APPENDIX A

SCOPE OF SERVICES

MARICOPA ASSOCIATION OF GOVERNMENTS (MAG)

NON-RECURRING CONGESTION STUDY

I. WORK PLAN & TASKS

The CONSULTANT shall perform the Non-Recurring Congestion (NRC) Study tasks described below. Oversight for the study will be provided by a Study Advisory Group (SAG) consisting of members of the MAG Intelligent Transportation Systems (ITS) Committee. Meetings with the SAG will occur throughout the study for status updates, review/discussion of results, and to confer at key study milestones before initiating a subsequent task. The execution of each task will result in a Technical Memorandum that will document the work performed and findings. The finalized Technical Memoranda will serve as chapters of the Final Report.

Task 1 - Literature Review

The literature review will concentrate on two areas:

1) Research and articles on congestion measurement, and

2) Research and articles on countermeasures for NRC. A formal literature review will be conducted to identify published research reports and articles on congestion measurement and non-recurring congestion countermeasures implemented over the last 10 years.

The following subtasks will be conducted to accomplish this task.

Subtask 1.1 Review of congestion measurement literature. A literature review of congestion measurement will be performed to identify several national, state, and regional studies on quantifying roadway congestion. The search will also look for information on quantifying congestion for transit and freight trucking operations. Literature on congestion measurement will be summarized and presented in the Technical Memorandum.

Subtask 1.2 Development of NRC taxonomy. A common issue in communicating transportation improvements to other professionals, decision makers, political officials, and the public is communicating the problem and potential solutions. The literature review will define common terminology and the relationships among the different elements of congestion and the corresponding countermeasures.

Subtask 1.3 Review of literature on NRC countermeasures and exemplary programs. The literature review will also concentrate on identifying potential countermeasures for NRC on freeways and arterial streets. The review will highlight successful programs in other regions of the country. These successful programs will be described in the literature review as case studies. The case studies will compare and contrast the congestion problems being solved, the countermeasures implemented, the methods for evaluation, and the benefits achieved. The CONSULTANT will also summarize any information about the implementation costs associated with successfully deployed countermeasures. Methodologies for assessing impacts and effectiveness of NRC countermeasures will also be described.

Deliverables

Technical Memorandum No. 1 - Literature Review and Summary of NRC Countermeasures.

Task 2: Develop a Methodology for Quantifying NRC and the Data Collection Plan

This task will be carried out in three subtasks as described below:

Subtask 2.1 *Develop a methodology to assess and quantify the occurrence of NRC. The CONSULTANT shall develop a methodology that is designed to assess the total NRC occurrence, in both freeway and arterial street environments, across the MAG region during an entire calendar year of traffic operations. Historical data such as traffic and transit volumes, travel times, and congestion patterns, will be utilized where available. The data that needs to be utilized in the methodology will be identified into three groups: (1) historical data; (2) field data to be gathered; (3) simulation-based data.*

Subtask 2.2 *Develop the data collection plan. A data collection plan will be developed to support the methodology for assessing NRC. This will ensure that all necessary data be collected in a timely and logical manner. It will outline the collection schedule, routes, coordination, and all procedures that are critical to a successful data collection effort. The plan will focus on field data collection essential for this project. This includes facilities lacking in historical data or gaps in the historical data due to data collection malfunctions or roadway construction. Specific freeway and arterial corridors along which field data collection will be carried out will be identified on a map to be included in the plan. The approach for gathering necessary freight and transit data will also be described in the plan. The CONSULTANT shall coordinate with MAG in seeking written permission from affected local agencies allowing the installation of data collection devices such as the Bluetooth devices in their signal cabinets. All related documents will be included in an Appendix of the Technical Memorandum.*

Subtask 2.3 *Develop the microscopic traffic simulation studies plan. A plan will be developed for performing microscopic traffic simulation studies to support the methodology for assessing NRC. The simulation studies will utilize VISSIM to supplement the historical data and field measurements. Simulation studies will be conducted for both the regional freeway system and for the arterial street system. The plan will identify a range of freeway and arterial traffic incidents/scenarios to be simulated. By simulating a range of incidents and durations, the benefit of reducing response and clearance times may be estimated. The Plan will identify the minimum number of simulations to be run with different seed numbers for statistical validity. The Plan will clearly identify the type of data and information to be generated through microscopic simulation studies with references to typical output generated from VISSIM simulation runs.*

Deliverable

Technical Memorandum No. 2 – Methodology for Quantifying Non-Recurring Congestion and the Data Collection Plan. SAG approval of this methodology will be required before work begins on Task 3.

Task 3 - Data Collection and Analysis of Non-Recurring Congestion

The CONSULTANT will collect all relevant historical and current data to establish a NRC database, which will be used to perform analyses and study the NRC occurrence. The following subtasks will be carried out:

Subtask 3.1 *Gather historical data. Past data on traffic volumes, incidents, extreme weather events, special events, and roadway construction will be gathered from available databases. The*

CONSULTANT will consult with MAG and member agencies to identify and review available data sources and determine the best data for use on the study. Data for 2006, 2007, and 2008 will be reviewed to ensure that typical trends are reflected and the best year of data will be selected to be analyzed. Additional years or non-consecutive years of past data may also be reviewed if there are major improvements (i.e., construction projects) in the area that would require another year for comparison.

The CONSULTANT will gather all available historical traffic data into a common NRC database. Any archived data available from Regional Archived Data Server (RADS) and local traffic signal systems will also be utilized. If necessary, 24-hour counts will also be factored to hourly counts using regional k-factors and directional splits. The CONSULTANT will also utilize traffic incident information available from a third party traffic information provider.

Subtask 3.2 *Gather traffic data on Freeway and Arterial corridors.* *Historical traffic counts will be used to the extent possible, especially where cities have good daily and monthly adjustment factors to approximate the traffic volumes for the day and time of the travel time study. Where necessary, these will be supplemented by counts carried out by the CONSULTANT. It is anticipated that freeway related traffic data can be gathered from the Freeway Management System.*

Subtask 3.3 *Travel time data on arterial roadways.* *Travel time data is needed to identify congestion patterns and the extent of queuing on arterial corridors. To collect this type of data, the CONSULTANT will utilize Bluetooth Mobile Data Collection units that are required to be placed in traffic signal controller cabinets to take advantage of the cabinet's power source. The CONSULTANT will coordinate with the local agencies in performing this task. The agencies and arterials to be instrumented would have been identified in Task 2. The Bluetooth devices will be used to gather traffic data over several weeks, thereby increasing the likelihood of capturing data during NRC events along the instrumented roadway section in addition to gathering non-event travel time data which is provided by time of day and day of week. The travel times during the NRC will be matched with the actual incident information. Where an Ethernet connection is available in the cabinet, the Bluetooth anonymous wireless network address information will be transmitted to the agency's Traffic Management Center. At locations where an Ethernet connection is not available in the cabinet, cellular modems will be utilized to transmit the anonymous wireless network addresses. Depending on the penetration of Bluetooth devices, it is estimated that the system could provide 30 to 60 travel time data points per segment per hour. This system will compile four weeks worth of travel time data for 100 centerline miles of arterial roadway.*

The deployment of the Bluetooth Mobile Data Collection units will be strategic based on three data sources: planned temporary construction zones, planned special event/traffic control, and archived incident response details. The CONSULTANT will coordinate with local agencies for collecting data at planned temporary construction/traffic control sites on the arterial street network. The Bluetooth Mobile Data Collection units will be used at these sites to collect traffic data for "before," "during," and "recovery" periods. Similarly, field data will also be collected in conjunction with known special events that either impacts traffic conditions and operations via its associated traffic demands or because it requires its own temporary traffic control plan.

Appropriate corridors for traffic data collection will be identified by reviewing archived data for arterial roadway segments that are prone to incidents/delays. Historical data on crashes and incidents available through the RADS that receives Computer Aided Dispatch information from City of Phoenix' Fire Department.

Subtask 3.4 *Gather transit and freight truck data.* *In order to estimate the impact of NRC on transit and freight operations, the CONSULTANT will gather data on transit and freight trucking operations in the MAG region. Transit passenger loads, park-and-ride lot utilization, and travel times for transit routes will be obtained from Valley Metro and other transit operators. In addition, information on typical truck volumes on major freeway and arterial routes will be gathered.*

Subtask 3.5 *Simulation studies.* *A sample system will be developed for a freeway segment and for an arterial street system based on existing facilities in the MAG area. These systems will be calibrated to the data collected in Tasks 3.2 and 3.3. Simulation studies will be conducted for the range of incidents and durations identified in Task 2. Measures of effectiveness such as travel time, system delay, and fuel consumption will be tabulated for the various incident types and durations for both the freeway system and the arterial street system.*

Subtask 3.6 *Cluster Analysis to identify causes of NRC.* *The CONSULTANT will use Cluster Analysis as the methodology to identify probable operating conditions that can cause NRC. The CONSULTANT will develop a matrix of peak period hours affected by causes of non-recurring congestion (i.e., traffic demand, incidents, weather, work zones, special events). The matrix will identify the sources and their share of the overall congestion.*

Subtask 3.7 *Estimate delay due to NRC.* *Perform analysis to estimate the delays caused by various sources of congestion in the MAG region using available traffic counts, speed, and travel time data as well as historical reports, such as the MAG Speed Study. Delay will be defined as the difference from being able to travel as free-flow speeds (as determined from desirable operating speeds or posted speed limits) in the system. Existing delay due to NRC will be estimated for freeway and arterial systems and presented to the SAG. This will serve as a baseline for future comparisons.*

Subtask 3.8 *Estimate the impact of NRC.* *This subtask will estimate the impact of NRC on freeways, arterials, transit, and freight operation. The impact of NRC shall be assessed based on appropriate measures such as estimated traffic delays (i.e., hours lost due to congestion), increased travel times and reduced reliability, overall loss of productivity, and cost to the region's economy on an annual basis.*

Key components of the multimodal transportation system will be analyzed to generate the following:

- *Estimated impact of NRC on the urban freeway system overall, and specifically on the gateway corridors I-17, I-10, and US-60.*
- *Estimated impact of NRC on the arterial street system.*
- *Estimated impact of NRC on regional transit services.*
- *Estimated impact of NRC on freight trucking industry.*

Subtask 3.9 *Benefits of reducing the number and duration of incidents.* *Measures of effectiveness documented in Technical Memorandum No. 2 will be used to estimate the potential benefits of reducing the number of and the duration of various incidents. These potential benefits will be used to identify and prioritize the potential countermeasures to be identified in Task 4.*

Deliverable:

Technical Memorandum No. 3 – Data Collection Results and Estimation of the Impacts of NRC.

Task 4 - Relevant Countermeasures, Required Resources, and Cost-Effectiveness.

The focus of this task shall be to identify proven countermeasures that are relevant and feasible for implementation in the MAG region. The CONSULTANT will perform the following subtasks:

Subtask 4.1 *Identify a suite of effective NRC countermeasures for implementation in the region. A comprehensive list of potential NRC countermeasures would have been identified in Task 1. This task will match effective, cost-efficient countermeasures from that list with the non-recurring congestion conditions summarized in Task 3. The resulting suite of countermeasures will be limited to those that are implementable in the MAG region, considering the region's institutional structure.*

Subtask 4.2 *Identify implementation costs for NRC countermeasures. In Task 1, the literature review is anticipated to reveal cost estimates for implementing countermeasures for projects around the country. The CONSULTANT will utilize the cost information generated in Task 1 and also consult with local agencies to generate realistic cost estimates for implementing and sustaining the countermeasures. The list of countermeasures will be rated Low, Medium, or High with respect to the resources required in terms of infrastructure, staff, and operating funds.*

Subtask 4.3 *Ranking Based on Cost-Effectiveness. Rank the list of countermeasures in terms of their reported cost effectiveness based on an appropriate measure such as potential NRC reduction per dollars expended on the countermeasure.*

Deliverable:

Technical Memorandum No. 4 – Potential NRC Countermeasures, Required Resources, and Cost-Effectiveness.

Task 5 - Development of An Implementation Plan

The CONSULTANT will develop an implementation plan for a potential regional initiative to reduce the impact of NRC across the region. A key component of this plan will be the identification of agency resources (both in terms of staff and funding) that will be required to create and sustain such an initiative.

Subtask 5.1 *Short List of Countermeasures. Utilizing the results from Task 4, the CONSULTANT will identify a short list of NRC countermeasures that could be implemented regionally over a period of five-years by interested MAG member agencies.*

Subtask 5.2 *Resource Requirements. Resources required by potential participating agencies will be identified for each of the countermeasures identified. This will include:*
Initial capital costs, annual operating costs, and agency staff requirements in Full Time Equivalent (FTEs).

Deliverable:

Technical Memorandum No. 5 - Implementation Plan.

Task 6: Development of the Framework for a Pilot Project

In consultation with the SAG, the CONSULTANT will identify two or three contiguous MAG member agencies that are willing to implement a pilot project. This pilot project would involve the implementation of a subset of the countermeasures identified in Task 5, over a period of two years and dedicate the required agency staff

for that period. The goal of the pilot project will be to encourage MAG agency members to serve as champions for the project and lead the deployment of countermeasures along a corridor in their jurisdictions. The pilot project will target high benefit countermeasures that are implementable in the near-term.

Subtask 6.1 *Identify Potential Pilot Project Participants. The identification of potential MAG member agencies willing to participate in a pilot project will be based on the existence of a significant NRC issue based on historical data and the willingness of the agencies to participate in the pilot project.*

Subtask 6.2 *Develop the Scope of Work. The CONSULTANT will develop the scope for the pilot project. The scope will define what countermeasures could be implemented in the selected multi-jurisdictional corridor/s. In addition to the scope, an estimate will be made as to the budget, schedule, and estimated staff resources needed from participating agencies.*

Subtask 6.3 *Develop an evaluation plan. The final step for the pilot project will be to develop an evaluation plan. The evaluation plan will identify the performance measures that should be analyzed to determine the success of the pilot project. The evaluation plan will also identify the data collection needed to assess the performance of the countermeasures.*

If a group of volunteer agencies does not emerge, the CONSULTANT shall formulate the pilot project for a typical corridor that would consists of a major freeway and an arterial street network, and identify the requirements of facilities, staff, and funds. The pilot project is planned to be launched as a separate regional transportation operations initiative, supported by a MAG funded project that would also evaluate the effects of the proposed NRC countermeasures.

Deliverable:

Technical Memorandum No. 6 - Framework for Pilot.

Task 7: Final Report and Executive Summary

The Final Report shall be a compilation of all six technical memorandums into one document titled "MAG Non-Recurring Congestion Study - Final Report". A draft document in Word 2007 will be provided to MAG for final review and finalization upon approval. The Executive Summary will present essential findings from the study, identify relevant countermeasures, describe the Implementation Plan and the Pilot Project. A draft document will be submitted for review by SAG.

Deliverables:

Draft Final Report - An electronic document in Word 2007.
Final Report - An electronic document in Word 2007.

Draft Executive Summary - A draft electronic document for SAG review.
Executive Summary - The final electronic document, 30 hard copies, and 1 camera ready copy.

II. DELIVERABLES

The deliverables to be produced through each of the study tasks are as described below. Each study task shall produce a Technical Memorandum that will present information in a succinct manner with extensive use of tables, matrices, and drawings. An administrative draft of each Technical Memorandum will be submitted, as a Microsoft Word document, to the MAG project manager at least one week prior to its planned distribution to the Study Advisory Group (SAG). All review comments provided by the MAG Project Manager, will be addressed by the CONSULTANT in a revised draft document to be made available to the SAG for a two-week

review. 30 hard copies of each draft document will be made available to the SAG. Review comments received from the SAG will be addressed and resulting changes will be incorporated into each final Technical Memorandum within two weeks.

The Draft Final Report will be delivered as an electronic document in Word 2007, for review by MAG. Upon finalization, the Final Report will also be delivered to MAG as an electronic document in Word 2007.

The Draft Executive Summary will be distributed to the SAG, for review, as an electronic document. The Final Executive Summary will be delivered to MAG as an electronic document, 30 hard copies and 1 camera ready copy.

Task	***Deliverable***
Task 1	*Technical Memorandum No. 1 – Literature Review and Summary of NRC Countermeasures.* *25 copies of the draft document for SAG review.* *Final Technical Memorandum delivered to MAG as Word 2007 and PDF documents.*
Task 2	*Technical Memorandum No. 2 – Methodology for Quantifying Non-Recurring Congestion and the Data Collection Plan.* *25 copies of the draft document for SAG review.* *Final Technical Memorandum delivered to MAG as Word 2007 and PDF documents.*
Task 3	*Technical Memorandum No. 3 – Data Collection Results and Estimation of Impacts of NRC.* *25 copies of the draft document for SAG review.* *Final Technical Memorandum delivered to MAG as Word 2007 and PDF documents.*
Task 4	*Technical Memorandum No. 4 – Potential NRC Countermeasures, Required Resources and Cost-Effectiveness.* *25 copies of the draft document for SAG review.* *Final Technical Memorandum delivered to MAG as Word 2007 and PDF documents.*
Task 5	*Technical Memorandum No. 5 – Implementation Plan.* *25 copies of the draft document for SAG review.* *Final Technical Memorandum delivered to MAG as Word 2007 and PDF documents.*
Task 6	*Technical Memorandum No. 6 – Framework for Pilot Project.* *25 copies of the draft document for SAG review.* *Final technical memorandum delivered to MAG as Word 2007 & PDF documents*
Task 7	*Final Report - delivered to MAG as Word 2007 and PDF documents.* *Executive Summary - 1 camera-ready original; 30 bound copies, 1 copy in Word 2007, and 1 copy in PDF.*

III. SCHEDULE

The planned project schedule is shown below. It is anticipated that the study will commence on or about February 5, 2010, and be completed by August 30, 2010.