gallon rate, while twelve states collect gasoline taxes at a rate lower than Arizona's. For all fifty states, plus the District of Columbia, that average statewide gasoline tax rate as of December 31, 2005 was $0.20 per gallon.

[53] See www.taxfoundation.org/files/7055845c51357607ffa02acd4a1be325.xls. Many states have additional sales taxes, etc., on fuel as well. This fact makes the Arizona rate appear artificially high in charts such as Exhibit 16.

Exhibit 66: State-by-State Comparison of Gasoline Tax Rates

State	Gasoline Tax (Per Gallon)
Wisconsin	$0.33
Washington	$0.31
Rhode Island	$0.30
N. Carolina	$0.30
Ohio	$0.28
Montana	$0.27
Nebraska	$0.26
Maine	$0.259
Connecticut	$0.25
Idaho	$0.25
Utah	$0.245
Kansas	$0.24
Oregon	$0.24
New York	$0.2390
Maryland	$0.235
Delaware	$0.23
Nevada	$0.23
N. Dakota	$0.23
Colorado	$0.22
S. Dakota	$0.22
Arkansas	$0.215
Massachusetts	$0.21
Iowa	$0.207
West Virginia	$0.205
Louisiana	$0.20
Minnesota	$0.20
Tennessee	$0.20
Texas	$0.20
D.C.	$0.20
Illinois	$0.19
Michigan	$0.19
Vermont	$0.19
Average	$0.24
Kentucky	$0.185
Alabama	$0.18
Arizona	**$0.18**
California	$0.18
Indiana	$0.18
Mississippi	$0.18
New Hampshire	$0.18
Virginia	$0.175
Missouri	$0.17
New Mexico	$0.17
Hawaii	$0.16
Oklahoma	$0.16
S. Carolina	$0.16
Wyoming	$0.14
Penn.	$0.12
New Jersey	$0.105
Alaska	$0.08
Georgia	$0.075
Florida	$0.04
Average	$0.20

Three states currently index there gasoline tax for inflation. Nebraska revises its index rate quarterly. North Carolina revises the raise every six months. Wisconsin revises its indexed rate annually, on April 1.

Impact of Inflation on Arizona's Effective Gasoline and Use Fuel Taxes

Arizona's gasoline tax rate has been set at $0.18 per gallon since 1990 and the use fuel tax rate has been at $0.26 per gallon since 1996, having been raised from the $0.18 per gallon that was collected previously. Exhibit 17 charts how inflation has eroded the effective gas tax and use fuel tax rates since 1990 and what the current rates would have to be to have kept pace with inflation.

Since 1990, the $0.18 per gallon tax rate is the equivalent of a rate of $11.6 per gallon in 2005, while the use fuel tax rate eroded in value from $0.18 to $16.5 between 1990 and 1994, when the Legislature raised it to $0.26. Since 1994, the effective use fuel tax rate has declined from $0.26 to $18.8 per gallon.

Conversely, to have kept pace with inflation, the respective tax rates in 2005 would have to have been $28.0 for gasoline and $36.0 for use fuel.

Exhibit 67: Impacts on Gasoline and Use Fuel Tax Rates as Result of Inflation: 1990 to 2005

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Impacts of Three Options for Increasing Gasoline and Use Fuel Tax Rates

This section does not recommend any strategy for raising gas and use fuel taxes, looking instead at the revenue impacts of three options for raising the taxes:

Option 1: Just increase the Gas Tax to $0.24/gallon, leaving the Use Fuel Tax at $0.26/gallon;

Option 2: Index Gas and Use Fuel Tax Rates to Inflation, starting in 2006 with the current tax rates of $0.18 and $0.26/gallon; and,

Option 3: Index Gas and Use Fuel Tax Rates to Inflation, starting in 2006 with the Gas Tax at $0.24/gallon and Use Fuel Tax at $0.26/gallon.

To conduct this analysis requires the following steps:

- estimating gas and use fuel gallons that will be sold between 2006 and 2026;
- projecting statewide gas and use fuel collections between 2006 and 2026 under each of the three options;
- converting statewide gas and use fuel collections into annual HURF receipts for MCDOT and calculating the additional revenues that MCDOT would realize under each option.

Estimating Annual Gasoline and Use Fuel Gallons Sold: 2006 to 2026

ADOT reports on the gallons of gasoline and use fuel sold in each year from 1990 to 2005.[54] Over that period, the gallons of gasoline sold increased by an average of 2.9% and use fuel by an average of 6.9%. For 2005, 2.7 billion gallons of gasoline and 814.6 million gallons of use fuel were sold. Exhibit 18 projects the gallonage to be sold through 2026, applying the

[54] See "www.azdot.gov/Inside_ADOT/fms/gallons2.asp"

average annual increases in gallons sold to the 2005 gallonage sold. The estimates for 2006 are 2.8 billion gallons of gasoline and 870.8 million gallons of use fuel. These annual estimates increase to 5.0 billion and 3.3 billion respectively by 2026.

Exhibit 68: Estimate Gallons of Gasoline and Use Fuel Sold, 2006 to 2026

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Projecting Statewide Collections under Three Options, 2006 to 2026

This section calculates estimated statewide collections of gasoline and use fuel taxes, assuming the projected gallons sold from Exhibit 18, under three options for raising gasoline and use fuel taxes.

Option 1 Raise the Gasoline Tax from $0.18 to $0.24/Gallon and Leave Use Fuel at $0.26/Gallon

The first option (Exhibit 19) would raise the gasoline tax from its current rate of $0.18/gallon, which is the average tax rate for the thirty-one states that currently carry higher tax rates than Arizona. In 2006, estimated statewide gas tax collections would be $675.5 million; use fuel tax collections $226.4 million; and statewide gas/use fuel tax collections would be $901.9 million. By 2026, those collections would be $1.2 billion, $859.9 million, and $2.1 billion respectively. For the entire period, total statewide collections of gas/use fuel taxes would be $29.2 billion.

Option 2 Index Gasoline and Use Fuel Taxes to Inflation, Starting in 2006 With a Gas Tax of $0.18/Gallon and Use Fuel of $0.26/Gallon

The second option (Exhibit 20) would index these taxes to inflation, staring in 2006 with the taxes at their current rate of $0.18/gallon for gasoline and $0.26/gallon for use fuel. This analysis assumes an inflation rate of 2.3% through 2026. The statewide collections of gasoline taxes would be slightly lower than under Option 1, but use fuel collections and total collections would increase, the latter from $29.2 billion to $32.1 billion.

Option 3 Index Gasoline and Use Fuel Taxes to Inflation, Starting in 2006 with a Gas Tax of $0.24/Gallon and Use Fuel of $0.26/Gallon

The third option (Exhibit 21) would index both taxes, assuming inflation of 2.3% per year, with the gas tax starting in 2006 at 40.24/gallon and the use fuel tax at $0.26/gallon. Under this, total collections of gas and use fuel taxes would increase to $38.3 billion between 2006 and 2026.

Exhibit 69: Estimated Statewide Gasoline and Use Fuel Taxes under Option One

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Exhibit 70: Estimated Statewide Gasoline and Use Fuel Taxes under Option 2

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Exhibit 71: Estimated Statewide Gasoline and Use Fuel Taxes under Option Three

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Converting statewide gas and use fuel collections into annual HURF receipts

This report only reviewed options for increasing gasoline and use fuel taxes, not any of the other taxes and fees included in the Highway user Revenue Fund. The ADOT projections of HURF revenues through 2014 and the 2005 TSP Update projections of those revenues through 2026 treated with total HURF revenues, not distinguishing between gas/use fuel taxes and other components of HURF. Having projected potential gas/use fuel revenues under three options, it is now necessary to convert these new revenues into projections of total HURF revenues.

ADOT's Fiscal Year 2005 Year End Report provides information on all HURF receipts, from 1996 to 2005.[55] Over that period, the combined gas/use fuel collections were 55.4% of total HURF receipts. Exhibits 22 to 24 reproduces the "Original Total HURF Estimates" (Column B); estimates "Original Gas/USE Fuel Taxes" assuming 55.4% of total HURF (Column C); reproduces the "Revised Gas Use/Fuel Taxes" under each option (Column D); and recalculates "Revised Total HURF Estimates" (Column E), using the data in Column D. The final column calculates how much total HURF receipts would increase under each of the options.

Under Option One, HURF receipts would increase by $4.4 billion;

Under Option Two, receipts would increase by $7.3 billion; and,

Under Option 3, receipts would increase by $13.5 billion.

Exhibit 72: Revised Total HURF Revenue Estimates, Option One

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Exhibit 73: Revised Total HURF Revenue Estimates, Option Two

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Exhibit 74: Revised Total HURF Revenue Estimates, Option Three

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Calculating the additional revenues that MCDOT would realize under each option

Exhibits 25 to 27 present the revenue impacts of each option for raising gasoline and use fuel taxes statewide. This analysis assumes that 1) the statutory formulas for distributing HURF revenues remain the same and 2) Maricopa County's share of statewide unincorporated population remains at its current 19.7%.

The results of this analysis are that:

Under Option 1, the average annual increase in MCDOT HURF revenues would be $16.0 million and the total increase through 2026 would be $335.6 million.

With Option 2, the average annual increase in revenues would be $26.3 million and the total increase through 2026 would be $553.0 million.

Under Option 3, the average annual increase would be $48.9 million and the total increase would be just over $1.0 billion.

[55] See www.azdot.gov/inside_adot/fms/hurfo5.pdf, Page 11.

Exhibit 75: Additional MCDOT HURF Revenues under Option One

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Exhibit 76: Additional MCDOT HURF Revenues under Option 2

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Exhibit 77: Additional MCDOT HURF Revenues under Option 3

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CONCLUSION

MCDOT faces a future of huge demand and inadequate revenues. In this circumstance, the department resembles transportation departments throughout the state and nation. The County and MCDOT must face several important policy issues. For example, providing a roadway system at LOS C might be too expensive, given the constraints on generating new revenues and LOS E might be too low for public acceptance, regardless of its lower costs.

Given the magnitude of projected growth in Maricopa County, and the additional demands that growth will place upon the transportation system, a roadway development impact fee offers a reasonable, and productive, source of new revenues.

Under any scenario regarding new revenues, HURF revenues will continue to be the major source of funding for MCDOT. If gasoline and use fuel taxes remain frozen at the levels set in the early 1990's, the purchasing power of this revenue source will continue to decline, while the costs of new capacity and O and M continue to increase, with the effects of inflation and increase in demand. Raising these taxes would improve the revenue picture for MCDOT, as well as every other jurisdiction in the County.

Both an impact fee program and increased gasoline/use fuel taxes could raise significant new revenues for MCDOT, the most optimistic scenarios are probably the least likely to occur. Some combination of both approaches under more constrained assumptions could generate significant new revenues for MCDOT. For example, the lowest estimate for impact fee revenues was $326.3 million and for gas/use fuel tax increase was $335.6 million. Combined, these options would generate an additional $662.0 million in revenues for MCDOT.

Finally, what the future holds in store for MCDOT, both in terms of revenues (existing and new) and costs will be heavily dependent upon how quickly annexation proceeds. The department ought to closely monitor this issue and adjust its projections of revenues and costs accordingly.

ASSET MANAGEMENT DOCUMENTATION
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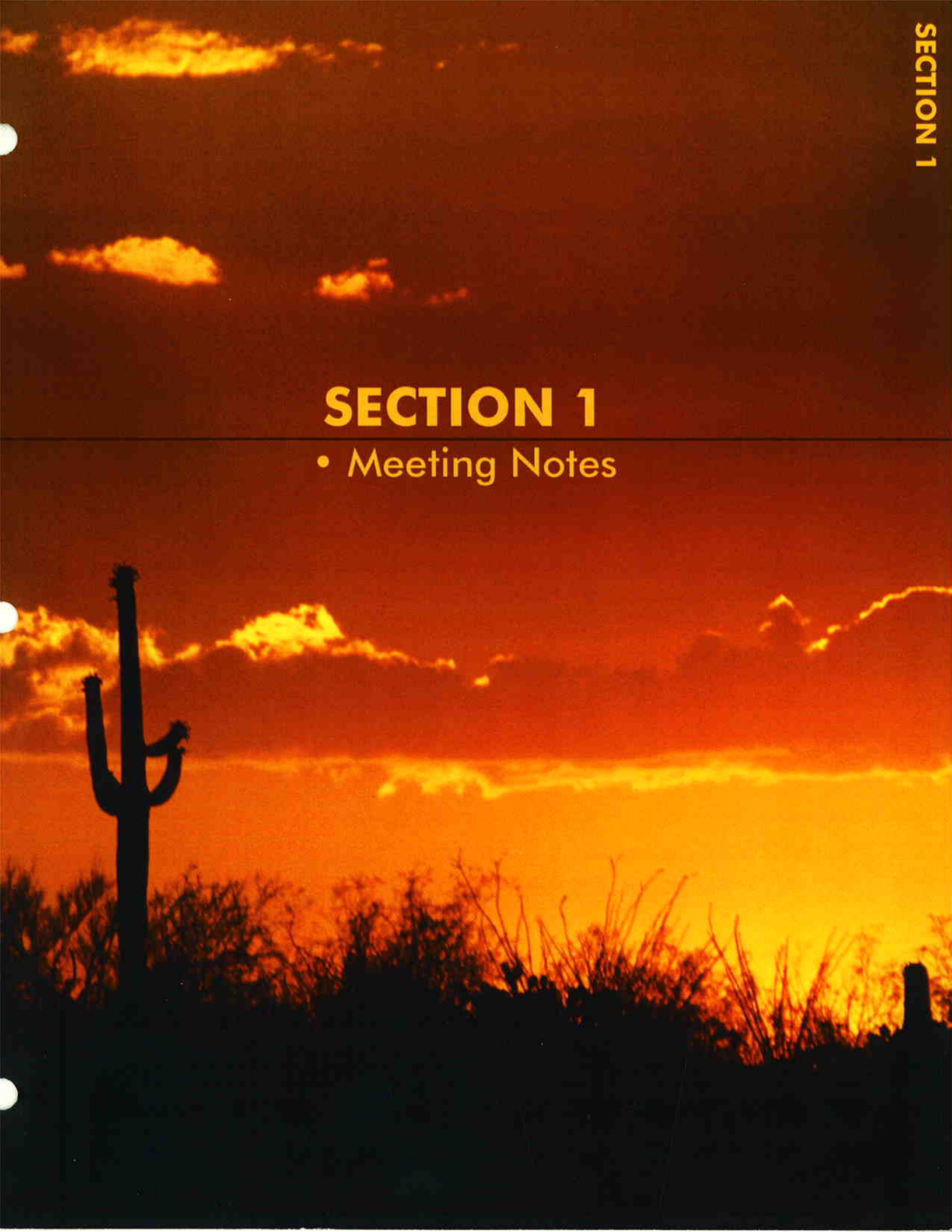


SECTION 1

• Meeting Notes

April 8, 2005

Jerry Fay

Meetings with Mike Sabatini, Assistant County Engineer Planning and Kent Hamm, Assistant County Engineer Program Management, Maricopa County Department of Transportation

On the morning of April 14, 2005 I met with Mike to discuss the entire MCDOT organization regarding our contract to update their Transportation System Plan and Needs Assessment and in the afternoon, Steve Rhoten and I met with Kent to discuss the county's new project management system.

During my meeting with Mike, he provided me with an entire set of detailed organization charts for MCDOT and went over each chart in detail. For purposes of this report, I will only discuss the revisions to their project delivery system. As Kent Hamm's discussion was identical to Mikes the following is a summary of both meetings.

The reason for the change in the project delivery process and the creation of the Project Management and Construction Division is the problem that the county has had in delivering their capital program. They have consistently missed bid dates and sometimes by as much as a year. Under Mike Ellegood's leadership and direction, Kent Hamm will be in charge of the new division as Director. The Planning, Operations and Engineering Divisions will remain in tact with little change. However, the Engineering Division will be primarily responsible for smaller in-house projects and all of the major projects will be overseen by the new PM&C Division.

Their new process will work as follows: When a project leaves the Planning Division and moves to the PM&C Division it will be assigned to a project manager. The project manager will be responsible for environmental, R/W, design and construction activities. All design efforts will include maintenance considerations. The project manager will select and manage the consultants for the various stages of the project. The current organization calls for a Senior Project Manager, Bob Erdman, and four project managers, Ray Smith, Tom Larson, Sami Ayoub and Nariman Zadeh. Chuck Williams will be the Program Manager. Construction Administration is under H. Miller and Bill Hahn will not be a project manager at this time due to immigration and citizenship issue.

Other miscellaneous items of interest discussed included possibility of county bonding to accelerate "Yes on 400" projects, Mike Ellegood wants to get more small local firms involved and they are considering hiring a consultant to manage a portion of their program, similar to ADOT's process. Projects being considered for acceleration are Williams-Gateway, SR 303, Grand Avenue and the ADOT I-10 Reliever.

Copies of the organization charts will be distributed at our next strategy meeting.

April 20, 2005

Jerry Fay

Meetings with Chris Plumb, Manager Transportation Programming and Systems Analysis, Maricopa County Department of Transportation

I had an excellent meeting with Chris and he was very helpful and informative and offered further meetings if I have additional questions. I was specifically interested in how they use their management systems to select projects and program projects and how they use the HERS Model in that process. I was also interested in his thoughts regarding the maintenance and any information he had on how maintenance programs their funds. The following is a summary of the information provide by Chris, which was in a somewhat unstructured format.

They have a Transportation Management System that includes four subsystems that they use to program projects. The systems are Congestion Management, Safety Management, Roadway Management and Bridge Management.

Under congestion management they keep current counts that are consistent with the MAG Model and are integrated in to their GIS. They look at the known capacity and utilize V/C to determine what roads need to be improved. They have a Roadway Design Manual that has LOS data. They look at the absolute capacity using the MAG Model.

For bridges they have PONTIS, but do not use it. They rely on the annual bridge sufficiency ratings for selecting bridge projects.

They use ADOT accident data for safety analysis which looks at accident rate and severity. ADOT assigns a dollar value to the accidents. Accident rate and dollar value are used in the evaluation to select projects.

Their Pavement Management System is part of the Roadway System and they are developing their own system, software. They have all the data they need, but as yet they have not been successful in finishing the development of the program. They currently only program maintenance for one year and predictive model is being developed to enable longer term programming of maintenance funding needs. They currently know the average pavement condition for all functional classifications.

The HERS Model looks at system condition and performance and is supposed to enable decisions to be made regarding maintenance and capital expenditures. There is a large number of variables that need to incorporated in to the modeling, such as; roadway condition information, geometrics and accidents. You can set the pavement level and look at benefit form various cost levels. This is measured by the International Roughness Index (IRL). HERS looks at the surface improvements needed and selects roads for maintenance. They have a pavement service ability index that provides and overall view of the pavements. This information is contained in the Maintenance Manual. They

currently do not have a policy that establishes their overall pavement condition rating. They do know that over the past several years that the overall rating has been going up because of additional funds being transferred from the capital program. The question becomes what is our system condition over the next twenty years if we continue at the current funding levels and what happens if we vary the funding. Only collectors and arterials are rated and not local streets. This causes a major problem when areas like Sun City, which was built forty years ago needs major rehabilitation and restoration. In the case of Sun City they are considering it to be a capital project because of the cost. Their maintenance cycle used to be six to seven years, but now is in the twelve to fifteen year range.

Regarding the relationship of the planning group to the new program management group, planning takes a project through the Candidate Assessment Report (CAR) and program management begin with the Design Concept Report (DCR).

There are major concerns regarding the YES on 400 projects and how they are programmed and funded. MCDOT has developed an Arterial Life Cycle Program (ALCP) for all of the projects. Chris believes it is not acceptable to do accelerated projects with out considering inflation. He thinks they should just readjust the schedule in to five year increments and move forward. He believes MAG is not capable of administering the YES on 400 arterial projects and that the phasing and inflation process will be a nightmare.

The County Supervisors are looking at bonding to accelerate freeway projects. However, Chris feels that once they look at the amount of money they can raise from bonding versus the impacts on there HURF funding over time, they will decide to not do it. The financial arm of the county is currently doing the analysis.

Regarding some final thoughts, the HERS Model has all the data in the system and could have the ability to be utilized effectively for programming capital and maintenance in the future.

May 2, 2005

Jerry Fay

Meeting with Gary Lashman, Operations Division Manager, Maricopa County Department of Transportation

Gary is responsible for roadway maintenance and traffic operations. One of his main responsibilities is management of the Roadway Management System (RMS). The following are my notes from my meeting with Gary:

The first area of discussion was the RMS. The RMS uses the following information for the Roadway Inventory Data:

Roadway name and cross road reference
Segment length
Functional Classification of the roadway
Number of lanes
Width of lanes
Surface type
Shoulder width and type
Maintenance history
Traffic volumes
Right-of-way width

Noise is also becoming an issue. They now do some milling and then overlay with rubberized asphalt instead of chip sealing.

They utilize the HERS model, however it only works on the main roads. Cost is an issue in trying to make valid comparisons. Roadway maintenance is $8,000 to $9,000 per mile yearly.

The RMS provides a lot of data on individual roadway segments, by evaluating cracking, rutting, raveling, etc. The International Roughness Index (IRI) is also determined using profiling and measuring devices. The majority of discussion can be found in the Divison Procedures for the RMS.

Based on our discussions there appear to be two areas that can provide the comparative data necessary to determine the impact of various expenditures. The two measures are overall system performance, the Pavement Serviceability Index (PSI) and the International Roughness Index. The impacts of various expenditure levels over time base on establishing an acceptable standard of performance can provide the data necessary to support budget decisions.

Fay, Jerry

From: Spargo, Benjamin
Sent: Wednesday, August 17, 2005 7:49 AM
To: Fay, Jerry
Subject: MCDOT TSP Meeting 8/10/05

Jerry-

Here are some notes that I took from the Asset Management meeting last week. Those attending were Ed Fritz, who runs the HERS model for MCDOT, Rick, who runs the pavement/roadway management services, and Alex, who does software development. I'll use the Meeting Agenda to help organize the general discussion.

- MCDOT's RMS development:
  RMS Phase 1 - Capture the data. Gather the existing information available from Rick's group including IRI, PCR, etc. Close to complete.
  RMS Phase 2 - Future strategies. The goal of RMS is to be able to create funding scenarios in order to keep the network at a chosen performance level. Where HERS is good for the capital program, the RMS is designed to provide a similar evaluation method for the maintenance program. Currently under development.
  HERS Model weakness - only able to use 1 maintenance strategy. Currently MCDOT institutes numerous types of maintenance procedures to repair and maintain pavement performance. Mainly outputs benefit/cost (b/c) ratios
  HERS Model pavement curve - the HERS Technical Report (Dec. 2000, FHWA) provides the background information for all of the curves, models and equations that are used within the model. MCDOT has adjusted many of the default curves to better reflect the climate and conditions of the environment in Arizona.

- HDR's asset management findings to date:
  Research peer jurisdictions to develop a rationale for the background models in the RMS.

  RMS - project's data needs:
  Develop performance standards (justification for the levels requires research of peer jurisdictions)
  Decide whether software should analyze the "bang for the buck" or the "buck for a certain performance measure"
  Pavement degradation curves (historical data, peer jurisdictions with similar climates, etc.)
  Further b/c analysis

- HDR's remaining asset management tasks:
  Support the development of MCDOT's RMS as needed
  Coordinate HERS training session with Ed to better understand the input and output data.

- Also:
  Continue making better decisions with maintenance funding. Not necessarily improve the worst roads first.
  Continue looking for better products and more efficient ways to deliver the improvements.
  Work to change the culture of the budgeting department to meet the needs of the maintenance program and then fund the capital program with remaining funds.

Ben

Ben Spargo, EIT

HDR | ONE COMPANY - ***Many Solutions***
3200 East Camelback Road Suite 350
Phoenix, AZ 85018-2311
Direct (602) 522-7776

MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION

DIVISION PROCEDURE

PPG NO: 94-3 **Effective Date:** **March 5, 1997**	**Revised Date:** **November 5, 2002**	**DIVISION:** **Construction & Operations**
SUBJECT: **Road Management System**	**Authorized Signature:**	
Owner/Contact: **Rick Boeger – 602-506-4509**	**M. Kent Hamm, P.E.** **Assistant County Engineer Operations**	

PROGRAM OVERVIEW AND BACKGROUND

The Road Management System (RMS) is a tool used to analyze the physical attributes of roadways as well as the current condition of roadway pavement and ride quality. The information derived from the RMS is used to make recommendations to decision makers concerning how to best maintain and preserve county roads. The primary goal of the RMS is to ensure acceptable ride quality and safety for the traveling public in a cost efficient manner in accordance with the specifications of the MCDOT Roadway Design Manual.

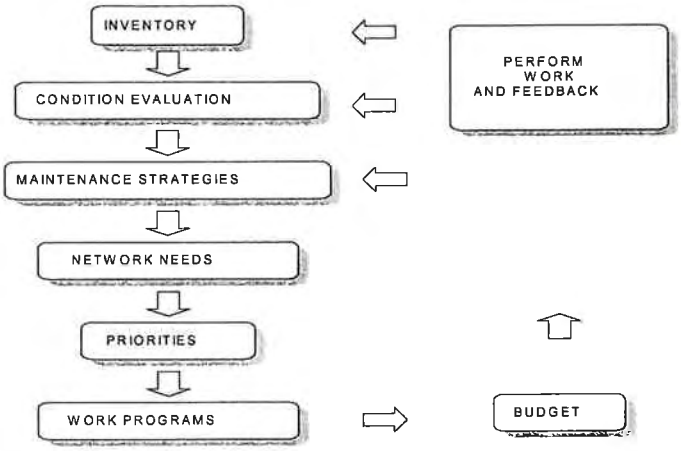
Purpose of the RMS

All road surfaces deteriorate over time due to traffic and environmental conditions. MCDOT's analysis has shown that it costs the traveling public less to have good roads than bad roads but only if the roads are kept at a reasonable level of serviceability. Therefore, the County has set up a program to continuously monitor roadway conditions, report the roadway conditions to the decision makers through the RMS, and attempt to maintain all of its roadways at an acceptable level. Preventive maintenance is the soundest way to reduce pavement failure.

Preventive maintenance is the treatment applied to prevent or reduce the rate of deterioration on roads and the expenditures for pavement work. Preventive maintenance is limited to such activities as surface seals and thin overlays that do little to change the structural capacity of the pavement but do add years of life to the road surface. The old colloquial saying of "pay me now, or pay me later" truly applies to pavement maintenance.

The County's general framework for roadway management activities is shown in Figure 1. The first feature is an inventory of the pavements in the network; Second, a systematic procedure is used to evaluate the condition of these pavements and; Third, the RMS defines maintenance and rehabilitation strategies. Finally, based on the pavement condition, the RMS identifies the network maintenance and rehabilitation needs, selecting the most appropriate strategy for each pavement section. The RMS program repeats the analysis for a five-year period and projects the Pavement Condition Ratings (PCR) over time so that long-term work plans and budgets can be prepared.

Figure 1: Roadway Management Process



LAWS AND POLICIES AFFECTING THE RMS

The Maricopa County Transportation System Plan and Comprehensive Plan outlines four management systems to help plan and program future roadway improvement projects. These management systems include Roadway, Safety, Congestion and Bridge. All were patterned after those described and required in the Federal Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991.

The 1998 implementation of the TEA 21, the Transportation Equity Act for the 21st Century, created changes to all of the Management Systems. While these reports are no longer required, Maricopa County has made a commitment to continue to collect data and carry out all management system reports for roadways under the County's Jurisdiction.

ROLES OF THE RMS IN CAPITAL IMPROVEMENTS PROGRAMMING

The RMS determines preventive maintenance, rehabilitation, and reconstruction needs over a five-year span. It also recommends strategies that maintain the overall network at a condition required by the MCDOT Roadway Design Manual and expected by the traveling public. These determinations are presented each November to the MCDOT Construction & Operations Division and Planning Division for consideration in the Transportation Improvement Program (TIP) or the Construction & Operations Maintenance Program.

RMS reports generated for use by MCDOT include:

- Transportation Improvement Projects (TIP) recommending road widening.
- Recommending reconstructing various two-lane roads to improve sufficiency rating.
- Recommending roadways to receive structural overlays.
- Recommending roadways to receive thin (maintenance) overlays.
- Recommending roadways to receive surface treatments (i.e., chip seal, slurry seal, crack seal, fog seal, routine maintenance.)

ROADWAY EVALUATION PARAMETERS

The RMS uses six different categories of information to determine which roadways in the network require attention. These categories are both independently analyzed and mathematically combined to offer a snapshot for the decision makers to annually monitor roadway conditions.
Data included in the RMS are the road inventory, the pavement conditions rating, the international roughness index, the sufficiency rating, the work history data, and the traffic volumes data. All play important roles in determining: What work needs to be done annually.

Roadway Inventory Data

Roadway Inventory information comes from the Road Information System (RIS) Platform Conversion Application (RPCA) to the RMS databases. The following types of information are available in the databases for roadways owned by the County:

- Road name, and cross road references
- Segment length
- Functional classification of the roadway
- Number of lanes
- Width of lanes
- Surface type
- Shoulder width and type
- Maintenance history
- Traffic volumes
- Right-of-way width

Pavement Condition Rating (PCR)

The MCDOT Road Management Section evaluates pavement conditions by inspecting all segments of paved roads in the County. The result allows for a quantifying of the overall pavement condition in the road network. Pavement conditions are updated annually on most section line roads (Arterials) and every other year on local roads. Measuring surface distress types determines the Pavement Condition Ratings (PCR) (see Table 1) such as:

- Transverse cracking
- Longitudinal cracking
- Fatigue cracking
- Block cracking
- Rutting
- Raveling
- Shoving / Pushing / Corrugations
- Excess asphalt Patching

The above information is then combined so that each road is scored on a scale from 1 to 100 with 100 representing an excellent roadway surface.

The Maricopa County Department of Transportation relies on the PCR for looking into potential preventive maintenance strategies and long range planning. Pavement preventive maintenance treatments need to be performed before the pavement conditions get to the point of rehabilitation or reconstruction. Timely treatment strategies prove to be the most cost effective.

Figure 2 shows the effectiveness of the Maricopa County Department of Transportation's preventive maintenance strategy.

Figure 2: Pavement Maintenance Strategies

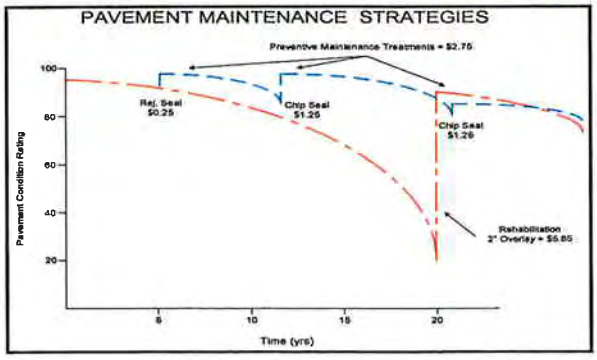


Table 1: Asphalt Pavement Surface Distress Evaluation

ASPHALT PAVEMENT SURFACE EVALUATION
100 Point System

TRANSVERSE CRACKS

EXTENT SPACING	SEVERITY WIDTH <3/8"	SEVERITY WIDTH >3/8"
>50 ft.	1	4
12 ft. to 50 ft.	2	5
<12 ft.	3	6

LONGITUDINAL CRACKS

EXTENT	SEVERITY WIDTH <3/8"	SEVERITY WIDTH >3/8"
Centerline Single	1	4
Wheel Path Single	2	5
Multiples	3	6

FATIGUE CRACKING

EXTENT	SEVERITY WIDTH <1/8'	SEVERITY WIDTH >1/8"	SEVERITY WIDTH Blocks
One or two < 50 sf	1	5	9
Three or more < 50 sf	2	6	10
One or two > 50 sf	3	7	11
Three or more > 50 sf	4	8	12

BLOCK CRACKS

EXTENT BLOCK SIZE	SEVERITY WIDTH <3/8"	SEVERITY WIDTH >3/8"
>50 ft.	1	4
12 ft. to 50 ft.	2	5
<12 ft.	3	6

RUTTING

EXTENT	SEVERITY DEPTH >1/2"
Localized or only partial length	1
Entire length of section	2

RAVELING

EXTENT	SEVERITY PITTING Minor	SEVERITY PITTING Major
Wheel Paths < 50% length	1	5
Wheel Paths > 50% length	2	6
Entire Width < 50% length	3	7
Entire Width > 50% length	4	8

SHOVING/PUSING/CORRUGATIONS

EXTENT	SEVERITY RIDE DISCOMFORT Mild	SEVERITY RIDE DISCOMFORT Harsh
At intersections only	1	4
Between intersections only	2	5
Present in entire section	3	6

PATCHING

EXTENT NUMBER	SEVERITY QUALITY OF REPAIR Good	SEVERITY QUALITY OF REPAIR Fair	SEVERITY QUALITY OF REPAIR Poor
< 5 Repairs	1	4	7
5 to 15 Repairs	2	5	8
>15 Repairs	3	6	9

EXCESS ASPHALT

EXTENT	SEVERITY FILM Thin	SEVERITY FILM Thick
Wheel Paths < 50% length	1	5
Wheel Paths > 50% length	2	6
Entire Width < 50% length	3	7
Entire Width > 50% length	4	8

Standard evaluation section should be minimum 10% of road termini length i.e.; 1 mile = 500' rating section and be subjectively selected to represent the general road way condition.

Sufficiency Rating

The geometric information for each section of the road is maintained and used in this rating. The MCDOT Road Management Section collects sufficiency data for each arterial road. The rating identifies how each roadway segment compares to the MCDOT Roadway Design Manual (RDM) standards for each road segment's functional classification. The following information is maintained in the RMS for each road segment:

- Lane width
- Shoulder width
- Bottleneck features
- Drainage features
- Vertical sight distance
- Horizontal sight distance

The above information is then combined so that each road is scored on a scale from 1 to 100 with 100 representing a road in complete compliance with the RDM standards.

International Roughness Index (IRI)

International Roughness Index (IRI) is determined by a CLASS II direct profile measuring devise as classified in the Highway Performance Monitoring System (HPMS) Field Manual published by the Federal Highway Administration. IRI rating (inches per mile) is achieved by dividing the total roughness count by the distance measured and reported as a whole number.

MCDOT uses Laser Road Profiler (LRP) and a Distance Measuring Instrument (DMI) mounted in a two wheel drive vehicle. The LPR measures the vertical displacement (upwards and downwards) that the vehicle would experience traveling at the posted speed limit. This is accomplished by measuring with the laser the distance between the road surface and the laser pick up every three inches (seven and half centimeters). The road roughness is measured in tenths of an inch (two and half millimeters) increment and converted through the IRI software. The DMI accumulates and records the total distance traveled. To ensure accuracy, all equipment is periodically calibrated on MCDOT or ADOT test sections with established profiles.

This information is then combined so that each roads is scored on a sliding scale from 1 to 500 scale with 500 representing an extremely rough section of a road.

Work History Data

The work history on each roadway is kept in the surface treatment RCPA database maintained by the Road Inventory Section. Records of major construction and maintenance activities performed on pavements are maintained by MCDOT and contain the following types of information:

- Type of work
- Material used, types, and thickness
- Completion date

Traffic Volume Information

The MCDOT Traffic Engineering Section conducts all traffic counts for MCDOT. Raw traffic count information is converted to Average Daily Traffic (ADT) volumes on all roadways within the network. The County conducts annual traffic counts on a major portion of roads classified as either collectors or arterials. Local roads are counted as needed. This data is used to determine preservation strategies and traffic congestion levels throughout the County.

Preservation Strategies and Maintenance

The Preservation Strategy Table 1 (next page) confirms that providing timely preventive maintenance curtails roadway failure and reconstruction. While the total mileage in the system has decreased, the percentage of preventive or low maintenance strategies has remained stable. As the matrices in the following table shows a roadway's roughness and pavement conditions are the determinants as to what preservation strategy is necessary. Additionally, if a road is deemed insufficient (a rating below 40) then reconstruction is recommended.

Recommended Roadway Widening

The RMS not only uses traffic volumes to recommend improvement strategies but also widening suggestions. Each roadways number of lanes and accompanying average daily traffic (ADT) affect possible expansion. Roads that have two or less lanes and currently experience more than 5,000 ADT are recommended for study. Additionally, roads that are projected to have more than 7,000 ADT (2 lane) and 15,500 ADT (4 lane) within six years are also recommended. Future ADT counts are estimated by using current data compounded annually 3.5%. Table 2 shows an example of the reported generated by the RMS section for the TIP Review Committee, with the 47.51 miles of County roadways recommended for widening.

Table 1: PCR vs. IRI Preservation Strategy Matrix

Maricopa County Department of Transportation
Operations Division
Roadway Management System

PCR vs. IRI Preservation Strategy Matrix
ASPHALT CONCRETE PAVEMENTS

		IRI		
		<=95	<=170	>170
PCR	>=70	PM	PM	TO
	>=40	ST	ST	SO
	<40	TO	SO	RE

PCR vs. IRI Preservation Strategy Matrix
PENETRATION AND CHIP PAVEMENTS

		IRI		
		<=125	<=220	>220
PCR	>=70	PM	PM	TO
	>=40	ST	ST	SO
	<40	SO	SO	RE

PM = Preventive Maintenance	(Crack Seal and/or Fog Seal)
ST = Surface Treatment	(High Volume or Low Volume Chip Seal or Slurry)
TO = Thin Overlay	(<= 2" Asphalt Rubber Overlay)
SO = Structural Overlay	(>= 2" Asphalt Rubber Overlay)
RE = Reconstruct	(Replace Pavement Structure)

All chip seals and overlays are repaired (patched) and crack sealed prior to resurfacing.
A "Sufficiency Rating" below 40 indicates a road section of poor design and will generate a recommendation to "Reconstruct"

Traffic volume also influence the recommended strategy, if projected ADT > 7,000 and the road section is two lanes then a "Reconstruct 2 to 4 lanes" strategy is generated.

PROJECTED (6) YEAR ADT = 3.50% Compounded Annually (22.8% / 6 years)
Section Line Collectors and higher.

	1995 ADT	2001 ADT
Source : Cathy Arthur, MAGTPO 5/22/95	5500	7000

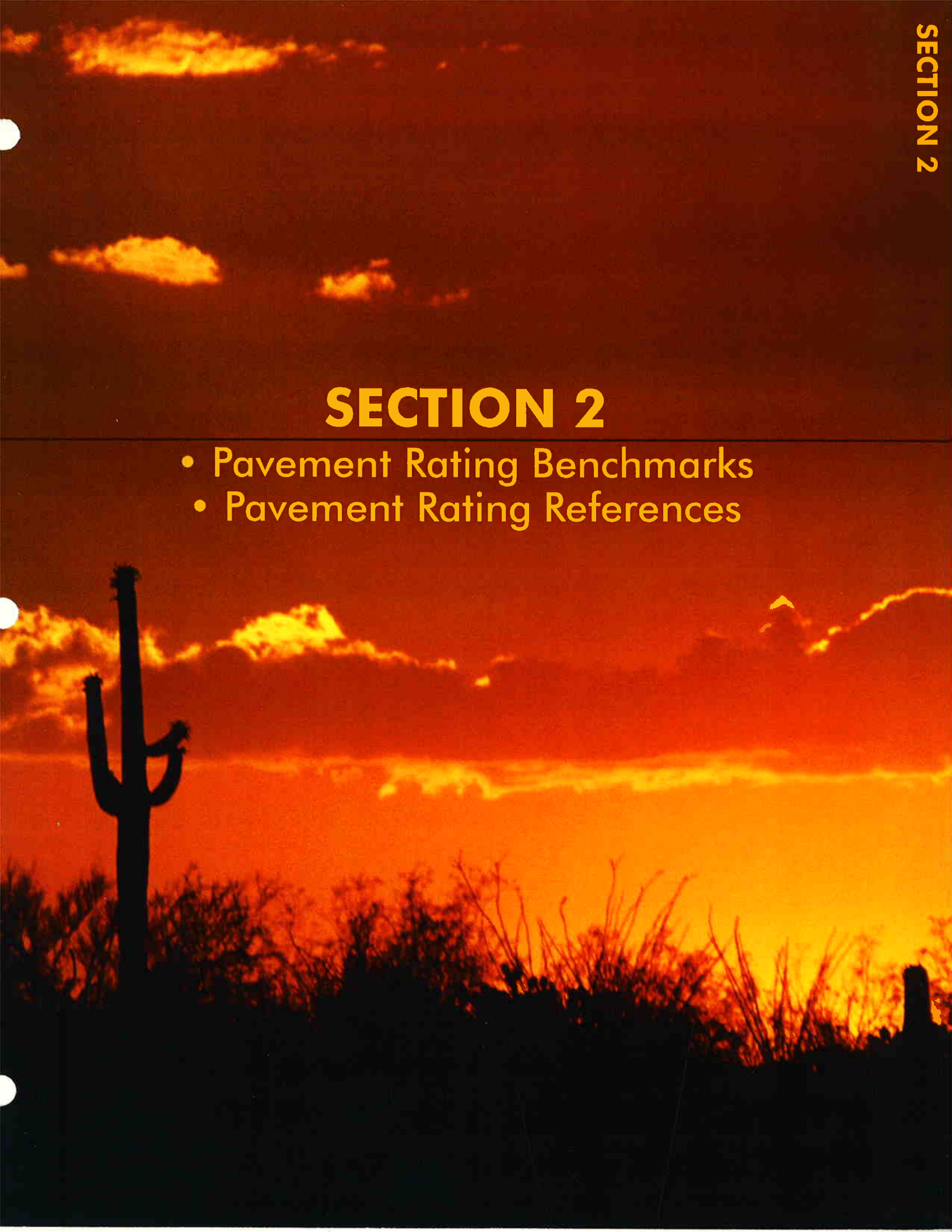
Mathematical models are used to generate recommended strategies, priority values and estimated cost for each road section for each of the next five fiscal years.

Road	From	To	Total Miles	ADT	Current Lanes	Future ADT
35th Ave	Baseline Rd	Southern Ave	1.00	5724	2	7029.07
56th St	I 10 Fwy	Gila River Indian Reservation	0.30	10879	2	13359.41
67th Ave	Pinnacle Peak Rd	Happy Valley Rd	1.00	7686	2	9438.41
83rd Ave	Peoria City Limits	Pinnacle Peak Rd	0.93	8740	2	10732.72
91st Ave	Camelback Rd	Northern Ave	3.00	19810	2	24326.68
99th Ave	Glendale City Limits	Loop 101	0.10	40038	2	49166.66
Alma School Rd	Mc Kellips Rd	Mcdowell Rd	0.68	6658	2	8176.02
Camelback Rd	El Mirage Rd	115th Ave	1.00	5937	2	7290.64
Carefree Hwy	7th Ave	52nd St	6.50	18514	2	22735.00
Cave Creek Rd	Phoenix City Limits	Cave Creek City Limits	0.90	16719	2	20530.93
Del Webb Blvd	Bell Rd	107th Ave	0.27	18651	2	22903.43
Ellsworth Rd	Empire Blvd	Germann Rd	5.00	6640	2	8153.00
Hayden Rd	Henshaw Rd	Mc Kellips Rd	1.00	24651	2	30271.43
Maricopa Rd	Queen Creek T. I.	I 10 Fwy	2.08	13656	2	16769.57
Mc Dowell Rd	Alma School Rd	Arizona Ave	0.77	13536	2	16622.21
Mc Kellips Rd	Mesa City Limits	Crismon Rd	0.51	5513	2	6769.96
Meridian Rd	Broadway Rd	Apache Tr	0.50	8477	2	10409.76
Northern Ave	115th Ave	Loop 101	2.12	9335	2	11463.38
Olive Ave	Reems Rd	Dysart Rd	3.00	6309	2	7747.00
Olive Ave	El Mirage City Limits	99th Ave	3.01	15204	2	18670.50
Peoria Ave	111th Ave	Peoria City Limits	2.00	9923	2	12185.00
Recker Rd	University Dr	Adobe Rd	0.50	10613	2	13032.76
Riggs Rd	I 10 Fwy	Price Rd	1.57	12355	2	15171.94
Rittenhouse Rd	Williams Field Rd	Recker Rd	0.95	6216	2	7633.25
Rittenhouse Rd	Power Rd	Ellsworth Rd	3.71	9235	2	11340.58
Southern Ave	35th Ave	27th Ave	1.00	5886	2	7228.01
Thunderbird Blvd	98th Ave	Peoria City Limits	0.49	20844	2	25596.43
Union Hills Dr	107th Ave	99th Ave	0.62	12177	2	14953.36
University Dr	Ellsworth Rd	Meridian Rd	3.00	18633	2	22881.32

Total Miles **47.51**

SECTION 2

- Pavement Rating Benchmarks
- Pavement Rating References



Metropolitan Transportation Commission

Street Talk

Volume 15 Number 2 | Current Issues in Pavement Maintenance and Management | July 2002

A Snapshot of the Region's Pavement Condition

by Theresa Romell

The pavement management staff at MTC has put together a summary of current pavement conditions as a precursor to the comprehensive "state of streets and roads" report MTC issues annually for the Bay Area. The findings show that, while 59 percent of Bay Area roads are in "Good" or better condition, 16 percent of the Bay Area's local streets and roads fall into the "Fair" category, and are in need of immediate repair. Sixteen percent are in the "Poor" or "Very poor" category, meaning that they require resurfacing or reconstruction and are very difficult to drive on.

The information for the MTC summary comes from databases received from jurisdictions using MTC's pavement management software, primarily through the Pavement Management Technical Assistance Program.

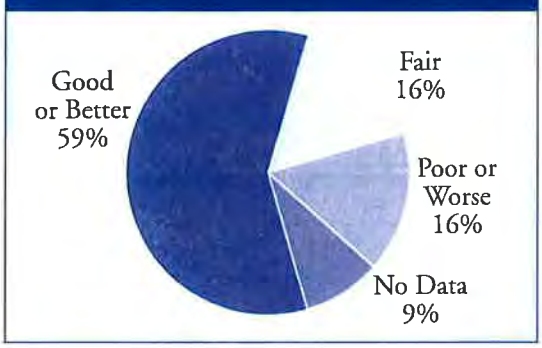
The unit of measure used to rate the condition of pavements is the pavement condition index (PCI), which rates pavements on a score of 0 to 100. A higher value of PCI indicates a better pavement condition.

Excellent: PCI 90–100 Pavements are most likely newly constructed or resurfaced and have few or no distresses.

Very good: PCI 75–89 Pavements require mostly preventative maintenance and have only low levels of distress such as minor cracks or surface flaking.

Good: PCI 60–74 Pavements exhibit some low-severity distresses but still have satisfactory ride quality. Pavements at the low end of the "Good" range have significant levels of distress and may require a combination of rehabilitation and preventative maintenance to keep them from deteriorating rapidly.

Pavement Condition of Local Roadways



Fair: PCI 45–59 Pavements are deteriorated and require immediate attention, including rehabilitative work; ride quality is significantly inferior to the better pavement categories above.

Poor: PCI 25–44 Pavements have extensive amounts of major distresses and require rehabilitation or reconstruction. Pavements in this condition significantly affect the speed and flow of traffic.

Very poor: PCI 0–24 Pavements need reconstruction and are difficult to drive on.

continued on page 2

Bay Area Local Streets and Roads Mileage/Condition

Condition	Excellent	Very Good	Good	Fair	Poor	Very Poor	No Data	Totals	Avg. PCI
Miles	2,648	5,626	2,945	3,000	1,591	1,533	1,660	19,003	66
Percent	14%	30%	15%	16%	8%	8%	9%	100%	

Inside:

- *Improving Pavement Projections* *page 2*
- *MTC Selects Projects for P-TAP Round 4* *page 3*
- *What Is FDR?* *page 3*
- *Upcoming Events* *page 4*
- *Software News and Information* *page 4*

Join Us for Our User Week Awards Luncheon

July 22
12 noon
MTC Auditorium

RSVP 510.817.3201

Improving Projections for Pavement Needs and Shortfalls

by Theresa Romell

As an advocate for local streets and roads in the Bay Area, MTC is seeking to put together new projections that will illustrate as precisely as possible the region's pavement needs, revenues and shortfalls through the year 2007.

Our goal is to greatly increase the accuracy of our projections so that they can be used as a reliable tool by jurisdictions seeking funding for local streets and roads. We think this can be achieved in three ways. Two of these require your help and cooperation:

1) The more databases we include the better. We now have 102 jurisdictions actively utilizing MTC's pavement management software, as opposed to only 39 active users in 1998. This means that we have more experience and information to draw on to make our projections.

2) Verifying the information we already have about pavement conditions and revenues will help ensure that we are relying on the latest and best numbers available. MTC will begin contacting jurisdictions later this summer to launch this phase of the work.

The third element in improving projections is to limit our projections to a shorter time frame, covering a 5-year period as opposed to the 25 years we have used in the past. By reducing the length of time covered, we increase the confidence that our numbers are statistically valid.

Accurate projections benefit cities and counties that are trying to make the case for funding streets and roads in an era when public service budgets are shrinking and competition for local, state and federal transportation funds is growing. Improved streets and roads projections will serve as ammunition in the battle for a fair share of public moneys.

As many of you know, MTC has published projections on several occasions in the past. Most recently, MTC's pavement management staff produced 25-year projections for the Bay Area *2001 Regional Transportation Plan*. While these projections were done with a great deal of care, we hope that, with your help, the pavement management annual report that we expect to complete by the end of the year will be the most accurate and useful that we have done to date.

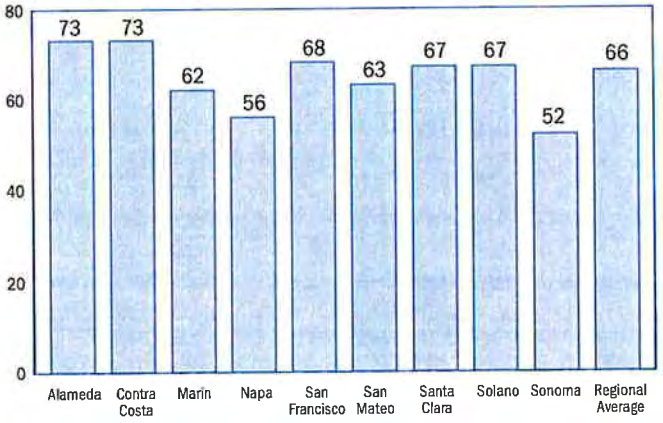
A Snapshot of the Region's Pavement Condition

continued from page 1

Based on the available data, the Bay Area averaged a regionwide PCI of 66, placing the general condition of the region's pavements in the "Good" category. Although this seems like a positive rating, it is only a few points higher than the threshold at which a significant amount of maintenance and rehabilitation will be required: Rapid deterioration of pavements typically occurs after roadways drop to a PCI score of 60 or lower.

MTC's summary shows that, while no Bay Area jurisdiction's pavements have yet reached the top rating of "Excellent," some are getting close. The cities of Belvedere and Los Altos have achieved the upper stratum of the "Very good" category, with a PCI of 86, and Brentwood and Oakley are not far behind, with a PCI of 85 and 84 respectively. Rounding out the top six are Contra Costa County and the city of Santa Clara, each with a PCI of 80.

Average Pavement Condition Index by County
(includes counties and cities)



In compiling the data for its summary of Bay Area pavement conditions, MTC did not use information about jurisdictions that do not use MTC's pavement management software or those that did not provide updated pavement condition information.

The exceptions to this are the jurisdictions of Larkspur, San Rafael and San Francisco. While the former two do not use MTC's software and San Francisco is too new an MTC PMS user to have converted its data from its old system, the pavement condition data of all three were correlated to MTC's PCI scale in order to be able to include their information in this summary.

For a full description of the method used to determine pavement conditions, contact Theresa Romell at 510.817.3243 or tromell@mtc.ca.gov. The method used also will be described in detail in MTC's pavement management annual report, due out at the end of 2002.

BAY AREA

Local Roadway Pavement

Bay Area Jurisdictions Falling Behind in Roadway Repairs; Some Bright Spots

- Typical pavement conditions on the Bay Area's roughly 19,000 miles of local streets and roads continued their slow but steady deterioration in 2003, with the average pavement condition index (PCI) score dropping to 63 (out of a possible 100) from 65 in 2002 and 66 in 2001.

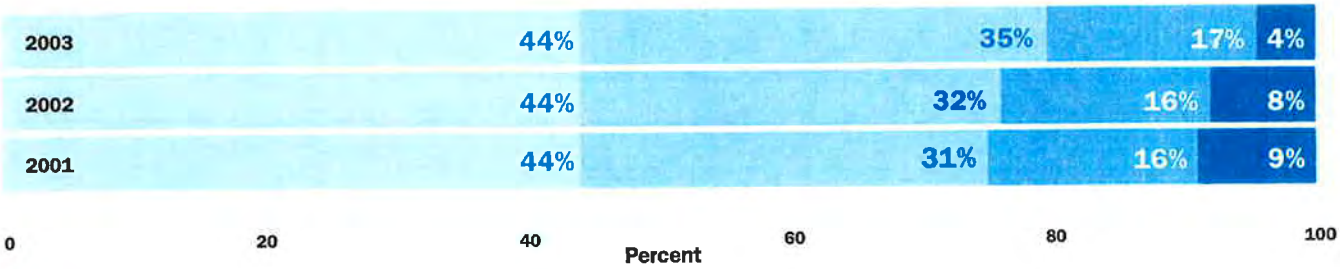
- The share of pavements rated "excellent" or "very good" remained steady at 44 percent of Bay Area roads in 2003. These roads require preventive maintenance only. Pavements in "good" or "fair" condition – which require some rehabilitation but are still drivable – increased to 35 percent from 32 percent a year earlier. Pavement in "poor" or "very poor" condition, which needs extensive rehabilitation, increased from 16 percent to 17 percent.

- The increases in pavement rated less than very good are small, but they are significant enough to tip the regional average downward. And while the average falls into the "good" category, it is sliding toward the lower end of this range.

- At present, the Bay Area is not spending the money needed to maintain the condition of its pavement over time. Tight city budgets – and the failure of the state to pass along road maintenance funds authorized by the voters in 2002 – have forced many jurisdictions into a "worst first" approach in which only the streets in the worst condition are repaired and preventive maintenance is foregone. This approach is increasingly expensive over time, since the cost of major repairs is about five times that of routine maintenance.

- MTC estimates a current, cumulative backlog of $2.9 billion for local street and road repairs in the Bay Area. This represents the cost of upgrading pavement to the point where it is cost-effective to maintain, typically when PCI scores fall within the range of 75 to 85.

Pavement Conditions for Local Roadways, 2001 – 2003 (total pavement miles)



Excellent (PCI = 90–100) or Very Good (PCI = 75–89)
Pavements that have no distress and require mostly preventive maintenance

Good (PCI = 60–74) or Fair (PCI = 45–59)
Pavements in this middle range offer acceptable ride quality, though road surfaces are becoming worn to the point where rehabilitation is needed to prevent rapid deterioration.

Poor (PCI = 25–44) or Very Poor (PCI = 0–24)
Pavements that have extensive amounts of distress and require major rehabilitation or reconstruction

No Data

2003 Bay Area PCI = 63
The regional PCI score is an average of the scores of all participating jurisdictions, weighted by centerline miles.

Source: Metropolitan Transportation Commission

97 cities and nine counties reporting

PCI = pavement condition index, a measure of pavement distress

55 of 106 jurisdictions provided updated databases to MTC for 2003. For other jurisdictions, MTC used its pavement management system software to project 2003 conditions based on the latest data available.

A Closer Look at Bay Area Jurisdictions with the Best and Worst Pavement Conditions

- The cities and counties with the best and worst average pavement conditions in 2003 are listed here.
- The cities of Belvedere and Dublin each made their first appearance in the top 10.
- The cities of Petaluma and Sausalito, which ranked near the bottom in previous reports no longer appear in the bottom 10.

A Closer Look – The Bay Area jurisdictions with the best and worst average pavement conditions are shown below. Often a jurisdiction's low average pavement condition rating is the result of a roadway maintenance budget that is insufficient to cover a backlog of needs.

Bay Area Jurisdictions With Best and Worst Pavement Conditions, 2003

Best		2003 PCI[1] (out of 100)	Worst		2003 PCI (out of 100)
1.	Oakley	87	96	Larkspur	55
2.	City of Santa Clara	86		San Mateo	55
	Contra Costa County (unincorporated)	86		City of Napa	55
4.	Sunnyvale	84		Half Moon Bay	55
5.	Los Altos	83	100	Vallejo	54
6.	Brentwood	82	101	Marin County (unincorporated)	53
	Belvedere	82		Richmond	53
8.	Dublin	81	103	Monte Sereno	52
9.	Fairfield	80	104	Colma	50
10.	**Foster City**	**79**		Hillsborough	50
			106	Sonoma County (unincorporated)	47

Source: Metropolitan Transportation Commission

106 of 109 jurisdictions reporting

[1] PCI = pavement condition index; PCI of 100 = Excellent

OXNARD

FACTSHEET

Streets and Waterways Division

CITY OF OXNARD ■ PUBLIC WORKS DEPARTMENT ■ STREETS AND WATERWAYS DIVISION ■ UPDATED APRIL 16, 2004

PAVEMENT Management

Program Description

The Streets and Waterways Division performs an annual assessment of streets and alleys within the City limits. The results of this evaluation are used to develop the ongoing street maintenance Five Year Capital Improvement Project (CIP) Plan. This plan prioritizes street maintenance and repair (M&R) projects based on the Division's pavement management system (PMS).

Definition of Pavement Management

Pavement management is the process of evaluating and tracking the conditions of streets, identifying when streets require maintenance and choosing the appropriate maintenance for those streets. It also includes budgeting for street maintenance funding and conducting inventories of street assets. It provides a systematic and objective method for determining priorities and the optimal time for repair.

Purpose of a Pavement Management System (PMS)

All streets deteriorate over time and will eventually require some form of maintenance. The timing and type of maintenance needed for any given street depends on several variables including the condition of the street, the type of traffic on the street and the structural properties of the street. A pavement management system tracks and quantifies these factors. This provides the Division with helpful information used to decide which streets require maintenance, when to perform the maintenance and how much it will cost. The primary uses of a PMS are planning and budgeting; other tools are used to design projects.

Pavement Management Software

The Division uses software developed by the American Public Works Association (APWA) called MicroPAVER. This software is a modified version of the Army Corp of Engineers' PAVER software that was developed for the management of pavement on military bases. MicroPAVER is widely used by cities as a PMS.

Pavement Condition Index

The basis for the pavement management system is the Pavement Condition Index (PCI). Streets are ranked on a PCI scale of 0 to 100. New pavements with no defects receive a score of 100. From this score, the MicroPAVER software deducts points based on the type and severity of defects identified during a visual inspection. After the initial PCI for a street segment is calculated, MicroPAVER predicts future PCI by reducing the PCI on an annual basis using deterioration curves. Photographs of streets with various PCI's are shown below in Figure 1 and typical deterioration curves are shown in Figure 3 on page 2.

Figure 1
Typical street condition for various PCI ranges.

City of Oxnard
Public Works Department
Streets and Waterways Division

Paving the Way

(805) 385-8051
1060 Pacific Ave., Bldg. 2
Oxnard, California 93030-7337

·w Streets are Rated

On each street, a representative area of approximately 2,500 square feet is chosen. The area is examined for any of eight typical defects. If a defect is present, its severity is rated (Low, Medium or High) according to predetermined standards. The severity of the defect(s) is entered into MicroPAVER and it calculates a PCI for the street.

Pavement Defects

Pavement defects are caused by fatigue, aging and construction activities. Vehicles passing over the pavement cause fatigue that can lead to alligator cracking, rutting and shoving. Over time, water and sun cause aging that can lead to block cracking, longitudinal and transverse cracking, weathering, and raveling. A combination of fatigue and aging can cause bumps and sags. Construction activities and utility repairs often involve patching and utility cuts. All of these defects affect the quality of the pavement and reduce the PCI rating.

Types of Streets

Each street in the City is categorized as residential, collector, 'erial, industrial or alley based on use and traffic volume. .sidential streets are those streets within residential developments and neighborhoods. These streets tend to have low traffic volume and deteriorate mostly from aging. Residential streets can last 25 to 30 years* before requiring resurfacing. Collector streets are those streets connecting residential areas to the arterial streets. These streets have medium traffic volume and deteriorate from both aging and fatigue. Collector streets require resurfacing every 20 to 25 years*. Arterial streets are the major streets running across the City and have high volumes of both automobile and truck traffic. These streets tend to deteriorate from fatigue and can last 15 to 20 years*. Because of higher traffic volume and higher speeds, arterial streets need to be maintained at a higher PCI. Industrial streets are located in industrial areas and have characteristics similar to collector streets. Alleys have characteristics similar to residential streets. Figure 2 lists some characteristics of each type of street.

**Lifetime figures assume regular maintenance. Useful life without regular maintenance will be 5 to 10 years shorter.*

Typical Street Condition Deterioration Curve

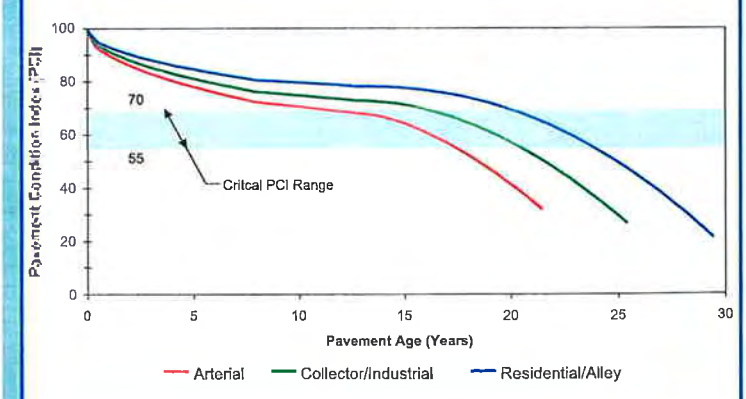
The life of a street can be represented by a curve on a graph in Figure 3. Time is on the horizontal X-axis and the PCI is on the vertical Y-axis. The condition of the street drops from "Brand New" to "Very Good" quickly but then levels off for some time (represented by the relatively flat part of the curve). As the street continues to age, the condition reaches a point where the PCI decreases more quickly (the curve begins to get steeper). This critical point ranges from a PCI of 55 to 70. If a street is maintained at or before it's condition reaches this point, the condition of the street will improve and the curve will flatten out again. Typically, maintenance procedures at this point are more cost effective. If nothing is done to the street in the critical range, the deterioration progresses more rapidly and, in a short time, the cost to fix the street goes up by four or five times.

Figure 2
Characteristics of types of streets.

Street Type	Traffic Volume	Major Cause of Deterioration	Life* (years)
Arterial	High	Fatigue (from vehicle loads)	15-20
Collector/Industrial	Medium	Fatigue & Aging	20-25
Residential/Alley	Low	Aging (from Weather & Time)	25-30

*Assumes regular maintenance. Useful life without regular maintenance will be 5 to 10 years shorter.

Figure 3
Typical deterioration curves for different types of streets.



aintenance and Repair (M&R) Techniques

There are several types of maintenance and repair (M&R) techniques that fall into three categories; Localized, global and major repair. Localized maintenance techniques can be used as preventative maintenance or as stopgap measures when adequate funding is not available. These include pothole filling, patching and crack sealing. Global preventative maintenance techniques include fog seal, slurry seal, chip seal and cape seal. These preventative maintenance techniques will slightly improve the quality of the street, but more importantly, they will reduce the rate of deterioration and prolong the life of the street. Major repair techniques include cold milling, overlay and reconstruction. These techniques are used when a street has reached the end of its useful life to restore it to "Brand New" condition.

Choosing M&R Techniques

The M&R technique chosen to maintain a street depends on the type and condition of the street. Figure 4 lists various M&R techniques and the appropriate PCI ranges for ·ing them on each type of street. For example, slurry als are generally appropriate for arterial streets with a PCI of 76-90, while collector streets with a PCI of 41-70 might receive a light overlay and residential streets with a PCI of 51-70 might receive a cape seal.

M&R Cost Trend

Figure 5 gives the cost for various M&R techniques as of November 2003. Comparing Figures 4 and 5, notice that the cost of M&R increases significantly as pavement condition worsens. This can be seen clearly in Figure 6. The X-axis of the graph in Figure 6 is the pavement age. The Y-axis is the PCI and the cost to repair. The green curve is a typical pavement deterioration curve, showing how the PCI decreases as the pavement ages. The red curve gives the cost to maintain that pavement as it ages. For example, at 15 years, the PCI is about 70 (green curve) and the M&R cost is about $13 per 10 SF (red curve), at 20 years, the PCI is 55 and the cost is $29 and at 25 years, the PCI is 30 and the cost is $72. As the condition of the street deteriorates, the M&R cost increases exponentially. The most cost effective time to perform maintenance is when ·he pavement condition is between 55 and 70, before the ·st begins to rise rapidly.

Figure 4
Typical PCI ranges for M&R techniques.

Maintenance & Repair Technique	Street Condition	PCI Range*		
		Arterial	Collector	Residential
No Maintenance Required	Very Good	91-100	91-100	86-100
Slurry Seal	Good	76-90	71-90	71-85
Cape Seal	Fair	NA	NA	51-70
Light Overlay		56-75	41-70	41-50
Heavy Overlay	Poor	31-55	26-40	21-40
Reconstruction	Very Poor	0-30	0-25	0-20

*Ranges vary depending on factors including street maintenance history, subgrade conditions and drainage pattern.

Figure 5
Cost for various M&R tecnniques.

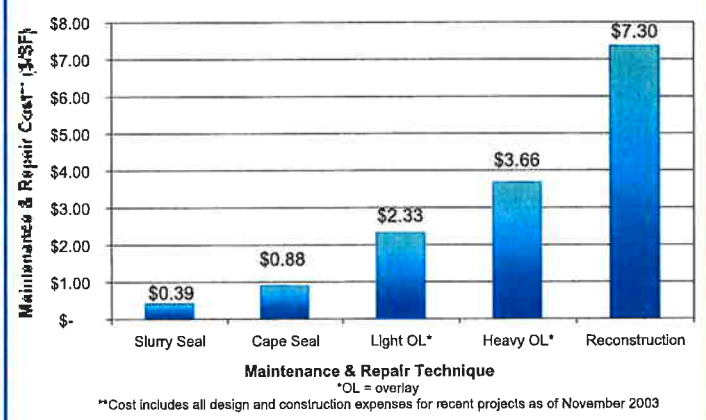
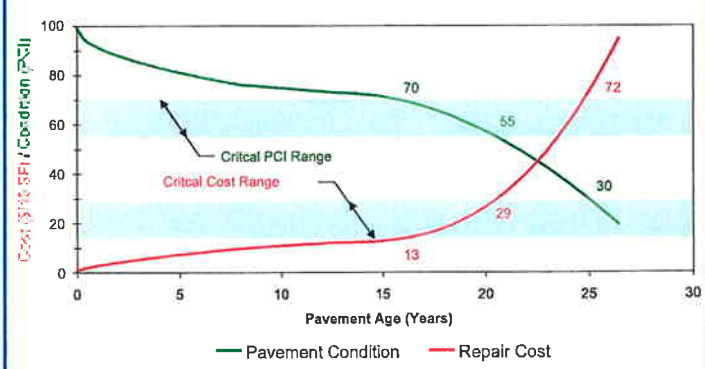


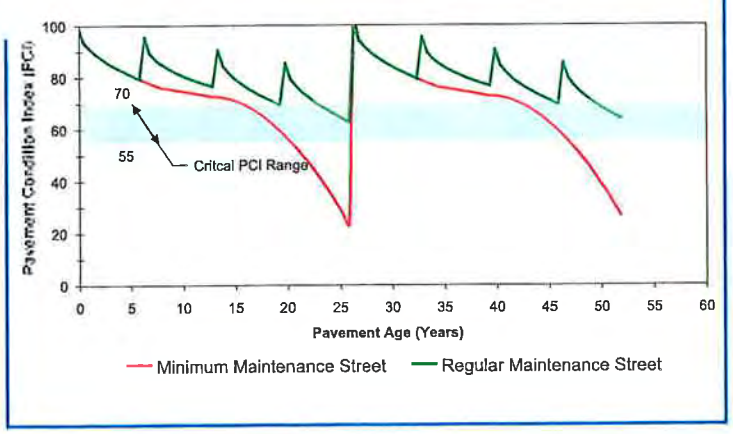
Figure 6
Repair cost increases greatly as PCI decreases.



M&R Life Cycle Cost (LCC)

e best measure of M&R cost effectiveness is the life cycle cost CC) defined as the present value of an M&R program over the life of a street. Figure 7 shows the pavement condition over time for two different M&R programs on a typical residential street. The red curve shows the condition of a street with minimum maintenance and the green curve shows the condition of a street with regular maintenance. In this example, the street represented by the red curve deteriorates for 26 years until its condition reaches a PCI of 25. At that point, the street is reconstructed. The green curve shows the condition of a street that receives two slurry seals and a cape seal at equal intervals over 26 years. Its PCI is then 64, at which point, the street receives a light overlay. This process is repeated over the next 26 years. The LCC over 52 years for the street represented by the green curve is $2.85 per SF and the LCC for the red curve is $4.54, which is 59% higher. This example shows that performing regular maintenance is actually much less expensive in the long run. The curves also show that the condition of the street represented by the green curve is much better. Its average PCI is 79, whereas, the street represented by the red curve has an average PCI of 68. So, performing regular maintenance is not only less expensive, it also provides higher quality streets.

Figure 7
Street maintenance life cycle comparison for a typical residential street.



Pavement Management Approaches

The three main approaches to pavement management are ad hoc, present condition and life cycle. For the ad hoc approach M&R techniques are chosen based only on past practice. Techniques that have been successfully used in the past on similar streets are selected. This technique is fast and requires little analysis, but may not give the most cost effective solution. In the present condition approach, the pavement is first evaluated. Then, based on the condition analysis, an M&R technique is selected. This approach is better at identifying M&R techniques est suited for the street, but it still may not produce the most st effective solution in the long run. The life cycle approach requires not only an evaluation of the current condition of the pavement, but also a prediction of its future condition. This approach not only selects the best M&R alternative, but also indicates the optimal time to perform it. Properly using this approach will produce the lowest LCC maintenance program.

Pavement Management Strategies

Three different strategies may be used to implement a pavement management approach. The first two are interim strategies used when adequate funding is not available for a comprehensive M&R program. These are Best First and Worst First. In the Best First strategy, streets are prioritized based on PCI. The streets with the highest PCI's are maintained first. The objective here is to keep the best streets in good condition until adequate funding is available to maintain all of the streets. This strategy works well when the poor condition streets are already in the PCI range requiring the most expensive maintenance. When this is the case, waiting to repair these streets will not significantly increase the cost. In the Worst First strategy, streets with the lowest PCI's are maintained first. The objective is to put all available resources into the streets that need the most M&R. This strategy works well when additional funding will be available soon so that good streets will not have time to deteriorate below the critical range, which would greatly increase their repair cost. In the third strategy, Critical PCI, M&R techniques are selected for streets at the critical point in each PCI range. The critical point is the lowest PCI at which an M&R technique will be effective. For example, for a residential street, Figure 3 shows that the critical point for a slurry seal is a PCI of 71, the critical point for a cape seal is 51 and the critical point for a light overlay is 41. In the Critical PCI strategy, only streets with conditions near a critical point are maintained. This strategy is used with the life cycle approach to produce the lowest LCC maintenance program.

Practical Considerations

There are two practical considerations in implementing a pavement management system. First, evaluating street conditions is time consuming and costly and, therefore, not all streets are inspected every year. A common schedule is to evaluate all arterial streets every year and to evaluate one-third of the rest of the streets each year, so that every street is evaluated in a three-year period. Another consideration is economy of scale. It is less expensive to perform M&R on groups of streets in the same area than on individual streets spread throughout an entire city. Therefore, streets requiring maintenance in similar time periods are often grouped together into neighborhood projects. This saves on contractor mobilization costs and reduces inconvenience to residents.

Street Maintenance Five Year Capital Improvement Project (CIP) Plan

The Division performs a pavement assessment each year and updates the ongoing Five Year CIP Plan based on projected street maintenance revenue. The CIP plan is used to develop specific street repair projects about two years before scheduled start of construction.

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YUMA
Yuma

Fay, Jerry

From: LaFronz, Nicholas J.
Sent: Friday, September 16, 2005 11:15 AM
To: Fay, Jerry
Subject: Pavement Degradation Curves - Yuma County Public Works
Attachments: Donahue_paper_Yuma_County_Pavement_Asset_Mgmt_2001.pdf

Jerry,

Attached is the paper by Donahue Consultants in Yuma, from a 2001 annual conference (Geospatial Information and Technology Assoc, or GITA).

Based on my read of the paper, Yuma County has in fact developed pavement degradation curves for one or more classes of County roadways.

I never did follow-up, however, to try and locate an individual within the County Dept of Public Works who might know more or have access to the curves and supporting data.

- Nick

JASON PHIPPS - YUMA COUNTY
- UTILIZE 8 FACTORS TO RATE PAVEMENT
- SCALE 0 - 100
- DESIRED 100% > 75

Print

Yuma county, AZ. Public Works Department Automated Asset Management System

James G. Donahue
Donahue Consultants
2755 South Mesa Avenue, Yuma, AZ 85364

Introduction

The Yuma County Department of Public Works has embarked upon the information super highway by bringing computer-based technology into the County Asset Maintenance Management System. The former manual system was cumbersome and needed modernization in order to optimize expenditures for County asset maintenance. A study was performed and a "Pilot Project" was completed in 1998, which demonstrated that an off-the-shelf computer-based software package, utilized to establish a database of the current condition of all public works physical assets, will "in fact" save tax dollars over the old manual system at a Cost/Benefit ratio of at least 3:1.

Yuma County DPW Statistical Items 1500 miles of gravel or dirt roads 500 Miles of paved highway Yearly Maintenance Includes 50 miles of Chip Sealing 10 Miles of Slurry Sealing and 10 Miles of Plastic Sealing 300 Miles of Striping and Hole Patching Maintains 12,000 Signs and 3,000 Bridges and Canal Crossings, all with six Clerks, two Administrators, four Technicians, 4 Foreman, and 80 Maintenance personnel.

Project Definition

Land Base Design: In setting up specifications for the accomplishment of the "Pilot" Study, both the City and County of Yuma Mapping/GIS Units were contacted to make sure that "Land Base" integration would be accomplished as a "by product" when the entire AMS Project was completed. This integration is needed to make sure that all geographic-based information generated by one agency can be utilized by others without rigorous and time-consuming transformations between unlike systems. The land Base being used by both the City and County Mapping Units is based on the United States Public Land Survey System of Sections, Townships, and Ranges from the Initial Point on the GILA MERIDIAN AND BASELINE, which governs land descriptions in Yuma County. The PLSS is digitally integrated to the Arizona State Plane Coordinate System (NAD 1927). This coordinate system has been used due to the fact that most cadastral data now available, without doing new control surveys over the entire County, was identified earlier by other agencies of government for mapping purposes.

It is highly recommended that this project be fully integrated with the ASPCS/NAD'83 when it is adequately densified on the ground by Global Positioning System (GPS) technology.

Public Land Survey Identification: In order to utilize the PLSS, the ASPCS, and the Asset software modules (ASM) requirements, all at the same time, a digital system of numbering is being utilized to identify Section and Quarter Section corners of the PLSS that will tie directly to the ASM requirements for line segmentation and identification. The known coordinates of the ASPCS/NAD'27 are input within the ASM line segments, with node identification input fields. This is a beneficial aid in the identification of cadastral parcels on the current Assessment Rolls and located along any given road or highway. Also, current GIS software can easily be implemented within the AMS for specific spatial analytical tasks related to geography.

Asset Management Modules

Pavement Management Module: The Pavement Management Module provides a systematic, consistent method for determining maintenance needs, priorities and the optimal time of repair. Early detection and repair of a roadway distress are extremely important in reducing long-term maintenance costs. Most pavements exhibit a deterioration rate that accelerates as they reach advanced age. When examining deterioration curves, it becomes clear that significant maintenance costs can be saved if remedial action is undertaken prior to a roadway reaching the steep decline in condition. The Pavement Management Module is used to track the life cycle of road segments in the network and to highlight segments in need of attention. In Network-Level–In Network-Level management, the entire roadway network is considered for budgeting, planning, scheduling, and selection of maintenance projects. Sufficiency Inspections are periodically conducted for all segments in a network. These inspections are fast and easy observations of condition, geometry, safety, ride, etc. Ideally, inspections should occur before the segment begins the sharp decline in condition and at a point where timely maintenance can still be scheduled. The Critical Pavement Condition Rating (PCR) value can be used to evaluate the need for preventive and major maintenance. The critical PCR value occurs at the point where the condition of a segment begins to deteriorate at an accelerating rate. Typically, the maintenance costs increase dramatically once a segment reaches this point. It is advantageous to begin maintenance efforts before the Critical PCR is reached.

Today, upper management is more demanding of management techniques that consider the needs of the entire

network. With money in short supply, it is imperative that the greatest benefits are achieved from each dollar expended. Network-Level analysis complements Project-Level analysis to arrive at the required conclusions.

Deterioration : The Deterioration Matrixes within the AMS allows you to define a Deterioration Curve that is associated with each Pavement Class. Once defined, these Deterioration Curves can be referenced elsewhere in the PMS application. You may create one Deterioration Curve for each Pavement Class.

A Deterioration Curve is a model of how the condition of segments that belong to a Pavement Class will deteriorate over time (on the average). With a Deterioration Curve defined for a Pavement Class, individual road segments can be compared to the curve to determine performance/ life expectancy.

The Deterioration Curves are most accurate when they are developed from local historical data.

Pavement Analysis Module: Assists in creating multiple CIP planning models and "what if" type scenarios and Generates multi-year budgets and maintenance profiles. Also assists in the preparation of MR&R decision trees, calculating cost vs. Benefit scenarios, predicting performance of individual assets, and aids in projecting funding to achieve overall agency goals.

Safety Signage and Markings: Is a complete inventory of signs, mountings and pavement markings. It yields a complete GPS/GIS location and identification for spatial analysis and mapping of individual assets. It supplies a complete history log of events with attached images and videos. It also supplies queries, reports, and cost of materials analyzes along with access to predefined sign and marking libraries.

Bridge and Culvert Module: It provides a complete bridge and culvert inventory along with inspection records by category. It provides a complete structure history with database rollback queries and reports. Also, provides full English and Metric support, while maintaining a complete structure inventory and appraisal information (si&a). It also supplies complete support for FHWA, NBI and PONTIS data.

Asset Manager Module: It is the "Workhorse" of all of the AMS for it serves as a clearing house for all managed assets. Records labor, equipment and material costs. It relates work activities to specific work orders. It projects and tracks maintenance schedules. It furnishes customized queries and reports while tracking inventory levels. It also tracks public complaints and generates work requests/orders. It may contain standard operating procedures (Cook Book) for most all types of maintenance work. This is truly the "work horse" of the system.

New Techniques and Developments

Voice Activated Data Collection: It provides vocabulary building capabilities and GPS on the fly locations. Captured data downloads data directly into predefined data bases with no more manual data input except for QA/QC. This technology speeds up the data collection and data processing by about 3x.

Voice Recognition Technology 101: It interprets spoken words and converts it to text while associating an asset or other item with their exact physical location via GPS/GIS. It stores data in an RDBMS using key fields to relate one record with another. One simply tells the laptop field computer what you see and it will record the field data as defined in the vocabulary dictionary. In the office one downloads the data to your office computer and performs QA/QC to check the accuracy of data being exported to the proper asset management module.

Advantages of Desktop Asset Management

- ***Low Cost:*** $1000 To $15000 depending on the number of Modules.
- ***Short Learning Curve:*** 1 TO 6 Months for an intermediate computer operator with a technical background, depending on the number of modules being implemented at one time.
- ***Software Technology:*** Windows Based in 16 bit or 32 bit versions.
- ***Predefined Forms:*** For any amount of Data collected.
- ***Predefined Tools:*** For Editing, Analysis and Reporting.
- ***Ease of Integration:*** With GIS and other Mapping tools

After Thoughts/Lessons Learned

When undertaking an Asset Management project like this, be aware that several months research and study must be done before buying into any particular software. Unless your agency is a very large agency, an off-the-shelf software package will probably yield the best results for the time and money spent. Also, one should "Bench Mark" test the top 3 packages identified to see which one will perform the best in your specific environment. We did not do this and we suffered the consequences of a lot of down time to fix problems we didn't know we were going to have. By doing a "Pilot Project" one can better make a more intelligent judgment on the best package to use. Once the decision is made to buy a specific package, a decision as to how to best implement the system is a major item to consider. We at Yuma County did this one module at a time because of a lack of in-house resources to do anything else. However, if the money and the physical resources are available, and can be utilized, it is strongly suggested that the most needed modules be implemented at the same time to save duplicating trips into the field to gather data for one module without getting everything needed for several modules. Inspecting Roads, Bridges, Culverts, and Traffic signs can be done at the same time, on the same segment of highway, using two technicians. By implementing only one module at a time, both time and effort is duplicated.

Thirdly, it has been found that a stand alone Asset Management Server is the best solution to avoiding down time. Having data base sets out on a large Network, tends to slow done production and often corrupts certain types of data. This means daily backup is mandatory and become very time consuming to reset back to a certain date and time. Lastly, make sure your vendor offers great technical support. The 1-800 phone number does not usually give you the timely response needed to identify specific remedies to problems that can arise without warning at times. Using Internet (EMail) messaging can be faster when attached digital files can be immediately examined by technical support personnel. Even a faxed document showing the problem you are having is better than trying to explain everything over the phone. Sometimes a combination of all three methods is required to solve problems as quickly as possible.

Conclusion

One thing is clear to all who manage Public Works Assets--maintenance funds are becoming increasingly difficult to come by. As a result, improved methods for determining maintenance needs and priorities are required. It is no longer acceptable to focus on short-term repair techniques. Greater emphasis must be placed on selection of remedies that provide the greatest long-term benefits. Today, upper management is more demanding of management techniques that consider the needs of the entire set of Assets. With money in short supply, it is imperative that the greatest benefits are achieved from each dollar expended. Network-Level analysis complements Project-Level analysis to arrive at the required conclusions.

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Street Maintenance

The Field Operations staff is responsible for maintaining city streets. This includes repairing street infrastructure, sidewalks, curbs and handicap ramps, performing street sweeping services, maintaining alleys, shoulders, streetlights, street signage and striping, and providing street patching and overlay service.

Want to know just how far your tax dollars actually stretch in terms of street maintenance services? Read about what street maintenance crews are able to do with only $3 per resident, per month!

Contract Administration

The Contract Services Group monitors service contracts with private vendors for landscape maintenance, mainline street sweeping, asphalt and concrete repair, and bus shelter cleaning. Outside vendors competitively bid for City of Mesa contracts, allowing the Division to cost-effectively supplement City staff operations.

Pavement Management System

Report:

Report a Problem

Pothole
480-644-3038

Streetlight Outage
480-644-3191

Street Sign Missing/Damaged
480-644-3038

Traffic Signal Outage
480-644-2160

Graffiti
480-644-3083

After Hours
480-644-2262

One of the street maintenance functions of the Field Operations group is to preserve the condition of paved streets in the best possible state. Pavement Management is the key to developing preventative maintenance strategies and operational activities. The Pavement Management Program is an Information Management System, which allows staff to track the changing inventory levels, history, surface condition and distresses of every street in the City.

Pavement condition surveys are performed each year on over 1,200 miles of streets by our Pavement Management technicians. Information from the annual surveys identifies specific areas where various types of preventive maintenance treatment, such as slurry seal, acrylic seal or other sealcoats, can be applied. The surveys also identify areas requiring more aggressive rehabilitation projects like a rubberized asphalt overlay or partial reconstruction. Each year over 6,000,000 square yards of needed work is identified, prioritized and delegated. One goal of the Pavement Management group is to establish a balanced treatment forecast plan for the street repair and preventive maintenance program that will help to maintain targeted pavement condition levels. These levels are based on a Pavement Condition Index (PCI) of 0 to100, with 100 being excellent and 0 being failed. The PCI is calculated from data collected during the annual pavement condition survey. The Pavement Management Group has been collecting pavement condition, inventory, and maintenance history information on Mesa streets for over 18 years with details and quality of data improving with each year.

Learn more about our various pavement maintenance programs.

Right-of-Way Maintenance

City right-of-ways are also maintained by Field Operations crews. Maintenance of rights-of-way includes landscaping, storm drainage, and graffiti abatement. An emergency response crew is always on duty to keep the streets and right-of-ways clear and safe throughout Mesa.

Report:

What can we do with $3 a month?

Streetlight Facts

Pavement Maintenance Facts

Street Sweeping

Fay, Jerry

From: Ted.Stalder@cityofmesa.org
Sent: Tuesday, January 03, 2006 4:21 PM
To: Fay, Jerry
Cc: Lenny.Hulme@cityofmesa.org; Transportation.Info@cityofmesa.org
Attachments: UserOptions.pdf

Mr. Fay,

We do have goals set for minimum desired pavement condition levels and have established these levels for each classification of street in our network. We also have minimum acceptable levels for each class. The goal is to remain at the minimum desired level (MDL) but to not allow the condition of the pavement to drop below the minimum acceptable level (MAL). These targeted levels are listed in the MDL and MAL figures included in the attached PDF file. If you have any questions about the information included, please give me a call.

Classification description;

A = Arterial Street, C = Collector Street, I = Intersections, R = Residential, P = Paved Alleys, L = Parking Lots.

MDL = Minimum Desired Level
MAL = Minimum Acceptable Level

Ted W. Stalder
Chief Engr. Technician
City of Mesa
Transportation Field Operations
480-644-3511
Ted_Stalder@cityofmesa.org

User Options

Tuesday 3 Jan 2006

Classification: Arterial

Fiscal Year: July

Copy Path: T:\AVHOME\TABLES\

Net Path: T:\MPAV\

User Defined Fields

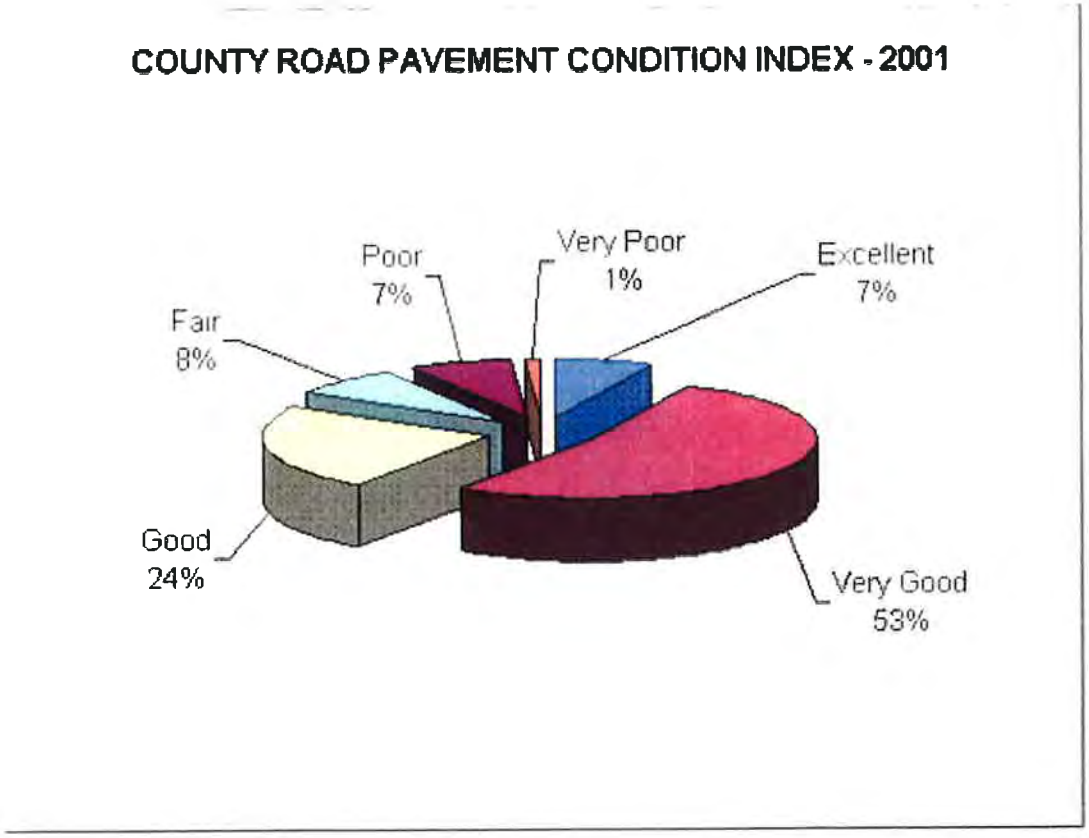
	User 1	User 2	User 3	Latitude	Longitude
Visible:	[_]	[_]	[_]	[_]	[_]
Label:	Bus Route	School Zone	Industrial Area		
FieldName:	USER1	USER2	USER3		
Length:	20	20	20		

Classification:	A	C	D	I	L	M	O	P	R	U	F	H	T
MDL:	85	70	0	85	65	0	0	65	70	0	0	0	0
MAL:	60	55	0	60	45	0	0	30	50	0	0	0	0
Group Name:	[_]	[_]	[_]	[_]	[_]	[_] R	[_]	[_]	[X]	[_]	[_]	[_]	[_]
Network:	[X]	[X]	[X]	[X]	[X]	[_] ACDILPRU	[_]	[X]	[X]	[X]	[_]	[_]	[_]
Use:	[X]	[X]	[X]	[X]	[X]	[X] ACDILMOPRU	[X]	[X]	[X]	[X]	[_]	[_]	[_]

Reports	ERA		PCI		RIDE	
Maximum:		100		100		100
9:		0		100		0
8:		0	EXCELLENT	85		100
7:		0	VERY GOOD	70	FAILED	90
6:		100	GOOD	55	VERY POOR	75
5:	EXTREME	81	FAIR	40	POOR	60
4:	HIGH	61	POOR	25	FAIR	45
3:	MEDIUM	31	VERY POOR	10	GOOD	30
2:	LOW	1	FAILED	1	VERY GOOD	15
1:	GOOD	0	ZERO	0	EXCELLENT	0

YAMHILL COUNTY
ROAD PAVEMENT CONDITION INDEX
2001

CATEGORY	MILES	% OF TOTAL
Excellent	25.51	7%
Very Good	198.17	53%
Good	87.97	24%
Fair	31.20	8%
Poor	26.98	7%
Very Poor	4.12	1%
Total Miles of Paved Road	**373.95**	



Resolution No. _____

Board of Supervisors, County of San Mateo, State of California

* * * * * *

Resolution Revising the Standard Used to Evaluate the Condition of the County Maintained Road System

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RESOLVED, by the Board of Supervisors of the County of San Mateo, State of California, that

WHEREAS, Government Accounting Standards Board Statement No. 34 (GASB 34) requires governments to capitalize their eligible infrastructure assets; and

WHEREAS, GASB34 also requires governments, where the Modified Approach is used in the financial reporting of any such assets, to document that these assets are being preserved at or above a condition level established and disclosed by the government; and

WHEREAS, this Board previously established minimum percentages of primary and secondary roads that would be maintained at specific Pavement Condition Indices (PCI) as defined by the Metropolitan Transportation Commission's Pavement Management Program; and

WHEREAS, due to funding constraints, the minimum percent of secondary roads cannot be sustained at the standard previously adopted by this Board; and

WHEREAS, the Director of Public Works has recommended that the minimum percentage of secondary roads meeting a specific PCI be reduced in order for the County to continue to use the Modified Approach to meet GASB34 requirements, and this Board concurs with the recommendation of the Director of Public Works.

NOW, THEREFORE, IT IS HEREBY ORDERED AND DETERMINED that:

1. Seventy Five Percent (75%) of the County's primary roads as defined in the County's Pavement Management System shall continue to be maintained at the Metropolitan Transportation Commission's Pavement Management Program Pavement Condition Index of 55 or better; and

2. The percentage of the County secondary roads as defined in the County's Pavement Management System, maintained at the Metropolitan Transportation Commission's Pavement Management Program Pavement Condition Index of 40 or better, is hereby reduced from Seventy Five Percent (75%) to Sixty Five Percent (65%).

* * * * * *

The City of Indianapolis has about 3,000 centerline miles of streets and about 1,000 miles of thoroughfares and 2,000 miles of residential streets. We recommend street segments to be included in our resurfacing and curb and sidewalk programs on an annual basis. The plan development process for bidding these type of projects is a matter of months.

Resurfacing Program

Pavement repair projects are generally selected on 2 main factors, the Pavement Condition Index (PCI) and the International Roughness Index ((IRI). The PCI is a measure of the pavement condition (developed by the Army Corp of Engineers) and is generally the engineering evaluation of pavement distresses (ruts and cracks). The ranges of PCI ratings is from 0-100. The following is a breakdown of that range.

PCI	Pavement Condition
0-10	Failed
10-25	Very Poor
25-40	Poor
40-55	Fair
55-70	Good
70-85	Very Good
85-100	Excellent

In Indianapolis we generally are selecting pavement repair projects that are in the 30 range.

The other main factor, IRI, is a measure of the rideability of the pavement. There is not a scale (per se) here. The ratings are established specifically to each city they are used in. In Indianapolis, the minimum and maximum IRI on thoroughfares, is .88 and 32.92 respectively. The lower the number, the better the ride. The minimum and maximum IRI on residential streets is .88 and 46.91 respectively. In Indianapolis, if the rating is over 5 we should be planning on doing something to the pavement in the very near future.

There are also other factors that weigh into the project selection criteria. A listing of the other main factors are listed below.

Focusing the location selections on the thoroughfares. More 'bang for your buck' is achieved with this strategy because of the comparison between the investment level and the high number of vehicular users. We strive for a 75 per cent thoroughfare 25 per cent residential mix of street segments each year.

Missing segments connecting up previous projects.

Attempting to balance the project workload across all 9 townships is also a factor as well as across other geographic boundaries such as City-County Council Districts.

Economic development or other type of commitments that are made.

SARATOGA, CA

CITY INFRASTRUCTURE & FACILITIES NEEDS ASSESSMENT

INFRASTRUCTURE TYPE	ANNUAL OPERATING NEED	DEFERRED MAINTENANCE	NOTES
STREETS (INCL. CURBS/GUTTERS/STORM DRAINS)	$950,000	$14,000,000	1
SIDEWALKS	$100,000	$700,000	2
BRIDGES	N/A	$620,000	3
MEDIANS	$50,000	$250,000	4
CITY FACILITIES	$200,000	$2,430,000	5
TOTAL	$1,300,000	$18,000,000	

NOTES:

1. STREETS:

Pavement Management

- Centerline length of public streets: 135.2 miles
- Approximate replacement value of City owned streets: $75 Million
- Annual Operating Shortfall: $850,000
- Current Maintenance Backlog: $10 Million

Pavement condition is tracked by Public Works using both visual inspection and a computer program titled the MTC Pavement Management System (PMS). This program is administered, and continually being improved by the Metropolitan Transportation Commission. The Pavement Management System for the City of Saratoga provides a current pavement network inventory, current network conditions, maintenance recommendations, and a forecasting of the budget needs and funding scenario impact. This program combined with resident requests and engineering judgment, determines the year-to-year priorities of streets to be addressed by the City's annual Pavement Management Program and Pavement Maintenance Program.

The grading system used to determine the pavement's condition is a numerical scale from zero to one hundred (0-100), with 0 being completely failed and 100 indicating a new street. This scale is known as the Pavement Condition Index (PCI). PCI's for the City's

pavement network are based on a distress rating calculated by an algorithm the Metropolitan Transportation Commission (MTC) Bay Area modified from algorithms the Army Corps of Engineers. For the purposes of mapping and general summarization of condition, the classifications are sometimes simplified to four categories:

Very Good 100-75, **Good** 74-50, **Fair** 49-25, **Poor** 24-0

Budget Scenarios are run on PMS to determine the funding levels required to maintain and/or improve the current level of overall condition and generate a work program for the next ten (10) years based upon actual road pavement conditions.

At the City's current funding level of $650,000 the overall network condition declines from a 72 PCI in the year 2001 to a 65 PCI in the year 2010 (PCI scores after suggested treatments applied). The backlog of deferred maintenance, valued at approximately $10 million in the year 2001, increases to about $20 million in the year 2010.

The Budget Scenario analysis shows that the $1.5 million annual budget level is required to maintain the overall network PCI and maintain the current level of deferred maintenance and a $2.5 million annual budget over 10 years is required to eliminate the current $10 million maintenance backlog.

Curbs & Gutters

- Approximately 87 percent of Saratoga's streets (235 miles) are bordered by curbs and gutters
- Approximate replacement value of City curbs & gutters: $50 Million.
- Annual Operating Shortfall: $50,000
- Current Maintenance Backlog: $2 Million

Most streets in the improved residential and commercial areas of Saratoga incorporate concrete curbs and gutters with a length of approximately 235 miles. These structures are designed to control and channel rainfall runoff, provide a wheel-stop for parked vehicles, and establish a physical border between the street and any adjacent property, landscaping, and/or sidewalk.

The overall condition of curb and gutter segments in Saratoga may be considered good, with damage at specific locations particularly adjacent to street trees. Curb and gutter uplifting and breakage tends to occur simultaneously with that of sidewalks where the two are adjacent, and where a root extends underneath both the sidewalk and curb section. On an annual basis the Concrete Repair Program addresses approximately 400 linear feet curb and gutter. The tracking of curb and gutter conditions is combination of Street Maintenance observations resident notifications.

The annual budget for curb and gutter repair is $25,000 with an average of reported repairs totaling twice that amount $50,000. It is estimated that 5% of the City's curbs and gutters are in need of repair, which equals $2.5 Million. The current CIP has

Lake Oswego Engineering

Street Maintenance Fee

Summary

Transportation funding is one of the most challenging issues facing cities. Over the past decade, the City of Lake Oswego has used a variety of funding sources to construct and maintain its transportation system valued at $177,000,000. These funding sources including State gas taxes, franchise fees, systems development charges, general fund monies, road transfer revenues and most recently, general obligation bonds, have either been spent or are diminishing in purchasing power relative to inflation and thus are not sufficient to protect the City's investment in its street system. Recognizir the Lake Oswego City Council established a goal in January 2002 of identifyin a sustainable funding source for street maintenance.

Pavement Management Program

In 1999 the City adopted a Pavement Management Program concurrent with t the City's first pavement condition assessment. This program required a com pavement condition assessment for each street in the City. From this "on the assessment, City engineers rated the condition of each street using a "Pavem Index" (PCI) number from 0 to 100 with the value 100 representing the cond new street. The average PCI for the City's street system at that time was 69. remaining from the City's 1996 street bond measure and the advantage of a l construction market, the City was able to improve its street system and the 2 average PCI was 72.

Investment Fundamentals

Due to advances in construction techniques and materials quality, new aspha expected to last about 20 years before complete reconstruction is required. H each dollar spent for street maintenance before major deterioration begins, $ typical street could decline 40% in quality in as little as five years without nee

To maximize the return on our investment, the City's Pavement Managemen

- Prioritize maintenance investments to streets with PCI ratings less thar
- Strive to achieve and then maintain a system-wide average PCI of 80 t

Investment Options

One City Council goal was to identify a stable and equitable means to fund st City staff and the City Council evaluated options, including a local gas tax, a (registration fee, additional property taxes, and a street maintenance fee. Of a

evaluated, the street maintenance fee was deemed the most equitable and st street funding.

Following a public hearing at the November 4, 2003 Council meeting, the stre fee proposal was approved for implementation. The adoption of the ordinance maintenance will remain a priority in the future by providing a mechanism for

Implementation

Starting in July, 2004, the monthly fees assessed to condominiums and apart to $2.68, for houses it was $3.75, and businesses are assessed a usage-base Nonresidential rates have been phased in at 50% starting in July 2004, and w 100% in July 2005. All funds collected from the fee will be used for maintenai roads.

What's Next

Because the passage of the State Transportation Investment Act III during th session provided new funding for local roads, the City's fee is actually less tha anticipated.

Additionally, if it is determined that pavement conditions have improved suffi program is in place, the fee may be adjusted.

Questions?

Do you have any other questions about the City's proposed street maintenan check out our Frequently Asked Questions page.

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STOCKTON
CA.

June 4, 2004

PAVEMENT NETWORK CONDITION AND RESURFACING PLAN FOR 2004

Background

In October 1999, the City Council authorized the Public Works Department to initiate implementation of a computerized Pavement Management System. The City implemented the new system in August 2000. The system included an inventory of the condition of the City's street pavement network, undertaken by pavement consultant Harris and Associates. All streets were surveyed and the pavement condition ranked on a numerical scale (known as a pavement condition index or PCI) from 0 to 100. Streets are then grouped by PCI into categories to establish the type of maintenance treatment that is warranted. The following chart denotes these categories:

Treatment Strategy					
Arterials and Collectors			Local/Residential		
PCI	Category	Treatment	PCI	Category	Treatment
80-100	Very Good	None	80-100	Very Good	None
50-79	Good	Surface*	50-79	Good	Surface*
25-49	Poor	Overlay**	14-49	Poor	Overlay**
0-24	Very Poor	Reconstruction	0-13	Very Poor	Reconstruction

* --- Surface treatment options include microsurfacing or slurry seal.

** --- Overlay treatment options include cape-seal (chip-seal plus microsurfacing).

Streets with a PCI near or on the borderline of a treatment category are scrutinized at the project level to determine the actual treatment warranted. Streets requiring reconstruction are not considered "maintainable". Streets in this category need to be totally replaced, which is a very expensive and time consuming process.

Detailed information on the new system was provided to Council during a study session on Pavement Management on August 30, 2000. The objective of the pavement management system is: 1) to keep streets from falling into the expensive reconstruction category, 2) to give priority to streets in the PCI borderline areas so they do not fall into the next, more expensive, maintenance category, and 3) to eventually get all of the streets into the "good" category and keep them in that category. Since 2000, in accordance with the direction of Council, the City's preventative maintenance emphasis has been in alignment with these objectives. The following is a brief update on the types of projects that have been undertaken since 2000, and the results of a re-survey of the pavement network that was undertaken in 2003.

PAVEMENT CONDITION INDEX (PCI) METHOD

Background:

The Pavement Condition Index (PCI) method is used to obtain a Pavement Condition Index (PCI) value for airfield pavements through a visual survey of the pavement. The Pavement Condition Index (PCI) is a numerical rating of the pavement condition that ranges from 0 to 100, with 0 being the worst possible condition and 100 being the best possi condition. The Pavement Condition Index (PCI) method was developed by the Construction Engineering Research Laboratory of the U.S. Army Corps of Engineers. This method can be used on both asphalt surfaced as well as jointed portland cement concrete (PCC) pavements. This method has been adopted by Federal Aviation Administration to determine pavement condition (Advisory Circular No. 150/5380-6, Guidelines and Procedures for Maintenance of Airp Pavements).

Determination of PCI Value:

The following procedure is followed in the PCI method to obtain the PCI value of the pavement.

1. Divide pavement section into sample units and select sample units for inspection.

2. Identify and record pavement distress in sample units.

3. Compute PCI of sample units based on distress within sample unit.

4. Compute PCI of section.

A description of each of these steps is presented next.

1. Divide Pavement Section Into Sample Units and Select sample Units for Inspection:

For asphalt surfaced pavements, a sample unit consists of 5000 ± 2000 sq. ft. of pavement. The actual area of the sample units to be used is determined based on the geometry of the pavement section. For a PCC pavement, a sample unit consists of 20 ± 8 slabs. As for asphalt surfa pavements, the number of slabs to be included in a sample unit is determined based on the geometry of the pavement section. Once the sam unit size is determined, the pavement section is divided into sample units. Thereafter, the number of sample units for inspection is determin

The minimum number of sample units for inspection is determined based on the total sample units within the section, shown in the following table.

Number of sample units for inspection.

Total Number of Samples in Section	Number of Samples for Inspection
1 to 5	1
6 to 10	2
11 to 15	3
16 to 40	4
Over 40	10%

A much higher sampling rate than the minimum sampling rate shown in the above table was used during the inspectio that were carried out in 2002. Typically, a minimum sampling rate of 20% was used for all sections, irrespective of th number of total sample units within the section.

Once the number of sample units to be inspected has been determined, the spacing interval of the sample units to be inspected is determined. The spacing interval (i) of the sample units is calculated by the following formula and rounde the lowest whole number:

$$i = N/n$$

where,

N = total number of sample units in the section

n = number of sample units to be inspected

The first sample unit to be inspected is selected at random from sample units 1 through i. The sample units within the section that are successive increments of the interval i after the first randomly selected unit are also inspected. If the are sample units within the section that are not representative of the section, such sample units are inspected in addit to the sample units that are selected at random. Such sample units include very poor or excellent samples that are not typical of the section, such as sample units that contain an unusual distress such as an utility cut.

2. Identify and Record Pavement Distresses in Sample Units:

The type, severity and quantity of pavement distress within each sample unit is determined by visual inspection of the pavement and recorded on data sheets. The procedures described in ASTM Standard D 5340 are used to determine the distress types, identify severity levels, and to measure the quantity of distress. Sixteen types of distresses are identifi on asphalt surfaced pavements, while fifteen types of distresses are identified on PCC pavements. The types of distres identified on asphalt surfaced pavements and PCC pavements are presented in the following tables.

Distress types for airfield pavements.

Distress Types on Asphalt Surfaced Pavements	Distress Types on PCC Pavements
Alligator Cracking	Blow Up
Bleeding	Corner Break
Block Cracking	Longitudinal, Transverse, Diagonal Cracks
Corrugation	Durability (D) Cracking
Depression	Joint Seal Damage
Jet Blast Erosion	Patching –Small
Joint Reflection Cracking	Patching Large and Utility Cuts
Longitudinal and Transverse Cracking	Popouts
Oil Spillage	Pumping
Patching and Utility Cut Patching	Scaling, Map Cracking and Crazing
Polished Aggregate	Settlement or Faulting
Raveling and Weathering	Shattered Slab/Intersecting Cracks
Rutting	Shrinkage Cracks
Shoving	Joint Spalling
Slippage Cracking	Corner Spalling
Swell	

3. Compute PCI of Sample Units Based on Distress Within Sample Unit:

The procedure to compute the Pavement Condition Index (PCI) of a sample unit is described in ASTM standard D 5340 This procedure has been implemented in PAVER to compute the PCI value of each sample unit when the distress data entered into PAVER. The following steps that are used to compute the PCI of a sample unit.

Determine Distress Quantities: For asphalt concrete surfaced pavements, the total quantity of each distress type at ea severity level is added up. For PCC pavements, the total number of slabs that have a particular distress type for a spe severity level are added up.

Determine Distress Density: For asphalt concrete surfaced pavements, the total quantity of each distress type at each severity level is divided by the total area of the sample unit and multiplied by 100 to obtain the percent density of eac

ress type and severity. For PCC pavements, the total number of slabs for each distress type at each severity level is divided by the number of slabs that are contained within the sample unit and multiplied by 100 to obtain the percent density of each distress type and severity.

Determine Deduct Value: The deduct value for each distress type and each severity level is determined by using the deduct value curve for that particular distress type. These deduct value curves are shown in ASTM Standard D 5340. T following figure shows a deduct value curve for linear cracking in asphalt surfaced pavements.

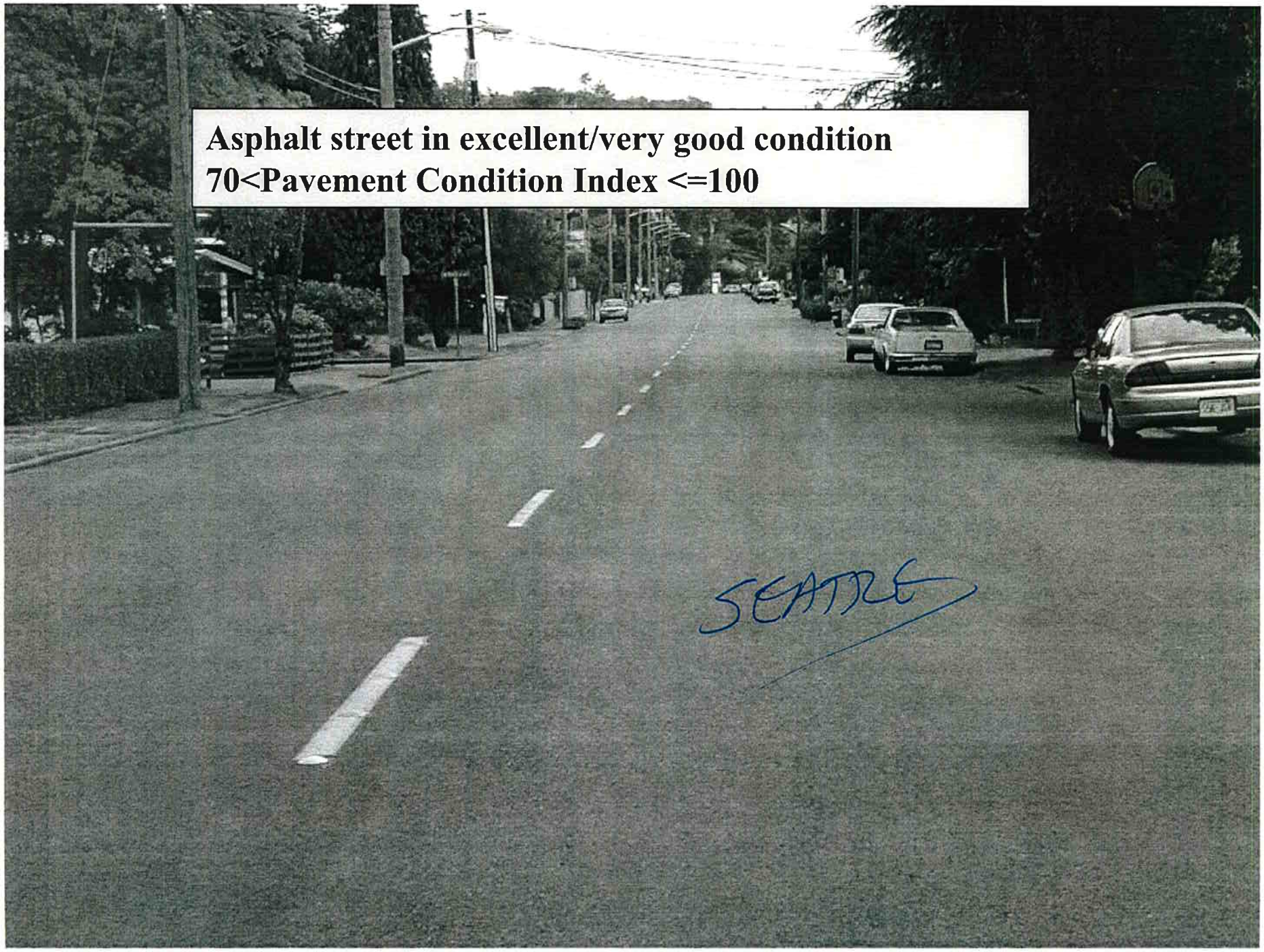
educt value curve for linear cracking on asphalt surfaced pavements.

Obtain Correct Deduct Value: If none or only one deduct value is greater than five, the sum of the deduct values is use obtain the total deduct value for the sample. Otherwise, a value called the corrected deduct value for the sample is computed using the deduct values obtained for the different distress types. This procedure is used because there is an interacting effect between different distress types, and if the deduct values were not corrected an unreasonable dedu value would be computed for the sample. The deduct values obtained for each distress type and each severity levels a combined using the procedure described in ASTM standard D 5340 to obtain the corrected deduct value for the sample

Obtain PCI of Sample Unit: Subtract the deduct value (or corrected deduct value if applicable) from 100 to obtain the F of the sample unit.

4. Compute PCI of Section:

If all surveyed sample units that were surveyed were selected randomly, or if all sample units within the section were surveyed, the PCI of the section is the average of the PCI values that were obtained for the samples within the sectior additional sample units were surveyed within the section, then a weighted averaging method is used to compute the F of the section. The details of this method are given in ASTM standard D 5340.


Asphalt street in excellent/very good condition
70<Pavement Condition Index <=100
SEATTLE

OHIO DOT

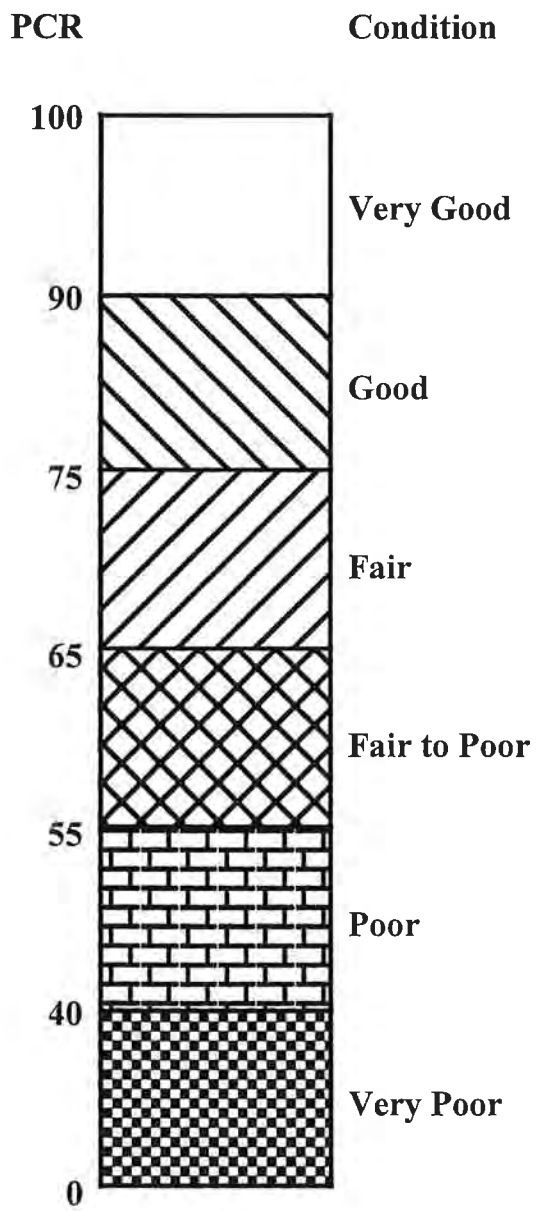


Figure 1. Pavement Condition Rating (PCR) Scale

Each Region was asked to report paving projects that were being conducted and completed in 1998 to the Pavement Management Group. This information was used to update the condition survey data to reflect the state of pavement conditions at the end of the construction season. The paving projects reported include both overlay and new construction projects. The 1998 paving projects for all state jurisdiction highways amounted to approximately 510 miles (directional miles for the Interstate and centerline miles for Non-Interstate highways). This total includes over 140 miles of paving from reallocation projects. The paving project lists provided by each Region are presented in Appendix F.

Historical pavement performance data has suggested that approximately 550 miles of state highway need to be rehabilitated annually due to normal pavement deterioration. If this deterioration rate is not matched by improvements completed by paving projects, the overall condition of the state highway system will decrease. In reality, the actual amount of paving required to maintain the network condition level for each specific year will vary from the typical 550-mile value. The amount of paving necessary depends on the age distribution of the pavements in the given year. To illustrate, if a large number of projects were constructed in one year, it would be expected that these pavements would need rehabilitation at approximately the same time in the future. In that future year, the amount of paving necessary to maintain the condition level would be expected to be higher than the typical 550 miles.

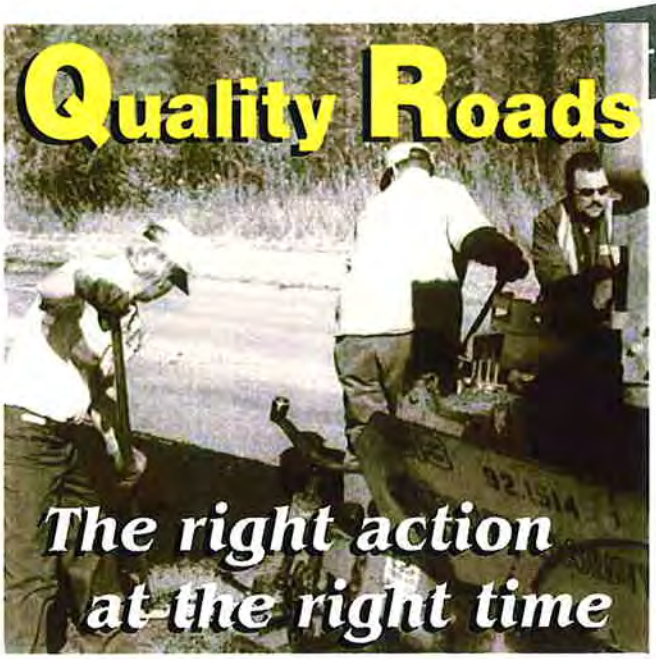
In 1998 the overall "fair-or-better" condition remained at 77%. Although the percentage remained the same, ODOT saw a drop in overall "fair-or-better" miles. In 1997 there were approximately 6297 miles of pavements in "fair-or-better" condition. In 1998 the total of pavements in "fair-or-better" condition dropped to 6273 miles. The continued loss of "fair-or-better" mileage will eventually result in a drop in the percent of pavements in "fair-or-better" condition.

ODOT has established a goal to have 90% of its pavements in "fair-or-better" condition. If this goal is to be obtained by the year 2010, the average amount of paving completed each year will need to be increased from 550 miles to approximately 640 miles. This is based on making a 13% improvement to the condition of the system over a 12 year period. Again, the actual mileage required to improve the condition level will vary from year to year based on the age distribution of the pavements in the network.

City of Bloomington
Public Works Department

Public Works working for you –

Pavement Management Program (PMP)



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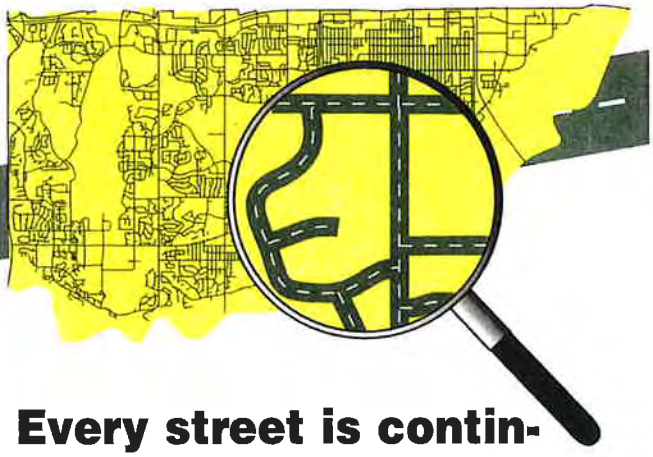
The Pavement Management Program (PMP) is a maintenance plan for streets that utilizes repair techniques at the optimum time. The results include:

- Prolonged pavement life.
- Reduced cost for streets.
- Reduced assessment rates for property owners.



Every street is continually investigated

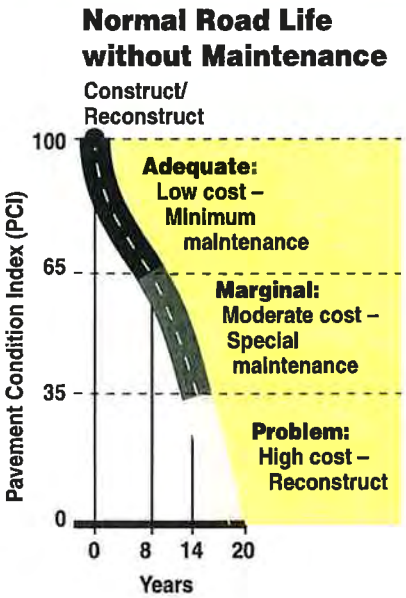
Bloomington has 360 miles of roadways valued at $168 million. That's a big investment and a lot of pavement – and the condition of all those road surfaces is in the City's PMP database.

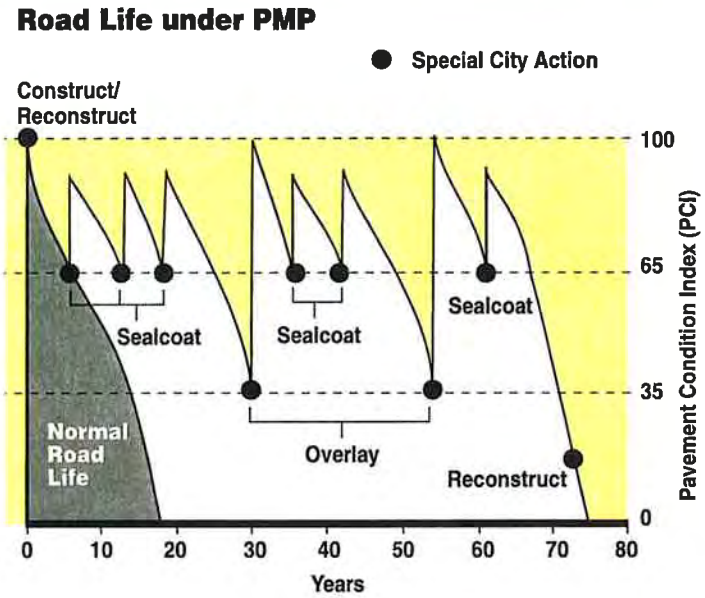
How does the PMP work? Information such as the number of cracks, road thickness and maintenance history are entered into a database. The database outputs a Pavement Condition Index (PCI) number which is used for budgeting and as a guideline for suggested maintenance. Before any work is performed, the street is carefully inspected and assigned maintenance as appropriate. In general:

PCI	*Description*	*Probable Maintenance*
100	Newly reconstructed	None
99 - 66	Adequate	Sealcoat
65 - 36	Marginal	Mill and overlay
35 - 1	Problem	Reconstruct

Affordable price – PMP equals less costly roads

The typical street with little or no maintenance will last less than 20 years before it needs to be totally rebuilt. By performing periodic pavement sealcoats or overlays at the correct times, a street's lifespan can be more than tripled before costly reconstruction is needed.





Funding the PMP

The Public Works' Pavement Management Program has reduced the overall cost of keeping our streets in good condition. Sealcoating, the low-cost maintenance of roads, is funded from the City's General Fund. Overlay funds come from the Infrastructure Replacement Fund, distributed by the State of Minnesota from the fuel sales tax. Costly reconstruction of a street is funded from taxes and special assessments to property owners.

Lower assessment policy

Individual properties are only assessed for street reconstruction and, even then, only a portion of the costs. A single- or two-family residence only pays 25 percent of their portion of a project's cost. Other properties, such as commercial, industrial or multi-family residences, pay half the cost. Other funding sources make up the difference.

Assessment payment options

Road assessments may be paid with a one-time payment or over 10 years with a low simple interest charge.

Condition Rating Systems

Based on measurements of roughness, surface distress, skid resistance and deflection, pavement assigned a score that reflects their overall condition. This score, sometimes called a pavement c rating, quantifies a pavement's overall performance and can be used to help manage pavement r carefully choosing the rating scale (called the condition index), pavement condition scores can be (Deighton, 1998):

- *Trigger treatment*. For instance, once a pavement's condition rating reaches a certain l scheduled for maintenance or rehabilitation.
- *Determine the extent and cost of repair*. A pavement condition score is a numerical rep of a pavement's overall condition and can thus be used to estimate the extent of repair likely cost.
- *Determine a network condition index*. By combining pavement condition scores for an network, a single score can be obtained that gives a general idea of the network conditi whole.
- *Allow equal comparison of different pavements*. Since a pavement condition score accc types of pavement performance measures it can be used to compare two or more pave different problems on an equal footing.

A pavement condition index is simply the scale, or series of numbers, used to describe a paveme Typical pavement condition indices may be based on a scale of 0 to 5 or perhaps 0 to 100. The p pavement condition index depends upon the objectives of whatever system is used to manage a pavement network (called a Pavement Management System or PMS). This section will present tv pavement condition indices.

Present Serviceability Index (PSI)

The Present Serviceability Index (PSI) is a 0 to 5 scale that was originally based on a panel of rat between 1958 and 1960, rated various roads in the states of Illinois, Minnesota, and Indiana. PS 5 (excellent) to 0 (essentially impassable), and is still used today throughout the country. It is o choice for a smaller, less sophisticated pavement rating system.

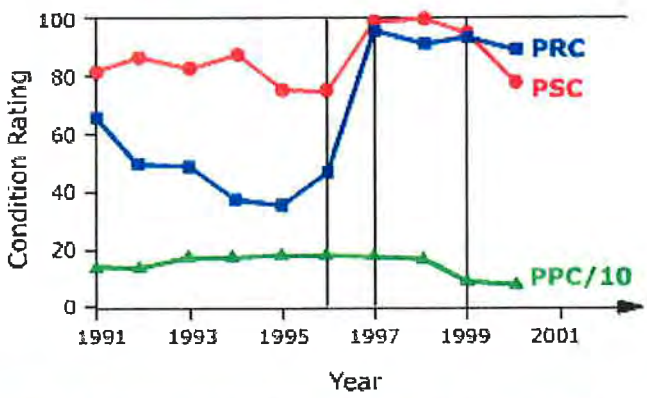
WSDOT's Pavement Rating System

WSDOT uses a more sophisticated pavement rating system for its Pavement Management Syster system uses three different rating scales:

1. *Pavement Structural Condition (PSC).* A measure of pavement distress such as crackin distress measures and ranges from 100 (no distress or very good condition) to zero (ex distress or very poor condition).
2. *Pavement rutting condition (PRC).* A measurement of rut depth in inches. The scale ra 100 (no rutting) to 0 (0.70 inches of rutting).
3. *Pavement profile condition (PPC).* A measure of roughness using IRI.

Generally, as a pavement gets older and more worn its PSC and PRC decrease, while PPC increas

WSDOT PMS Condition Rating for:
I-90 Eastbound, milepost 126.40 - 136.76 in Kittitas County



PSC = Pavement Structural Condition. A rating of the pavement's structural ability to carry loads. Scale is from 100 (best condition) to 0 (worst condition).

PRC = Pavement Rutting Condition. Rated on a scale of 100 (0 inches rutting) to 0 (0.70 inches rutting).

PPC = Pavement Profile Condition. This graph shows IRI in inches/mile divided by 10.

Notes

1996 - 1997
Some time after the survey in 1996 the pavement was overlayed with 1.8 inches of Class A hot mix asphalt.

1999
After the 1998 survey WSDOT switched to from a sonic to a laser profiler. The decrease in IRI seen here is typical throughout the State as a result of this change in instrumentation.

Discssion
1. The individual measurements seem to jump around from year to year (which is normal), but PRC and PSC generally decrease until the resurfacing in 1996.

2. Generally PSC or PRC values of < 50 will trigger a resurfacing. It appears this portion of I-90 was resurfaced due to low PRC values.

Figure 1: An Example of the WSDOT Pavement Condition Rating System

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Pavement Condition of Nebraska Highways

Activity Drivers: District Engineers

Data Owner & Collector: Dan Nichols : Classification, Needs, & Pavement Engineer : Materials & Research Division

Category : Transportation System Safety and Performance

Description:
Measurement of the quality of the highway surface.

Purpose:
This is a measure of the surface condition of the states' highways. [1] Surface condition ratings are based upon annual visual inspections and ride quality (smoothness). This information is used to determine appropriate strategies for either maintenance, rehabilitation, or reconstruction.

Goal:
82% of the highway system miles shall be rated at least good or very good *(NSI ratings >= 70.)*

Frequency of Reporting:
Annually, as of October each year.

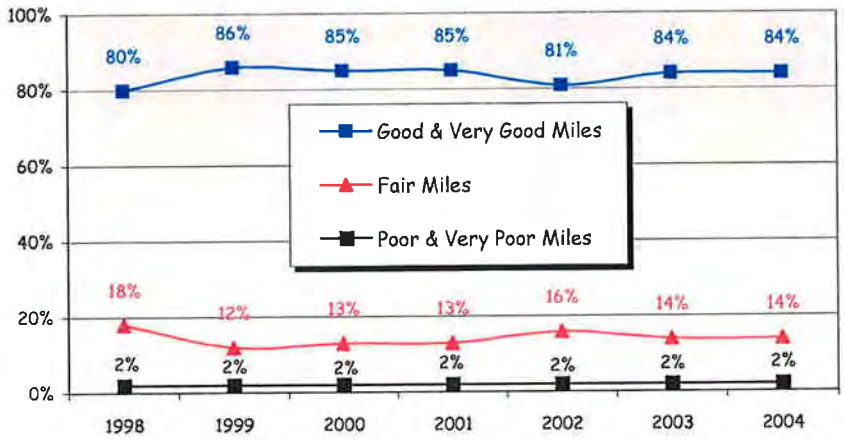
Revised Date:
October 21, 2004

Year 2004 Performance Data [2]

Pavement Condtion Ratings Miles	Interstate System	Expressway System [3]	Other State Highways	Total State Highway System
Very Good Miles	264	350	2,925	3,539
Good Miles	196	168	4,402	4,766
Fair Miles	15	72	1,252	1,339
Poor Miles	6	12	227	245
Very Poor Miles	0	0	27	27
	481	602	8,833	9,916

Pavement Condtion Ratings %	Interstate System	Expressway System [3]	Other State Highways	Total Highways
Very Good Miles %	55%	58%	33%	36%
Good Miles %	41%	28%	50%	48%
Fair Miles %	3%	12%	14%	14%
Poor Miles %	1%	2%	3%	2%
Very Poor Miles %	0%	0%	0%	0%

2004 Pavement Condition Ratings
(Nebraska Serviceablity Index)



Comments:
Surface condition ratings are based upon the NSI (Nebraska Serviceability Index):

Very Good Rating:	90 to 100
Good Rating:	70 to 89
Fair Rating:	50 to 69
Poor Rating:	30 to 49
Very Poor Rating:	0 to 29

[1] *"Centerline"* miles of the state highway system, which includes Interstate and Expressway system miles.

[2] Data from the Materials & Research Division's Integrated Inventory (IHI) data base.

[3] An expressway is a 4-lane divided roadway with limited access.

Pavement Surface Condition
RATING MANUAL

Northwest Pavement Management Systems Users Group

Sponsored by:
Northwest Technology Transfer Center
Local Programs Division
Washington State Department of Transportation

Severity and Extent Summary

1. Rutting and Wear

Severity

The average rut depth in the wheel path for the segment or sample.

Low	1/4 in. to 1/2 in.
Medium	1/2 in. to 3/4 in.
High	over 3/4 in.

Extent

Assumed to be the full length of the surveyed segment.

2. Alligator Cracking

Severity

Low	Hair Line (< 1/4 inch)
Medium	Spalling
High	Spalling and pumping

Extent

Percentage of the length of both wheel paths.

Suggested ranges for estimating:

1% - 9%	of both wheel paths
10% - 24%	of both wheel paths
25% - 49%	of both wheel paths
50% or more	of both wheel paths

Old WSDOT ranges for estimating - prior to 1991:

1% - 24%	of both wheel paths
25% - 49%	of both wheel paths
50% - 74%	of both wheel paths
50% or more	of both wheel paths

3. Longitudinal Cracking

Severity

Low	< 1/4 in. wide
Medium	> 1/4 in. wide
High	Spalled

Extent

Percentage of the length of the surveyed segment.

Suggested ranges for estimating:
1% - 99% of the length of the segment
100% - 199% of the length of the segment
200% or more of the length of the segment

4. Transverse Cracking

Severity

Low	< 1/4 in. wide
Medium	> 1/4 in. wide
High	Spalled

Extent

Frequency, count per 100 feet.

Suggested ranges for estimating:
1 - 4 cracks per 100 ft.
5 - 9 cracks per 100 ft.
10 or more cracks per 100 ft.

5. Raveling

Severity

Low	Slight
Medium	Moderate
High	Severe

Extent (estimated):
Localized
Wheel Paths
Entire Lane

6. Flushing

Severity

Low	Slight
Medium	Moderate
High	Severe

Extent (estimated):
Localized
Wheel Paths
Entire Lane

7. Patching

Severity

Low	Chip seal patch
Medium	Blade patch (cold or hot mix)
High	Dig-out, full depth patch (or repair)

Extent

Percentage of the length of both wheel paths.

Suggested ranges for estimating:

1% - 9%	of both wheel paths
10% - 24%	of both wheel paths
25% or more	of both wheel paths

8. Corrugation and Waves

Severity

The maximum deviation from a 10-foot straight edge

Low	1/8-in. to 2-in. change per 10 ft.
Medium	2-in. to 4-in. change per 10 ft.
High	Over 4-in. change per 10 ft.

Extent

The percentage of the affected surface area.

Suggested ranges for estimating:

1% - 9%	of the area of the segment
10% - 24%	of the area of the segment
25% or more	of the area of the segment

9. Sags and Humps

Severity

The maximum deviation from a 10-foot straight edge.

Low	1/8-in. to 2-in. change per 10 ft.
Medium	2-in. to 4-in. change per 10 ft.
High	Over 4-in. change per 10 ft.

Extent

The percentage of the affected surface area.

Suggested ranges for estimating:

1% - 9%	of the area of the segment
10% - 24%	of the area of the segment
25% or more	of the area of the segment

10. Block Cracking

Severity

Block Size:

Low	12-ft. x 12-ft. blocks	(9 x 9 and larger)
Medium	6-ft. x 6-ft. blocks	(5 x 5 to 8 x 8)
High	3-ft. x 3-ft. blocks	(2 x 2 to 4 x 4)

Crack Size:

Low	< 1/4 in. wide
Medium	> 1/4 in. wide
High	Spalled

Extent

Assumed to be the full length of the segment.

11. Pavement Edge Condition

Edge Raveling Extent (Severity is undefined):

1% - 9%	of the length of the segment
10% - 24%	of the length of the segment
25% or more	of the length of the segment

Edge Patching Extent (Severity is undefined):

1% - 9%	of the length of the segment
10% - 24%	of the length of the segment
25% or more	of the length of the segment

Edge Lane Less Than 10 Feet Extent (Severity is undefined):

1% - 9%	of the length of the segment
10% - 24%	of the length of the segment
25% or more	of the length of the segment

12. Crack Seal Condition

Severity

Low	Hairline cracks in the sealant allow only minimal water passage.
Medium	The crack sealant is open and will allow significant water passage.
High	The crack sealant is very open or non-existent.

Extent

1% - 9%	of the total length of cracks or joints
10% - 24%	of the total length of cracks or joints
25% or more	of the total length of cracks or joints

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P.O. Box 2501
Oak Ridge, TN 37831-2501
E-mail: ltppinfo@fhwa.dot.gov
Phone: (865) 481-2967
Fax: (865) 481-8555

LTPP Research Staff

U.S. Department of Transportation
Federal Highway Administration
Turner-Fairbank Highway Research Center
6300 Georgetown Pike, HRDI-13
McLean, VA 22101-2296
Tel: 202-493-3143
Fax: 202-493-3161

Aramis Lopez, Jr., P.E.
LTPP Team Leader
Tel: 202-493-3145
E-mail at aramis.lopez@fhwa.dot.gov

Jack Springer. P.E.
Tel: 202-493-3144
E-mail at jack.springer@fhwa.dot.gov

Deborah Walker
Tel: 202-493-3068
E-mail at deborah.walker@fhwa.dot.gov

Eric Weaver
Tel: 202-493-3153
E-mail at eric.weaver@fhwa.dot.gov

Larry Wiser
Tel: 202-493-3079
E-mail at larry.wiser@fhwa.dot.gov

LTPP On-Site Contractors

William Bellinger, P.E.
Tel: 202-493-3156
E-mail at william.bellinger@fhwa.dot.gov

Mary Anne Deeney
Tel: 202-493-3463
E-mail at mary.deeney@fhwa.dot.gov

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- LTPP FAQ's
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- Related Links

Events

- **LTPP: Standard Data Release #20** scheduled for availability November 2005
- View all Upcoming Pavements Events

Contacts

Aramis Lopez
Turner Fairbank
202-493-3145
aramis.lopez@fhwa.dot.gov

Customer Service
ltppinfo@fhwa.dot.gov

Don Fohs
Tel: 202-493-3157
E-mail at don.fohs@fhwa.dot.gov

Sean Lin
Tel: 202-493-3399
E-mail at sean.lin@fhwa.dot.gov

Wendy Lin
Tel: 202-493-3155
E-mail at wendy.lin@fhwa.dot.gov

LTPP Product Team

Antonio Nieves
Resource Center
6300 Georgetown Pike, Room F209
McLean, VA 22101
Tel: 202-493-3074
E-mail at antonio.nieves@fhwa.dot.gov

Mike Moravec
Resource Center
10 S. Howard Street
Suite 4000
Baltimore, MD 21201
Tel: 410-962-5623
E-mail at mike.moravec@fhwa.dot.gov

LTPP Regional Support Contractors (RSC)

North Atlantic RSC Office
Regional Contact: Frank Meyer
E-mail: FMeyer@Stantec.com
Tel: 716-632-0804
Fax: 716-632-4808

North Central RSC Office
Regional Contact: Frank Meyer
E-mail: FMeyer@Stantec.com
Tel: 716-632-0804
Fax: 716-632-4808

Southern RSC Office
Regional Contact: Mark Gardner
E-mail: mgardner@fugro.com
Tel: 512-977-1800
Fax: 512-973-9565

Western RSC Office
Regional Contact: Kevin Senn
E-mail: ksenn@nce.reno.nv.us
Tel: 775-329-4955
Fax: 775-329-5098

LTPP Technical Services Support Contractor (TSSC)

Technical Services Support Contractor (TSSC)
Contact: Gonzalo Rada
E-mail: grrada@mactec.com
Tel: 301-210-5105

Fax: 301-210-5032

Contacts by Topic

Topic: Climatic Data/Seasonal Monitoring
Primary Contact: Jack Springer
E-mail at jack.springer@fhwa.dot.gov
Other Contacts: Aramis Lopez
E-mail at aramis.lopez@fhwa.dot.gov

Topic: Communications
Primary Contact: Deborah Walker
E-mail at deborah.walker@fhwa.dot.gov
Other Contacts: Aramis Lopez
E-mail at aramis.lopez@fhwa.dot.gov

Topic: Data Analysis
Primary Contact: Larry Wiser
E-mail at larry.wiser@fhwa.dot.gov
Other Contacts: Aramis Lopez
E-mail at aramis.lopez@fhwa.dot.gov

Topic: Data Requests and Information
Primary Contact: LTPP Customer Support Service
E-mail: ltppinfo@fhwa.dot.gov
Other Contacts: Aramis Lopez
E-mail at aramis.lopez@fhwa.dot.gov

Topic: Database
Primary Contact: Eric Weaver
E-mail at eric.weaver@fhwa.dot.gov
Other Contacts: Aramis Lopez
E-mail at aramis.lopez@fhwa.dot.gov

Topic: DataPave
Primary Contact: LTPP Customer Support Service
E-mail: ltppinfo@fhwa.dot.gov
Other Contacts: Antonio Nieves
E-mail at antonio.nieves@fhwa.dot.gov
DataPave Online
www.fhwa.dot.gov/pavement/ltpp/datapave.cfm

Topic: Directives
Primary Contact: Technical Services Support Contractor (TSSC)
Other Contacts: Jack Springer
E-mail at jack.springer@fhwa.dot.gov

Topic: Distress
Primary Contact: Bill Bellinger
E-mail at william.bellinger@fhwa.dot.gov
Other Contacts: Jack Springer
E-mail at jack.springer@fhwa.dot.gov

Topic: Falling Weight Deflectometer
Primary Contact: Eric Weaver
E-mail at eric.weaver@fhwa.dot.gov
Other Contacts: Jack Springer
E-mail at jack.springer@fhwa.dot.gov

Topic: International Coordination

Primary Contact: Aramis Lopez
E-mail at aramis.lopez@fhwa.dot.gov

Topic: Materials
Primary Contact: Jack Springer
E-mail at jack.springer@fhwa.dot.gov
Other Contacts: Don Fohs
E-mail at don.fohs@fhwa.dot.gov

Topic: Operations Performance Reports
Primary Contact: Technical Services Support Contractor (TSSC)
Other Contacts: Jack Springer
E-mail at jack.springer@fhwa.dot.gov

Topic: Products
Lead Contact: Antonio Nieves
E-mail at antonio.nieves@fhwa.dot.gov
North Atlantic & Southern Regions: Mike Moravec
E-mail at mike.moravec@fhwa.dot.gov
North Central & Western Regions: Antonio Nieves
E-mail at antonio.nieves@fhwa.dot.gov

Topic: Profile
Primary Contact: Larry Wiser
E-mail at larry.wiser@fhwa.dot.gov
Other Contacts: Jack Springer
E-mail at jack.springer@fhwa.dot.gov

Topic: Publications/Web Page
Primary Contact: Mary Anne Deeney
E-mail at mary.deeney@fhwa.dot.gov
Other Contacts: Wendy Lin
E-mail at wendy.lin@fhwa.dot.gov

Topic: Regional Coordination and Data Collection

North Atlantic RSC Office
Primary Contact: Frank Meyer
E-mail: FMeyer@Stantec.com
Tel: 716-632-0804
Fax: 716-632-4808
Other Contacts: Jack Springer
E-mail at jack.springer@fhwa.dot.gov

North Central RSC Office
Primary Contact: Frank Meyer
E-mail: FMeyer@Stantec.com
Tel: 716-632-0804
Fax: 716-632-4808
Other Contacts: Jack Springer
E-mail at jack.springer@fhwa.dot.gov

Southern RSC Office
Primary Contact: Mark Gardner
E-mail: mgardner@fugro.com
Tel: 512-977-1800
Fax: 512-973-9565
Other Contacts: Jack Springer
E-mail at jack.springer@fhwa.dot.gov

Western RSC Office

Primary Contact: Kevin Senn
E-mail: mailto:ksenn@nce.reno.nv.us
Tel: 775-329-4955
Fax: 775-329-5098
Other Contacts: Jack Springer
E-mail at jack.springer@fhwa.dot.gov

Topic: Software Performance Reports
Primary Contact: Technical Services Support Contractor (TSSC)
Other Contacts: Jack Springer
E-mail at jack.springer@fhwa.dot.gov

Topic: Traffic Data
Primary Contact: Deborah Walker
E-mail at deborah.walker@fhwa.dot.gov
Other Contacts: Larry Wiser
E-mail at larry.wiser@fhwa.dot.gov

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PAVEMENT CONDITION RATING PROCEDURES

INTRODUCTION

The rating method is based upon visual inspection of pavement distress. Although the relationship between pavement distress and performance is not well defined, there is general agreement that the ability of a pavement to sustain traffic loads in a safe and smooth manner is adversely affected by the occurrence of observable distress. The rating method provides a procedure for uniformly identifying and describing, in terms of severity and extent, pavement distress. The mathematical expression for pavement condition rating (PCR) provides an index reflecting the composite effects of varying distress types, severity, and extent upon the overall condition of the pavement.

The model for computing PCR is based upon the summation of deduct points for each type of observable distress. Deduct values are a function of distress type, severity, and extent. Deduction for each distress type is calculated by multiplying distress weight times the weights for severity and extent of the distress. Distress weight is the maximum number of deductible points for each different distress type. The mathematical expression for PCR is as follows:

$$PCR = 100 - \sum_{I=1}^{n} Deduct_i \qquad (1)$$

Where:

n = number of observable distresses, and
Deduct = (Weight for distress) (Wt. for severity) (Wt. for Extent)

The Appendices A-D that follow describe various distresses for rigid, flexible, and composite pavements and current guidelines for establishing their severity and extent. Three levels of severity (Low, Medium and High) and three levels of extent (Occasional, Frequent, and Extensive) are defined. The definition for distress type, severity, and extent must be followed closely and be clearly understood by field personnel if the rating method is to provide meaningful data. To illustrate the method for calculating PCR, consider the distress "Faulting" in a hypothetical jointed concrete pavement. If the severity of this distress in the pavement is "Medium" and extent is "Frequent", then, the deduct points for "Faulting" in the pavement would be equal to [(10) (0.7) (0.8)] or 5.6 (see Table on page 11 for the weights of this distress). If an extensive amount of medium severity "Surface Deterioration" is also observed the deduct points for this distress would be equal to [(10) (0.7) (1)] or 7.0. The PCR for the pavement based upon these 2 distresses would equal to:

$$PCR = 100 - (5.6 + 7.0) = 87.4 \qquad (2)$$

The deduct weights for each pavement type have been developed on the basis of the review of the rating methods developed in the United States, Europe, and Canada and the experience gained from the rating methods developed by the Resource staff as a result of studies conducted in this connection. Two premises were considered when assigning the weights:

1. Overlaying and/or rehabilitation of high type (multi-lane) roadways should be considered when the PCR drops within the range of 65 to 55.

2. Deteriorated pavements normally exhibit several different types of distress. Rarely is only a single type of distress observed for a particular pavement.

The first premise is useful in establishing a target value for the proper PCR of pavements that are in a certain state or condition. Roadways scheduled for rehabilitation and resurfacing have to be rated by the PCR procedure.

A Pavement Condition Rating (PCR) Scale was developed to describe the pavement condition using the PCR numbers calculated from Equation (1). This scale has a range from 0 to 100; a PCR of 100 represents a perfect pavement with no observable distress and a PCR of 0 represents a pavement with all distress present at their "High" levels of severity and "Extensive" levels of extent. Figure 1 illustrates the PCR Scale and the descriptive condition of a pavement associated with the various ranges of the PCR values.

FIELD MONITORING PROCEDURE

The pavement condition rating is intended to apply to the entire pavement section being monitored. Section lengths are established by the monitoring procedure, with the average length being from 3 to 5 km (2 to 3 miles). Directional lanes of multilane roadways are considered separate roadways by the monitoring procedure. On multilane roadways the heaviest traveled lane (usually the outside lane) should be rated. For two lane roadways, rating one direction is sufficient unless a significant difference in condition is observed between the two lanes. The monitoring procedure checks the variance of the Pavement Serviceability Index (PSI) within a section to limit section length. This limitation should produce sections that have a fairly constant visual condition. If a definite variation in condition is observed within a section, the section should then be subdivided for condition rating. Recording of visible distress for the PCR calculations involves three steps:

Step 1. The rating team (the rating team should consist of a Driver and a Rater) should ride the predetermined roadway section at a speed of about 60 km (40 MPH). During this step, readily visible distresses such as potholes, bleeding, settlement, faulting, spalling, and surface deterioration should be rated. Also the need for subdividing the section should be evaluated in step 1.

Step 2. A second pass along the roadway section should be made with stops at approximately 1.5 km (1 mile) intervals. For example, a 3 km (2-mile section) would require 2 stops to be made. At each stop the raters should evaluate the roadway by viewing 30 m (100') of the pavement. Close inspection of pavement cracking, crack sealing, rutting, raveling, joint spalling, D-cracking, and other visible distress should be made by viewing the pavement from the roadway shoulder.

Step 3. Complete the PCR form. The final rating form for the roadway section should represent the observed average of visible distress for the entire section. Separate rating forms based upon the step 1 observations and the individual stops made during step 2 are not required. However, raters may wish to use additional rating forms for each stop, simply for note keeping purposes.

Using the pavement distress data collected by the Objective condition surveys, condition index values are mathematically calculated. These values are then used to determine the condition rating of specific highway segments. For 1998, six condition index values were calculated for each pavement section: a rut index, a raveling index, a patching index, a fatigue index, a no load index, and an overall section index. All indices range from zero to 100 with a larger value indicating a better pavement condition. The overall section index is used to categorize the condition of the pavement section as good, fair, poor, etc. as shown in Table 2. The calculations used to determine the index values are described in detail in Appendix D.

Table 2 - Index Category

Overall Section Index	Condition Category
99-100	Very Good
76-98	Good
46-75	Fair
11-45	Poor
0-10	Very Poor

To remain consistent with the historical reporting of condition data, only the "add" mileage information has been used to determine the "fair-or-better" statistical summary for the Non-Interstate highways. For the Interstate highways, both the "add" and "non-add" rating results were included in the statistical summary.

NON-NATIONAL HIGHWAY SYSTEM (Non-NHS)

The subjective Good-Fair-Poor (GFP) Rating procedure was used to rate the state jurisdiction highways excluded from the National Highway System. For 1998, personnel from the ODOT Operations Support Section and Bridge Section conducted the GFP ratings. The raters used to conduct the 1998 Non-NHS condition survey are shown in Table 3.

The basic GFP Rating method has been used since its inception in 1970. Ratings are conducted by two person crews. This method involves driving a highway and conducting a visual inspection of the pavement surface. Highways are rated according to previously defined pavement management sections. Each section is given a condition score ranging in value from 1.0 to 5.0 based on the ride quality and surface distresses. Definitions of the rating categories are provided in Appendix E.

Table 3 - 1998 Non-NHS Condition Raters

Rater	Rater
Henry Ng	Danny Hori
Tom Satchell	Shivinder Singh
Karen Scott	Jeff Gower
Cole Mullis	Kevin Brophy

Rating scores are reported to a tenth of a point in order to indicate the relative condition of a pavement within a general condition category. The numeric ratings have the descriptive terms of very good (1.0 to 1.9), good (2.0 to 2.9), fair (3.0 to 3.9), poor (4.0 to 4.9), and very poor (5.0). Smaller values indicated better pavements. For example, a section rated as 1.0 would be in better condition than a section rated as 1.9.

The GFP surveys for 1998 were conducted on all "add" and "non-add" roadbeds. To be consistent with historical reporting of condition information, only the "add" mileage data was used to determine the "fair-or-better" statistical summary for the Non-NHS highways.

PAVEMENT CONDITION RATING FORMS AND KEY FORMS

Note: The Key forms summarize data presented in Appendices A through D. These key forms will aid field personnel in establishing distress severity and extent while performing the PCR surveys.

SUMMARY

The 1998 pavement condition surveys indicate that the overall condition of the state highway system is approximately the same as in 1997. The statewide overall "fair-or-better" mileage for 1998 remains at 77%. No progress was made toward the goal of having 90% of the state jurisdiction highways in "fair-or-better" condition.

The overall statewide pavement conditions remained nearly the same. The Interstate highway system "fair-or-better" mileage dropped from 87% in 1997 to 86% in 1998. The remainder of the National Highway System excluding the Interstate system "fair-or-better" mileage improved from 79% in 1997 to 81% in 1998. The Non-NHS highways dropped in "fair-or-better" mileage from 71% in 1997 to 70% in 1998.

Although 1998 saw no change in the overall conditions, some dramatic changes took place at the Region and District level. Region 1's Interstate drop from 89% to 80% while their Non-NHS improved from 76% to 81%. Region 2's Non-NHS fell from 56% to 51%. Region 4's Interstate improved from 68% to 74%. And Region 5's NHS w/o Interstate improve from 80% to 84%.

However the most dramatic changes took place at the District level. District 14's Interstate had the largest drop, decreasing from 97% to 70%. District 2C's Interstate also suffered severely, dropping from 74% to 50%. District 5's Non-NHS fell from 74% to 51%. The most improved Interstate went to District 9, whose Interstate improved from 68% to 74%. Other major improvements were District 8 whose NHS w/o Interstate improved from 80% to 90% and District 12's NHS w/o Interstate improving from 75% to 84%. A summary of the percentage of pavements in "fair-or-better" condition is presented in Table 4.

Table 4 - 1998 % Fair -or-Better Pavement Condition Summary

REGION	INTERSTATE	NHS W/O INTERSTATE	NON-NHS	ALL HWY 1998 *	ALL HWY 1997 *
1	80%	85%	81%	82%	83%
2	100%	82%	51%	69%	71%
3	86%	81%	78%	81%	82%
4	74%	78%	72%	75%	73%
5	87%	84%	76%	81%	81%
TOTAL	86%	81%	70%	77%	77%

* "All Hwy" consists of Interstate, NHS without Interstate, and Non-NHS highways.

Table 5 shows Statewide paving over the past four years. In 1996 the paving goal of 550 miles per year was nearly met with construction on approximately 535 miles. In this year the statewide "fair-or-better" condition remained constant with the previous year. In 1995 the paving goal of 550 miles was well short with construction only on approximately 385 miles. In this year the statewide "fair-or-better" condition dropped 2% from the previous year. In 1997 approximately 480 miles of paving took place and the statewide "fair-or-better" condition dropped 1%. In 1998 approximately 510 miles of paving took place and the statewide "fair-or-better" condition remained constant with the previous year.

Table 5 - 1998 % Fair -or-Better Pavement Condition Summary

YEAR	MILES PAVED	% FAIR-OR-BETTER	% CHANGE FROM PREVIOUS YEAR
1998	510	77	0%
1997	480	77	-1%
1996	535	78	0%
1995	385	78	-2%
1994		80	

Trend graphs for statewide and Region pavement conditions are presented in Appendix A. Detailed mileage summaries are also provided by pavement condition category for each Region and District. Appendix B provides the pavement condition rating information for all state highways by pavement management section.

APPENDIX A

1998 PAVEMENT CONDITION SUMMARIES

The results of the 1998 pavement condition survey are summarized in this appendix. Graphs displaying pavement condition distribution and historical pavement condition trends are included. The trend graphs track pavement condition for All State Highways and for each Region.

Tabular summaries of the pavement condition information are also included in this section. The tabular summaries present mileage of highway that is in each condition category. This information is grouped in various ways and organized by Region and District. The various grouping categories include All State Highways, Interstate Highways, NHS Highways excluding the Interstate, Non-NHS Highways, and Access Oregon Highways.

International Roughness Index (IRI)

This page describes the International Roughness Index (IRI) used to describe road roughness. It is part of a set of Web pages related to road roughness, and is provided as a service of The University of Michigan Transportation Research Institute (UMTRI).

Background

Almost every automated road profiling system includes software to calculate a statistic called the International Roughness Index (IRI). Since 1990, the Federal Highway Administration (FHWA) has required the states to report road roughness on the IRI scale for inclusion in the Highway Performance Monitoring System (HPMS).

The IRI was proposed by The World Bank as a standard roughness statistic.

The World Bank sponsored several large-scale research programs in the 1970's that investigated some basic choices facing developing countries: should the governments borrow money to build good, expensive roads, or should they save money with poor, cheap roads? It turns out that poor roads are also costly to the country as a whole, due to user costs such as damage to vehicles. Road roughness was identified as a primary factor in the analyses and trade-offs involving road quality vs. user cost. The problem was, roughness data from different parts of the world could not be compared. Even data from the same country were suspect because the measures were based on hardware and methods that were not stable over time.

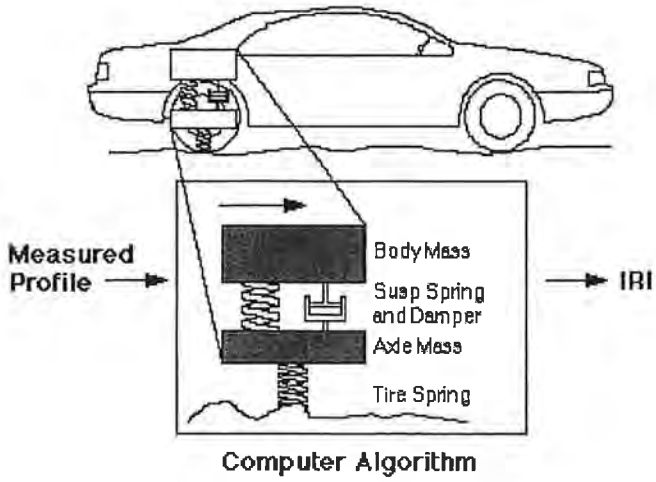
In 1982, the World Bank initiated a correlation experiment in Brazil to establish correlation and a calibration standard for roughness measurements. In processing the data, it became clear that nearly all roughness measuring instruments in use throughout the world were capable of producing measures on the same scale, if that scale were suitably selected. From that point on, an objective of the researchers was to develop the IRI.

The IRI is reproducible, portable, and stable with time.

The IRI is the first widely used profile index where the analysis method is intended to work with different types of profilers. It is defined as a property of the true profile, and therefore it can be measured with any valid profiler. The analysis equations were developed and tested to minimize the effects of some profiler measurement parameters such as sample interval. Example computer programs were published by The World Bank and have been used by profiler developers and others to test new software that computes IRI.

The IRI simulates a standard vehicle with a perfect road meter.

At the time of its development, response-type road roughness measuring systems were common, so the index was tailored to correlate well with the output of these systems. The filter in the IRI is based on a mathematical model called a quarter-car. The quarter-car filter calculates the suspension deflection of a simulated mechanical system with a response similar to a passenger car. The simulated suspension motion is accumulated and divided by the distance traveled to give an index with units of slope (m/km, in/mi, etc.).



Much of the research underlying the IRI was funded by the National Cooperative Highway Research Program (NCHRP). The IRI is based on the "Golden Car" described in NCHRP Report 228.

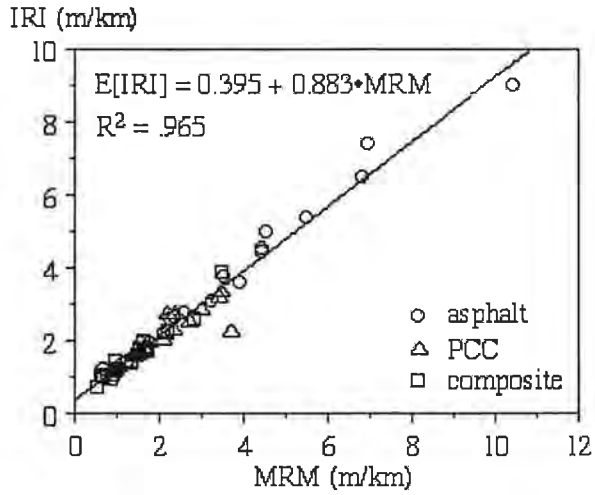
Properties of the IRI Analysis

The quarter-car model used in the IRI algorithm is just what its name implies: a model of one corner (a quarter) of a car. The model is shown schematically in the above figure: it includes one tire, represented with a vertical spring, the mass of the axle supported by the tire, a suspension spring and a damper, and the mass of the body supported by the suspension for that tire.

The quarter-car model was tuned to maximize correlation with response-type road roughness measuring systems.

This quarter-car simulation is meant to be a theoretical representation of the response-type systems in use at the time the IRI was developed, with the vehicle properties adjusted to obtain maximum correlation to the output of those systems. Considerations in its design are described in NCHRP Report 228. The model was called "The Golden Car" at the time, because it was intended to serve as a reference for response-type systems.

The parameters used in the quarter car give it simulated response properties typical of most highway vehicles with one exception: the damping is higher than most cars. This keeps the IRI from "tuning in" to certain wavelengths and degrading correlation with other vehicles. The figure below shows how IRI values from profile data relate to raw measures from a response-type system.



The IRI describes profile roughness that causes vehicle vibrations.

The response of the IRI to sinusoids is intentionally very similar to measured physical response of highway vehicles. It was mainly developed to match the responses of passenger cars, but subsequent research has shown good correlation with light trucks and heavy trucks. The IRI has become recognized as a general-purpose roughness index that is strongly correlated to most kinds of vehicle response that are of interest. Specifically, IRI is very highly correlated to three vehicle response variables that are of interest:

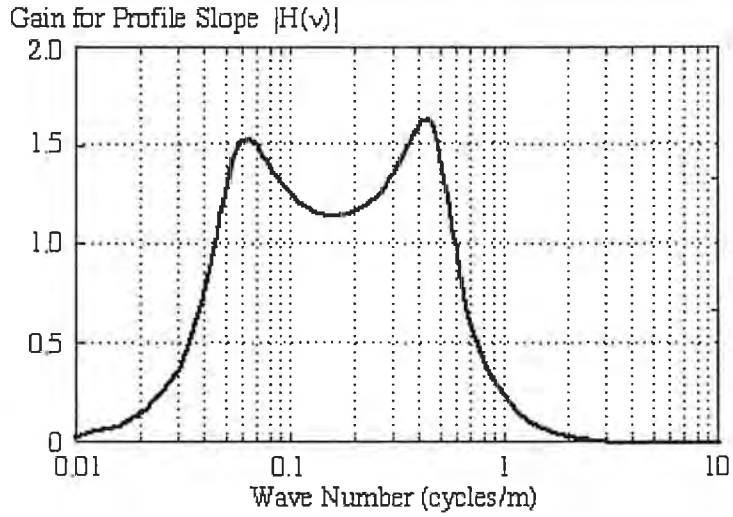
- road meter response (for historical continuity),
- vertical passenger acceleration (for ride quality), and
- tire load (for vehicle controllability and safety).

The IRI is not related to all vehicle response variables. For example, it does not correlate well with vertical passenger position, or axle acceleration.

The fact that IRI correlates well with both road meter response and passenger acceleration is no coincidence: the correlation between road meter response and passenger acceleration was certainly a factor in the decades of acceptance of the road meter as a useful tool for measuring roughness.

IRI is influenced by wavelengths ranging from 1.2 to 30.5 m (4 to 100 ft).

The wave-number response of the IRI quarter-car filter is shown in the next figure. The amplitude of the output sinusoid is the amplitude of the input, multiplied by the "gain" shown in the figure. The gain shown in the figure is dimensionless. Thus, if the input is a sinusoid with an amplitude that is slope, the output is the product of the input amplitude and the value taken from the plot.



The IRI filter has maximum sensitivity to slope sinusoids with wave numbers near 0.065 cycle/m (a wavelength of about 15.4 m) and 0.42 cycle/m (a wavelength of about 2.4 m). The response is down to 0.5 for 0.033 and 0.82 cycle/m wave numbers which correspond to wavelengths of 30.5 m and 1.2 m, respectively. However, there is still some response for wavelengths outside this range.

The IRI scale is linearly proportional to roughness.

If all of the elevation values in a measured profile are increased by some percentage, then the IRI increases by exactly the same percentage. An IRI of 0.0 means the profile is perfectly flat. There is no theoretical upper limit to roughness, although pavements with IRI values above 8 m/km are nearly impassable except at reduced speeds.

The IRI was the first highly portable roughness index that is stable with time.

The IRI is not the first profile-based roughness index. When it was introduced, profilers from different countries and different manufacturers were each used with profile analyses developed for their specific hardware. Most of the analyses were not intended to work with true profile. Those that did had specific requirements for the interval between elevation measures, and gave significant errors when applied to profiles that had a different interval.

The software published by The World Bank was tested by new users, who found that under controlled research tests, they could obtain nearly identical IRI values using different profilers.

Definition of the IRI

The above descriptions of the IRI background and properties are intended to give an idea of what the IRI computer software is intended to simulate, and how you can interpret the IRI scale. However, the IRI is rigorously defined as a specific mathematical transform of a true profile. The specific steps taken in the computer program to compute IRI are listed below.

The IRI is calculated for a single profile.

If your profiler measures several profiles simultaneously, then you can get the IRI for each. The

IRI standard does not specify how you locate the line on a road that defines the profile. Any possible line on the ground has an associated IRI statistic.

The standard does not specify how you combine IRI values for different profiles taken for the same road. They can be averaged, but the result is not IRI--it is the average of several IRI's.

The profile is filtered with a moving average with a 250-mm base length.

The moving average is a low-pass filter (it attenuates short wavelengths) that smoothes the profile. It has no effect unless the profile sample interval is shorter than 167 mm (6.6 in).

The 250-mm moving average filter should be omitted for profiles obtained with some systems.

This step should be omitted if the profile has already been filtered by a moving average or with an anti-aliasing filter whose cut-off attenuates wavelengths shorter than 0.6 m. Profilometers by K.J. Law detect elevation values at intervals of 25.4 mm, apply a 300 mm moving average filter, and store the result at 152.4-mm intervals. It is important to skip the 250-mm filter when processing profiles from these systems.

The profile is further filtered with a quarter-car simulation.

The quarter-car parameters are specified as part of the IRI statistic, and the simulated travel speed is specified as 80 km/h (49.7 mi/h). The output of the filter represents suspension motion of the simulated quarter car.

The filtered profile is accumulated by summing absolute values of the filtered point, and divided by the profile length.

The resulting IRI statistic has units of slope. As a user, you can express the slope in any appropriate units. The most common choices are in/mi and m/km (1 m/km = 63.36 in/mi).

Summary: IRI is a profile index.

The IRI is a specific profile index. The analysis is applied to a single profile, the profile is filtered (twice), the filtered result is accumulated, and finally divided by the length of the profile. The IRI is linearly related to variations in profile, in the sense that if all of the elevation values in the profile are doubled, the resulting IRI will also be doubled.

Software

Two programs are available for the calculation of the IRI. The first is a free user-friendly Windows-based software package called RoadRuf for interpreting longitudinal road roughness profile data, including the calculation of IRI. The second is a sample Fortran program for calculating IRI and RN (Ride Number). It is meant to give developers of profilers and profile analysis software a stripped-down program for getting IRI. Download the IRI source code.

Bibliography

A few of the following documents can be downloaded via FTP. The documentation is in Adobe Acrobat's Portable Document File (pdf) format which can be read by the Adobe Acrobat Reader. For information about Adobe Acrobat Reader, including free copy of the software, visit Adobe's web site: Steps to Downloading the Free Acrobat Reader.

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Webmaster: Steve Karamihas -- stevemk@umich.edu. Last update: January 17, 2005.

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Program Manager: T.J. Freeman

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The Pavement Management Program focuses on improving pavement management through the analysis of pavement data. One recent project was to develop a Guide for Pavement Management, for consideration and adoption by AASHTO, that discusses technologies and processes pertaining to selection, collection, reporting, management, and analysis of data used in pavement management. Because much of the material needed for Guide development is currently available, the work will focus on compiling, reviewing, and documenting relevant information.

Contact or visit us at:

CE/TTI Building, Room 503
TTI/Pavement Management
Texas A&M University System
3135 TAMU
College Station, TX 77843-3135

979-845-7511
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NAPA National Asphalt Pavement Association

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NAPA is the only national trade association that exclusively represents the Hot Mix Asphalt (HM industry.

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NAPA's professional staff

NAPA Partners
NAPA connects to the Hot Mix Asphalt industry through partnerships with other associations, universities, and government agencies.

What is NAPA?
The National Asphalt Pavement Association is the only trade association that exclusively represents the interests of the Hot Mix Asphalt producer and paving contractor on the national level with Congress, government agencies, and other national trade and business organization: NAPA supports an active research program designed to answer questions about environmental issues and to improve the quality of HMA pavements and paving techniques used in the construction of roads, streets, highways, parking lots, airports, and environmental and recreational facilities. The Association provides technical, educational, and marketing materials and information to its members, and supplies technical information to users and specifiers of paving materials. The Association, which counts more than 1,100 companies as its members, v founded in 1955.

What does NAPA do?
NAPA's staff consists of professionals ready to help its members learn the latest technology, understand environmental issues, gain market share, and receive training. NAPA is the most valuable resource in the Hot Mix Asphalt industry.

Where is NAPA located?
NAPA is conveniently located just outside the Washington Capital Beltway, and just minutes frc downtown Washington, DC. The NAPA office is convenient to all three Washington-area airport: (BWI Airport , Reagan National Airport, Dulles International Airport). For directions to the NAPA office, please [click here].

Who are NAPA Members?
Companies or individuals in the HMA industry that operate on a for-profit basis which include H producers, paving contractors, equipment and materials manufacturers, materials suppliers, equipment distributors, engineering firms, and consultants.

What is Hot Mix Asphalt (HMA) pavement?

Asphalt pavement refers to any paved road surfaced with asphalt. Hot Mix Asphalt is a combination of approximately 95% stone, sand, or gravel bound together by asphalt cement, a product of crude oil. Asphalt cement is heated aggregate, combined, and mixed with the aggregate at an HMA facility. The resulting Hot Mix Asphalt is loaded into trucks for transport t the paving site. The trucks dump the Hot Mix Asphalt into hoppers located at the front of pavin machines. The asphalt is placed, then compacted using a heavy roller, which is driven over the asphalt. Traffic is generally permitted on the pavement as soon as the pavement has cooled.

For questions about NAPA, please e-mail Margaret Cervarich.

NAPA National Asphalt Pavement Association
5100 Forbes Blvd.
Lanham, MD 20706
888-HOT-MIXX (468-6499)
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Office of Highway Policy Information

Pavement Surface Condition of the NHS and Interstate System (Rural and Urban)

NHS

IRI 95-170: 39.0%

IRI < 95: 54.5%

IRI > 170: 6.5%

INTERSTATE

IRI 95-170: 33.4%

IRI < 95: ~~3.2%~~ 63.2

IRI > 170: 3.4%

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FHWA

United States Department of Transportation - **Federal Highway Administration**

International Roughness Index (IRI)

This page describes the International Roughness Index (IRI) used to describe road roughness. It is part of a set of Web pages related to road roughness, and is provided as a service of The University of Michigan Transportation Research Institute (UMTRI).

Background

Almost every automated road profiling system includes software to calculate a statistic called the International Roughness Index (IRI). Since 1990, the Federal Highway Administration (FHWA) has required the states to report road roughness on the IRI scale for inclusion in the Highway Performance Monitoring System (HPMS).

The IRI was proposed by The World Bank as a standard roughness statistic.

The World Bank sponsored several large-scale research programs in the 1970's that investigated some basic choices facing developing countries: should the governments borrow money to build good, expensive roads, or should they save money with poor, cheap roads? It turns out that poor roads are also costly to the country as a whole, due to user costs such as damage to vehicles. Road roughness was identified as a primary factor in the analyses and trade-offs involving road quality vs. user cost. The problem was, roughness data from different parts of the world could not be compared. Even data from the same country were suspect because the measures were based on hardware and methods that were not stable over time.

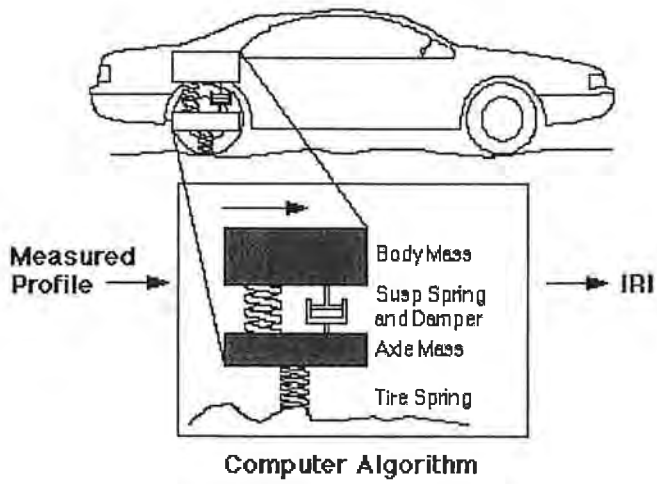
In 1982, the World Bank initiated a correlation experiment in Brazil to establish correlation and a calibration standard for roughness measurements. In processing the data, it became clear that nearly all roughness measuring instruments in use throughout the world were capable of producing measures on the same scale, if that scale were suitably selected. From that point on, an objective of the researchers was to develop the IRI.

The IRI is reproducible, portable, and stable with time.

The IRI is the first widely used profile index where the analysis method is intended to work with different types of profilers. It is defined as a property of the true profile, and therefore it can be measured with any valid profiler. The analysis equations were developed and tested to minimize the effects of some profiler measurement parameters such as sample interval. Example computer programs were published by The World Bank and have been used by profiler developers and others to test new software that computes IRI.

The IRI simulates a standard vehicle with a perfect road meter.

At the time of its development, response-type road roughness measuring systems were common, so the index was tailored to correlate well with the output of these systems. The filter in the IRI is based on a mathematical model called a quarter-car. The quarter-car filter calculates the suspension deflection of a simulated mechanical system with a response similar to a passenger car. The simulated suspension motion is accumulated and divided by the distance traveled to give an index with units of slope (m/km, in/mi, etc.).



Much of the research underlying the IRI was funded by the National Cooperative Highway Research Program (NCHRP). The IRI is based on the "Golden Car" described in NCHRP Report 228.

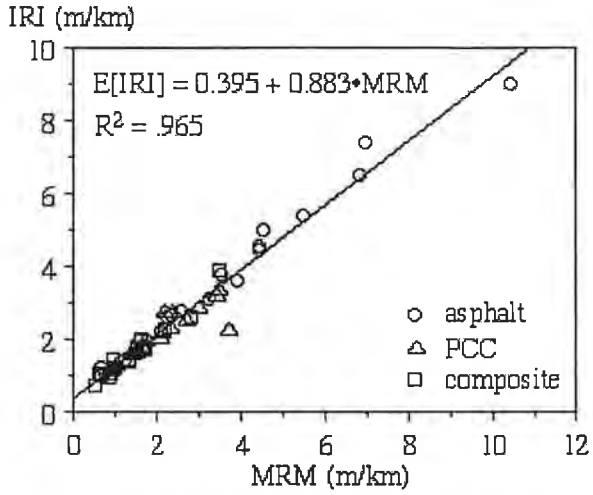
Properties of the IRI Analysis

The quarter-car model used in the IRI algorithm is just what its name implies: a model of one corner (a quarter) of a car. The model is shown schematically in the above figure: it includes one tire, represented with a vertical spring, the mass of the axle supported by the tire, a suspension spring and a damper, and the mass of the body supported by the suspension for that tire.

The quarter-car model was tuned to maximize correlation with response-type road roughness measuring systems.

This quarter-car simulation is meant to be a theoretical representation of the response-type systems in use at the time the IRI was developed, with the vehicle properties adjusted to obtain maximum correlation to the output of those systems. Considerations in its design are described in NCHRP Report 228. The model was called "The Golden Car" at the time, because it was intended to serve as a reference for response-type systems.

The parameters used in the quarter car give it simulated response properties typical of most highway vehicles with one exception: the damping is higher than most cars. This keeps the IRI from "tuning in" to certain wavelengths and degrading correlation with other vehicles. The figure below shows how IRI values from profile data relate to raw measures from a response-type system.



The IRI describes profile roughness that causes vehicle vibrations.

The response of the IRI to sinusoids is intentionally very similar to measured physical response of highway vehicles. It was mainly developed to match the responses of passenger cars, but subsequent research has shown good correlation with light trucks and heavy trucks. The IRI has become recognized as a general-purpose roughness index that is strongly correlated to most kinds of vehicle response that are of interest. Specifically, IRI is very highly correlated to three vehicle response variables that are of interest:

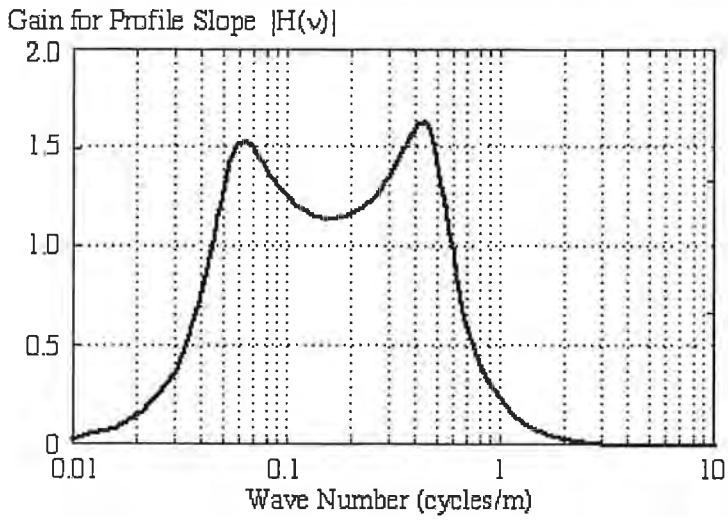
- road meter response (for historical continuity),
- vertical passenger acceleration (for ride quality), and
- tire load (for vehicle controllability and safety).

The IRI is not related to all vehicle response variables. For example, it does not correlate well with vertical passenger position, or axle acceleration.

The fact that IRI correlates well with both road meter response and passenger acceleration is no coincidence: the correlation between road meter response and passenger acceleration was certainly a factor in the decades of acceptance of the road meter as a useful tool for measuring roughness.

IRI is influenced by wavelengths ranging from 1.2 to 30.5 m (4 to 100 ft).

The wave-number response of the IRI quarter-car filter is shown in the next figure. The amplitude of the output sinusoid is the amplitude of the input, multiplied by the "gain" shown in the figure. The gain shown in the figure is dimensionless. Thus, if the input is a sinusoid with an amplitude that is slope, the output is the product of the input amplitude and the value taken from the plot.



The IRI filter has maximum sensitivity to slope sinusoids with wave numbers near 0.065 cycle/m (a wavelength of about 15.4 m) and 0.42 cycle/m (a wavelength of about 2.4 m). The response is down to 0.5 for 0.033 and 0.82 cycle/m wave numbers which correspond to wavelengths of 30.5 m and 1.2 m, respectively. However, there is still some response for wavelengths outside this range.

The IRI scale is linearly proportional to roughness.

If all of the elevation values in a measured profile are increased by some percentage, then the IRI increases by exactly the same percentage. An IRI of 0.0 means the profile is perfectly flat. There is no theoretical upper limit to roughness, although pavements with IRI values above 8 m/km are nearly impassable except at reduced speeds.

The IRI was the first highly portable roughness index that is stable with time.

The IRI is not the first profile-based roughness index. When it was introduced, profilers from different countries and different manufacturers were each used with profile analyses developed for their specific hardware. Most of the analyses were not intended to work with true profile. Those that did had specific requirements for the interval between elevation measures, and gave significant errors when applied to profiles that had a different interval.

The software published by The World Bank was tested by new users, who found that under controlled research tests, they could obtain nearly identical IRI values using different profilers.

Definition of the IRI

The above descriptions of the IRI background and properties are intended to give an idea of what the IRI computer software is intended to simulate, and how you can interpret the IRI scale. However, the IRI is rigorously defined as a specific mathematical transform of a true profile. The specific steps taken in the computer program to compute IRI are listed below.

The IRI is calculated for a single profile.

If your profiler measures several profiles simultaneously, then you can get the IRI for each. The

IRI standard does not specify how you locate the line on a road that defines the profile. Any possible line on the ground has an associated IRI statistic.

The standard does not specify how you combine IRI values for different profiles taken for the same road. They can be averaged, but the result is not IRI--it is the average of several IRI's.

The profile is filtered with a moving average with a 250-mm base length.

The moving average is a low-pass filter (it attenuates short wavelengths) that smoothes the profile. It has no effect unless the profile sample interval is shorter than 167 mm (6.6 in).

The 250-mm moving average filter should be omitted for profiles obtained with some systems.

This step should be omitted if the profile has already been filtered by a moving average or with an anti-aliasing filter whose cut-off attenuates wavelengths shorter than 0.6 m. Profilometers by K.J. Law detect elevation values at intervals of 25.4 mm, apply a 300 mm moving average filter, and store the result at 152.4-mm intervals. It is important to skip the 250-mm filter when processing profiles from these systems.

The profile is further filtered with a quarter-car simulation.

The quarter-car parameters are specified as part of the IRI statistic, and the simulated travel speed is specified as 80 km/h (49.7 mi/h). The output of the filter represents suspension motion of the simulated quarter car.

The filtered profile is accumulated by summing absolute values of the filtered point, and divided by the profile length.

The resulting IRI statistic has units of slope. As a user, you can express the slope in any appropriate units. The most common choices are in/mi and m/km (1 m/km = 63.36 in/mi).

Summary: IRI is a profile index.

The IRI is a specific profile index. The analysis is applied to a single profile, the profile is filtered (twice), the filtered result is accumulated, and finally divided by the length of the profile. The IRI is linearly related to variations in profile, in the sense that if all of the elevation values in the profile are doubled, the resulting IRI will also be doubled.

Software

Two programs are available for the calculation of the IRI. The first is a free user-friendly Windows-based software package called RoadRuf for interpreting longitudinal road roughness profile data, including the calculation of IRI. The second is a sample Fortran program for calculating IRI and RN (Ride Number). It is meant to give developers of profilers and profile analysis software a stripped-down program for getting IRI. Download the IRI source code.

Bibliography

A few of the following documents can be downloaded via FTP. The documentation is in Adobe Acrobat's Portable Document File (pdf) format which can be read by the Adobe Acrobat Reader. For information about Adobe Acrobat Reader, including free copy of the software, visit Adobe's web site: Steps to Downloading the Free Acrobat Reader.

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Everything You Always Wanted to Know about the IRI, But Were Afraid to Ask!

by

Thomas D. Gillespie, Ph. D.
The University of Michigan Transportation Research Institute

Presented at the
Road Profile Users Group Meeting
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Abstract

The International Roughness Index has become the standard scale on which road roughness information is reported both here in the United States [1]* and in many countries of the world. Procedures for determining the IRI are well developed and reliable, yet many users are unaware of the history of its development and the physical significance of this measure of roughness. This paper describes the history of roughness measurement from which the IRI evolved, and explains the physical meaning of the index.

Roughness Measurement in the Past

"Ever since roads and highways have been constructed, the people who use them have been keenly aware of the relative degrees of comfort or discomfort experienced in traveling" [2]. The evidence that remains today from the paved roads of the Roman Empire (see Fig. 1) suggests that roughness must have been a concern for chariot travel. Even in the 1800s, high-speed travel in this country by stage coach had a reputation for rigor directly resulting from roughness of the roadway.

Fig. 1 Photograph of an early Roman road [2]

* Numbers in brackets refer to references at end.

With the introduction of the gasoline-powered motor vehicle at the turn of the Twentieth Century, more people had access to means of high-speed personal travel and the travel speeds rapidly surpassed the limits practical with horses. The increase in speed placed even greater premium on building and maintaining roads with a smooth travel surface.

Those early years saw the first rudimentary attempts to measure the roughness properties of a road. A sliding straightedge, known as the "Viagraph," (see Fig. 2) was one of the first methods to measure roughness by recording the deviation at the center point of the straightedge [2]. The measurement response of the straightedge is indicated by the gain shown in the figure. Long wavelengths (low wavenumbers) produced no response, whereas the gain approached unity at wavelengths equal to or less than the base length of the straightedge. Interestingly enough, the roughness measured by this device was reported in feet of deviation per mile, with 15 feet/mile (180 inches/mile) recommended as the standard for construction.

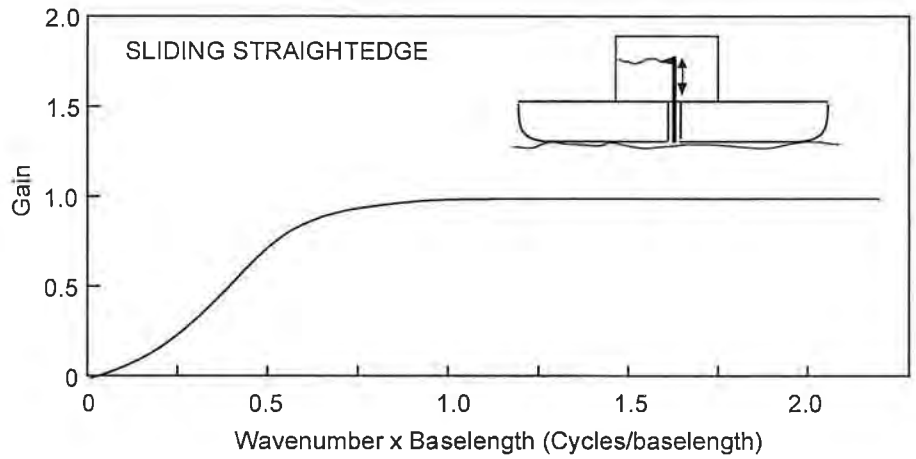

Fig. 2 Response of the sliding straightedge road roughness measuring device

With the obvious disadvantages of the effort to move the sliding straightedge and the wear and tear that resulted, it was not surprising to see development of the rolling straightedge (see Fig. 3). This device had its own unique response to roughness that was different from the sliding straightedge, characterized by the fact that it recorded every bump three times—once when the front wheel passed over, a second time when the measuring wheel passed over, and a third time when the rear wheel passed over. Because the straightedge contacted the road surface at three points, bumps of certain wavelengths recorded at twice amplitude, while others did not record at all. Thus the rolling straightedge "tuned" to certain wavelengths of roughness in the road, while ignoring others.

To overcome this problem the rolling concept was subsequently improved by adding an array of wheels to establish a reference plane from which to measure deviations (see Fig. 4), and remains with us today memorialized as the Profilograph. Bogey attachments for the array of wheels averaged the elevation of all points under the wheels, and roughness was measured as deviation of the center wheel from this reference. With a large number of wheels the response approaches the theoretical limit shown in the figure.

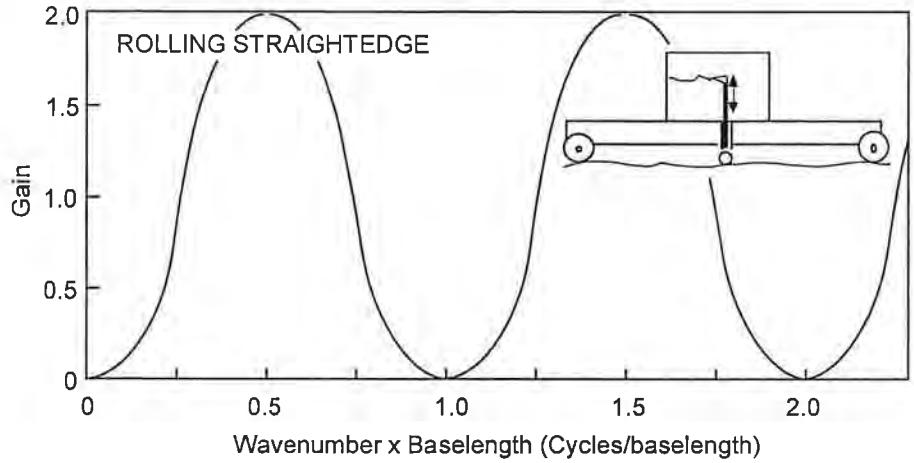

Fig. 3 Response of the rolling straightedge road roughness measuring device

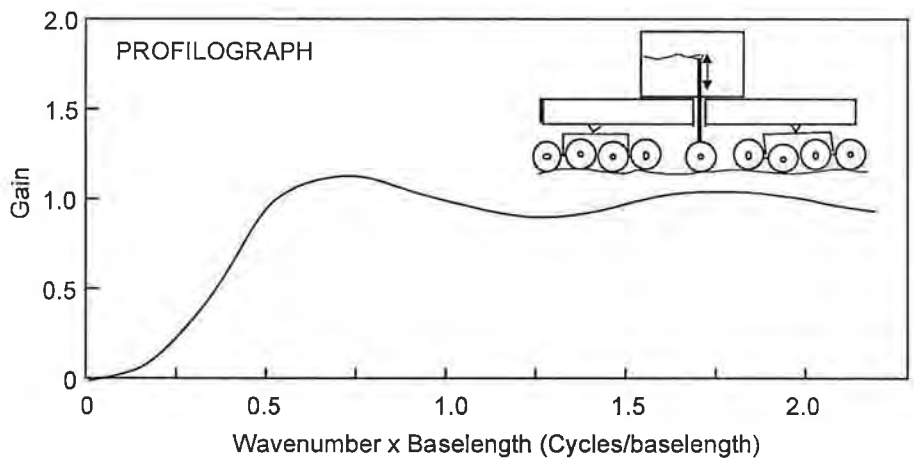

Fig. 4 Response of the Profilograph

With the variation in response properties for each of these measurement devices, it is clear that progress was not being made toward consensus on a universal and standardized measure of road roughness.

By the 1920s highway engineers recognized that roughness properties in a road of greatest importance were those responsible for causing vibrations of motor vehicles. The "Via-Log" developed by the State of New York evidenced this thinking by measuring the suspension travel of a passenger car as an indication of the roughness level. The first devices recorded the suspension motion, but were soon modified to sum the motion on a mechanical counter and measure an "inches/mile" statistic.

Over the next decades the difficulty of obtaining consistent measurements by this method, due to the variations in dynamics of motor vehicles, led to the attempt to "standardize" the vehicle. The Bureau of Public Roads (BPR) Roughometer (later adapted in similar form as the Bump Integrator by the Transport and Road Research Laboratory in

England) was born in 1941. The Roughometer was a single-wheel trailer (see Fig. 5) in which all dimensions, mass properties, and tire and suspensions properties were standardized in an effort to achieve comparable performance on all devices.

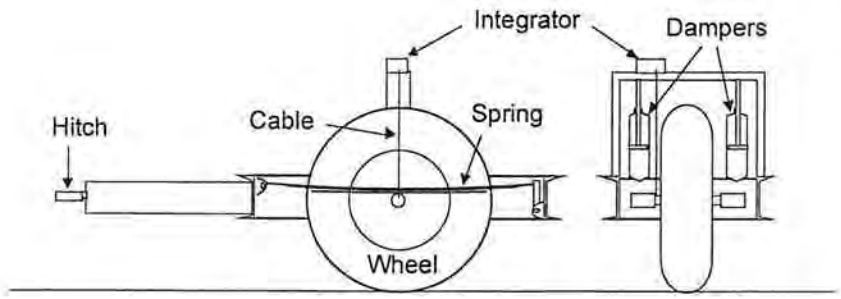

Fig. 5 The BPR Roughometer

One other important roughness measurement device developed at the time of the AASHO Road Test [3] was the CHLOE (an acronym formed from the first letters of the inventors' names). The CHLOE (see Fig. 6) consisted of a trailer towed at a low speed on which was mounted two small wheels 9 inches apart with instrumentation to measure and record the local road slope. The signal recorded was the slope deviation (or slope variance), which is generically an "inches/mile" statistic. The slope variance measured by the CHLOE is of particular significance to highway engineers today as it was the historical reference for roughness used in development of the Pavement Serviceability concept [4]. Despite this special status, the CHLOE is no longer in routine use today.

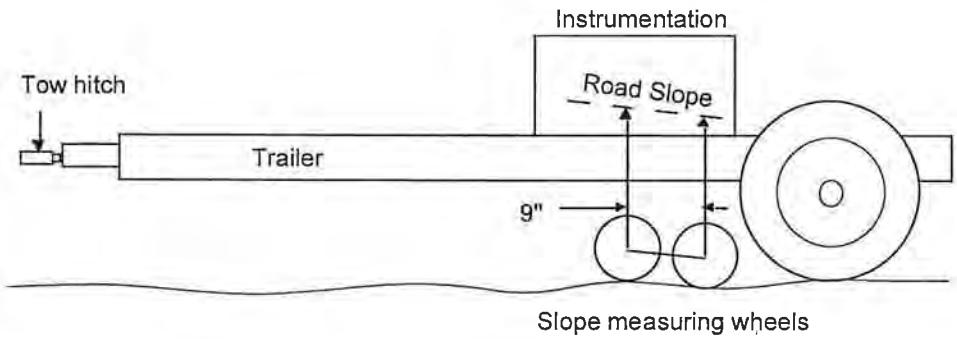

Fig. 6 Illustration of the CHLOE

By the 1960s the attraction of being able to measure roughness properties from a moving vehicle motivated development of "roadmeters" (sometimes called "ridemeters") in the form of the Mays Meter [5], the PCA Meter [6], and other comparable devices. The relatively inexpensive devices could be mounted in any available automobile as shown in Figure 7, and would measure the axle displacement as the vehicle traversed a test section. Most of the roadmeters measured accumulated axle displacement, which is the "inches/mile" deviation of the road surface colored by the dynamics of the vehicle. (The PCA Meter differed in that it would give greater weight to large displacements, but could also be used to simply accumulate displacements like the other meters.) This general class of devices became known as Response-Type Road Roughness Measurement Systems (RTRRMS).

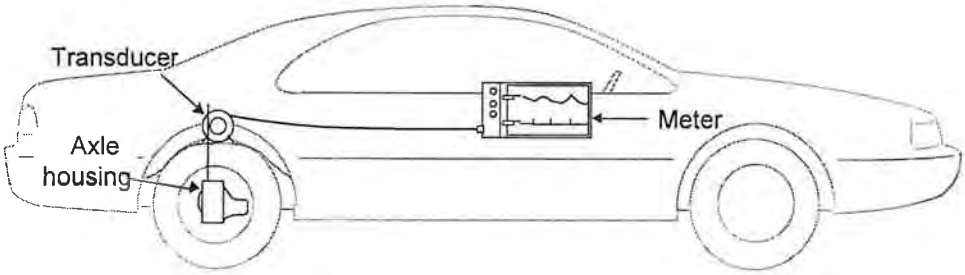

Fig. 7 Illustration of an RTRRMS

Because of their simplicity and low cost, RTRRMS were acquired by the highway departments of approximately half of the states by the late 1970s. Although they reliably measured high "inches/mile" on bad roads and lower numbers on smooth roads, they were not accurate enough for most engineering applications. As might be expected, no two roadmeters gave identical measurements because of differences in the dynamics of the vehicles, and consistent performance from day-to-day with individual roadmeters was also difficult to achieve. Such routine actions as adding fuel or passengers, adjusting tire pressure, balancing tires, etc. changed the "calibration" of the device. As a result it was difficult to develop and maintain a database of road roughness conditions without extensive effort at controlling or compensating for vehicle changes by frequent calibration exercises.

This problem was addressed by the National Cooperative Highway Research Program in 1978 in the Project 1-18 [7], "Calibration and Correlation of Response-Type Road Roughness Measuring Systems," which began the work eventually leading to development of the International Roughness Index (IRI).

The NCHRP project examined the sources of variability in roughness measurement with RTRRMS and identified calibration procedures to compensate for each so that measurements would be consistent and correlatable between different systems. Concurrently, the World Bank faced a similar though broader problem of obtaining comparable measurements of roughness (for data input to highway cost models) in the many countries in which it was providing loans for development of road systems. Although RTRRMs were used in many of these countries, to achieve consistent measurement performance rigorous calibration methods were needed that could be based on technology available at these sites. Equally important was the need for a standard scale of roughness that would be stable over time and transportable throughout the world to allow comparison of measurements on a worldwide basis. To address this problem the International Road Roughness Experiment was organized and conducted in Brazil in 1982 [8].

The outcome of these efforts was the identification of a standard scale now known as the International Roughness Index (IRI). Many factors were considered in its selection:

- The index had to be related to the vibration response of motor vehicles, as most roughness indices were either directly or indirectly linked to motor vehicle performance

- The scale had to be mathematically related to road profile in order to be stable with time (as all attempts to standardize hardware had been unsuccessful)

- It had to be measurable by a widest possible range of hardware (i.e., rod and level, RTRRMS, profilometers, etc.)
- It had to be transportable (i.e., procedures and hardware requirements had to be defined so that it could be reliably reproduced throughout the world).

The Rationale behind the IRI

The International Roughness Index (IRI) is a scale for roughness based on the response of a generic motor vehicle to roughness of the road surface. Its true value is determined by obtaining a suitably accurate measurement of the profile of the road, processing it through an algorithm that simulates the way a reference vehicle would respond to the roughness inputs, and accumulating the suspension travel. Thus it mathematically duplicates a roadmeter.

In virtually all of the measuring systems described above the roughness is quantified by some measure of vertical deviations over a section of road. The cumulative deviations per mile (i.e., "inches/mile") are a summary measure of road slope deviations. Nearly all roughness measurement systems—from the early straightedge devices, to the CHLOE of the AASHO Road Tests, to the roadmeters—measure a slope statistic. However they don't obtain identical measurements because each device has unique sensitivities to different wavelengths in the road as illustrated in the previous figures. There is no such thing as a "true" measure of slope deviations, because over the full range of wavelengths the value is infinite. Finite values are obtained only by limiting the band of wavelengths over which measurements are made. This happens naturally with every measurement system because each has limits to its response, although the limits are often ill-defined and response is variable with wavelength.

In the case of roadmeters, the cumulative stroke of the automobile's suspension is measured over a section of road colored by the particular response characteristics of the automobile. This is what is done in computation of the IRI. The relevant response properties of an automobile are captured by a simple dynamic model known as the quarter-car model shown in Figure 8. At each wheel position the vehicle behaves as a sprung mass sitting on a suspension with stiffness and damping, which in turn is attached to the unsprung mass of the wheel, brake, and suspension components. The wheel contacts the road by a tire which acts like a spring. Road inputs to the car flex the tire, stroke the suspension, and cause the sprung and unsprung masses to vibrate in the vertical direction.

Whether the roughness is viewed as deviations in elevation (displacement inputs), slope (velocity inputs), or change of slope (acceleration inputs) the quarter car responds in a defined manner. The response can be mathematically described with a relatively simple set of dynamic equations known as a quarter-car simulation. At very low frequencies (corresponding to long wavelengths in the road) the suspension response is zero because the wheel and the vehicle body move up and down together. Road inputs at frequencies near one Hertz cause the sprung mass to resonate on the suspension producing stroke that is slightly greater than the road input. The response is maintained up through frequencies near 10 Hertz where axle resonance occurs. Above the axle resonant frequency the response again drops to zero as the road bumps simply deflect the tire without producing significant suspension stroke.

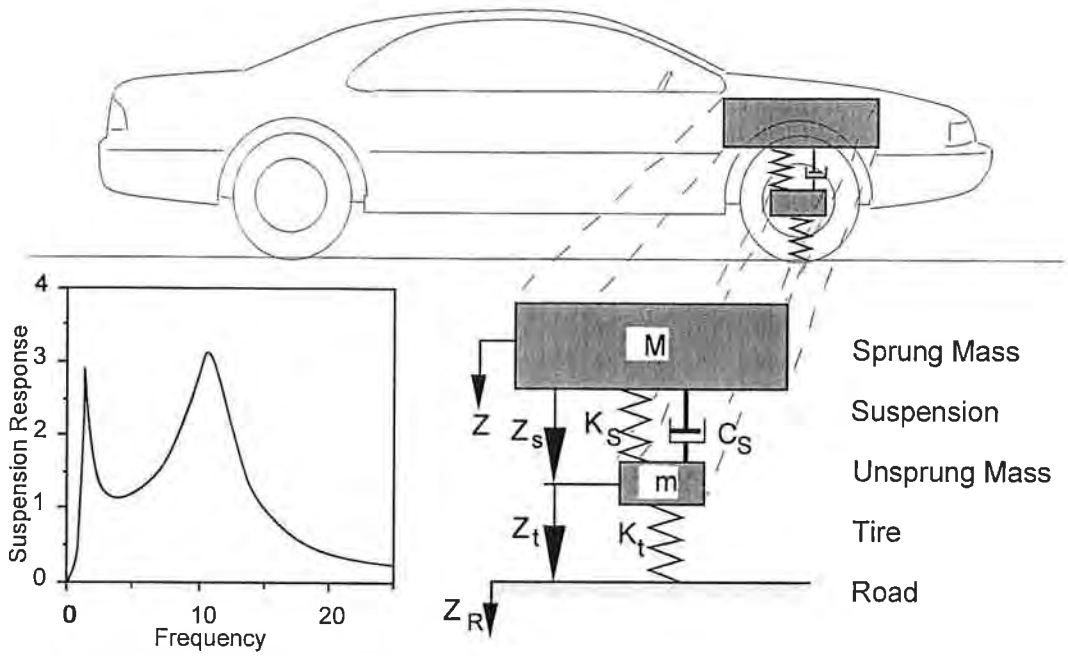

Fig. 8 The quarter-car model

The frequency response of the quarter car extends from approximately 0.5 to 20 Hz. with some emphasis on roughness at the body bounce frequency and the axle resonance frequency. Although this differs from the response properties of the other devices shown earlier, it is more uniform in the waveband of measurement than many of the devices; and more importantly, it is characteristic of motor vehicle dynamics. The rationale favoring the quarter car is the fact that it covers the appropriate frequency range responsible for exciting vehicle vibrations and emphasizes those that excite modal resonances.

The measurement of suspension stroke as the roughness response was chosen for convenience back in the early development period of the "Via-Log" and roadmeters. Although it was not known at that time to be a valid measure of "ride" it turns out to be a reasonable approximation. The "ride" of a motor vehicle is most commonly measured by the acceleration on the body. On a typical road this turns out to be a body acceleration spectrum (a power spectral density, or PSD) similar to that shown in Figure 9. Also shown in the figure is the PSD from which the IRI accrues. Although slightly different in shape, they both cover the same frequency range and both place emphasis on the one Hertz body resonance and the 10 Hertz axle resonance.

Roughness is also significant to motor vehicle performance in other ways. The existence of roughness necessitates suspension systems on motor vehicles to reduce the vibration exposure of passengers. A primary consideration in design of suspension systems is the stroke necessary to accommodate the displacements caused by roughness. (Ride improves with stroke. The more generous suspension stroke in a luxury car is the primary factor that allows it to ride better than compact cars.) Thus, the likely stroke in the suspension must be rationalized with available package space in a vehicle. A relevant roughness measurement should therefore encompass the qualities that determine

suspension stroke requirements. The PSD for suspension stoke shown in Figure 9 reveals that the body resonant mode, which is captured by the IRI, is dominant.

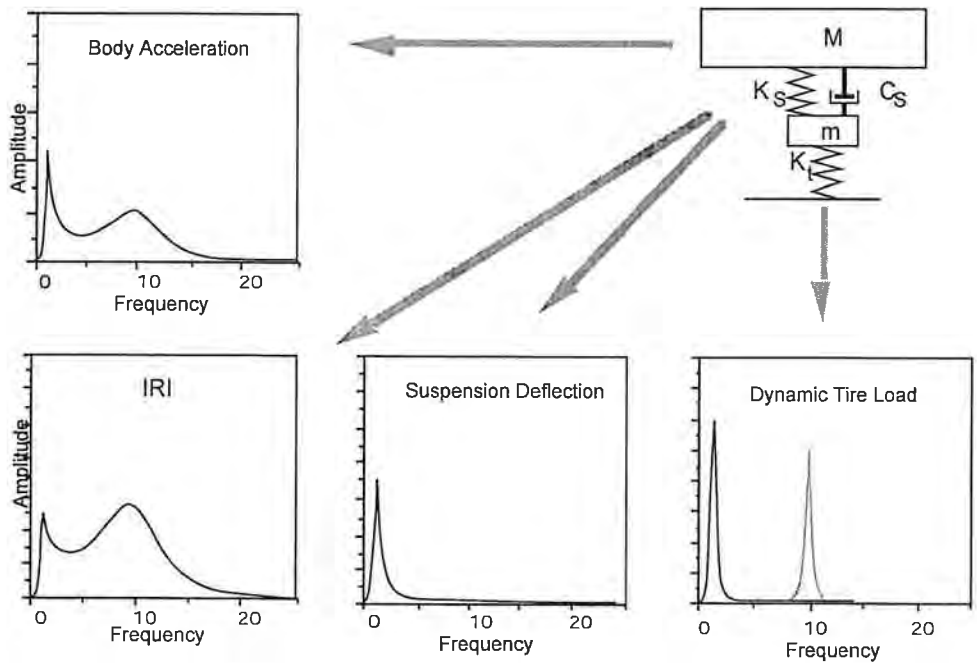

Fig. 9 Comparison of IRI with other vehicle responses

Finally, the dynamic load variations caused by roughness reduce the road holding ability of tires and contribute to road damage from heavy trucks. The PSD of dynamic tire load shown in Figure 9 is dominated by motions at the body resonant frequency for most vehicles. One exception of special concern to the highway community is the truck with a walking-beam tandem suspension which may also generate dynamic loads at about 10 Hz (the light curve in the figure).

Because of the similarity in the response between these various modes of vehicle performance, roughness measured on the IRI scale is closely related to each mode of performance. Figure 10 shows data from the International Road Roughness Experiment [9] relating Pavement Serviceability Index (PSI) to IRI. Inasmuch as serviceability ratings are dominated by vehicle ride perception [4], a close correlation with IRI roughness is expected. The data in the figure show a precise relationship which is approximated by the simple equation:

$$PSI \approx 5.0 - IRI/100 \qquad \text{for } 0 < IRI < 300 \text{ (in/mile)}$$

Other research looking specifically at the correlation of ride ratings and roughness wavelengths in the road [10, 11] have concluded that the quarter-car response is less than optimal. The best correlation was obtained when roughness measurement is limited to wavelengths corresponding to the axle-hop resonance of the car. While the correlation coefficients were higher for this limited band of wavelengths, those for the quarter-car reflected in IRI measures were still quite high. Limiting the band of wavelengths to achieve slightly higher correlation with ride has the disadvantage that it excludes roughness that

excites body motions important to dynamic loading. I.e., the roughness measurement specifically "tuned" to ride misses other important roughness qualities in the road.

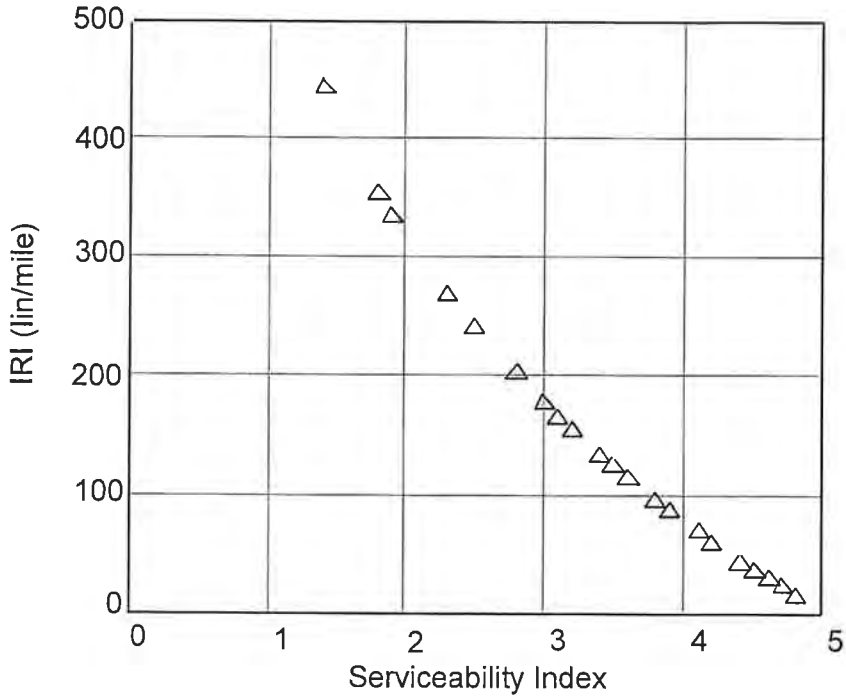

Fig. 10 Correlation of IRI with Serviceability Index [9]

The ability of IRI to measure roughness important to dynamic loading was demonstrated in a research project in which dynamic loads were measured on trucks with three different suspensions [12]. Figure 11 shows the relationship between roughness and the dynamic load expressed as a Dynamic Load Index. The Dynamic Load Index (DLI) is defined as the standard deviation of the load normalized by the static load. Thus, an index of zero implies the load is its static value, whereas an index of 0.25 represents load variation for which the standard deviation is 25% of the static load.

As seen in the figure, the dynamic load for the torsion-bar and walking-beam suspensions increases in direct proportion to the IRI roughness. This is as expected because the IRI scale includes roughness wavelengths that excite body bounce and pitch motions in trucks that are responsible for most of the load variation. (Although not proven here, dynamic loads for the walking-beam suspension are higher due to the strong axle-hop resonance in this suspension [13]. The wavelengths that excite this motion are also captured in the IRI, so it is an appropriate index of roughness for this vehicle as well.)

The relationship between IRI and the DLI for the leaf-spring suspension is not as linear as for the other suspensions. This arises from the fact that leaf-spring suspensions have high levels of coulomb friction. On smooth roads these suspensions exhibit high stiffness and little damping (accounting for the high initial increase of DLI with roughness). On rough roads, however, the suspension softens and increases damping, which limits the increase in DLI as the roads get rougher.

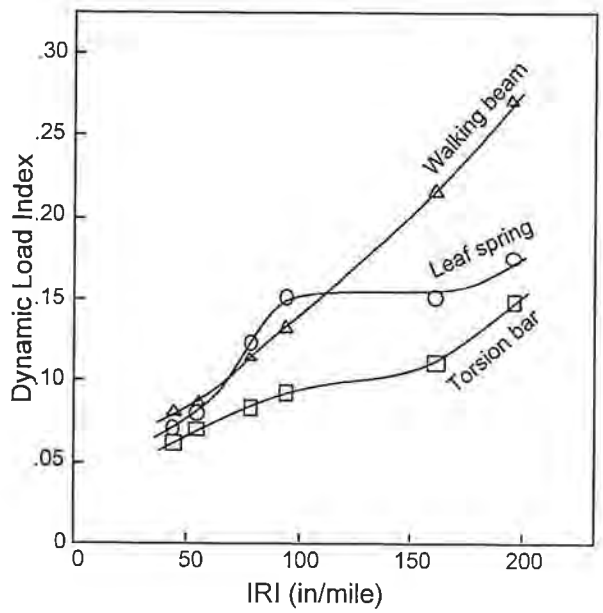

Fig. 11 Relationship of RTRRMS roughness to truck dynamic load [12]

Finally, Figure 11 illustrates one other important aspect of the precision that can be achieved by using the IRI roughness scale. Although there were no "perfectly" smooth roads (zero IRI) in these tests the slopes of the curves nominally project to a DLI value of about 0.05 at zero roughness. This corresponds to dynamic loads generated not by the road, but by nonuniformities (imbalances and runouts) in the tires of the trucks under test. Specifically, it is evidence that a typical truck has dynamic load variations on its axles of about 5% of the static load due to the truck itself, not road roughness.

Speed and Wheel Track Options of the IRI

While the discussion above presents the rationale that drove the choice of a quarter-car based roughness scale, the fact that it emulates a vehicle leaves choices as to how it is implemented, specifically with regard to the travel speed assumed for the calculation and the option for evaluating roughness of individual wheel tracks or combined left and right tracks.

Speed—On any road the level of roughness to which a vehicle is exposed depends on the travel speed. The perceived roughness generally increases with speed. This arises from the fact that the forces and accelerations imposed on a wheel by a bump increase with the speed at which it must "follow" the bump. Thus, roughness to the road user is not a constant, but may be judged differently on low- and high-speed roads. However, to the highway community roughness is a geometric property of the road. The geometry is constant, therefore a road should have a single roughness value.

To accommodate the differences in these viewpoints, the IRI is based on quarter-car response at 50 mph (80 km/h). A fixed speed for evaluating IRI ignores the fact that the prevailing travel speed varies with different types of roads. Thus, the choice of a fixed speed is a compromise between needs of the highway engineer and the realities of the physics governing vehicle behavior.

However, it should be recognized that the compromise is not unique to the IRI. Any geometrically based measurement of roughness—specifically measures that depend on a particular band of wavelengths—do exactly the same thing. The choice of allgeometrically-based measures has been driven by the goal of evaluating a quantity that is closely correlated to vehicle response. Thus the band of wavelengths selected is implicitly linked to an assumed vehicle travel speed, although that bias is usually unrecognized. The only difference is that the IRI explicitly reflects a chosen speed.

Single- vs. dual-track measurement—Another aspect of IRI measurement that can be confusing to the user is the choice of single- versus dual-track measurement. The common roughness measurement practices in use differ in treatment of wheel tracks. All profiling devices and all single-wheel RTRRMS (e.g., the BPR Roughometer) can measure single-track roughness. However, RTRRMS that use an automobile for the host vehicle are dual-track measurement devices. This arises from the fact that the roadmeter measures the average displacement of the left and right wheels.

The "minor" difference in methods, however, is not trivial in its consequences. Each wheel track has unique roughness features that contribute to bounce and roll of a motor vehicle. Measurements of individual wheel tracks quantify the total magnitude of the surface deviations. A car-based RTRRMS only measures the bounce component associated with the average deviation of the two wheel tracks. Thus, the IRI value from an car-based system is inherently 10% to 20% lower than the average of the IRI values of the two wheel tracks, and this factor must be taken into account in the calibration process.

The IRI calculation method has the flexibility to allow measurement in either fashion, however the single-track measurement has been selected as the standard. (Dual-track measurements from an RTRRMS are duplicated by the half-car simulation and should be denoted as HRI values rather than IRI values [14].) The single wheel track method provides more complete information about a road at the cost that two numerical values must be recorded. The unfortunate aspect is that averaging the IRIs from two wheel tracks is not identical to the average obtained with a car-based RTRRMS. This is not a fault of the IRI, but a consequence of the physical differences in the measurement process. IRI computed from an "average" left and right elevation duplicates car-based RTRRMS measurement, but at a loss in information about the road. Inasmuch as most roads deteriorate more rapidly in the right wheel track, the single track values provide a more precise indication of road condition.

Closure

The objective of this paper was to point out for those who must use the IRI today the historical basis from which it evolved. Roughness measurement technology developed around the conviction that imperfections in the surface geometry of a road were primarily important because of the vibrations induced in road-using vehicles. That conviction later transformed into a principle when Carey and Irick [4] identified roughness as the most important component in Present Serviceability. With that proof it was natural to see measures of vehicle response emerge as roughness indices. The development that led to the IRI was simply a formalization of the existing practice used by the highway community for measuring road roughness.

In the course of the development, consideration was given to alternative measures of vehicle response. For example, root mean square (RMS) of suspensions stroke was considered in lieu of the average rectified value (used by roadmeters) because of its greater mathematical utility. Likewise, the RMS body acceleration was considered in place of suspension stoke because of its more direct link to ride. However, no significant advantage was gained from the alternatives. The average rectified stroke was so similar to the others that it was incorporated in the IRI, thereby allowing highway agencies to maintain continuity of their roughness data bases.

The IRI is unique among roughness indices in the ease of measurement and the extent to which its measurability has been demonstrated. The World Bank experiments have validated that it can be measured by an extensive range of equipment including rod and level, Mays Meter cars, NAASRA car, French APL, BPR Roughometer, TRRL Bump Integrator, TRRL Beam, Swedish Road Surface Tester, ARAN, Face Dipstick, GMR-type Profilometers, South Dakota-type Profiling System and others. For each type of hardware, required procedures have been defined along with the level of accuracy to be expected, and these principles have been tested throughout the world. The rod and level method for measuring profiles from which to calculate IRI is now reduced to a standard method [15]. Thus, the IRI today provides highway engineers with a proven and robust basis for comparing roughness information across institutional boundaries.

The IRI is often criticized because it is not the "best" index for quantifying specific road roughness qualities or does not conform to local preferences for a roughness index. The most notable example of this comes from the extensive research that has been done to develop a roughness index that specifically relates to ride. The work by Janoff [10, 11] has identified profile wavelengths of 1 to 16 feet as most closely linked to passenger car ride, resulting in a Ride Number index that is the mean square amplitude of the profile in this range. Yet, from our knowledge of the broader issues in vehicle dynamics it is expected that Ride Number will prove inferior to other indices, particularly the IRI, in quantifying roughness relevant to truck ride and dynamic loads.

The fact that one index is better at quantifying a specific profile quality should not impede the acceptance of the IRI as a current measurement standard. As knowledge and technology develops for roughness measurement, it should be expected that a number of specialized profile indices will emerge as the "best" measure of specific roughness qualities. The development of new indices should not serve to discredit others. Rather, we need to recognize that each roughness index adds to our knowledge of road surface condition, and be prepared to maintain data bases of multiple indices as technology develops. At this time the IRI is the roughness measure of broadest utility (because it encompasses all wavelengths significant to motor vehicles) and should be the cornerstone of a roughness data base. Eventually, other indices should be added, as developed, to quantify surface profile properties related to specific performance qualities such as passenger-car ride, truck ride, dynamic loads, damage potential from dynamic loads, road holding, cracking and such. As it turns out, the highway engineers who developed the roughness measurement methods now in use and formalized by the IRI, made a choice that was not only rational then, but will remain so for the decades ahead.

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11. Janoff, M. S., "Pavement Roughness and Rideability Field Evaluation." NCHRP Report No. 308, 1988, 48 p.
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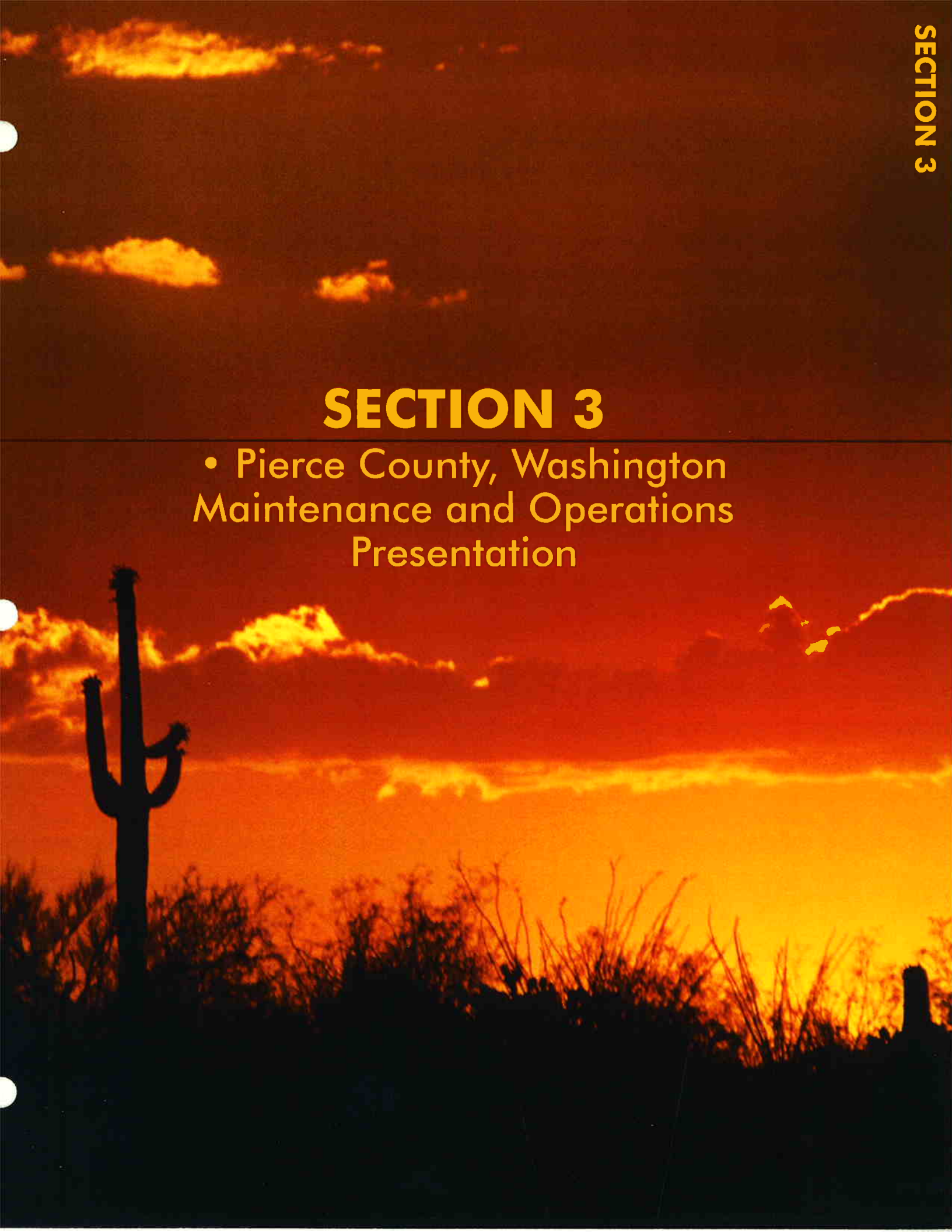
SECTION 3

• Pierce County, Washington Maintenance and Operations Presentation



Who Are We & What Do We Do?

- **Mission & Goals of Pierce County Roads**
  - Maintenance
  - Operations
  - Preservation
  - Improvements
  - Administration

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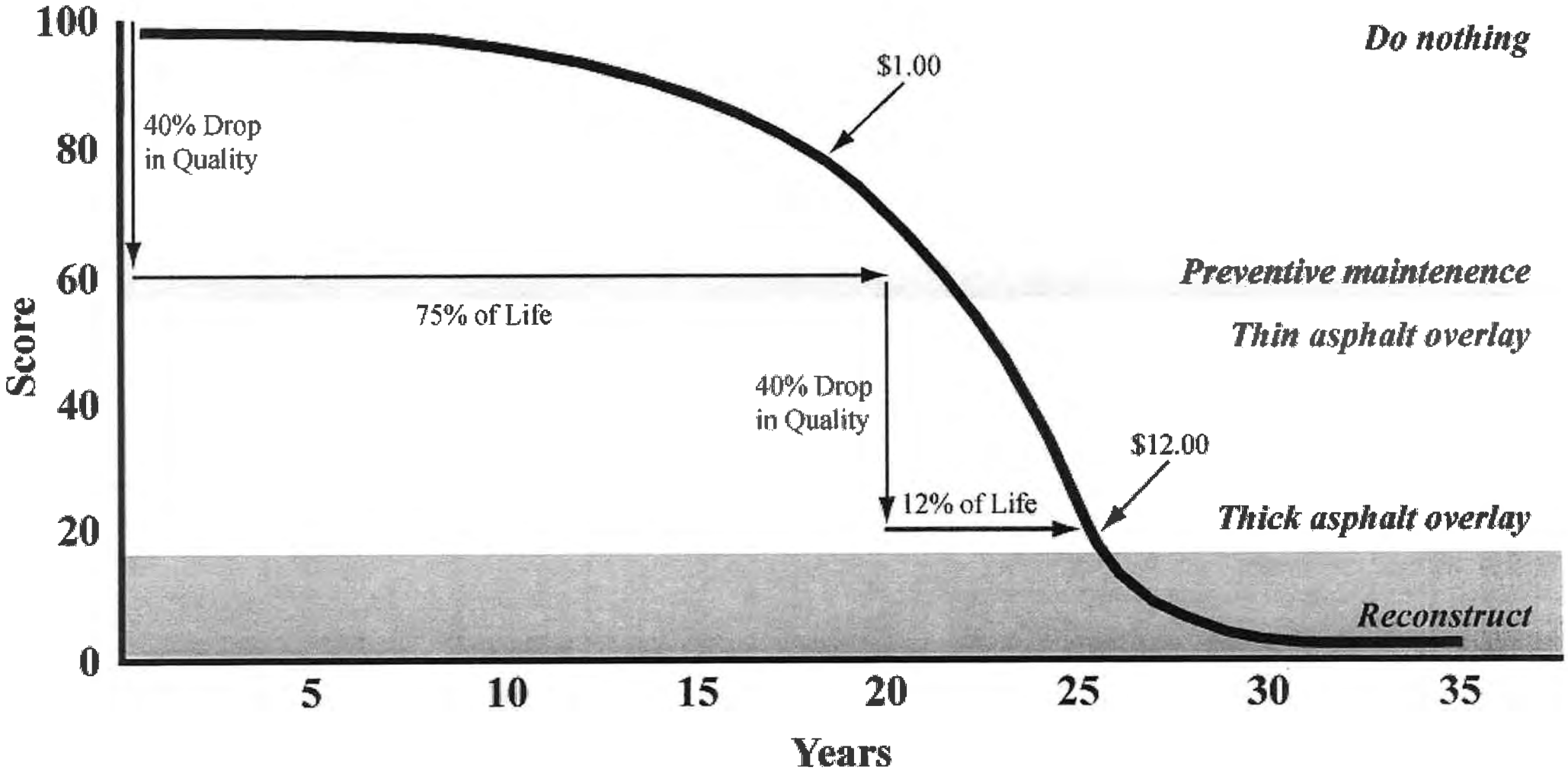
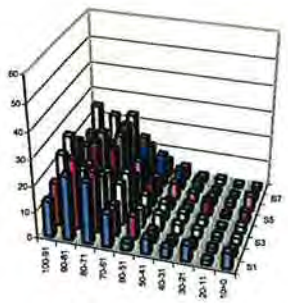
Typical Pavement Life Curve

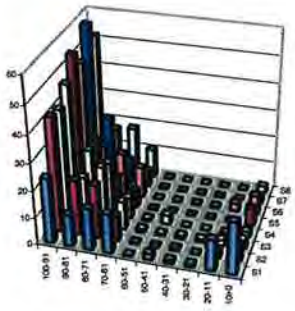


Current Deferred Maintenance in 2004 = ıction in 2004 = $28,049,353
Deferred Maintenance in 2013 = 2013 = $27,389,385

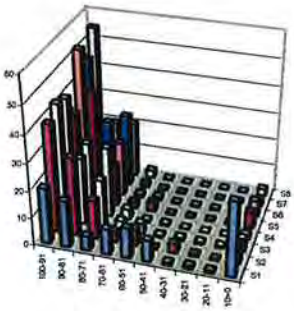
2004 Current



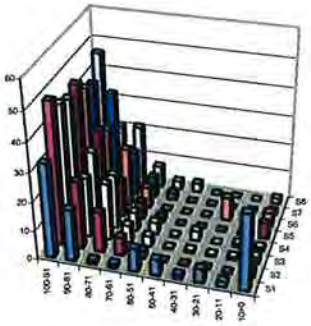
2007 optimized



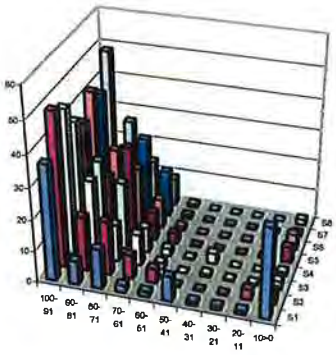
2008 optimized



2012 optimized



2013 optimized



nance		Total Lenths in Feet	
Total Costs	Deferred Costs	Select	Defer'd
1,499,958	$7,204,059	425.48	1445.51
1,499,960	$8,687,177	439.96	1463.83
1,499,977	$7,637,898	443.15	1238.39
1,499,360	$6,068,241	426.51	1197.19
1,499,604	$5,498,916	423.24	1185.81
1,499,382	$4,094,357	417.25	1263.85
1,499,842	$3,450,678	402.43	1266.74
1,499,030	$3,578,173	422.71	1279.94
1,499,637	$6,041,585	431.66	1291.51
1,497,834	$4,618,799	401.64	1316.74
:14,994,584			

Who Are We & What Do We Do?

Mission & Goals of Pierce County Roads

- **Maintenance**
  - **Day-to-Day Upkeep and Repair of the Road System**
- **Operations**
  - **Day-to-Day 24/7**

- Maintenance
  - Cleaning the gutters / mopping the floor
- Operations
  - Heating and cooling the house / responding to emergencies
- Preservation
  - Painting the house / Re-roofing the house
- Improvements
  - Adding on a room for the new baby / major remodeling of the kitchen
- Administration
  - Planning for the future / putting together the monthly budget

8/6/2004

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Who Are We & What Do We Do?

Mission & Goals of Pierce County Roads

- **Maintenance**
  - Day-to-Day Upkeep and Repair of the Road System
    - Pothole patching and crack sealing
    - Roadside vegetation management
    - Shoulder grading
    - Roadside litter removal
    - Street sweeping
    - Stormdrain cleaning and repair
    - Bridge cleaning and repair

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Who Are We & What Do We Do?

Mission & Goals of Pierce County Roads

- **Operations**
  - Day-to-Day 24/7 Running of the Road System
    - Traffic signs
    - Signals and illumination
    - Pavement markings
    - Traffic counting
    - Traffic studies
    - Crash records and analysis
    - Snow and ice removal
    - Disaster response

8/6/2004

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Who Are We & What Do We Do?

Mission & Goals of Pierce County Roads

- **Preservation**
  - Extending the Life of the Road System
    - Pavement overlays
    - Chip seals
    - Slurry seals
    - Bridge Painting

8/6/2004

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Who Are We & What Do We Do?

Mission & Goals of Pierce County Roads

- **Improvements**
  - Expanding or Enhancing the Road System to Serve Long Term Needs
    - Congestion / Concurrency
    - Design Standards / Safety
    - Efficiency
    - New Corridors
    - Economic Development

8/6/2004

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The Five P's of Decision Making

	Maintenance	Operations	Preservation	Improvements	Administration
Policies	-CRAB Standards of Good Practice -Maintenance Quality Standards	-MUTCD -County Rd Standards -Snow & Ice Removal -Policy/Procedures Manual	-CRAB Standards of Good Practice -Pavement Management System	-State Law (RCWs) -CRAB Standards -County Code -Comp. Plan-Transp. Element -Capital Facilities Element	-State Law (RCWs) -CRAB Standards -Pierce County Code -Comprehensive Plan -PC Admin. Guidelines -State BARS -B & F Policy Manual
Plans	-Road Maintenance Management System (RMS) -Vegetation Management Plan	- Road Maintenance System (RMS) -Snow and Ice Plan -Hazardous Materials Response Plan -All Hazards Response Plan	-Pavement Management System -Surface Treatment Plan	-Comprehensive Plan	-Comprehensive Plan -Title VI - Civil Rights Act of 1964
Prioritization Systems	-Road Maintenance Management System (RMS) -Pavement Management System	-Guardrail -Signalization -Limited Sight Distance -Snow and Ice Plan -Hazardous Materials Response Plan -All Hazards Response Plan	-Pavement Management System -Surface Treatment Plan	-Existing Roadways -Concurrency -Traffic Signals -Bridges -Limited Sight Distance	
Programs	-Vegetation Management Program -Budget -Road Sweeping Program - Adopt-a-Road	-Traffic Signs -Markings -Striping -Signals -Illumination -Snow & Ice Removal	-TIP -Chip seal program -Slurry seal program -Asphalt overlay program	-TIP - 6 year -Grants	-CTR
Projects	-Maintenance Accountability Program Development	-Controller Replacement -Sign Face Upgrade -Ped Head Conversion -Liquid De/Anti-icer Research	-Annual Element -Rubberized chip seal evaluation	-Annual Road Budget Program	-Planning Studies -Traffic Impact Fee Development -Time Track Project Cost System Support of RMS Virtual Vault Records System

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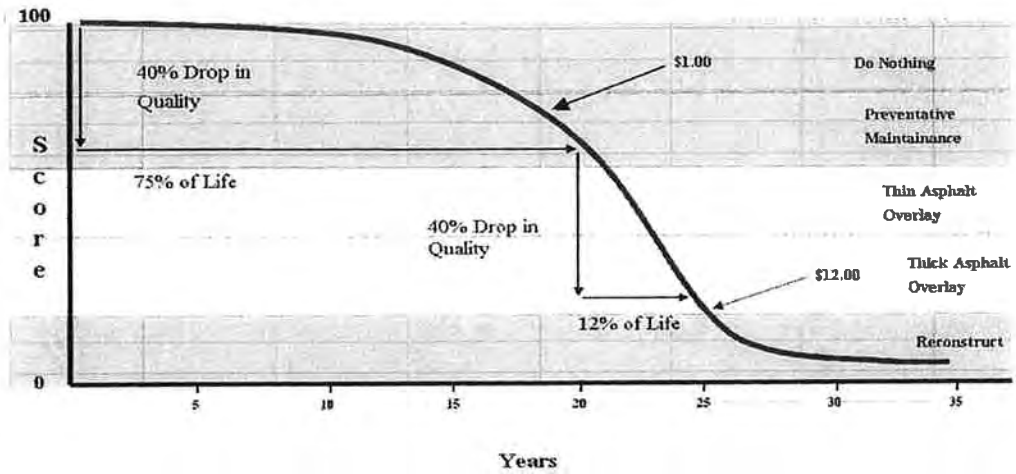
Who Are We & What Do We Do?

The Five P's of Decision Making

Typical Pavement Life Curve



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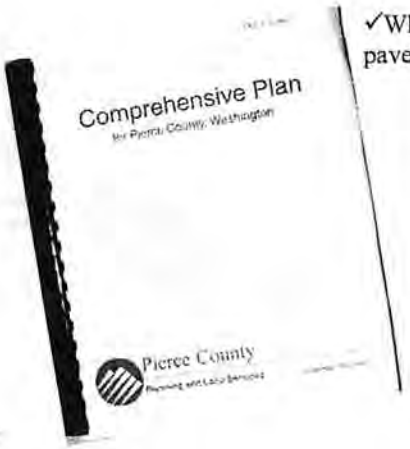
Who Are We & What Do We Do?

The Five P's of Decision Making

✓How do we decide what to do with pavement preservation and when?

✓What is lowest lifecycle pavement cost?



Pierce County Road Operations
Pavement Preservation Life Cycle Summary
Total Hard Surface Lane Miles = 3,092

Unit Cost Per Lane Mile:
Asphalt Overlay = $52K
Chip Seal = $ 6K
Chip/Slurry = $13K
Slurry = $7K

Urban Life Cycle		
Arterial Major Life Cycle = 18 Years	Arterial Minor/ Collector Life Cycle = 20 Years	Local Access Life Cycle = 12 Years
Year One - Asphalt Overlay	Year One - Asphalt Overlay	Year One - Chipseal/ Slurryseal
Year Twelve - Chipseal	Year Fourteen - Chipseal	Year Six - Slurry Seal
Year Eighteen - Asphalt Overlay (New Cycle)	Year Twenty - Asphalt Overlay (New Cycle)	Year Twelve - Chipseal (New Cycle)
608 Lane Miles	337 Lane Miles	1387 Lane Miles

Rural Life Cycle		
Rural Arterial Major Life Cycle = 20 Years	Rural Arterial Minor/Collector Life Cycle = 6 Years	Rural Local Access Life Cycle = 8 Years
Year One - Asphalt Overlay	Year One - Chipseal	Year One - Chipseal
Year Fourteen - Chipseal	Year Six - Chipseal (New Cycle)	Year Eight - Chipseal (New Cycle)
Year Twenty - Asphalt Overlay (New Cycle)		
1231 Lane Miles	377 Lane Miles	460 Lane Miles

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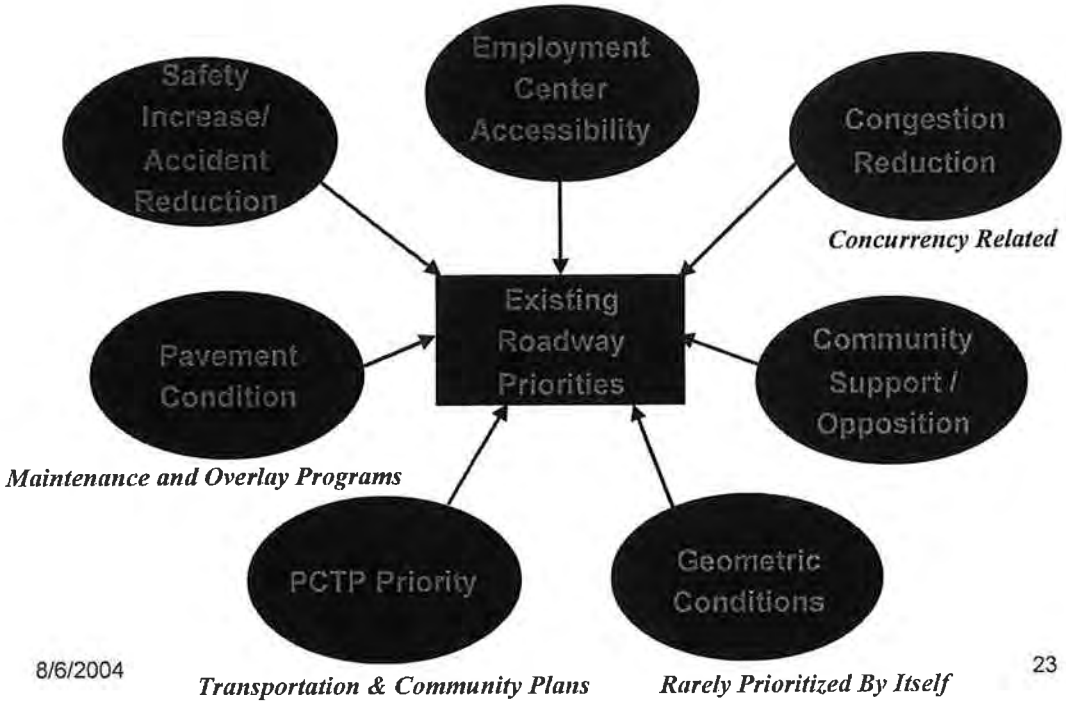
Existing Roadway Priority Criteria

Much of this Criteria Similar to TIB and RAP Criteria



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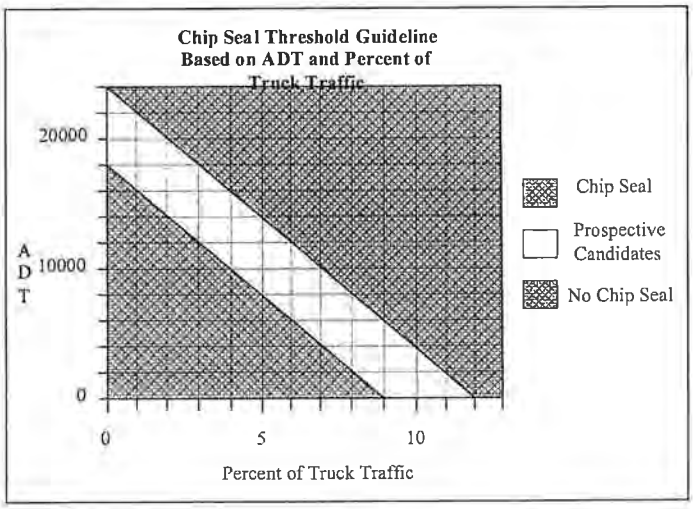
Who Are We & What Do We Do?

The Five P's of Decision Making

If chip sealing is more affordable, why not chip seal all the roads?



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Who Are We & What Do We Do?

Standards

- **Operations**
  - Road Maintenance System
    - Routine preventive maintenance
    - Repairs & operational enhancements
    - Sign & signal emergency response
  - Manual On Uniform Traffic Control Devices
  - Policy 922 – Traffic Impact Review

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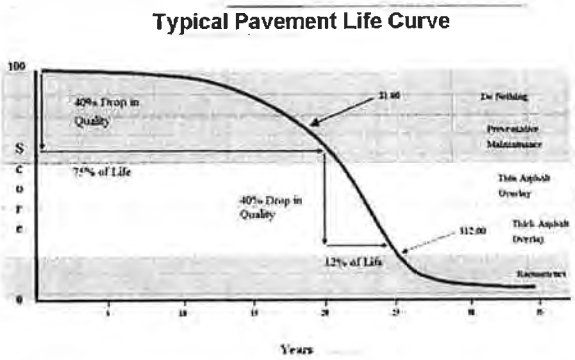
Who Are We & What Do We Do?

Standards

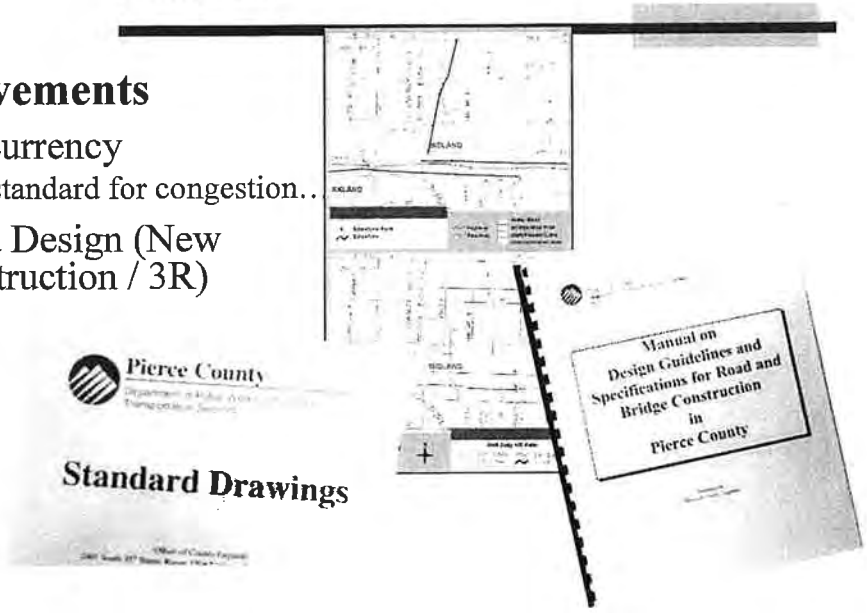
- **Preservation**



Who Are We & What Do We Do?

Standards

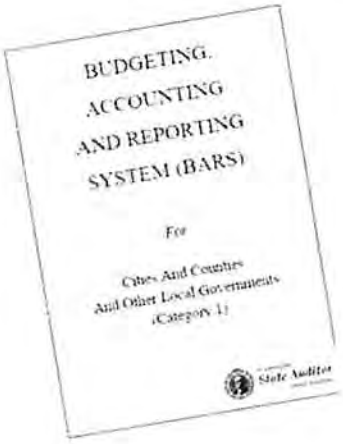
- **Improvements**
  - Concurrency
    - A standard for congestion..
  - Road Design (New Construction / 3R)



Who Are We & What Do We Do?

Standards

- **Administration**
  - GASB (Governmental Accounting Standards Board)
  - BARS (Budgeting, Accounting and Reporting System)


BUDGETING,
ACCOUNTING
AND REPORTING
SYSTEM (BARS)

For

Cities And Counties
And Other Local Governments
(Category 1)

State Auditor

GASB
Governmental Accounting Standards Board

8/6/2004

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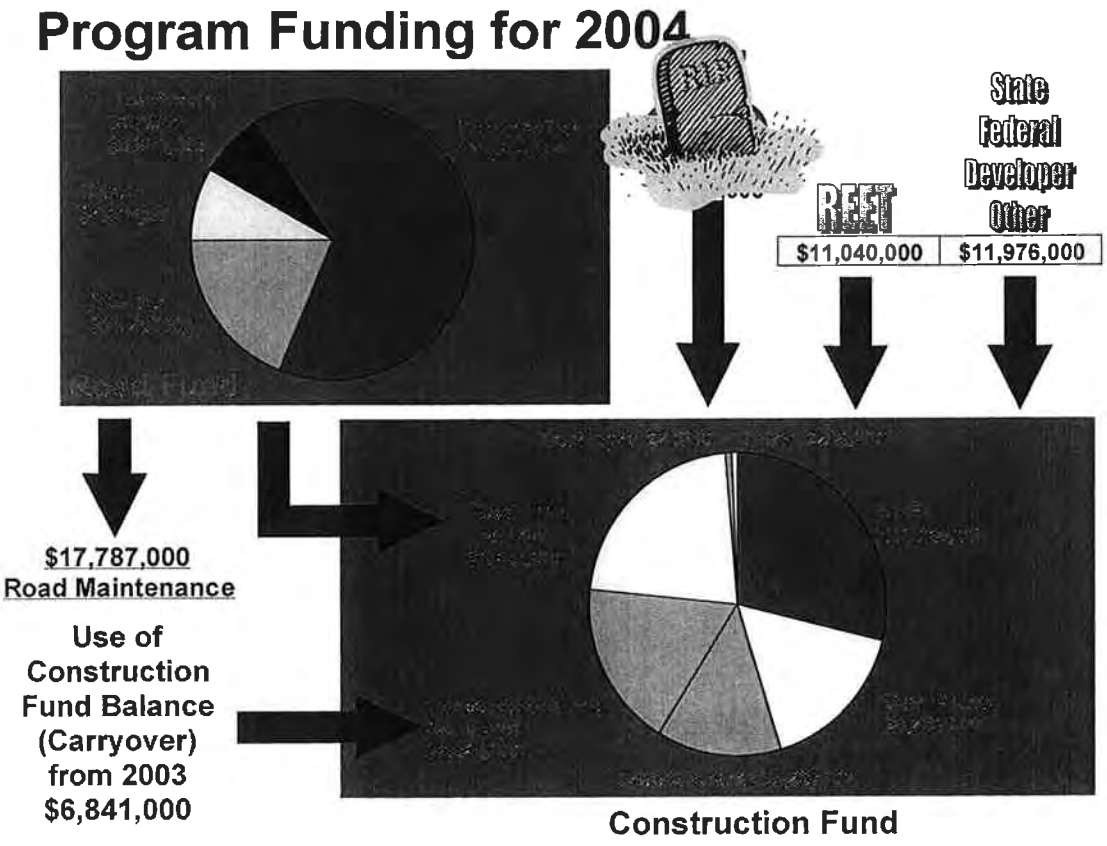
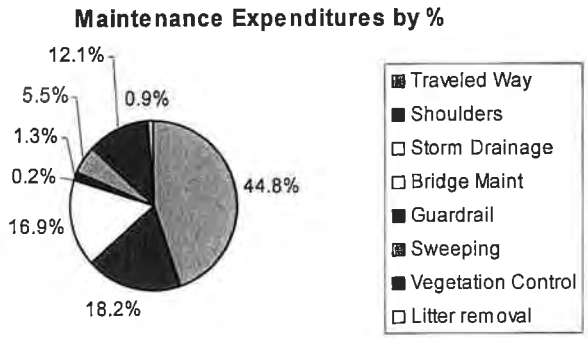

Program Funding for 2004
RAP
State
Federal
Developer
Other
REET
$11,040,000
$11,976,000
$17,787,000
Road Maintenance
Use of
Construction
Fund Balance
(Carryover)
from 2003
$6,841,000
Construction Fund

Where Have We Been & What Have We Accomplished?

Maintenance Accomplishments

(Annual work based on 5 year average)

- **Over 30,000 tons of asphalt repairs**
- **Over 900 miles of shoulders graded**
- **Over 65,000 feet of pipe cleaned**
- **Over 4,000 lane miles swept**
- **Over 2,400 shoulder miles mowed**
- **500,000 lbs of roadside litter removed**



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Where Have We Been and What Have We Accomplished?

Operations Accomplishments (Traffic)

(Annual work based on 5 yr average)

- **1,800 line miles striped**
- **120,000 sign inspections**
- **20,000 sign repairs**
- **4,000 signal indications relamped**
- **900 preventive signal maintenance checks**
- **1,000 traffic counts**
- **2,200 accident reports coded**
- **200 development traffic impact reviews**
- **300 citizen concerns reviewed**

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Where Have We Been & What Have We Accomplished?

Preservation Accomplishments

(Annual amount based on 5 yr average)

- **Over 270 lane miles chip sealed**
- **Over 30 lane miles slurry sealed**
- **Over 17 lane miles asphalt overlaid (Approximately 170 miles over 10 years)**

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Where Have We Been & What Have We Accomplished?

Improvements Accomplishments (1993-2004)

- $94.1 million Roadway Construction including Traffic Signals
  (Includes Construction and Engineering Related Costs)
- $48.6 million Bridge Construction/Rehabilitation
  (Includes Construction and Engineering Related Costs)
- $5.9 million Ferry Boat Construction
- Other
  - $29.5 million in Right of Way Acquisition
  - $7.1 million in Corridor Studies / Establishments
  - 200 Lane-Miles of Base Stabilization
  - 41,200 Lineal Feet of Guardrail Replacement
  - 34 Acres of Wetland Creation / Enhancement / Banking

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Where Have We Been & What Have We Accomplished?

Administration Accomplishments

- 10 Transportation Improvement Programs
- Transportation Plan
- Non-motorized Transportation Plan
- 4 Community Plans
  - Gig Harbor, Parkland Spanaway Midland, South Hill, Frederickson
- Transportation Concurrency Management Systems
- CTR Program
  - Increased Annual Participation from 87 to over 350
  - Total # of participants = 900
- Proposed Traffic Impact Fee Program
- Annual Maintenance and Update of County Road Log System
- Acquisition of over $70 million of outside grants for projects

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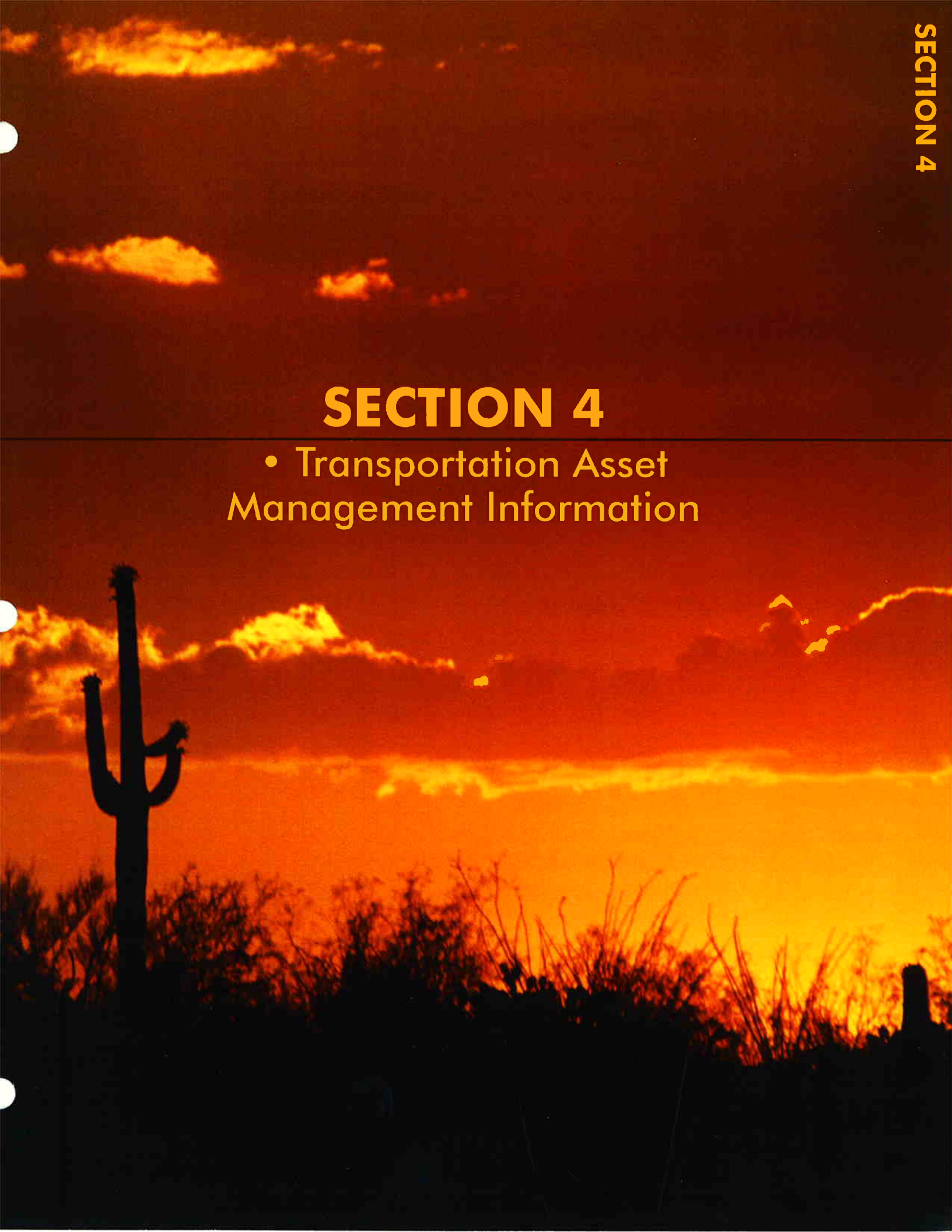
SECTION 4

• Transportation Asset Management Information



Transportation Asset Management Guide

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American Association of State Highway and Transportation Officials
444 North Capitol Street, NW
Suite 249
Washington, DC 20001

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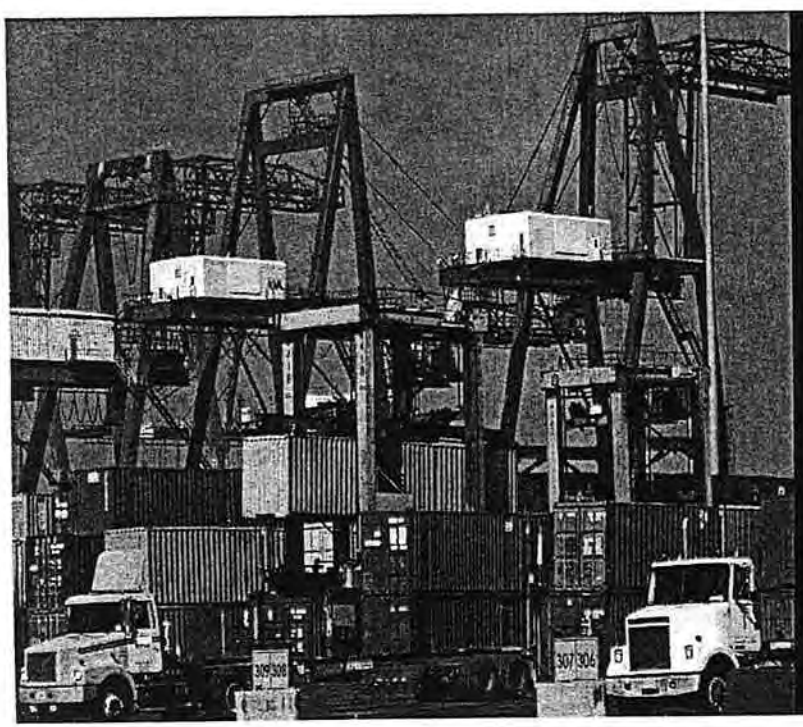
Transportation Asset Management



How are you doing?

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Introduction

Transportation infrastructure provides critical national lifelines for commerce, commuting and pleasure travel, support of national defense, and disaster response. Transportation facilities account for a major share of public-sector investment, and are among the most highly valued financial assets of state and local governments. The U.S. highway infrastructure alone represents an estimated $1 trillion in replacement value. Expenditures to build, operate, preserve, and improve transportation infrastructure are critical to meeting national goals of economic progress, social welfare, domestic security, environmental protection, and emergency preparedness. Transportation officials at all levels are faced with the challenge of making the best possible use of limited resources to manage a wide range of transportation assets in a way that responds to these important objectives and satisfies the needs of transportation users – their customers.

Transportation asset management promotes more effective resource allocation and utilization, based upon quality information, to address facility preservation, operation, and improvement. This concept covers a broad array of DOT functions, activities, and decisions: e.g., transportation investment policies and priorities; relationships and partnerships between DOTs and other public and private groups; long-range, multimodal transportation planning; program development for capital projects and for maintenance and operations; delivery of agency programs and services; and real-time and periodic system monitoring and data processing. All of these actions are accomplished within the limits of available funding.

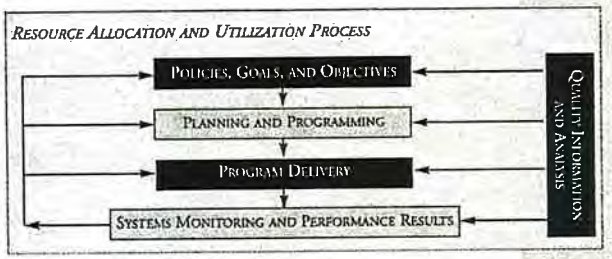
The following self-assessment exercise has been developed as part of the Transportation Asset Management Guide as part of the National Cooperative Highway Research Program (NCHRP) Project 20-24 (11) Asset Management Guidance for Transportation Agencies. This Guide helps you to examine, strategically and systematically, how investment decisions affecting your transportation infrastructure are made. It helps you to identify areas and priorities for possible improvement. It provides ideas, methods, and examples to accomplish more effective resource allocation and utilization. It does all of this by developing and applying the principles and practices of what is referred to as "transportation asset management."

Transportation asset management is defined as a strategic approach to managing transportation infrastructure.

"Good asset management" involves applying general principles smartly, effectively, and tactically to resource allocation and utilization – the heart of asset management. Core elements include:

- Well-defined policies that can be related to clear objectives and measures of performance.
- Organizational roles and responsibilities and business processes that reflect these policy and performance objectives.
- A reliance on good information at all stages of infrastructure management, and the capability to develop and continually update this information base.
- Examination of a range of options for solving infrastructure problems.
- A comprehensive decision-making approach to transportation investment, viewing the transportation system as an integrated whole, and considering tradeoffs among modes and categories of investment.
- An ability to deliver capital, maintenance, and operations programs in terms of time, cost, engineering quality, and effective use of departmental and outside resources.
- Management emphasis on customer service and accountability for system performance and cost-effectiveness.

The following diagram illustrates the key components of the asset management framework. This is the foundation for the self-assessment.



A Way of Doing Business

Asset management can touch nearly every aspect of a transportation agency's business, including planning, engineering, finance, programming, construction, maintenance, and information systems. Asset management should not be viewed, however, as yet another new program, requiring another new bureaucracy. Rather, asset management is a "way of doing business," not a separate business line or function:

- Clear linkages exist among goals, policies, plans, investment strategies, operating procedures, and delivery approaches.
- A proactive rather than reactive approach is taken, seeking constant improvement to ensuring the best use of available resources for improved performance.
- Strong top-down and bottom-up communication ensure that strategic decisions are well informed by tactical information, and that tactical decisions are aligned with strategic direction.
- Interdisciplinary decisions are coordinated across different agency divisions.
- Clearly defined organizational roles and responsibilities provide accountability for decisions and resulting system performance.

Benefits & Outcomes

The benefits of asset management may be seen in many different ways, depending upon an agency's transportation system, management philosophy, and current resources and priorities. Following are some possible outcomes when an agency takes action to improve asset management practices:

- Lower long-term costs for infrastructure preservation.
- Improved performance and service to customers.
- Improved cost-effectiveness and use of available resources.
- A focus on performance and outcomes.
- Improved credibility and accountability for decisions.

Achieving these benefits requires a willingness to evaluate current business practices and to take steps to improve where needed. Successful business process improvement will require:

- Strong executive leadership.
- Buy-in by managers and staff at all organizational levels.
- A multi-disciplinary perspective within the agency.
- A sustained and consistent commitment through implementation.

What "Quick Gains" Can Asset Management Provide?

- A snapshot of current infrastructure condition and performance – its status, what has been accomplished, areas of need.
- A framework for understanding investment needs – whether for structural repair, congestion mitigation, preservation of asset value, safety, operational improvements, environmental protection (e.g., at what locations and relative values?)
- A direct way to tie public perceptions of agency performance to your agency's methods of identifying and selecting projects and prioritizing services.
- Something better than anecdotal stories – facts, figures, and systematic methods by which to justify needed investments or additional resources.
- A "key to competition" – helping your agency to compete for scarce program funding, helping your staff to compete with other potential service providers in the quality and cost-effectiveness of their actions, and helping your organizational units to "sharpen their thinking" in looking for new ways to solve problems and delivering quality services cost-effectively.

Business

Benefits & Outcomes

Asset Management Self-Assessment

The Asset Management Self-Assessment exercise will help you characterize your agencies asset management practices and identify specific opportunities for improvement. This exercise is extremely useful to help organize thinking, develop a consensus among top-level managers as to where your agency's strengths and needs for improvement lie, and structure an agenda for asset management planning. The asset management self-assessment exercise has the following objectives:

- Develop a consensus among managers within your agency regarding the status of asset management.
- Assist your agency to identify asset management strengths, weaknesses, constraints, and opportunities for improvement.
- Develop priorities and recognize critical areas that need immediate attention.
- Provide a foundation for implementing your agency's asset management improvement strategy.

This exercise is a quick diagnostic tool that yields an overall impression, not a precise analytic measure, of where your agency is now regarding asset management practice. The statements in each survey form are designed to probe basic functions and capabilities that contribute to good asset management regardless of the particular characteristics and situation of your agency. They should prompt you to reflect on current business practices with a broad view:

"Even if we are constrained to do business or report information in a certain way, is there a better approach that satisfies asset management principles more closely?"

The self-assessment results will reflect your agency's individual institutional, organizational, financial, and IT environments. Involving top managers in this exercise will provide needed context for interpretation of the results. Because the results are specific to your agency's management environment and financial, organizational, institutional, and technological situations, they do not provide a meaningful basis for comparisons with peer agencies. The value of self-assessment is to help you move beyond possible preconceptions of where you are in asset management, and to provide a broad perspective from which you can plan asset management improvements more comprehensively.

The self-assessment survey lists a series of statements organized around the four key areas of asset management:

- Policy Guidance
- Planning and Programming
- Program Delivery
- Information and Analysis

Each statement covers a key aspect of asset management practice and is stated in a declarative form (e.g., "Our agency conducts life-cycle cost analyses for project alternatives."). Respondents are asked to rate the extent to which they agree with each statement, using a scale of 1 to 4. A "4" indicates strong agreement with the statement, whereas a "1" indicates strong disagreement.

Self-Assessment

A. Policy Guidance

How Does Policy Guidance Benefit from Improved Asset Management Practice?

	Strongly Disagree			Strongly Agree
Policy Guidance Benefiting From Good Asset Management Practice				
A1. Policy guidance supports preservation of existing infrastructure assets.	1	2	3	4
A2. Policy guidance encourages resource allocation and project selection based on cost-effectiveness or benefit-cost analysis.	1	2	3	4
A3. Policies support a long-term, life-cycle approach to evaluating investment benefits and costs.	1	2	3	4
A4. Policy guidance considers customer perceptions and expectations.	1	2	3	4
A5. Our customers contribute to the process that formulates policy goals and objectives.	1	2	3	4
Strong Framework For Performanced-Based Resource Allocation				
A6. Policy guidance on resource allocation allows our agency sufficient flexibility to pursue a performance-based approach.	1	2	3	4
A7. Our agency has a business plan or strategic plan with comprehensive, well-defined goals and objectives to guide resource allocation.	1	2	3	4
A8. Our agency's goals and objectives are linked to specific performance measures and evaluation criteria for resource allocation.	1	2	3	4
Proactive Role in Policy Formulation				
A9. Our agency estimates the resources needed to accomplish particular objectives as part of policy development.	1	2	3	4
A10. Our agency regularly communicates to customers and other stakeholders our accomplishments in meeting policy objectives.	1	2	3	4
A11. Our agency works with political leaders and other stakeholders to present funding options and consequences as part of our budget proposal.	1	2	3	4

Policy Guidance

B. Planning & Programming

Do Resource Allocation Decisions Reflect Good Practice in Asset Management?

	Strongly Disagree			Strongly Agree
Consideration of Alternatives in Planning and Programming				
B1. Our agency's long-range plan includes an evaluation of capital, operational, and modal alternatives to meet system deficiencies.	1	2	3	4
B2. Capital versus maintenance expenditure tradeoffs are explicitly considered in the preservation of assets like pavements and bridges.	1	2	3	4
B3. Capital versus operations tradeoffs are explicitly considered in seeking to improve traffic movement.	1	2	3	4
Performance-Based Planning and a Clear Linkage Among Policy, Planning, and Programming				
B4. Our agency's long-range plan is consistent with currently established policy goals and objectives.	1	2	3	4
B5. Our agency's long-range plan includes strategies that are consistent with plausible projections of future revenues.	1	2	3	4
B6. Our agency's long-range plan provides clear and specific guidance for the capital program development process.	1	2	3	4
B7. Our agency periodically updates its planning and programming methods to keep abreast of current policy guidance and critical performance criteria.	1	2	3	4
Performance-Based Programming Process				
B8. Criteria used to set program priorities, select projects, and allocate resources are consistent with stated policy objectives and defined performance measures.	1	2	3	4
B9. Our agency's programs are consistent with realistic projections of future revenues.	1	2	3	4
B10. Our agency's programs are based on realistic estimates of costs, benefits, and impacts on system performance.	1	2	3	4
B11. Project selection is based primarily on an objective assessment of relative merits and the ability to meet performance targets.	1	2	3	4
B12. The preservation program budget is based upon analyses of least-life-cycle-cost rather than exclusive reliance on worst-first strategies.	1	2	3	4
B13. A maintenance quality assurance study has been implemented to define levels of service for highway/transportation system maintenance.	1	2	3	4

Planning & Programming

C. Program Delivery

Are Appropriate Program Delivery Processes that Reflect Industry Good Practices Being Implemented?

	Strongly Disagree			Strongly Agree
Consideration of Alternative Project Delivery Mechanisms				
C1. Our agency periodically evaluates the use of alternative delivery-options such as maintenance outsourcing, intergovernmental agreements, design-build, design-build-maintain, and similar options.	1	2	3	4
C2. Our agency has an incentive program for recognizing or rewarding outstanding performance in improving upon schedule, quality, and cost objectives.	1	2	3	4
Effective Program Management				
C3. Our agency solicits input from all affected parties to ensure that project scope is consistent with objectives of the project.	1	2	3	4
C4. Our agency uses well-defined program delivery measures to track adherence to project scope, schedule, and budget.	1	2	3	4
C5. Our agency has a well-established and functioning process to approve project changes and program adjustments.	1	2	3	4
C6. When adding projects or changing project schedules, our agency considers effects on the delivery of other projects in the program.	1	2	3	4
C7. Projects with significant changes to scope, schedule, or cost are reprioritized to ensure that they are still competitive in cost and performance.	1	2	3	4
C8. Agency executives and program managers are regularly kept informed of program delivery status.	1	2	3	4
C9. External stakeholders and policy-makers feel that they are sufficiently updated on program delivery status.	1	2	3	4
Cost Tracking and Estimates				
C10. Our agency maintains and uses information on the full unit costs of construction activities.	1	2	3	4
C11. Our agency maintains and uses information on the full unit costs of maintenance activities.	1	2	3	4

Program Delivery

D. Information & Analysis

Do Information Resources Effectively Support Asset Management Policies and Decisions?

	Strongly Disagree			Strongly Agree
Effective and Efficient Data Collection				
D1. Our agency has a complete and up-to-date inventory of our major assets.	1	2	3	4
D2. Our agency regularly collects information on the condition of our assets.	1	2	3	4
D3. Our agency regularly collects information on the performance of our assets (e.g., serviceability, ride quality, capacity, operations, and safety improvements).	1	2	3	4
D4. Our agency regularly collects customer perceptions of asset condition and performance.	1	2	3	4
D5. Our agency continually seeks to improve the efficiency of data collection (e.g., through sampling techniques, use of automated equipment, other methods appropriate to our transportation system).	1	2	3	4
Information Integration and Access				
D6. Agency managers and staff at different levels can quickly and conveniently obtain information they need about asset characteristics, location, usage, condition, or performance.	1	2	3	4
D7. Our agency has established standards for geographic referencing that allow us to bring together information for different asset classes.	1	2	3	4
D8. Our agency can easily produce map displays showing needs/deficiencies for different asset classes and planned/programmed projects.	1	2	3	4
D9. Our agency has established data standards to promote consistent treatment of existing asset-related data and guide development of future applications.	1	2	3	4
Use of Decision Support Tools				
D10. Information on actual work accomplishments and costs is used to improve the cost-projection capabilities of our asset management systems.	1	2	3	4
D11. Information on changes in asset condition over time is used to improve forecasts of asset life and deterioration in our asset management systems.	1	2	3	4
Our agency uses asset management decision-support tools to:				
D12. Calculate and report actual system performance.	1	2	3	4
D13. Identify system deficiencies or needs.	1	2	3	4
D14. Rank candidate projects for the capital program.	1	2	3	4
D15. Forecast future system performance given a proposed program of projects.	1	2	3	4
D16. Forecast future system performance under different mixes of investment levels by program category.	1	2	3	4
System Monitoring and Feedback				
D17. Our agency monitors actual system performance and compares these values to targets projected for its capital preservation program.	1	2	3	4
D18. Our agency monitors actual system performance and compares these values to targets projected for its capital improvement program.	1	2	3	4
D19. Our agency monitors actual system performance and compares these values to targets projected for its maintenance and operations program.	1	2	3	4
D20. We periodically distribute reports of performance measures relevant to customer/stakeholder satisfaction with transportation system and services.	1	2	3	4

Scoring Guidelines (optional)

A. Policy Goals and Objectives

Policy Guidance Benefiting From Good Asset Management
(A1+A2+A3+A4+A5)/5 = _____

Strong Framework for Performance-Based Resource Allocation
(A6+A7+A8)/3 = _____

Proactive role in Policy Formulation
(A9+A10+A11)/3 = _____

B. Planning and Programming

Consideration of Alternatives in Planning and Programming
(B1+B2+B3)/3 = _____

Performance-Based Planning and Clear Linkage Among Policy, Planning, and Programming
(B4+B5+B6+B7)/4 = _____

Performance-Based Programming Process
(B8+B9+B10+B11+B12+B13)/6 = _____

C. Program Delivery

Consideration of Alternative Project Delivery Mechanisms
(C1 + C2)/2 = _____

Effective Program Management
(C3+C4+C5+C6+C7+C8+C9)/7 = _____

Cost Tracking and Estimating
(C10+C11)/2 = _____

D. Information and Analysis

Effective and Efficient Data Collection
(D1+D2+D3+D4+D5)/5 = _____

Information Integration and Access
(D6+D7+D8+D9)/4 = _____

Use of Decision Support Tools
(D10+D11+D12+D13+D14+D15+D16)/7 = _____

System Monitoring and Feedback
(D17+D18+D19+D20)/4 = _____

- The scores for each of the sections of the self-assessment can be used as part of the discussion for developing future strategies and directions for asset management.
- The percentage of statements in each area receiving a 3 or 4 can be used to further discuss how well the agency is doing with various aspects of asset management.
- These scores are rough indicators of how you see your agency's performance of each function or capability described in the statements.

Applying the Results

To learn how to translate the results of the self-assessment exercise into a plan for improving asset management at your agency, consult the NCHRP's Transportation Asset Management Guide. This Guide will help you further analyze your agency's strengths and weaknesses, build consensus on priority areas, develop a comprehensive asset management strategy, and identify specific actions for moving forward.

Scoring Guidelines

SPONSORSHIP

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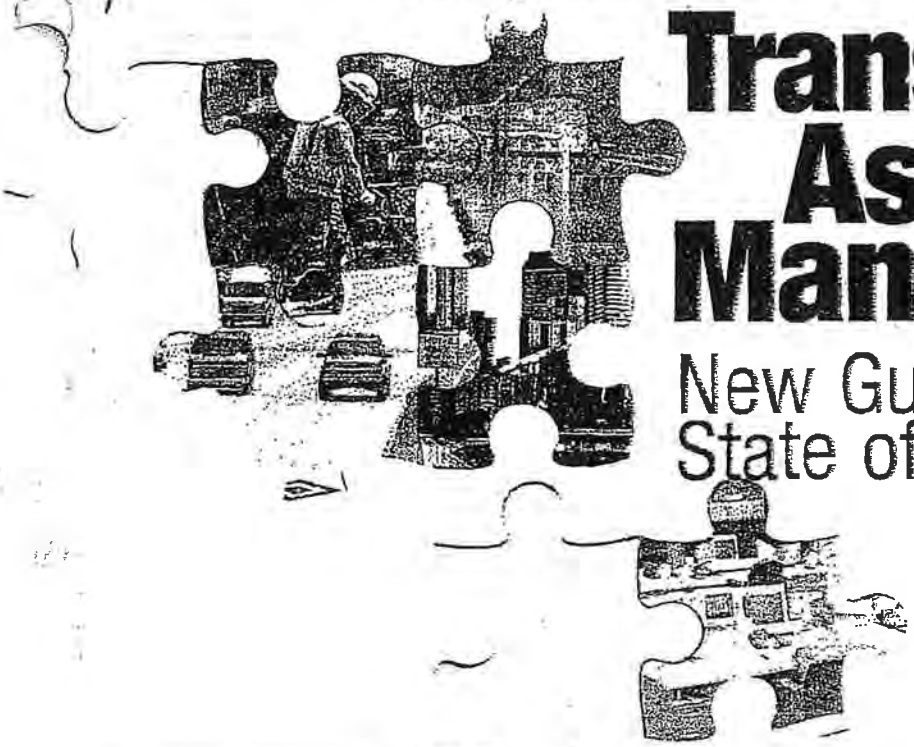
DISCLAIMER

The opinions and conclusions expressed or implied are not necessarily those of the Transportation Research Board, the National Academies, the Federal Highway Administration, the American Association of State Highway and Transportation Officials, or the individual States participating in the National Cooperative Highway Research Program.

PREPARED BY

Cambridge Systematics, Inc
150 CambridgePark Drive
Suite 4000
Cambridge, MA 02140
(617) 354-0167

FAX COPY TO: BOSTON - DAVE PETERS
JAX - LARRY ROMAINE, BOB WALTER, HAL LEWIS
MINN - ~~DOUG KIEBS~~
1/20/04
MAYBE USEFUL FOR THE MBTA + FEC WORK?
TOM S.
1/B



Transportation Asset Management

New Guide Advances State of the Practice

LANCE A. NEUMANN,
MICHAEL J. MARKOW,
AND LOUIS H. LAMBERT

Neumann is President, and Markow is Principal, Cambridge Systematics, Inc., Cambridge, Massachusetts. Lambert retired last year as Deputy Director, Transportation Planning Bureau, Michigan Department of Transportation, and is now Senior Associate, Cambridge Systematics.

The recent completion of a National Cooperative Highway Research Program (NCHRP) Project, Asset Management Guidance for Transportation Agencies,[1] marks a milestone in transportation asset management. The *Transportation Asset Management Guide* will help agencies gain new insights into asset management and improve their practices.

The NCHRP project also produced a synthesis of U.S., international, and private-sector practice in asset management, the management framework for the guide, and a prioritized list of research to fill gaps in the knowledge and practice of asset management for transportation infrastructure. These products resulted from tasks outlined in the American Association of State Highway and Transportation Officials' (AASHTO) Strategic Plan for Transportation Asset Management, issued in December 2000.

AASHTO has adopted and will distribute the *Transportation Asset Management Guide*. The final draft is available on NCHRP's website.[2] In addition, the Federal Highway Administration, through the National Highway Institute, has developed a one-day course on transportation asset management for agency executives and senior managers.[3]

Following is a preview of the concepts, principles, and techniques described in the guide, with examples of the improvements that asset management can introduce in the ways an agency allocates resources and employs different types of investments.

Defining the Principles

Asset management has many interpretations—for example,

- A next-generation infrastructure management system,
- A way to bring private-sector thinking into public-sector decisions,
- An economics-based approach to investment planning and decision-making,
- A comprehensive program of facility maintenance or maintenance contracting,
- A management philosophy to secure the future life of transportation infrastructure, and
- A way of combining pavement, bridge, safety, and other maintenance management systems to yield more effective information.

All of these descriptions reflect elements of sound asset management, but none captures the concept fully. Asset management is a strategic approach to managing transportation infrastructure. It builds on several principles:

- Asset management is policy-driven. Decisions about managing infrastructure reflect the policy goals and objectives that define the condition of assets, the

[1] NCHRP Project 20-24(11).
[2] http://www4.trb.org/trb/crp.nsf/All+Projects/NCHRP+20-24(11)
[3] www.nhi.fhwa.dot.gov/coursedesc.asp?coursenum=1130

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levels of performance, and the quality of services to meet customer needs and achieve economic, community, and environmental goals.

◆ **Asset management is performance-based.** Goals and objectives must have clear measures of performance. Targets established for performance measures will guide decisions in analyzing options, setting priorities, establishing budgets, and implementing programs, and must be technically and financially realistic.

◆ **Asset management examines options and tradeoffs at each level of decision making.** Resources are limited. Investment decisions in other areas and about other assets are interrelated and have an effect on transportation assets. Therefore decision makers should consider all options and evaluate the tradeoffs among alternatives.

◆ **Asset management takes the long-term view.** Analyses of program options should incorporate a long-term view of facility condition, performance, and cost. Analysis procedures rooted in engineering and economics are most effective in assessing the tradeoffs among different actions at different times in an asset's life cycle.

◆ **Asset management bases decisions on merit.** Choices among options during program development, project selection, and program and service delivery should be based on comparisons of costs and of the consequences of meeting performance targets. Objective, high-quality information must be applied at each step, using analytic methods and decision criteria consistent with policy goals and objectives and with the agency's business processes.

◆ **Asset management maintains clear accountability.** Performance measures are monitored and reported. This provides feedback on the effectiveness of transportation investments and services, as well as accountability to management for work accomplished and for the effectiveness of program and service delivery.

Applying the Principles

Applying these principles defines an agency's way of doing business, its procedures for decision making, and its applications of information technology. Asset management is not a separate function or system but a way of improving an agency's procedures for allocating and using available resources to achieve results cost-effectively.

Most agencies already employ aspects of good asset management practice; the principles in the guide therefore suggest ways for agencies to leverage strengths and improve the integration of data, information, and decision making. To be most effective, the asset management principles must be applied comprehensively to all of the agency's infrastructure expenditures, including preservation, operations, and system expansion—in capital construction as well as in maintenance and operations programs.

Asset management should be implemented in as many resource allocation and utilization processes as possible—for example, in policy development; long-range planning; project development; program development and priority setting; delivery of projects, programs, and services; and system monitoring and reporting. Agencies, however, may decide to focus at first on high-priority functions, to gain initial results quickly and affordably.

The *Transportation Asset Management Guide* covers asset management in these investment areas and in resource allocation and utilization. Nonetheless, an agency does not need to mount an all-encompassing effort to make headway in asset management. An agency can apply the concepts and principles quickly with current personnel and information technology—taking advantage of good asset management practices already in place.

Because state departments of transportation (DOTs) and other transportation agencies differ substantially in priorities, business practices, and available resources, the guide presents a broad treatment. By enabling agencies to understand the context of asset management, the guide helps agency managers to focus on the specific areas in which asset management improvements can have the strongest early payoff. A self-assessment exercise in the guide helps agencies determine strengths, identify areas for improvement, and develop an implementation strategy for priority areas.

Investment Categories

Some practical examples can show what asset management involves and how the principles can improve an agency's practices. Because agencies differ in program structure and in management culture, the examples relate to the types of investments common to all agencies. The descriptions are limited to three investment areas: preservation, operations, and system expansion. These investment areas encompass capital as well as maintenance and operations expenditures.

◆ **Preservation** extends the life of an asset or corrects a distress that impedes mobility, safety, serviceability, or engineering integrity. Preservation counters wear-and-tear, providing a cost-effective way to keep a facility functioning at its intended level. Corrective and preventive maintenance, repair, and rehabilitation are examples of preservation.

◆ **Operations** focus on real-time service and operating efficiency. Operations enable facilities to provide

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the maximum level of service before expansion becomes necessary. Examples include real-time traffic surveillance, intelligent transportation systems (ITS), real-time signal controllers, various strategies formerly grouped under transportation system management, safety improvements, ramp metering, incident response, road weather information systems, and traveler information systems.

◆ **Capacity expansion** affects a facility's level of service by adding physical capacity, by creating new capacity through a new facility, or by implementing long-term operating strategies. New construction, for example, may include new mainline facilities, interchanges, or intermodal facilities. Expansion also can be achieved through general-purpose or HOV lanes, climbing and passing lanes, bridge widening or construction of a parallel structure, and improvements on interchanges, intersections, and intermodal facilities. Long-term operating strategies could introduce reversible peak-hour lanes, adjustments to speed limits, and new signals and lane controls.

These investment categories provide a framework for the practical implications of transportation asset management. All agencies invest in these areas, but in different measures. Agencies with mature infrastructure in settled urban areas may emphasize preservation and operations improvements, while agencies in regions experiencing population and economic growth may have a relatively higher percentage of expenditures for capacity expansion.

Projects may comprise more than one investment type, creating interactions among preservation, operations, and capacity expansion. For example, preservation work in construction or maintenance work zones can cause traffic disruptions that require operations remedies. Capacity expansion may include installation of ITS or traffic monitoring hardware to serve operations needs. Operations equipment requires maintenance.

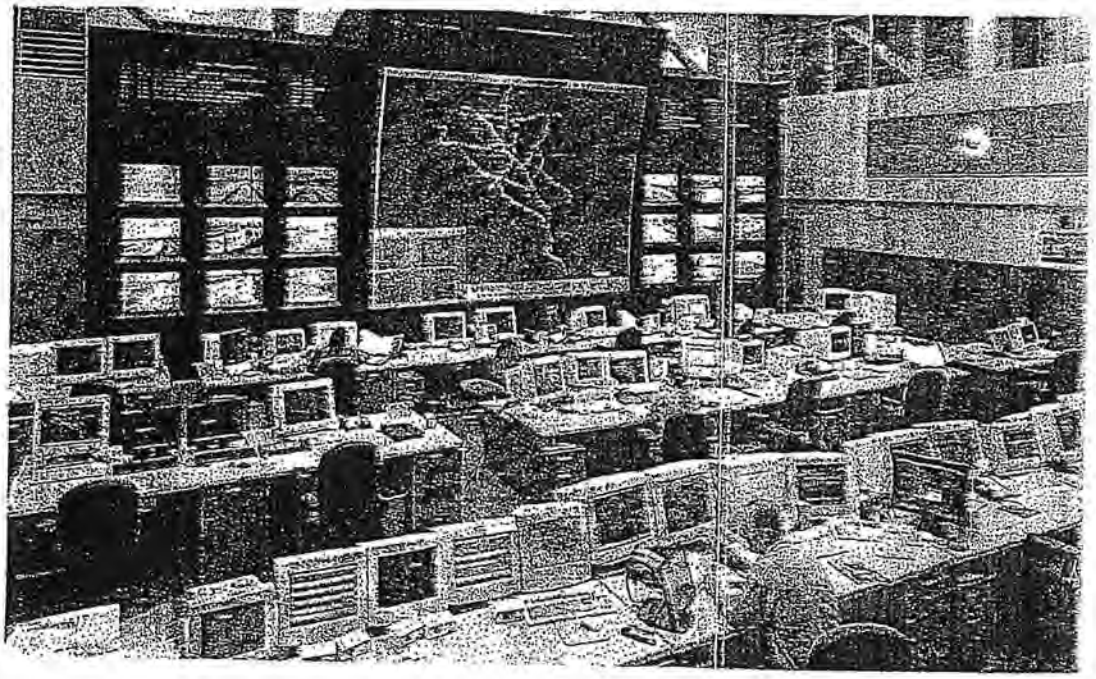
Breaking down an agency's infrastructure management into preservation, operations, and capacity expansion provides a straightforward way of organizing asset management techniques and of considering strategic tradeoffs among the categories of investment.

Preservation

Asset management has historical roots in preservation. During the significant capacity expansion under the Interstate program in the second half of the 20th century, the need to manage the maintenance, repair, and rehabilitation of the highway inventory increased, as pavements, bridge elements, and other key features of the earliest Interstate-era highways began to approach the end of their design lives.

As more and more portions of the network aged, competition increased for preservation resources. The need for knowledge and tools to preserve the system as cost-effectively as possible stimulated research programs and the development of computerized decision-support systems for pavement, bridge, and maintenance management.

In this way, preservation had a head start in the field of highway management, propelled by its importance and visibility for transportation agencies and motorists, as well as the early recognition by practi-



Transportation management centers regulate travel on streets and freeways and maximize levels of service.

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Crack sealing preserves pavement.

tioners that system preservation required ongoing management. Nonetheless, the *Transportation Asset Management Guide* emphasizes that the other areas of investment—that is, operations and capacity expansion—also must be considered within a comprehensive, balanced approach.

The guide encourages continuing improvements in preservation in areas such as the following:

- **Application of management systems and other analytic tools.** Pavement and bridge management systems are applied routinely to assess condition, identify projects, and track performance. However, use in higher-level management tasks—such as testing scenarios, developing programs and budgets, analyzing program tradeoffs, and supporting executive decisions—should be expanded.
- **Preventive maintenance strategies.** Capital and routine preventive maintenance offer economic benefits but are politically difficult to sell. Analytical methods and research documenting the benefits, moreover, are not as advanced as those for design and rehabilitation. Better information is needed on the long-term benefits of preventive maintenance strategies.
- **Continued development of new materials and practices.** Preservation benefits from better materials and remedial practices. New technology should provide cost-effective options for extending the service lives of assets.
- **More comprehensive analysis of strategies for road occupancy.** Work zone management is a major issue, involving the safety of workers and motorists, and is key in planning major rehabilitation projects. Economic analyses of the effects of work zone configurations and scheduling will become common practice as preservation activities increase, traffic volumes grow, and urbanized areas spread.
- **Continued enhancement of analytic and decision support tools.** Development and enhancement of decision-support tools for preservation have been ongoing. The focus will be on information for executives, integration with other applications, incorporation of customer-oriented performance measures and criteria, and analyses of program-level tradeoffs.
- **Maintenance quality assurance programs.** Maintenance quality assurance takes a performance-based approach, applying customer-oriented definitions of levels of service to budgeting decisions. Maintenance quality assurance embodies the principles of good asset management.

Operations

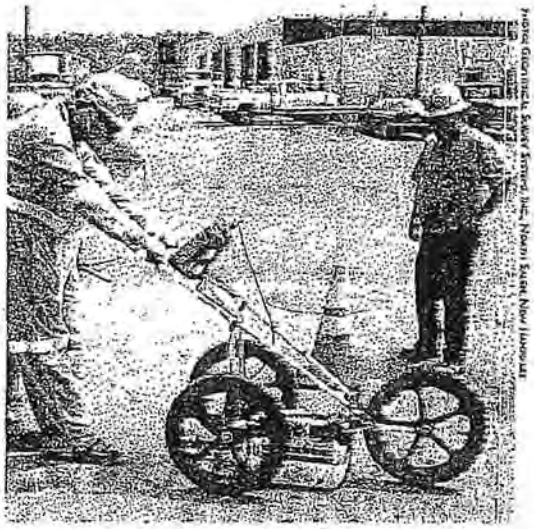
Operations always have been a component of highway management and are a logical extension of the asset management concept. Responsibility for operations, however, has been fragmented within and across agency jurisdictions. As a result, operations have not been integrated effectively into an overall system management strategy.

But just as preservation was recognized as critical to sustaining the service life of infrastructure cost-effectively, operations have been gaining recognition for a strategic role in maximizing the system's ability to move passenger and freight traffic. Operations have become a key element of good system management.

An effective operations strategy relies on a range of equipment and software that must perform reliably throughout the network. The physical assets supporting operations must be integrated into agency preservation programs for inspection, periodic maintenance, and repair.

The general principles of asset management apply to operations as much as to preservation, but with a different focus:

- The goals and objectives must reflect system service and reliability in real time;



Ground-penetrating radar instrument locates and inspects utilities, part of maintenance quality assurance.

◆ The focus is on immediate response to situations and real-time results, not on a program of projects; and

◆ Performance measures and monitoring must track real-time service delivery.

The principles of asset management therefore imply the following for operations:

◆ **More integrated decision making.** Decision making in operations must coordinate with decision making in other areas of asset management, to support a unified set of system performance measures. Coordination is necessary, for example, in allocating resources to balance investments in physical assets with those in operating programs; in maintaining and preserving operations assets, as well as other physical infrastructure; in long-range planning, project development, and design; in analyses of program tradeoffs; and in dealing with other agencies and jurisdictions that influence operations policies and practices.

◆ **Interjurisdictional considerations.** The so-called trip perspective looks at the entire transportation system without regard to jurisdictional boundaries and operating responsibilities. Many traffic management centers and incident response programs follow this principle.

◆ **Comprehensive asset inventories, condition databases, and analytic techniques.** An agency's overall preservation strategy should include the operations hardware. This requires database and analytic capabilities for the operations equipment on a par with those for other infrastructure assets. Moreover, other capabilities can be applied to operations—for example, maintenance management and bridge management systems that include such assets as traffic management devices, ITS systems, sign bridges, and tunnel facilities.

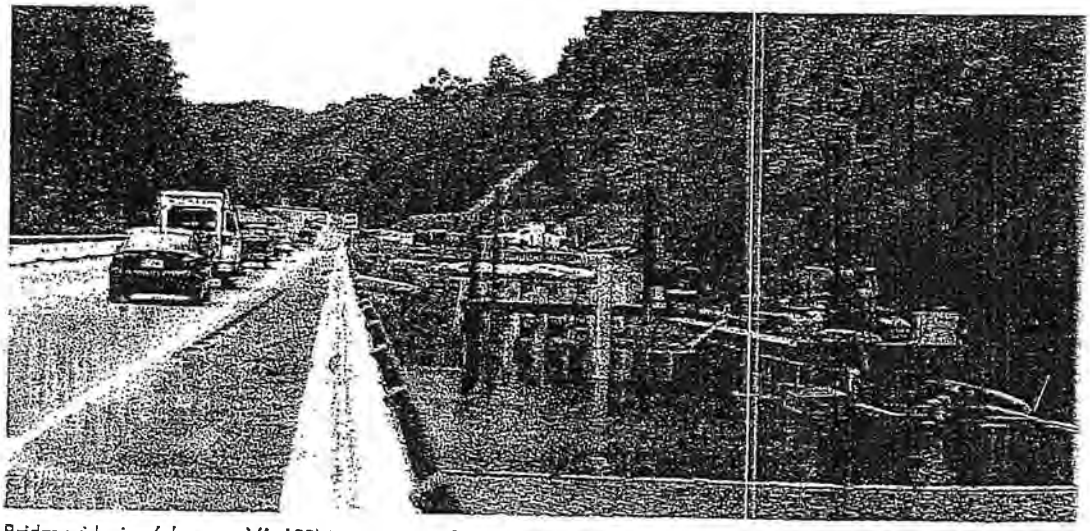
◆ **Methods to analyze operations strategies.** Analytic tools comparable to those used in preservation, for example, are needed to integrate operations fully into an agency's decision making about resource allocation and utilization. Developing such systems will require thinking "outside of the box," to analyze performance over time and in real time. Research is needed to understand performance from the perspective of reliability, response time, and the critical threshold values of motorists, as well as from the traditional viewpoints of physical condition and frequency of repairs.

◆ **Greater outreach and education.** Transportation agencies and operators may not recognize the relationship between operations and asset management. Clearly defining this relationship and communicating it through training, outreach, research, and deployment will help in advancing the state of the practice in system management and agency coordination.

◆ **Communication of the benefits of operations investments.** New analytic tools can improve an agency's ability to demonstrate the benefits of investing in operations, but demonstrating the actual benefits of systems that are already deployed also is valuable. Field tests and rigorous evaluations are critical in addressing agency skepticism about ITS, and particularly in communicating the advantages of strategies that improve system reliability and that benefit freight transportation.

Capacity Expansion

In contrast with operations, capacity expansion focuses on project development and program composition through a process that can extend for several years. In contrast with preservation, capacity expansion works through discrete—sometimes large and expensive—capital projects, instead of



Bridge widening (*above*, on VA-199) is an aspect of capacity expansion.

addressing continuing, systemwide needs.

In addition, the substantial federal matching formula for Interstate construction through the Highway Trust Fund has provided a direct and dependable funding mechanism for capacity expansion projects. The major expansion in U.S. highway capacity through the end of the 20th century, therefore, may be regarded as a massive, successful public works effort—but the expansion usually is not thought of in the context of asset management practice.

That has now changed—capacity expansion is part of resource-allocation decision making. Needs for funding have shifted toward preservation and, increasingly, toward operations.

Asset management for allocating and utilizing resources applies as much to capacity expansion projects as to preservation and operations. Translating asset management for more effective decision making in capacity expansion entails improvements in several functions and capabilities:

- **Performance-based planning.** A performance-based approach to long-range planning focuses on the outcomes of possible investments and the degree to which the outcomes support stated policies. Capacity expansion projects can affect a diverse customer base.
- **Updated performance measures.** Performance measures for new capacity projects must reflect more than level of service in evaluating operational or multimodal alternatives for expanding transportation capacity. Measures should enable analyses of the tradeoffs among capacity expansion and other types of investments and should reflect the interests of passenger and freight customers.
- **Procedures to analyze multimodal and intermodal investments and tradeoffs.** Different analytic methods and data requirements apply when assessing projects in different modes or evaluating the effects on passenger versus freight transportation. Methods for comparing cost and performance impacts across modes are under development but must be deployed and tested in agency settings. Data and analytic issues in freight transportation must be addressed.
- **Accelerated scheduling.** Capacity expansion projects often require several years from conception to completion, increasing costs and delaying benefits. Ways to accelerate this schedule while maintaining the necessary steps in planning, design, right-of-way, and construction include different ways of conceiving projects—for example, as corridor-based or multimodal—as well as streamlining or fast-tracking preconstruction activities and establishing contract incentives for rapid completion of construction.
- **Bidding and contracting mechanisms.** Agencies are applying contracting mechanisms such as design-build on projects with demanding schedules or to supplement agency expertise, as well as alternate bidding to base awards on lowest life-cycle cost. In awarding a paving contract for a new freeway, for example, Michigan DOT examined bids for concrete versus asphalt pavement and saved several million dollars in construction costs.

Agency Self-Assessment

Asset management takes a comprehensive view of resource allocation and utilization. Most agencies, however, will want to focus on particular priorities. To help identify the most promising areas for focus, the *Transportation Asset Management Guide* includes a self-assessment exercise.

Through the self-assessment, executives and senior managers can characterize agency practices, highlight the gains accomplished or under way, and identify opportunities for improvement. The exercise requires responses to a series of statements, organized under the four functional areas of asset management: policy development, planning and programming, program delivery, and information and analysis. Completing the form takes approximately 30 minutes.

The value of the exercise is in comparing the responses from the agency's executive office with those of managers for such units as planning, engineering, programming, maintenance, finance, operations, and information systems. Bringing together the different perspectives can help identify an agency's strengths and the areas that need improvement in asset management practice. Through this discussion, the agency can develop priorities for immediate and longer-term actions.

The self-assessment is a quick diagnostic tool that yields an overall snapshot of an agency's asset management practices. The information can be used in developing a more comprehensive asset management implementation plan, as described in the *Transportation Asset Management Guide*.

Implementing Programs

Several agencies have addressed asset management proactively, launching implementation programs and gaining organizational acceptance. The diversity of approaches, however, illustrates not only that asset management draws on a core set of principles, but that application should be customized to an agency's needs, priorities, and situations.

Some state agencies—such as the Colorado, Arizona, Pennsylvania, and Vermont DOTs—have developed plans to identify strengths and priorities for improvements in asset management and information technology. Other agencies have focused on innovations for asset management.

veral years. Montana DOT recently instituted a Programming Prioritization Process (or P[3]). Pennsylvania DOT summarizes performance information on a monthly report card, and Washington State DOT issues the quarterly *Gray Notebook* of performance measures and a monthly report card on construction projects.[4]

Asset management principles and techniques also are reflected in maintenance quality assurance programs and the associated levels of service. Several states have undertaken maintenance quality assurance programs, including Arizona, California, Colorado, Florida, Idaho, Iowa, Kansas, Maine, Maryland, North Carolina, Ohio, Texas, Utah, Vermont, and Washington State. A set of the performance measures commonly recognized for maintenance is in development, drawing from workshops, projects, and committee efforts sponsored by AASHTO, FHWA, and NCHRP.

National-Level Actions

Industry has supported asset management initiatives by individual agencies. At the national level, TRB, AASHTO, and FHWA have been active in supporting conferences, workshops, and TRB Annual Meeting sessions on asset management. The TRB and AASHTO task forces on asset management met jointly in summer 2002 to chart the implementation of asset management from a national perspective.

FHWA has sponsored development of a one-day training course on the *Transportation Asset Management Guide*, and AASHTO and FHWA collaborate in supporting "Transportation Asset Management Today," a community-of-practice website.[5] Other organizations, such as the American Public Works Association,[6] also have developed materials on asset management. The Midwestern Regional University Transportation Center provides several resources, including a website, research activities, and newsletters.[7]

Research is exploring advances in asset management practice that cut across the investment areas. The NCHRP project produced a prioritized list of research topics in the management, policy, analytic, technological, and academic aspects of asset management. AASHTO selected several of these topics, and studies already are under way through NCHRP.

The projects deal with analytic tools to support asset management, state DOT experience in implementing the Governmental Accounting Standards Board requirements in Statement 34, and identifying and setting targets for performance measures to support asset management. A project nominated for FY 2004 would investigate the effectiveness of asset management implementation. Other research efforts, such as the proposed Future Strategic Highway Research Program, complement the asset management research.

Where the Guide Goes

The *Transportation Asset Management Guide* can assist agencies in improving procedures and decisions about allocating and utilizing resources. The book is structured as follows:

- **Chapter 1: Introduction** defines transportation asset management and outlines past work by AASHTO, FHWA, NCHRP, and international agencies.
- **Chapter 2: Framework and Principles** explains concepts and terms of asset management, defines a framework of benchmark practices, and indicates how to customize the management framework to an agency's particular needs.
- **Chapter 3: Self-Assessment** explains how to use the agency self-assessment test to identify strengths and areas for improvement, provides forms for the exercise, and illustrates how to evaluate results.
- **Chapter 4: Developing A Strategy** traces how to build a strategy to improve asset management.
- **Chapters 5 through 8** describe specific applications of asset management to key functions: resource allocation and utilization, policy goals and objectives, planning and programming, program delivery, and information and analysis, including performance monitoring.
- **Chapter 9: Implementation** presents initial steps to improve asset management and provides a long-term perspective for continuing improvements.

Questions To Consider

Asset management provides the framework for agencies to assess business practices for infrastructure management, to highlight accomplishments, and to identify opportunities for improvement. When exploring what this framework might do, agency decision makers should consider the following questions:

- How far has the agency progressed in defining and communicating its strategic direction to all stakeholders?
- Does the agency comprehensively consider all options in solving problems?
- Does the agency evaluate tradeoffs in cost and performance?
- Is the agency concerned about achieving long-term results cost-effectively?
- Does the agency place value on setting performance goals and on measuring results?
- What should the agency do to be in the strongest position to justify requests for resources?
- Even if significant advances in management practices have been implemented, are there better ways to do things?

Asset management addresses these questions by providing an improved way of doing business. The how-tos are presented in the first edition of the *Transportation Asset Management Guide*.

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[4] www.wsdot.wa.gov/accountability/GrayNotebook.pdf
[5] http://assetmanagement.transportation.org
[6] www.apwa.net/
[7] www.mrutc.org/assetmgmt/index.htm