

**THE APPLICATION OF ADVANCED TRAFFIC  
MANAGEMENT SYSTEMS FOR SPECIAL EVENTS**

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## SUMMARY

Special events (e.g. sporting events, concerts, conventions, etc.) may overload a roadway network by increasing traffic volumes to unmanageable levels. Careful planning and implementation of a Transportation Management Plan (TMP) are essential to minimize congestion during special events. The development of a TMP should carefully analyze every possible ATMS strategy that can be used to improve traffic conditions to and from a special event. In addition, the plan should be the end result of a cooperative effort between public and private entities, so that it represents the interest of a broad range of people.

Little literature is readily available that explicitly covers the topic of managing special event traffic. A literature search and conversations with some of those experienced in handling special events led to the following eight-step methodology for managing special events:

1. Inventory Resources;
2. Analyze Traffic Impact;
3. Identify Problems;
4. Develop the TMP;
5. Analyze and Modify the TMP;
6. Implement the TMP;
7. Operate the TMP; and
8. Critique the TMP.

Using this methodology, a preliminary TMP was developed for Texas A&M University home football games at Kyle Field. The plan recommends route diversion, highway advisory radio, reversible flow lanes, and other ATMS strategies to handle the increased traffic associated with the football games.

Special events have not been thoroughly documented in the past. The knowledge for handling special events exists, but has not been disseminated amongst the profession. Further literature is needed to aid in planning special events. This document is envisioned to serve as a "how to" manual for managing special events.

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## **INTRODUCTION**

Special events often contribute to traffic congestion. These events (e.g. golf tournaments, musical concerts, conventions, and major sporting events) can generate large amounts of traffic that overload the roadway network. Proper planning and the use of elements of Advanced Traffic Management Systems (ATMS) can lead to the successful handling of traffic to and from the special event (1,2).

### **Problem Statement**

The techniques and experiences of handling traffic during special events have not been assembled into a separate document. A compilation of success stories and the identification of a planning framework to be used during special events may help traffic engineers in planning and handling the increased traffic associated with special events.

College Station, Texas, home of Texas A&M University and the Fightin' Texas Aggie football team, has to deal with a massive influx of spectators for home football games. The existing traffic management plan for traffic coming to Kyle Field should be critiqued, and a plan needs to be developed for exiting traffic.

### **Study Approach and Objectives**

This study was divided into two sections. The first part of this research documented case histories of how special events were handled in the past. In addition, the elements necessary for a successful traffic management system were identified for traffic engineers to use in planning for special events. The second part of the study involved the application of the identified methodology to the development of a traffic management plan for a typical Texas A&M home football game. Three objectives of this research were established:

1. Identify previous Traffic Management Plans for special events;
2. Develop a framework for planning and managing the increased traffic associated with a special event; and
3. Modify the existing Traffic Management Plan to a Texas A&M home football game using the methodology developed in Objective 2.

## BACKGROUND

Special events may be defined as special trip generators that produce a large amount of traffic on an infrequent basis. Special events may be divided into two classes. Occasional events are events that occur infrequently, such as the 1984 Los Angeles Olympics, the 1994 World Cup, or the 1994 25th Anniversary Woodstock concert. Frequent events are special events that may occur one or more times during a year. Some examples may include a professional or collegiate football game, a state fair or carnival, an annual convention or large meeting, and a music concert. Both types of special events require the same types of planning and strategies. However, frequent events may be modified and improved with experience in handling the event.

### Literature Review

Although several special events occur throughout the United States, little literature exists documenting the aspects of the traffic management plans for each special event. The Federal Highway Administration's *Freeway Incident Management Handbook* (FIMH) (3) devotes a section to the handling of special events. This document serves as the only widely available document found by the author specifically addressing special event planning and management. The FIMH suggests that a special event should be handled in the same fashion as an incident. This is accomplished using proven ATMS strategies during the event to reduce congestion. The FIMH also suggests that the same interagency coordination necessary for a Traffic Management Team is necessary for the special event. In addition, those who develop the Transportation Management Plan (TMP) should implement the plan as well; ready to modify the plan in accordance with real-time traffic. Table 1 shows the aspects necessary for a successful special event TMP (3). The following sections summarize examples of successful traffic management plans for special events.

#### *1986 U.S. Open Golf Tournament; Southampton, New York*

One documented special event plan is the 1986 U.S. Open Golf Tournament at the Shinnecock Hills Golf Club on Long Island, New York. The event was handled by Dunn Engineering Associates, and documented in "Traffic Management of Special Events: The 1986 U.S. Open Golf Tournament" (4). The event and the adjacent transportation network of the area presented major traffic management obstacles that were successfully handled.

The first problem was that the event coincided with the peak recreational period on Long Island. Traffic problems were experienced without the golf tournament, and it was envisioned that the additional golf traffic would completely overload the roadway network. Secondly, Shinnecock Canal was traversed by only two crossings, with a total of three lanes of travel in each direction across the canal. The canal is located between the golf club and New York City, so that all golf traffic would have to cross the channel. Finally, only one major roadway served the area of the golf club. These three problems were envisioned by some as impossible to overcome. A map of the Shinnecock Hills area is provided in Figure 1.

The problem was approached similar to the manner in which a traffic impact study (TIS) is prepared. First, a background traffic volume on the network was obtained from historical data. The attendance for the tournament was then projected, corresponding to the trip generation stage of a TIS. A modal split, projecting what percentage of the trips would be made by bus, rail, and car, was then projected. Finally, bus and auto trips were "assigned" to the transportation network.

The difference in a TIS and planning for a special event comes through the additional analysis that is done after traffic has been "assigned." With the projected volumes computed for the network, an analysis was done to see whether the anticipated traffic volumes exceeded the capacity of the roadway network. If volumes exceed capacity, ATMS strategies should be employed to mitigate congestion problems (4).

At the U.S. Open, a parking management strategy was developed to help minimize projected traffic problems. The strategy was to park vehicles in a location that would improve the efficiency of traffic flow. In addition, parking locations were chosen that would minimize superimposition of traffic flows. Furthermore, parking locations were chosen to separate bus, auto, and pedestrian traffic as much as possible. Finally, a signing strategy was developed to direct motorists to the correct parking locations. Different locations were established for spectators, season ticket holders, members of the media, and volunteer staff. Those visitors parking in locations a long distance from the event were taken to the golf course in shuttle buses along an exclusive bus roadway. Finally, a temporary pedestrian overpass was constructed over one of the major routes. Not only did this improve pedestrian safety, but traffic flow was made more efficient by eliminating pedestrian interferences.

In addition to the parking management plan, other ATMS strategies were also implemented. Highway advisory radio was used to offer specific instructions to visitors coming to and leaving the event. This was done by installing a monopole antenna at the traffic command center set up for the event. Pre-recorded messages were used, and on-site engineers had the option of creating new messages to respond to real-time traffic information, particularly in the case of an incident.

Aerial surveillance via helicopter was used to monitor traffic flow throughout the event. This, in conjunction with "metering" traffic exiting the event, proved to be a useful strategy for maximizing traffic efficiency after the event. Simply put, police officers directing traffic out of the parking lot could either increase or reduce the flow of exiting vehicles, depending on current traffic conditions, as reported from the helicopter. This concept is very similar to freeway ramp metering, and was developed on-site, after the TMP was developed and in operation. By metering the flow of exiting traffic, smooth traffic flow along the major streets could be preserved. In addition, incidents could be quickly detected and confirmed using the aerial surveillance system, so that any necessary route diversions could be quickly established.

Finally, reversible flow lanes, left turn restrictions, and shoulder usage were used along the two highways leading to the event to maximize flow. Three lanes were used in either direction, by using cones to denote travel lanes. Three lanes were open into the event in the morning, and three lanes were used for outbound travel following the event. Left turns were prohibited along vital sections of major roadways to minimize flow interruptions. Detour routes

Table 1. Methodology for Special Event Planning (3).

<b>Identify Major Concerns</b>	-	Designated parking lots with shuttle bus service
• Limited access to site		
• Limited capacity of roadways feeding site	-	Separation of pedestrian, automobile, and shuttle bus traffic to the extent possible
• Potential "Hot Spots"		
• Coincidence of event with commuter or recreational peak periods	-	Bus-only ramps and streets
• Parking availability	-	Temporary signing
• Transit service	-	Portable signing to direct motorists to available parking
<b>Assemble Representatives from Participating Agencies</b>	-	Special bus lanes
• Assign task groups	-	Temporary one-way streets
• Develop working relationships among agencies	-	Parking restrictions
• Obtain inputs into development of event plan	-	Traffic officer placement
• Prepare Traffic Impact Study and Traffic Management Plan	-	Signal timing
• Engage consultant if external resources are required	-	Highway advisory radio use
	-	Left turn restrictions
	-	Radio Communications
	-	Aerial surveillance
	-	Temporary metering
	-	On-site traffic management
	-	Temporary lane control
	-	Temporary command center
<b>Assess Impact of Event on Affected Roadways</b>	•	Establish media contacts and assign representatives
• Review event schedules		
• Estimate attendance	•	Prepare information, brochures, releases
• Estimate modal split		
• Assemble existing traffic data		
• Estimate directional distribution of event generated attendance		
• Assign traffic to approach roadways		
• Compute composite traffic comprising event and non-event generated traffic		
• Compare to capacity of approach roadway		
• Identify problem locations		
<b>Prepare Traffic Management Measures</b>		
• Identify mitigating measures		
- Diversion to underutilized approach roads		
		<b>Implement Plan</b>
	•	Assign traffic management teams
	•	Build in flexibility to modify plan on-site as required
	•	If multi-day event, hold critique sessions each day to improve operations
	•	Provide information to media
		<b>Evaluate Plan</b>
	•	Hold critique session
	•	Identify shortcomings and possible solutions
	•	Identify future special events



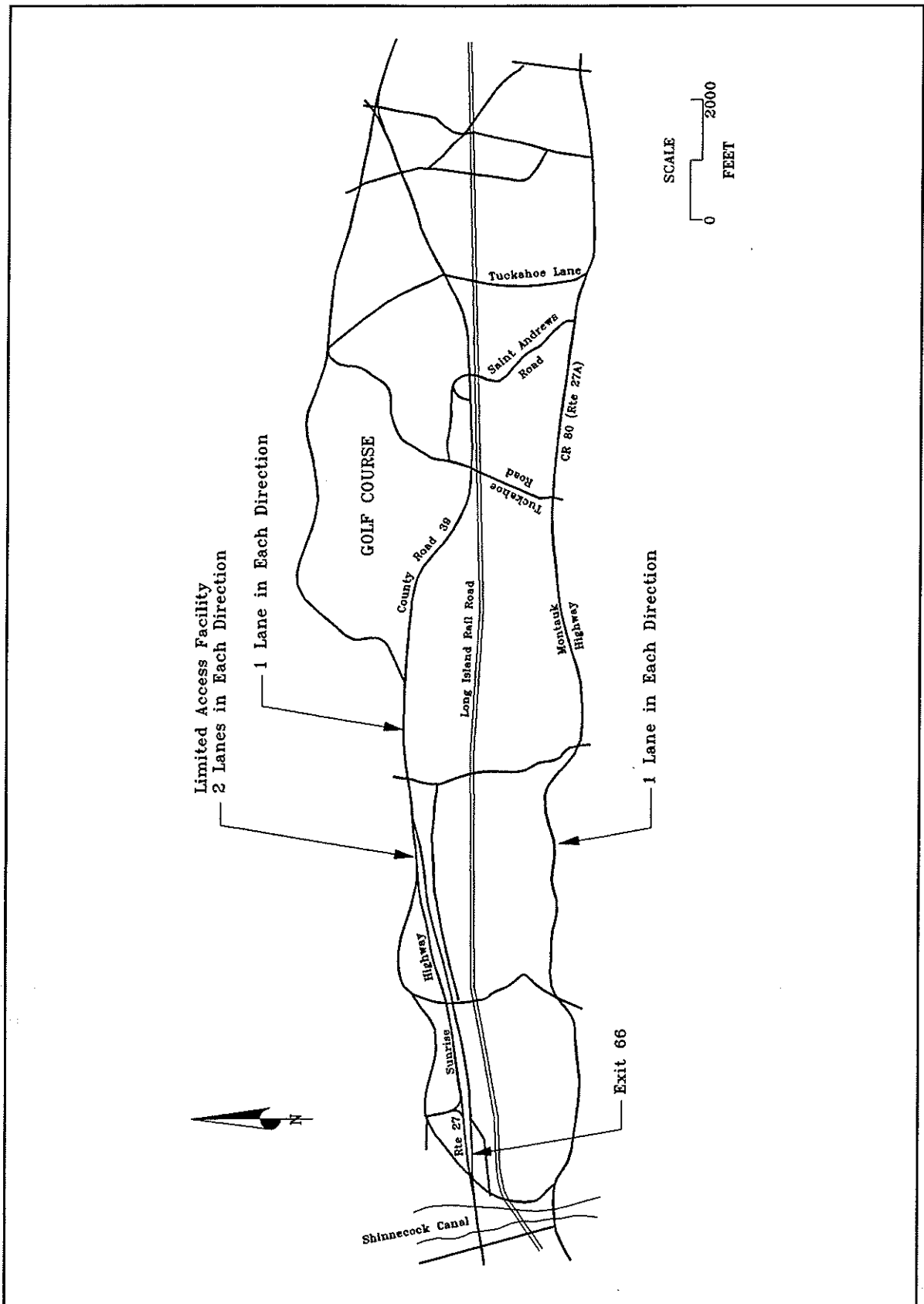


Figure 1. Roadway Location Map in the Vicinity of Shinnecock Hills Golf Club.

were provided for those inconvenienced by the left turn restrictions. The roadway shoulders were also used to provide an additional travel lane during the event.

The 1986 U.S. Open demonstrates a success story in handling special events. Dunn offers five reasons for the success (4). First, the TMP was carefully thought out and tailor-made to fit the traffic needs of the event. Second, the TMP was the result of input from several agencies, including law enforcement, the U.S. Golf Association, transit services, local governmental officials, and transportation professionals. Third, the plan was implemented and operated by those who designed it. In the opinion of the consultant, the plan was realistic and affordable. In addition, each of the contributing parties chipped in to assure the plan's success. Fourth, traffic was handled on-site, allowing for emergency vehicles to have quick access to the site. Cart crossings were separated from major pedestrian flows to maximize efficiency and provide for pedestrian safety. Fifth, and perhaps most importantly, the plan could be easily modified to match real-time traffic volumes and flows (1). Traffic engineers and professionals were on-site throughout the event to design and apply any changes to the original plan. The plan will be tested again in 1995, as Shinnecock Hills will play host again to the U.S. Open (2).

### *Rose Bowl; Pasadena, California*

The annual Rose Bowl and Tournament of Roses parade in Pasadena, California offer additional needs for good special event planning (1). The California Department of Transportation and the California Highway Patrol have developed and refined the TMP for the Rose Bowl and Tournament of Roses Parade each year. The Rose Bowl differs from the U.S. Open in that the Rose Bowl is an annual special event that can be refined and improved with time. However, the Rose Bowl is handled largely in the same way as the 1986 U.S. Open, in that the same planning process and methodology occurs.

The Rose Bowl offers a different set of problems to be dealt with. Limited parking exists at the Rose Bowl itself. The stadium is surrounded by three freeways as shown in Figure 2. Of the three freeways, I-210 lies north and east of the stadium, California State Highway 2 lies west of the stadium and California State Highway 134 lies south of the stadium. Heavy traffic demands to the stadium from California Highway 134 complicate the problem, in that the network is unable to handle the increased demands. A map of the Rose Bowl area is shown in Figure 2.

To solve the parking problem, some traffic is allowed to park on an adjacent golf course. This works well during good weather, but may be a problem during rainy weather and muddy conditions. Access is then restricted to the few parking places that are available. As with the 1986 U.S. Open, parking management is a vital part of the Rose Bowl TMP.

Spectators that are not allowed to park close to the Rose Bowl are brought to the stadium via shuttle bus. Park and ride lots are set up only a mile outside of the stadium. Transportation to and from the stadium is expedited using bus exclusive facilities. Shuttle buses are free to spectators attending the event, and riders only have to show their event ticket to ride on the buses. In addition, other park and ride lots are set up at farther distances from the stadium for charter busing to the event. Charter busing is heavily emphasized for transportation to the stadium from outlying areas such as Long Beach or Santa Monica. This is an attractive transportation alternative, as bus parking is directly adjacent to the stadium.

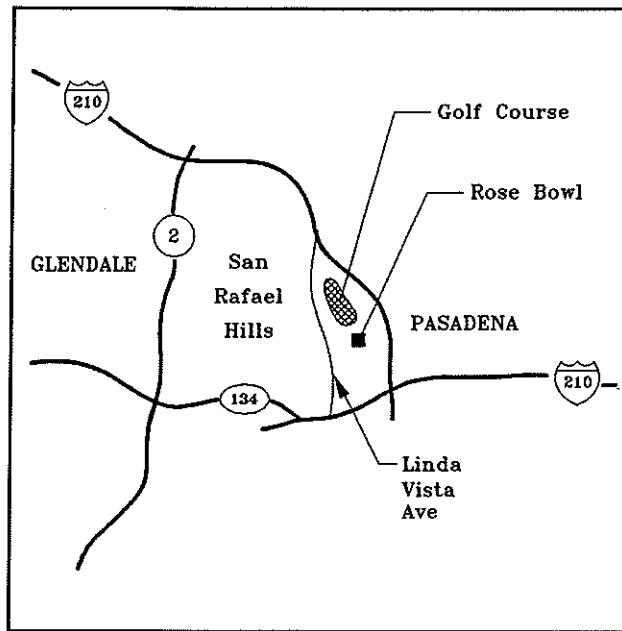


Figure 2. Rose Bowl Stadium and Vicinity.

A route diversion plan has been employed at the Rose Bowl to move some of the heavy traffic demands on the freeway south of the stadium (SH 134), to the freeway on the north side of the stadium (I-210). This is done when necessary using variable message signs. Also, when demand exceeds capacity, ramps on SH 134 are often closed to reduce traffic volumes and prevent congestion.

The Rose Bowl and Tournament of Roses parade TMP introduces another concept to special event planning. This concept may be referred to as a "forced modal split," which is performed in four steps. First, the number of people attending the event was estimated. Second, the amount of traffic to the site was predicted. Third, the amount of site parking was determined. Finally, by determining the difference between available parking and predicted traffic, the needed amount of bussing to the stadium was estimated. This amount of bussing was then provided to event attendees.

#### *1990 Goodwill Games; Seattle, Washington*

The 1990 Goodwill Games held in Seattle is another example of a special event that demanded a special TMP (5). Fortunately, most of the events centered around the University of Washington, so the TMP developed for football games Husky Stadium could be slightly refined and implemented for the Goodwill Games with little additional effort.

Several ATMS strategies were used for the Goodwill Games. Variable message signs were used to reinforce route diversion information according to real time traffic conditions. Service patrols were increased for the event to ensure quick removal of accidents and disabled vehicles. Parking incentives were offered to carpools of three or more to encourage higher auto

occupancies. Finally "bus only" routes were established for quick transport to the event. These routes were particularly helpful for transporting the athletes to and from the event sites.

#### *1990 Gorbachev Visit; Minneapolis, Minnesota*

In 1990, former Soviet President Mikhail Gorbachev visited the United States. His tour of the country included a stop in Minneapolis, Minnesota. Traffic management techniques had to be developed to provide for the safe movement of the Gorbachev motorcade through the city. In addition, security for Gorbachev was a major concern. The specifics of the plan are documented by Richard Stehr of the Minnesota Department of Transportation (6).

The movement of the Gorbachev motorcade required the closing of freeway segments while the motorcade passed. Variable message signs and highway advisory radio were used to inform motorists of the freeway segment closures. Diversion information was also given to route traffic around the freeway closures. However, since Gorbachev's visit occurred on a Sunday, traffic volumes were low and no major problems occurred. Service patrols were increased to quickly remove potential hazards that might endanger Gorbachev. The TMP was coordinated by a number of agencies to develop the best plan possible.

#### *1984 Summer Olympics; Los Angeles, California*

In 1984, Los Angeles hosted the Summer Olympics for the second time in that city's history. Since 1932, the first time Los Angeles hosted the Olympics, the city and its transportation network have grown and changed dramatically. Since 1932, the city has changed from depending largely on transit (27% of trips by rail) to a city almost completely dependent on the automobile (97% of all trips) (7). The challenges of managing the projected traffic to the Olympics were enormous (1).

The development of the Olympics TMP began in 1982 with the development of an interagency task force. The task force included elements of each of the following agencies:

- Los Angeles Olympic Organizing Committee (LAOOC)
- California Department of Transportation (CalTrans)
- Los Angeles City Department of Transportation (LADOT)
- Southern California Rapid transit District (SCRTD)
- California Highway Patrol (CHP)
- Los Angeles Police Department (LAPD)

Different responsibilities were then assigned to each agency. The LAOOC handled Olympic family transportation and on-site planning issues. CalTrans analyzed the operation and planning of the area freeways. LADOT was responsible for handling traffic on city streets. CHP was placed in charge of handling freeway system enforcement and incident management. LAPD handled traffic management on city streets (7). Other city and area governmental agencies were contacted and used when needed. This interagency cooperation was an essential element of the plan (8).

Since the Olympics were held at several sites in the Los Angeles area, traffic management plans for each event venue were developed. Many of these plans included aspects such as parking management, exclusive bus facilities, temporary one-way streets, traffic officer placement, and special signal timings (7). Media and traffic operations centers were established for making real-time traffic management decisions (8). Information detailing the plan was distributed to the Olympic spectators informing them of the TMP.

Existing traffic patterns were analyzed and the anticipated Olympic traffic was superimposed on the network. This analysis led to the conclusion that five days would be critical to the operation of the transportation network (8). Knowing the event times and possible locations of congestion, engineers could determine effective ways of handling traffic. Trucking companies were encouraged to shift operations to off-peak periods to help avoid congestion. Commuters were urged to make trips during the less critical off-peak hours. Many simply avoided driving due to the perceived traffic problems. The TMPs centered on merging freeway, street, bus, and parking operations to manage traffic to and from the Olympics (8).

The 1984 Los Angeles Olympics represent another example of a successful application of a TMP to solve traffic problems. The Los Angeles area experienced a 5% increase in traffic during the Games, but conditions stayed at free-flow for essentially the entire event. One of the big stories from the Olympics was the traffic congestion that never occurred (8). Slight shifts of normal transportation patterns led to the success of the event (7). Table 2 shows the particular elements used for each special event TMP.

#### *Other Sources*

Several other sources exist that offer ideas for special event TMP's. One of the more popular of these documents is ITE's *A Toolbox for Alleviating Traffic Congestion* (9). Although this document does not specifically address special events, many of the Transportation Demand Management (TDM) measures identified in the document are applicable to special events. This document may serve as a valuable reference when planning for a special event.

Similar to the *Toolbox...*, another useful reference is the Federal Highway Administration Manual entitled *Implementing Effective Travel Demand Management (TDM) Measures: Inventory of Measures and Synthesis of Experience*. (10). This compendium critiques some of the more classic TDM strategies such as staggered work hours, carpooling incentives, and HOV treatments, many of which are inappropriate for the temporary use associated with a special event. The document apparently is intended to guide metropolitan areas and large employers in developing large scale TDM policies.

Research was also done on determining the success that variable message signs and highway advisory radio have in handling and diverting traffic at special events. This research shows that both strategies are effective in diverting traffic at special events. A study done in Dallas (11,12) showed that variable message signs greatly influenced route diversion. The effect of the variable message signs on route diversion were measured at the Texas State Fair, Cotton Bowl football game, and the Fourth of July fireworks display. Different message contents were tested, and while some messages were more effective than others, all messages greatly influenced route diversion for the special events.

Table 2. Inventory of Strategies Used in Previous TMPs.

	86 U S O P E N	84 O L Y M P I C S	90 G O O D W I L L G A M E S	90 G O R B A C H E V	R O S E B O W L
Route Diversion	√	√	√	√	√
Parking Management	√	√	√		√
Shuttle Busing	√	√	√		√
Park-n-Ride		√	√		√
Bus Exclusive Facilities	√	√	√		√
Signal Timing		√			
Traffic Officer Placement	√	√	√	√	√
Reversible Flow Lanes	√	√	√	√	√
Ramp and Road Closures		√			√
Left Turn Restrictions	√	√	√		√
Variable Message Signs		√	√	√	√
Highway Advisory Radio	√	√	√	√	√
On-Site Management	√	√			
Service Patrols		√	√	√	√

A highway advisory radio system for the annual WurstFest celebration in New Braunfels, Texas, was analyzed in another research study (13). The study showed that about a third of attending the event tuned to highway advisory radio. Of that amount, about two-thirds diverted to another route.

## **How to Plan for Special Events**

Following a review of relevant literature, a methodology for planning for special events was developed to serve as a "how to" guide for planning for special events. A discussion of that process follows.

### *Introduction*

Special events require careful planning and implementation of ATMS strategies to alleviate traffic problems associated with the increased traffic generated by the special event. If not properly managed and handled, even a small event may cause major traffic problems.

Each traffic management plan should be unique for each special event, but the same considerations and concerns should be addressed for every special event (1). Special events may and often do present the same types of problems, but the manner with which they are managed should differ from site to site. For example, congestion at intersections in the vicinity of a special event is likely to occur at almost all special events. A shuttle bus system may appropriately solve the problem at some special events, whereas a preferred parking system may be more appropriate in other areas. Both of these strategies, however, should be considered before recommending one over the other. The following sections describe the eight-step methodology for managing special events:

### *Step 1: Inventory Resources*

From the initial planning of the TMP through the final evaluation and critique of the plan after the event, the handling of special events should be a cooperative effort. A task force should be created consisting of representatives from all agencies necessary to adequately do the job. This task force should be developed at the onset of the program to determine what available resources can be used during the special event. A strong, cooperative interaction among all parties strengthens the TMP. The special event task force should include the contributions of: local government, chamber of commerce, state and city transportation officials, law enforcement agencies, service patrols, event sponsors and organizers, transit agencies, and any consulting engineer hired on for the task. With each of these parties represented, the TMP blends the interest of each organization into a more effective TMP. Healthy cooperation between agencies strengthens the plan, in that each agency becomes comfortable with the plan as it is developed (2).

Also at this time, resources should be pooled to make a preliminary determination of what ATMS strategies may be easy to implement. For example, a member of the task force from the state department of transportation may have variable message signs that could be used for the event. The law enforcement representative may have traffic cones for delineating

reversible lane roadways. By pooling resources, it becomes apparent as to what ATMS strategies may be easily put into place.

Simultaneously, any previous plan for handling the special event in question should be critiqued and analyzed for strengths and weaknesses. If a plan exists, the special event planning may only consist of modifying the plan to better handle the problems associated with the event. If no plan exists, any available data and input from previous events should be analyzed to get an initial idea of what problems exist. This may include quantifiable data, such as traffic volume counts, or non-quantifiable data, such as input from citizens about perceived problems. If the event is a first time affair, and no historical data exists, then a preliminary analysis should be done to identify potential problems that the event might cause.

### *Step 2: Analyze Traffic Impact*

Having a preliminary idea of potential problem areas, work may begin on predicting the impact of the special event. The problem may be approached similar to the manner in which a Traffic Impact Study is prepared. First, event attendance should be predicted using data provided by either ticket sales, historical attendances, and stadium capacity. Second, estimate the total number of autos predicted to come to the site, factoring in modal split estimates for bus, walking, rail, and any other non-automobile modes. It is also important to remember that auto occupancies for traffic to and from special events is likely to be significantly higher than normal occupancies. It would not be unreasonable to assume an average auto occupancy of 2.5 or 3, compared to approximately 1.2 for everyday traffic (2). Third, determine the parking capacity of the event site and adjacent parking facilities. Comparing the amount of cars coming to the site to the number of parking places available will determine whether enough parking is available to handle all those wishing to travel by auto. Traffic should then be assigned to the roadway network, adding background traffic that will be using the network for reasons other than the special event. This value may be obtained by counts or historical data. It should be noted that many special events occur on weekends when traffic volumes are light. In addition, a large special event is likely to reduce the level of background traffic, as many will avoid the area for fear of getting stuck in congestion associated with the event (1).

### *Step 3: Identify Problems*

Using the projected travel volumes and modal split, the engineer must address two main issues. First, can all those wishing to drive vehicles park at the event? If the answer is no, then the difference between projected vehicular traffic and parking capacity must access the site via a non-auto mode. This may be done via bus, park and ride, or light rail, if facilities exist. Second, can the roadway network adequately handle the projected traffic volumes? If the answer is no, then traffic must be reduced or rerouted, and/or the capacity of the existing roadway must be increased by using a strategy such as reversible flow lanes. For the TMP to work, traffic problems that might occur after the event associated with exiting traffic should also be considered. This aspect is often overlooked in TMP development.



#### *Step 4: Develop the TMP*

After identifying the problems identified in Step 3, the engineer may develop a preliminary TMP to address and alleviate the problems. The TMP consists of several management strategies, used in coordination to alleviate the anticipated traffic problem associated with the special event.

Parking shortages and the inability of the roadway network to handle traffic are the two most common problems associated with special events (1). If there is a shortage of parking, the "forced modal split" as described on page 7 should be developed. Buses can be mobilized to carry spectators to the site in one of two ways. First, and most common, is to establish park-and-ride lots in outlying areas. Charter buses can be set up to connect outlying areas to the stadium. Many of these shuttle buses are free to event attendees. "Bus only" routes and lanes may be established for quick transportation to the event site. If exclusive bus facilities are used, busing may become an attractive alternative over driving due to the ease and potential travel time that busing may offer.

Busing is often done in conjunction with a parking management strategy. The limited parking spaces are assigned to those attending the event, and drivers can go directly to the parking lot to which they are assigned. Temporary event parking may also be established in locations such as golf courses and open fields to handle any deficiencies in parking amounts. Those not assigned parking are instructed to use shuttle buses.

If the roadway network cannot handle the anticipated traffic loading, an appropriate ATMS strategy should be employed to handle the increased traffic loading. These measures may include route diversion, left turn restrictions, special signal timings, officer controlled intersections, and reversible flow lanes. Whatever the strategy employed, either the transportation supply (capacity) must be increased and/or the traffic demand (volume) must be decreased so that transportation demand does not exceed transportation supply. When traffic volumes exceed roadway capacity, flow breaks down resulting in congestion.

The TMP can be supplemented by reinforcing the driver with good information. Highway advisory radio can be used to inform drivers of real-time traffic conditions and how to reach the event in the most efficient manner. Variable message signs can be used to help achieve any desired route diversion. Flyers may be distributed with the event tickets advertising park and ride shuttles, recommended routes, and other aspects of the particular TMP. The media may be contacted to announce and describe the plan. Also, real-time traffic information, such as an incident or full parking lot may be broadcast. Aerial surveillance, TV cameras, and spotters may be used to determine up-to-the minute information (1).

Finally, the use of service patrols should be considered. Incidents may occur at any time, endangering the stability of traffic flow. Service patrols should be considered to quickly remove accidents and stalled vehicles, providing minimum disturbance to the TMP operation.

### *Step 5: Analyze and Modify the TMP*

In this step, the engineer refines the plan that has been developed in Step 4. The developed TMP must be a realistic, attainable option. The plan should be implemented within budgetary and time constraints. In addition, the plan should be agreed upon by all members of the special event task force. Furthermore, make sure the plan is not overkill, using unnecessary measures that provide little benefit. The plan also should be adaptable to changing conditions. For example, if the TMP includes using an open dirt field for parking, is there an alternative in case of rain? Flexibility should be incorporated whenever possible to be able to respond to changing conditions. Finally, and perhaps most importantly, will the general public be happy with and obey the TMP as it stands. Public opinion and reaction may be the most important measure of success or failure for a special event. Basically, if the public is not happy, then the TMP is a failure! The TMP should be revised to reflect any of these concerns, before implementation.

### *Step 6: Implement the TMP*

Once the TMP is finalized in Step 5, the plan should then be implemented. The TMP must be approved by necessary agencies before operation begins. The plan should be publicized through local media agencies and information brochures so that the public will be aware of and understand the TMP. In getting the plan out, many will likely choose simply not to travel on game days due to the event and the perceived traffic problems with the event. Any equipment, such as additional signs, cones, and highway advisory radio hardware should be purchased. In addition, some equipment should be tested before the event begins.

### *Step 7: Operate the TMP*

Implementation of the plan should be carried out by those who devised it, and by those understanding the concepts of traffic flow (1). This allows the plan to be modified as real-time traffic conditions change. If certain aspects of the plan are ineffective, the plan can be modified on the spot by a qualified person. However, with frequently recurring events, such as a professional baseball game, the TMP will soon become standard practice, and it may not be necessary for the developer of the plan to be the full-time implementor/operator of the plan. In any case, a qualified traffic engineer should be available for trouble-shooting. Hopefully, the plan has incorporated room for some degree of modification, depending on conditions. These modifications should be designed so that any changes can be performed quickly, with little disruption.

### *Step 8: Critique the TMP*

After the event, the task group should reconvene to compile lists of the success and failures of the TMP. The results should be written and published for future special event planning. In the case of frequent special events, the TMP should be reanalyzed and modified to address the concerns stemming from the special event just past. Planning should begin for the next special event, and the eight-step process repeats itself.

## CASE STUDY EXAMPLE

Using the procedure developed in the preceding section, a Traffic Management Plan was developed for a typical football game held at Texas A&M University's Kyle Field in College Station, Texas. The plan will be presented to the City of College Station and the Texas A&M Athletic Department and PTTS for review and possible implementation during the 1994 football season.

### Step 1: Inventory Resources

Initially, information was gathered on the TMP currently used at Kyle Field from the Texas A&M Department of Parking, Traffic, and Transit Services (PTTS). Tom Williams (14), director of PTTS, was contacted and interviewed for traffic information from the University's stance. Jim Koch (15), director of the Stadium Ticket Office was contacted concerning information about seating capacity of the stadium and anticipated trip generation of Kyle Field. Ed Hard (16) of the City of College Station Planning Commission was contacted concerning potential problems from the city's standpoint. These contacts were made individually, and not simultaneously. Therefore, the interagency cooperation required for an effective TMP was not developed from the onset. This cooperation will be actively sought following the publication of this document. During other circumstances, cooperation should be developed during this stage.

#### *Current Transportation Management Plan*

The current transportation management plan is simple, but accepted by the public (14). The vehicles park on the main campus until it is full. The main campus is then closed off to traffic. Extra vehicles then park on the west campus. The campus can adequately handle the additional parking demand generated by a game (14). The 12th Man alumni association operates a shuttle bus service from some on-campus lots located a long distance from the stadium. Brazos Transit Authority operates a small park and ride system from Post Oak Mall and Manor East Mall for longer commutes to the games. The City of College Station provides special signal timings for the football games, based on prioritizing flows to and from the game (16). In addition, some local hotels operate small shuttle services for their tenants to and from the games. No plan has been developed for post-game traffic. Figure 3 illustrates the Bryan/College Station area.

#### *Perceived Problems*

Congestion is a problem along Wellborn Road, George Bush Avenue, University Avenue, and Texas Avenue on game days. Some local residents are also displeased with the large amount of traffic parked in their neighborhoods on game days. Revisions to the current plan included attempts to mitigate pre-game congestion and neighborhood parking problems. In addition, a post-game traffic plan needed to be developed.

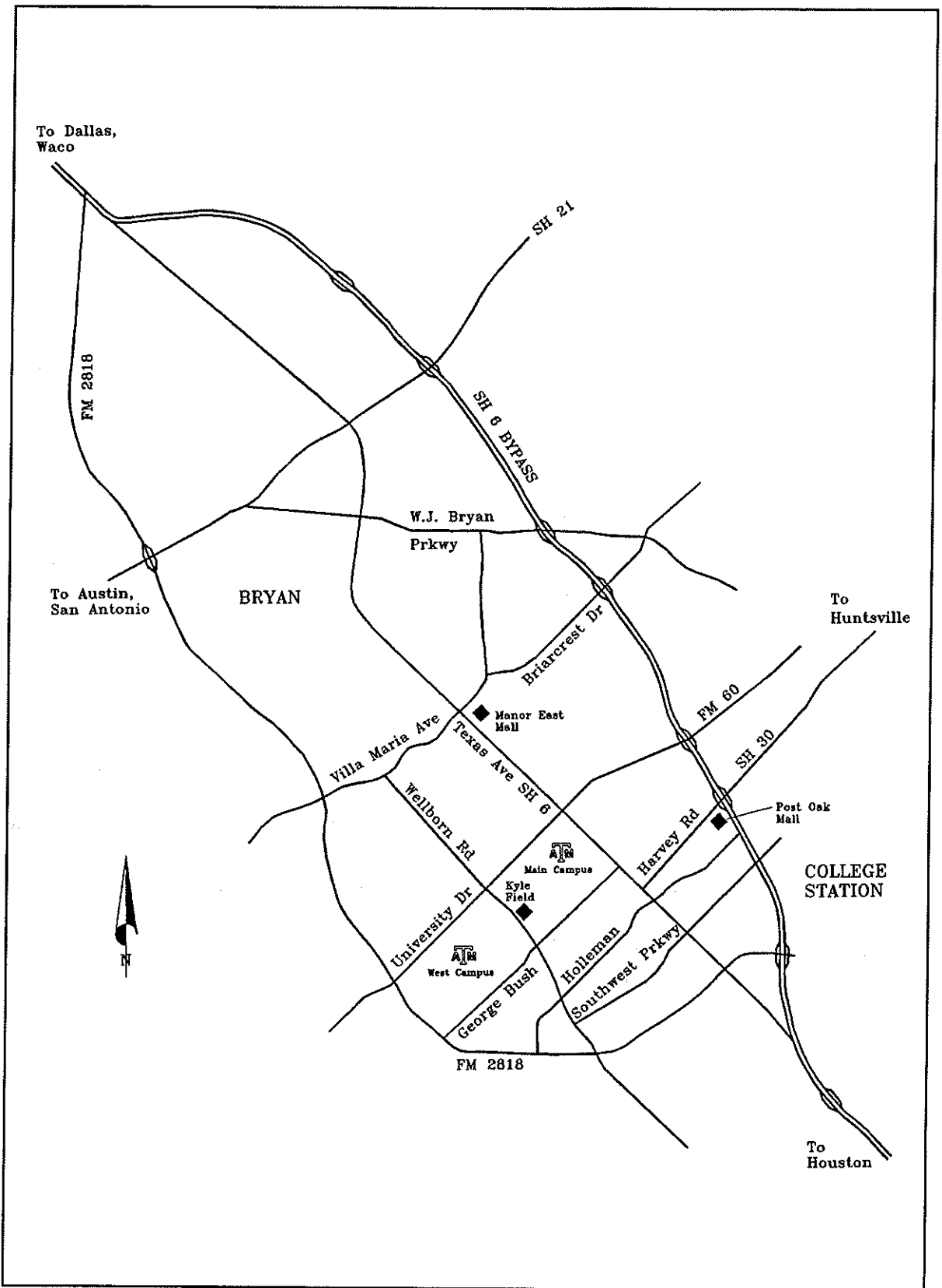


Figure 3. Bryan/College Station, Texas.  
 (Note: Not to Scale)

## **Step 2: Analyze Traffic Impact**

Using data provided by Jim Koch (15), traffic to the stadium was estimated. The seating capacity is approximately 70,000. Of these 70,000, approximately 25,000 represent Texas A&M students, a third of which live on campus. On-campus students will likely walk, removing about 8000 spectators. About 10,000 tickets are sold to the visiting team for usual sell-outs. These 10,000 are assumed to live outside of the College Station area. Subtracting out the students and the visiting team spectators leaves 52,000 spectators. Of these 52,000, several are expected to live in College Station, while many likely live in other areas and will drive to College Station for the game. The out of town trips became the focus of the traffic management areas. Out-of-town spectators may enter College Station by only a few routes, making traffic flows predictable.

It should be noted that traffic flows to games are likely to fluctuate greatly depending upon the particular game. For example, opponents are not likely to draw the large crowds associated with big inter-conference rivalries such as Texas and Baylor. In addition, the location of Texas and Baylor will likely create different traffic flows. Baylor is located in Waco, north of College Station, and Texas is located in Austin, west of College Station. Night and day games are also likely to have different traffic flows. For day games, many spectators will likely drive to College Station the night before the game. On the other hand, many will drive to College Station the day of the game if the game is held in the evening.

## **Step 3: Identify Problems**

Again, problems identified in the area include congestion on George Bush Drive, Texas Avenue, University Drive, Wellborn Road, and various campus roads prior to and immediately following the football games. Parking in residential neighborhoods was also identified as a problem. Texas A&M PTTS also expressed a desire to manage post-game traffic (14).

## **Step 4 and 5: Develop and Modify the TMP**

The final TMP focused on diverting out-of-town traffic to underutilized facilities and away from the already congested roads surrounding Kyle Field. Out-of-town traffic was estimated to comprise at least 2,000 vehicles coming to and leaving the event. By removing the out-of-town traffic from the congested routes, traffic was envisioned to have a more efficient distribution on the roadway facilities of the area.

A route diversion and parking management strategy was developed as the main portion of the TMP. The object was to divert traffic to underutilized roadway and parking facilities in order to remove some of the traffic from the congested arterials and parking lots. Shoulder usage and reversible flow lanes were also suggested to increase capacity along some arterials.

Some strategies were identified in Step 4 with the initial creation of the plan, and then dropped in Step 5, with plan modifications. As specified in the eight-step methodology identified in the previous section, the plan should be modified in Step 5 to remove unnecessary or unrealistic aspects of the TMP. The recommendations described in the following paragraphs are those of the author.

## *Route Diversion*

One of the major aspects of the revised TMP includes diverting traffic to underutilized roadways. Two bypasses of Texas Avenue are located on the east and west side of College Station. The bypasses offer limited access and increased capacity. Traffic entering the Bryan/College Station area will be encouraged to park on the west side of Wellborn Road, accessing the parking areas via F.M. 2818 (the western bypass) and George Bush Drive. To handle post-game traffic, spectators would be redirected from the west campus parking lots, backtracking along the routes used for pre-game traffic, Figure 4 depicts the projected pre-game flows. Figure 5 depicts major post-game flows. The effect of the Union Pacific Railroad operation on the TMP has not been analyzed as part of this study. The railroad crosses F.M. 2818 at-grade just west of the Wellborn Road intersection.

The route diversion must be accomplished through the supply of adequate information to the motorist. This may be done by placing variable message signs in key locations to inform drivers of the route diversion as shown in Figure 4. Fixed signing that is used only on game day may also be used. For either fixed or variable message signing, signs should be displayed only on game days when the signing information is relevant, so as to not disrupt everyday traffic on non-game days.

## *Reversible Flow Lanes, Shoulder Usage, and Left Turn Restrictions*

Reversible flow lanes are suggested on George Bush Drive in the vicinity of Kyle Field. The lanes will switch flows before and after football games, to correspond with the peak directional flows. West of Wellborn Road, George Bush Drive (two lanes) is recommended to be closed to westbound traffic before the game, and operate with a one-way operation. Conversely, traffic will be closed to eastbound traffic after the game, with a westbound one-way operation.

The cross-section of George Bush Drive allows for additional lanes on game days. West of Wellborn Road, George Bush has a wide shoulder that may be used as an additional lane. East of Wellborn, George Bush has a wide right lane that may be divided into two lanes by coning or another method. The wide lane is used as a bike route, so the closure of this lane to bicycles on game day should be publicized. In addition, parallel parking is allowed on certain sections of George Bush along the wide right lane. Parking must be prohibited to allow for the additional travel lane.

Left turns may also be restricted as necessary along minor streets intersecting George Bush, Texas Avenue, and University Drive. This restriction reduces vehicle conflicts and helps to stabilize the traffic flow (17).

## *Parking Management*

A parking management strategy was developed to help the parking situation in residential neighborhoods. This strategy is to use lots and several open fields on west campus. This is similar to the current TMP, but in this case, vehicles will begin parking on west campus before the Main Campus is full. Out-of-town spectators are routed to the lots through the route diversion strategy.

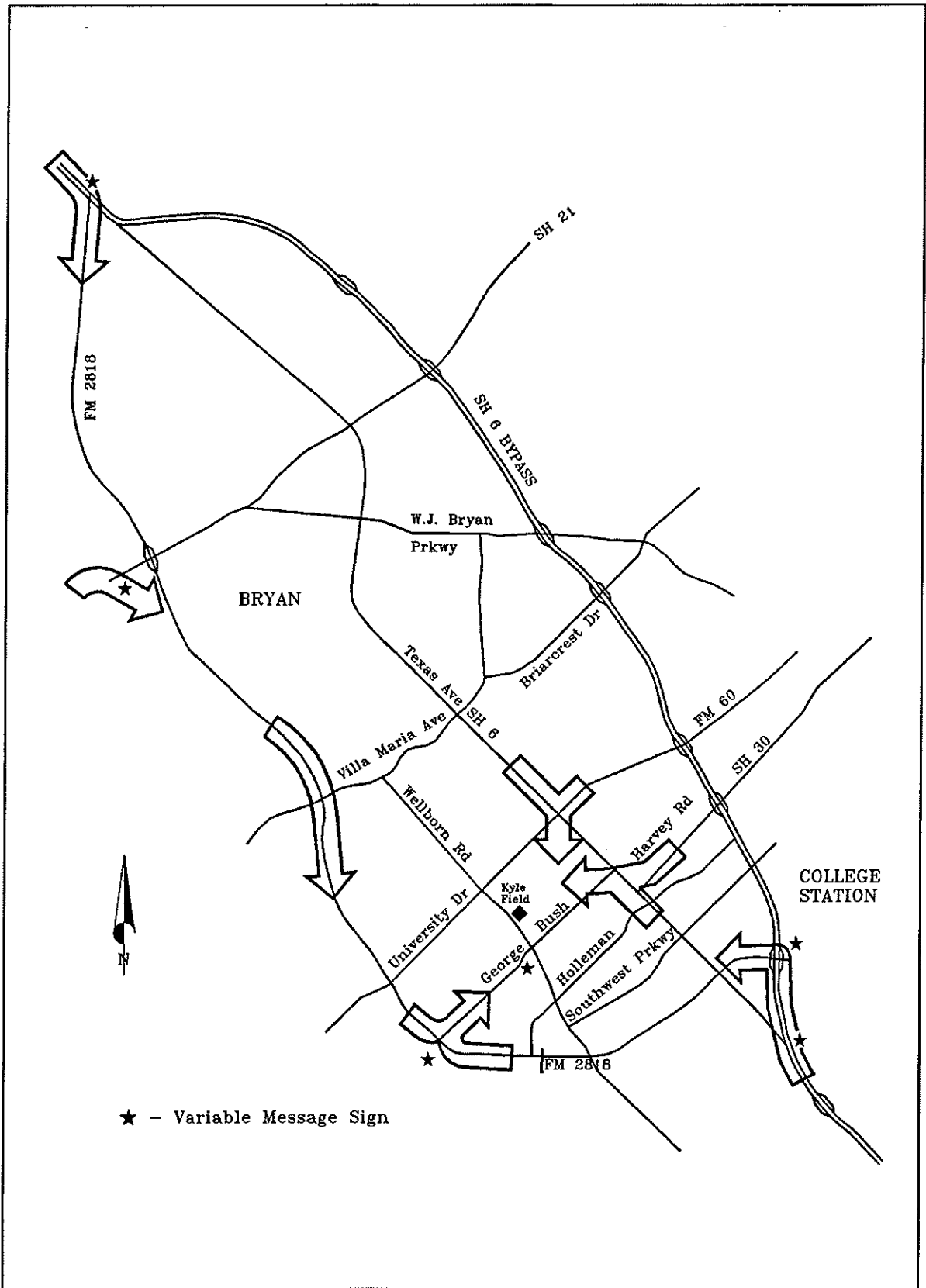


Figure 4. Projected Major Pre-Game Traffic Flows with TMP Implementation.  
 (Note: Not to Scale)

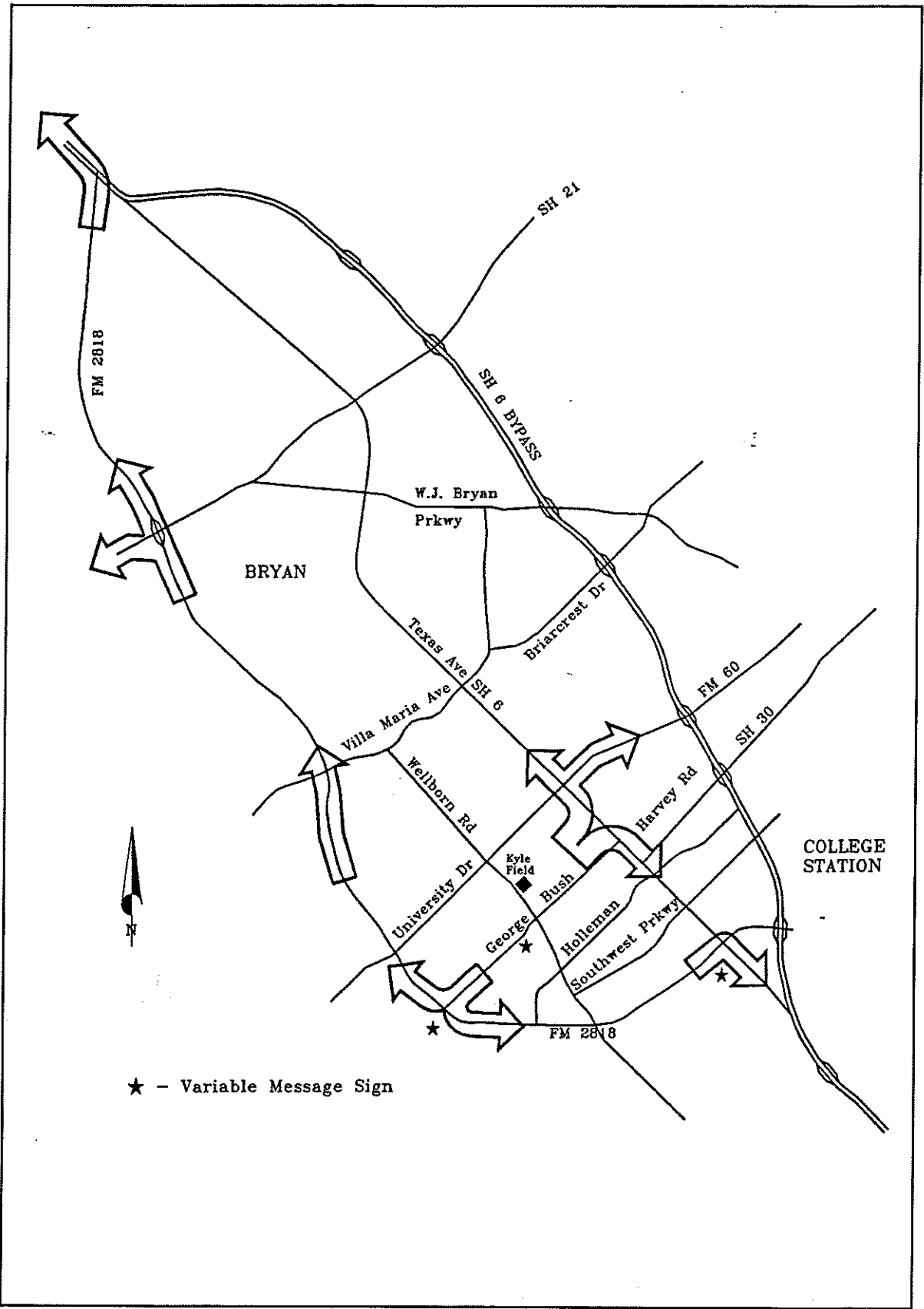


Figure 5. Projected Major Post-Game Traffic Flows with TMP Implementation.  
 (Note: Not to Scale)



If lots are unable to handle the parking demand, several open fields on the west campus near the stadium may be used to accommodate overflow parking. Parking shuttles should be considered if parking in the open fields is to occur. The fields considered are the student intramural fields and the George Bush Presidential Library site. The fields lie at a great enough distance away from the stadium so that shuttling may need to be provided.

Preferred parking will be retained in lots immediately adjacent to Kyle Field. Handicapped spectators will keep designated spaces along Joe Routh Drive on the main campus. Shuttle and charter buses will also be allowed to park adjacent to the stadium.

Parking information should be distributed to game spectators along with their game tickets to help guide spectators to the proper lots. This will hopefully avert the erratic parking patterns currently associated with Texas A&M home football games. In addition, the parking brochure should contain information and specific restrictions on parking to cut down on the problem of parking in residential neighborhoods.

Other parking patterns occurring on the main campus will be allowed to continue. Hopefully, the diversion to west campus parking areas will be enough to reduce parking demands of the main campus substantially enough to reduce traffic congestion on main campus.

### *Signal Timing*

Traffic signals at the following intersections should be retimed, following the collection of game-day traffic volumes. The City of College Station uses separate signal timings for game conditions (16). The special timings may be adequate, but should be examined. Until that time, critical intersections should be officer controlled. The following intersections should be examined:

1. Texas Avenue intersections, between F.M. 2818 and Villa Maria;
2. University Avenue intersections, between F.M. 2818 and the SH-6; Bypass
3. George Bush intersections, between Texas Avenue and F.M. 2818; and
4. Wellborn Road intersections, between F.M. 2818 and Villa Maria.

### *Closure of Wellborn Road*

As part of the TMP, Wellborn Road is recommended to be closed to traffic on game days between University Avenue and George Bush Drive. This is to be done using manned barricades. However, access on Wellborn Road will be provided to buses, preferred parking, and handicapped spectators upon display of proper identification. The closure of Wellborn to general traffic will hopefully alleviate congestion problems along Wellborn and adjacent routes. Pedestrians from the west campus may use the pedestrian overpass in the immediate vicinity of Kyle Field, limiting pedestrian vehicle conflicts along Wellborn Road. Figure 6 details the west campus traffic management plan.

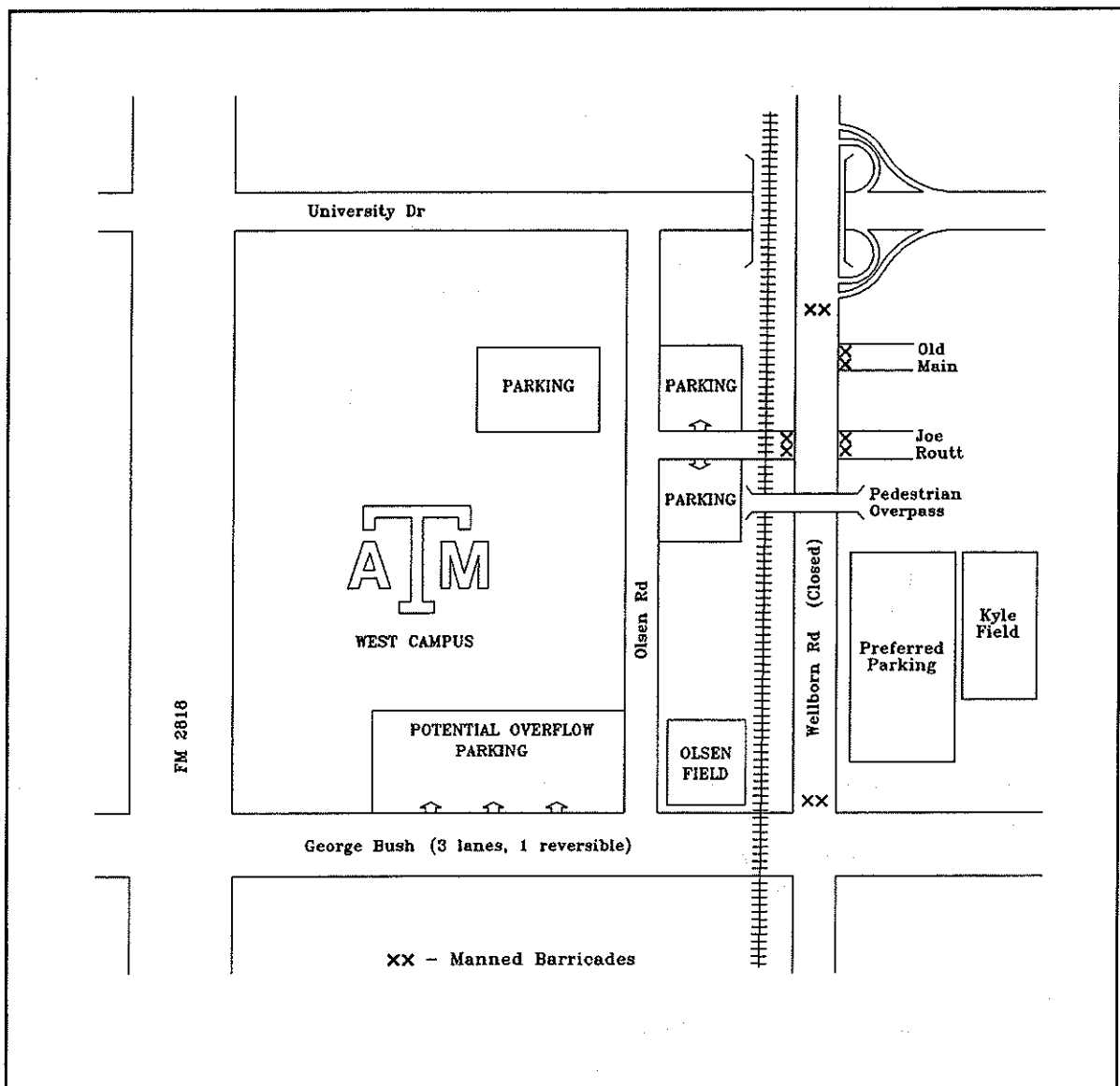


Figure 6. West Campus TMP.  
(Note: Not to Scale)

### *Traffic Operations Center*

A Traffic Operations Center at Kyle Field is another part of the TMP. Traffic engineers and personnel would man the center on game day to refine the TMP as real-time conditions stipulate. Spotters and/or aerial surveillance would be use to supply the Traffic Operations Center with real-time traffic information via two-way radio. Spotters may use Kyle Field and other tall buildings on the A&M Campus to observe traffic conditions

Highway advisory radio would be used to communicate real-time traffic and parking operations. In addition, any incidents can quickly be communicated to spectators informing them of up-to-the-minute conditions. The broadcasts may be made more exciting by providing a short segment on the upcoming game. The highway advisory radio station would be set up at the Kyle Field using a monopole antenna.

### *Increased Shuttle Busing and Exclusive Bus Routes (Dropped)*

The use of park and ride lots at Post Oak Mall and Manor East Mall by Brazos Transit Authority was initially recommended to be expanded. The establishment of express bus only routes was also examined during the establishment of the preliminary TMP. The major lot was to be established at Post Oak Mall, with room for overflow at Wolf Pen Creek, pending on weather conditions. The operation was proposed to use buses from the A&M shuttle bus fleet, using exclusive bus facilities provided by the City of College Station. Use of the shuttle was to be free to all riders with a game ticket.

During Step 5, the increased busing idea was dropped from the plan. Since the Texas A&M campus can handle the parking demands generated by the football games, busing will likely be an unattractive transportation alternative. However, busing may be included in future revisions if it can be identified as an attractive alternative.

### **Step 6: Implement the TMP**

The scope of this study ended with Step 5. Steps 6, 7, and 8 are offered as suggestions for completing the identified TMP. Many of these steps will be performed by the author following the publication of this report.

The TMP must be approved through any necessary agencies, such as Texas A&M University, the City of College Station, Texas Department of Transportation and any other requiring approval. The political and social implications of this plan have yet to be identified, and should take place in the plan implementation stage.

The plan should be advertised and specific route and parking information should be given to ticket buyers along with their game tickets. Newspapers and local media should be informed of the plan and given details to inform the public of the plan. Special parking passes and identification needs to be distributed to preferred and handicapped parking holders to pass the Wellborn Road barricades. In addition, any needed equipment, such as variable message signs and highway advisory radio equipment should be procured and tested.

### **Step 7: Operate the TMP**

The plan should be operated by a qualified professional to adapt the TMP to fit real-time traffic demands and conditions. In addition, a service patrol may be established to ensure quick removal of disabled vehicles and accidents from vital roadways. TMP operation will be performed at the Kyle Field Traffic Operations Center as described in a previous section. Operations must be conducted by those experienced in handling large traffic demands. The plan may be modified on site if such a need arises.

### **Step 8: Critique the TMP**

After each game, the plan should be analyzed to determine the effectiveness of the TMP in handling the football game. The plan should be modified and "fine tuned" to account for any deficiencies. Results should be written up for future reference. Since Texas A&M football

games are recurring special events, the plan may be modified and improved over time. It should be noted that specific games will likely result in different traffic flows, depending on game time and the opponent. The TMP should be modified in Step 8 to address the particulars of each game.

### **Potential Shortcomings**

As stated previously, the pre-game traffic plan is still generally well accepted by the public. In addition, the generous amount of parking on campus will make changing driver game day habits difficult. The public's acceptance of this plan was not analyzed as part of this research. The feasibility of implementing this plan was also not analyzed. The likelihood of all of the plan being implemented is slim, as a generous amount of funding would be required to incorporate every facet of the plan. Finally, the interagency cooperation required for a successful TMP has not yet been developed, further jeopardizing implementation.

## CONCLUSION

Special events may deteriorate operations on a roadway network by increasing traffic volumes to unmanageable levels. Careful planning and implementation of a Transportation Management Plan (TMP) are essential to minimize congestion during special events. The TMP should carefully analyze every possible ATMS strategy that can be used to improve traffic conditions to and from a special event. In addition, the plan should be the end result of a cooperative effort between public and private entities, so that it represents the interest of a broad range of people. For the plan to be effective, it must be communicated to the public.

Little literature has been written that explicitly covers the topic. A literature search and conversations with those experienced in handling special events led to the following eight-step methodology for managing special events:

1. Inventory Resources and Assess the Problem
2. Analyze Traffic Impact
3. Identify General Problems
4. Develop the TMP
5. Analyze and Modify TMP
6. Implement the TMP
7. Operate the TMP
8. Critique the TMP

Using this methodology, a preliminary TMP was developed for Texas A&M home football games at Kyle Field. The plan recommends route diversion, highway advisory radio, bus services and bus only routes, reversible flow lanes, and other ATMS strategies to handle the increased traffic associated with the games.

### **Suggestions for Further Research**

Special events have been poorly documented in the past. The knowledge for handling special events exists, but has not been disseminated amongst the profession. Further literature is needed to aid in planning special events. As future special events are planned and managed, the results of the TMP's should be published for the edification of the profession.

The TMP suggested by this report should be critiqued and modified to reflect the feelings of a diverse base of public and private agencies. Any plans implemented as a result of this research should be critiqued to determine the effectiveness of the TMP.

In addition to implementing the described TMP, traffic data should be collected to add detail to the plan. This data collection should be performed during the 1994 football season. The TMP will have to be further refined for the 1995 season, as the reconstruction of Texas Avenue in College Station will limit the capacity of that roadway. An effective TMP can minimize the effects that the capacity reduction will have.

## **Benefits of Research**

This report has combined the findings of previous TMP's and been designed to serve as a guide to planning and implementing ATMS strategies for special events. In addition, this report suggests a TMP for Texas A&M football games, a direct benefit to both Texas A&M University and the City of College Station, the City of Bryan, and Brazos County, Texas.

## ACKNOWLEDGEMENTS

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