Defense Access Road Program Criteria Study

prepared for

Surface Deployment and Distribution Command
Transportation Engineering Agency

prepared by

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1 EXECUTIVE SUMMARY

The Defense Access Road (DAR) Program is jointly administered by Military Surface Deployment and Distribution Command (SDDC) for the Department of Defense (DoD) and the Federal Highway Administration (FHWA) for the Department of Transportation (DOT). It is the means for DoD to pay its fair share for public highway improvements required as a result of sudden or unusual defense-generated traffic impacts or requirements. The DoD emphasis is on unusual or extraordinary changes, not increases in traffic which remains the responsibility of the various Federal, State and local authorities responsible for road construction.

1.1 Study Purpose

In October of 2008, on behalf of the Secretary of Defense, SDDC completed a report to Congress on the DAR Program eligibility criteria as directed in the National Defense Authorization Act (NDAA) for Fiscal Year 2009. The conclusion of that report was that DoD believes that the current criteria provides flexibility necessary to address concerns of local communities concerned about the traffic impacts. The DoD does, however, recognize that it is difficult to determine if safety issues can be tied to any one criterion and that the impact of DoD growth on safety is of particular concern for local communities and Congress. Based on the results of this study, the DoD is considering expanding or modifying the criteria to make DAR eligible those projects that address installation population growth that creates such a significant increase in traffic congestion to present a public safety risk, especially in urban areas.

The DoD requested that SDDC undertake a study that evaluated the merits of safety as a potential criterion. In scoping the study, SDDC identified that safety and congestion should be investigated as a potential criterion. Specifically, this study focused on the following:

- An investigation of existing safety criteria that may apply to public roadways near military installations
- Determination of the applicability, availability, and reliability of predictive crash models
- An evaluation of existing DAR criteria for potential safety incorporation
- Identification of appropriate operational impact criteria to deal with congestion and a cost evaluation
- Development of a methodology to conduct a fair-share analysis to ensure that the DoD contributes appropriately to address infrastructure needs

1.2 Safety Evaluation

There has been wide experimentation with statistical modeling within the transportation research field to try and predict future crash locations and frequency. In recent years the dedication of US DOT research funding has increased the sophistication of experimental software being developed. However, at this time the conclusion of the safety evaluation is that there is not a software or other method to predict the likelihood of crashes near military installations to the degree necessary for determination of fair share cost offsetting. The common limitations among literature that promotes crash analysis is the dependency on a demonstrated crash history. The most common limitation on simulation tools are reliability of results, the degree of difficulty and time consuming nature of setting up and validating the model, as well as the possibility of significantly increasing the cost of engineering studies and analysis during the project evaluation phases.

1.3 Operations Evaluation

Some studies have identified a link between congestion and safety, and that addressing congestion issues may result in less crashes for a facility. From a land development perspective, the main tool for identifying traffic impacts and associated mitigation measures is the traffic impact analysis. There are some common requirements identified as part of the traffic impact analysis process including those shown below:

- A development must occur in an area that warrants a traffic impact study
- The study area must be defined
- Data collection requirements must be defined, and
- Traffic analysis requirements must be defined.

1.4 Development of New Criteria

According to the Institute of Transportation Engineers, traffic access and impact studies are conducted to assess the transportation impacts of proposed developments and other land use changes. This may include new facilities or changes in land use resulting from the redevelopment of an existing area. When considering installation growth related to mission change, BRAC, or other factors, ultimately the traffic impacts experienced are a result of the activity associated with new or modified facilities. In that way installation impacts are almost identical in nature to that of the construction of a new office building or shopping center by a land developer. Therefore, it makes sense to use the same policies and procedures in identifying the transportation impacts of a military installation that apply to land development. The criteria must also include a definition of the following:

Urban Area - Defined in terms of the Federal Highway Administration's classification of Transportation Management Areas of populations of 200,000 or more.

Study Area - Based on state of the practice, defined as locations experiencing an increase in approach volume of at least 100 vehicles per hour up to a maximum of one mile from the installation access points.

1.5 Recommended Criteria

The recommended criterion should consider the following factors to determine eligibility of projects in highly urbanized areas where military growth causes sudden or unusual traffic impacts:

- Military installation is within urbanized area with population greater than 200,000
- Proposed project area must be within a mile of the military facility perimeter
- Proposed project area has a minimum increase of 100 peak hour DoD trips
- The project area must operate below a Level of Service D after the military impact

Upon determination that a project is eligible for defense access road funding, a fair-share analysis would be conducted to identify the installations potential contribution to roadway improvements necessary to maintain acceptable or current operating conditions. This fair-share contribution will be based on the installations proportion of the total traffic volume added at the subject roadway segment.

1.6 Cost

The recommended project will, at a minimum, restore the level of service or delay time to levels which existed prior to the military action. For all DAR projects, SDDC conducts an analysis to determine the fair-share that should be funded by DoD. This analysis considers the military impact to traffic on the subject roadway segment and mitigation required to address the impact. The appropriate military funding share is then determined based on the installations proportion of the total traffic which utilizes the subject roadway segment. For large, complex projects involving military and non-military impacts, other factors (such as overall project scope, total project cost, and funding available from other sources) are taken into consideration. A similar fair-share analysis shall be conducted for projects found eligible for DAR funding using the criteria recommended in this study.

Based on a review of growth installations, it appears that the potential DoD order-of-magnitude contribution cost could be $530 million or more for the improvement of off-installation roadways. This is based on a very rough extrapolation of four case studies documented in this paper. The cost analysis did not involve a detailed examination of each of the installations specific site conditions.

2 Introduction

The Military Surface Deployment and Distribution Command's (SDDC's) mission is to provide global surface transportation to meet national security objectives in peace and war. Since its establishment in 1965, SDDC has played a vital role in the nation's defense by providing support to major contingencies, training exercises, and humanitarian relief operations where our military forces have been deployed. SDDC accomplishes its mission through its Department of Defense (DoD) and industry partners in the commercial transportation industry.

The Defense Access Road (DAR) Program is jointly administered by SDDC for DoD and the Federal Highway Administration (FHWA) for the Department of Transportation (DOT). It is the policy for DoD to pay its fair share for public highway improvements required as a result of sudden or unusual defense-generated traffic impacts or requirements. The DoD emphasis is on sudden or unusual defense generated changes, not increases in traffic which are caused by non military sources. The DAR Program has its basis in and is authorized by Title 23, United States Code, "Highways," Section 210 which states:

> The Secretary [of Transportation] is authorized, out of the funds appropriated for defense access roads, to provide for the construction and maintenance of defense access roads (including bridges, tubes, and tunnels thereon) to military reservations, to defense industries and defense industry sites, and to the sources of raw materials when such roads are certified to the Secretary as important to the national defense by the Secretary of Defense or such other official as the President may designate, and for replacing existing highways and highway connections that are shut off from the general public use by necessary closures or restrictions at military reservations and defense industry sites.

To implement the authorities given in Title 23, DoD developed criteria with FHWA input. Generally, projects meeting the following requirements can be considered for the DAR Program:

- Access roads providing new connections between either old or new military installations and main highways.
- Urgently needed improvements of existing highways upon which traffic is suddenly doubled (or more than doubled) by reason of the establishment or expansion of a permanent military installation.
- Urgent improvements needed to avoid intolerable congestion or critical structural failure of any highway serving a temporary surge of defense-generated traffic (such as that which results from the establishment and operation of a temporary military installation, or from large-scale construction activity) may be considered eligible for financing to the extent necessary to provide the minimum essential facility to accommodate the temporary surge of traffic.
- Alteration of a public road in the immediate vicinity of a military installation to accommodate regular and frequent movements of special military vehicles such as tank transporters or heavy ammunition carriers.
- Highways constructed to replace existing highways and highway connections that are shut off from the general public use by necessary closures or restrictions at military reservations and defense industry sites.

Of the criteria, the last is the only DAR criteria directly tied to Title 23. It is clearly the DoD responsibility to replace capacity if needed for the permanent closing of a public highway resulting from a DoD decision to create a new or expand an existing installation. The other criteria are more discretionary. They are more likely to apply in those situations in which Military Service determines that a future base expansion will affect traffic in some way. If a Military Service determines that a transportation requirement may be eligible for DAR funding, the Service can submit a DAR Needs Report to SDDC to ascertain whether correcting the deficiencies can be met by application of the DAR criteria.

In applying the criteria, it is DoD's underlying policy that State and local authorities are responsible for developing, operating and maintaining those roads outside the installation just as these authorities perform this task for private citizens and private industry. The strength of the DAR program is that it provides a fair and equitable method which allows DoD to off-set the impact of installation growth.

2.1 DAR Process

The DAR Program process starts with the installation commander. The installation commander knows what new or changed missions and resulting development is coming to the installation and best understands the concerns of the surrounding community. Installation personnel develop planning and implementation documents, and appropriate environmental impact documents to execute the installation requirements of mission growth. If as part of the process public transportation deficiencies are identified, the installation commander is responsible for bringing expected transportation deficiencies resulting from installation impacts to the attention of the owning transportation authorities. If the owning transportation authorities cannot or will not correct the problems to meet the defense requirements, the installation commander should determine how the expected transportation deficiency impacts the installations mission. If the installation commander determines that there will be an adverse mission impact, or if the deficiency creates a safety or security situation, then a DAR Needs Report should be prepared.

The DAR Needs Report includes the following data and descriptions: installation population; existing road (if there is one); existing traffic data; defense generated development and population growth; projected traffic data; expected roadway deficiency due to the defense impact; possible roadway improvements needed. The needs report also contains a gross cost estimate and date when improvements are required. The installation commander is responsible for submitting the needs report through the military chain of command. It is through this process that the parent Military Service validates the requirements and makes an initial determination about whether to support funding the necessary public highway improvements through the DAR Program. As appropriate, the Military Service provides the DAR Needs Report and other appropriate information to SDDC which determines if the new defense-generated development impacts potentially meet DAR eligibility criteria.

If SDDC determines the defense–generated impact has the potential for being eligible for the DAR Program, civil transportation authorities are formally brought into the process. SDDC requests FHWA to conduct an engineering evaluation with participants from the State Department of Transportation, local highway officials (as appropriate), the installation, and SDDC. The engineering evaluation: refines the identification and quantification of the defense-generated traffic impacts and identifies solutions; details the procedures to execute a highway improvement project; provides cost estimates and schedules to execute the project, identifies the civil transportation agency to administer the project, and identifies available and potential funding sources. DoD looks to the State Department of Transportation or FHWA to identify cost-effective, efficient, and safe transportation (highway and transit) solutions to solve transportation requirements. The FHWA evaluation report is forwarded to SDDC for review and analysis to determine DAR eligibility.

Occasionally the FHWA evaluation report identifies recommended transportation improvements that are in excess of what is required for the defense-generated impact. In those instances, SDDC will attempt to negotiate a defense share and adjustments to civil transportation programs to meet the defense impacts and have other identified improvements funded through other civil programs. Based on the FHWA evaluation report and DAR Program negotiations, Commander SDDC, will determine DAR Program eligibility and certify the road segment as important to national defense, per 23 USC 210, so defense funds can be expended on those sections of road.

The Military Services are responsible for programming and budgeting Military Construction (MILCON) funds for eligible DAR projects. For projects necessary to complete a Base Realignment and Closure (BRAC) directed action, BRAC funds are a possible source of funding when identified within the BRAC funding timeline. As stated above, DAR eligible projects must compete with other Service MILCON requirements for funding. If the project is approved and authorized and appropriated by Congress, funds for DAR projects are forwarded from the Military Services to FHWA. FHWA is responsible for ensuring the proper execution of DAR projects through Federal-Aid Highway Program procedures by State or other owning highway authorities. This could include preliminary engineering, getting the project included in the State Transportation Improvement Program, environmental documentation, final design, right-of-way acquisition, utility adjustments, and construction. SDDC ensures DAR projects meet the defense requirements as agreed to in the DAR certification package by reviewing project documents and authorizing the expenditure of the DAR funds by FHWA for the appropriate phases of the work.

2.2 Study Purpose

In October of 2008, on behalf of the Secretary of Defense, SDDC completed a report to Congress on the DAR Program eligibility criteria as directed in the National Defense Authorization Act (NDAA) for Fiscal Year 2009. The conclusion of that report was that DoD believes that the current criteria provides flexibility necessary to address concerns of local communities concerned about the traffic impacts. The DoD does, however, recognize that it is difficult to determine if safety issues can be tied to any one criterion and that the impact of DoD growth on safety is of particular concern for local communities and Congress. The DoD is considering expanding or modifying the criteria to make DAR eligible those projects that address installation population growth that creates such a significant increase in traffic congestion to present a public safety risk, especially in urban areas. To make this determination, the DoD is directing SDDC to provide an independent study on the merits of specific criteria to address safety and congestion issues related to growth.

The DoD requested that SDDC undertake a study that evaluated the merits of safety as a potential criterion. In scoping the study, SDDC identified that safety and congestion should be investigated as a potential criterion. Specifically, this study focused on the following:

- An investigation of existing safety criteria that may apply to public roadways near military installations
- Determination of the applicability, availability, and reliability of predictive crash models
- An evaluation of existing DAR criteria for potential safety incorporation

- Identification of appropriate operational impact criteria to deal with congestion and a cost evaluation.

2.3 Study References

The following documents and sources were used to conduct this evaluation:

- Traffic Engineering Handbook, 6th Edition, 2009, *Institute of Transportation Engineers*
- Roadside Design Guide, 3rd Edition 2006, with updated Chapter 6, *American Association of State Highway and Transportation Officials*
- Interactive Highway Safety Design Model Software Tutorial, 2009, *Federal Highway Administration*
- Manual of Transportation Engineering Studies, 1994, *Institute of Transportation Engineers*

2.4 Study Methodology

The following process was used to identify the criteria that resulted from this evaluation.

- **Literature Search and Review** – Using both printed publications and the internet, sources of knowledge regarding public safety and crash research were reviewed and summarized. Ultimately this research led to the presentation of best practices to the DoD for consideration.
- **Published Criteria Review** – Specifically for the capacity evaluations, a review of State department of transportation and best practices was completed.
- **Analysis Tool Evaluation** – Ultimately the research led to the identification of several potential software tools that practitioners could use to predict the number of crashes for a segment of roadway. Each of these software tools was evaluated.

3 SAFETY EVALUATION

Safety of motorists is a concern of any agency, and motorists traveling on or near a military installation are no exception. According to most transportation professionals, the possibility of a crash increases as the volume of traffic increases for a given road section. According to the 6th Edition of the Institute of Transportation Engineer's Traffic Engineering Handbook, from 2001 through 2005 there were an average of nearly 6 million motor vehicle crashes resulting in 3 million injuries and 43,000 traffic fatalities per year[1]. In general, there are three types of factors that contribute to motor vehicle crashes; human factors, roadway environmental factors and vehicle factors. The table below shows a sample of each type.

Human Factors	Roadway Environmental Factors	Vehicle Factors
♦ Alcohol and drugs	♦ Poor lighting	♦ Failed brakes
♦ Attentiveness	♦ Lacking or confusing signs and pavement markings	♦ Missing lights
♦ Impatience	♦ The type, location and operational characteristics of traffic control devices	♦ Lack of warning
♦ Age and physical disabilities	♦ Demand versus capacity	♦ Malfunctioning seatbelts
♦ Unfamiliarity		♦ Poorly designed fuel tanks
♦ Poor vision		

Typical studies that are performed near military installations will identify ways to mitigate crashes due to human factors and roadway environmental factors through a variety of solutions in the traffic safety toolbox including policy, education and infrastructure. The challenge for the DoD is in assessing its fair share participation in mitigating the factors discussed in the table above that may exist at specific installations.

3.1 Safety Evaluation Goal

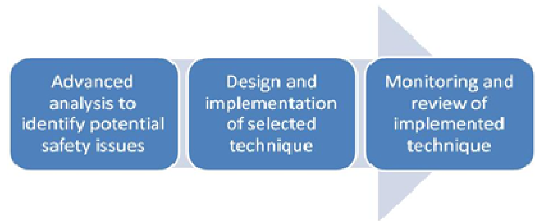
Traditional crash analysis and identification of improvements to mitigate high or severe crash locations has focused on a demonstrated experience of crashes and an established trend. From these experiences and trends practitioners are able to identify tools to potentially mitigate problem areas. However, in the case of establishing what the expected crash experience might be, and to assign the risk responsibility by agency, practitioners must have a way to predict what the crash frequency and severity will be for a section of roadway. The area of predictive crash analysis is an emerging field and so the goal for the safety aspect of this evaluation was:

<u>Determine if there is a mature, dependable crash prediction procedure that can be used to determine the DoD fair share contribution to crash mitigation.</u>

[1] Traffic Engineering Handbook, 6th Edition, *ITE*, Page 137.

Traditional Safety Mitigation Process

Predictive Safety Mitigation Process



3.2 Literature Review

It is important to realize that there are well established methods for evaluating the impacts of safety using the traditional safety mitigation process. As part of the literature review for this effort related to safety, documents from the Institute of Transportation Engineers (ITE) and the American Association of State Highway and Transportation Officials (AASHTO) were reviewed. An internet search was then conducted to identify any other potential sources from the professional or academic sectors that may have identified approaches. Finally, consultation with FHWA was conducted to ensure that all possible leads were investigated.

3.2.1 Roadside Design Guide, 3rd Edition 2006, with updated Chapter 6 (AASHTO)

The Roadside Design Guide is developed and maintained by the AASHTO Subcommittee on Design, Technical Committee for Roadside Safety. The guide presents a synthesis of current information and operating practices related to roadside safety. It is not a standard, nor is it a design policy. It is intended for use as a resource document from which individual highway agencies can develop standards and policies.[2]

Analysis Procedure for Safety

According to chapter 2, one of the deciding factors of implementing a selected mitigating element is a comparison of the benefits to the associated costs. One of the primary benefits obtained from selecting a design is the expected reduction in the future cost of crashes. These costs are typically associated with property damage costs and personal injury costs. Costs of all types need to be determined based on the estimated effect that the improvement will have on the crash experiences. In all cases these estimates are based on historical experiences with similar situations on similar facility types.

Why the Roadside Design Guide is not Applicable

As stated at the bottom of page 2-1, the three major factors needed to evaluate the value of identified enhancements are:

- Encroachments (the total number by type and severity)
- Roadside geometry, and
- Crash costs

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[2] Roadside Design Guide 3rd Edition, *AASHTO*, Preface

The encroachment criteria is the limiting factor in that it requires the practitioner to estimate the number of encroachments based on historical data and traffic volumes. In formulating a fair-share contribution amount the cost could not be determined because there is no reliable research that indicates that the increase in traffic volume will be directly or indirectly proportional to the crash experience.

3.2.2 Traffic Engineering Handbook, 6th Edition (ITE)

The primary purpose of the handbook is to provide practicing professionals and other interested parties with a basic, day-to-day source on the proven techniques of professional traffic engineering. The handbook provides information on various subjects but is not intended to be a "standard of practice". It is not intended to be used as a textbook but a valuable resource, with additional resources noted in each chapter.[3] Chapter 5 is dedicated to safety.

Analysis Procedure for Safety

On page 138, the section on Quantifying Safety Approaches discusses the fact that methods that rely on analysis of past crash data are categorized as reactive because they are based on crash histories. These types of analyses identify locations that have an abnormal concentration of crashes and evaluate the potential for improvement. Data that must be collected for a comprehensive analysis includes:

- Crash Records Systems to collect the basic information pertaining to the event
- Traffic volume data, and
- Roadway/site characteristics and traffic control device inventory

Once the information has been collected, a crash frequency and crash rate must be established. The handbook has a detailed formula for calculating crash rates which includes a past analysis period and the number of reported crashes over the analysis period.

Why it is not Applicable

Countermeasures can only be selected once a high-crash location is identified by comparing the computed crash rates of several intersections in the area or comparing the computed crash rates to local, regional, statewide or national crash rates. In formulating a fair-share contribution amount the cost could not be determined because there is no reliable research that indicates that the increase in traffic volume will be directly or indirectly proportional to the crash experience.

3.3 Toolbox Review

During the literature review and as a result of coordination with SDDCTEA and FHWA, several potential predictive crash software platforms were identified. The study team either conducted testing to try and establish confidence, or interviewed the software development team to determine if it would meet the needs of the DoD.

[3] Traffic Engineering Handbook, 6th Edition, *ITE*, Forward

3.3.1 Interactive Highway Safety and Design Model (IHSDM) Version 5.3.0

The American Association of State Highway Officials (AASHTO) has published the Highway Safety Manual. This manual is intended to move the transportation industry towards predictive crash analysis. According to the Introduction information published about the manual, the IHSDM is a software tool that has been developed to support practitioners' use of the Highway Safety Manual[4].

At the outset of the project this software appeared to have the most potential for being applicable to the DoD's needs. The IHSDM is being developed and researched by the US Department of Transportation's Federal Highway Administration Safety Research and Development Program at the Turner-Fairbanks Research Center. Most of the software is being developed by ITT Corporation, Information Systems under contract number GS-23F-0190L/DTFH61-08-F-00118[5].

Program Architecture

The IHSDM crash prediction model uses two analytical components to predict crash experience on a segment of roadway or at an intersection. Safety performance functions (SPFs) are used to establish formulas to be entered into algorithms and typically include historical crash experience, traffic volumes, and roadway geometries. Accident modification factors (AMFs) are used to represent the effects on specific geometric design and traffic control features within the formulae. Overall the IHSDM takes the SPF and AMF information along with some calibration factors and uses a combination of statistical regression and dispersion to arrive at a predicated crash experience.

Minimum Inputs

To create a predication there are a number of inputs that are required:

- Design speed
- Annual average daily traffic
- Roadway cross slope
- Shoulder width
- Travel lane width
- The presence of passing, turning lanes or climbing lanes
- Driveway density
- Roadside hazard rating
- All information pertaining to intersection density and configuration

In addition to these required inputs users can also choose to include crash history data, aerial photos and engineering CAD-grade information.

Evaluation

To compare the software to actual results, previous projects that showed a crash history were selected for duplication and evaluation. The following scenarios were developed and tested:

- Run the Crash Prediction Evaluation on the representative projects and compare the predicted crash results with the actual crash history over a set number of years.

[4] http://www.highwaysafetymanual.org/Documents/HSMP-1.pdf
[5] http://www.ihsdm.org/wiki/credits

  - Results: The program predicted reasonable amounts of crashes that were in line with actual crash history results.
- Add actual crash history data to the evaluation and see how it affects the results.
  - Results: The program responds logically in that the predicted crashes drop if fewer actual crashes occurred over the set number of years compared to what the program was predicting without any crash history data, and the predicted crashes increase if more actual crashes occurred over the set number of years compared to what the program was predicting without any crash history data.
- Create an alignment from an aerial photo and compare the results to the actual alignment from Inroads.
  - Results: The created alignment resulted in almost identical crash history predictions as the actual uploaded Inroads file. Logically, the better the alignment created from the aerial photo the closer the results match the Inroads file results.
- Double the predicted ADT and see how it affects the evaluation results.
  - Results: As expected, the predicted crash amounts increased as the ADT increased.

Below is a specific case study sample.

IHSDM CRASH PREDICTION SAMPLE PROJECT

In this sample project, an existing alignment and two (2) alternatives will be analyzed to determine their potential for accidents over a five year period. The following are the results of the analysis, which assume all traffic and speed factors remain the same except for the lane and intersection configurations.

	Existing	Option 1	Option 2
Road 1	68.78 crashes	59.29 crashes	84.79 crashes
Road 2	55.90 crashes	64.64 crashes	52.70 crashes
Road 3	29.72 crashes	45.62 crashes	48.89 crashes
Total	**154.40 crashes**	**169.55 crashes**	**186.38 crashes**

The results clearly demonstrate an increase in the predicted crashes with both option 1 and option 2. The main increase can be found in the data for road 3 and is a result of the fact that in the existing condition road 3 does not intersect road 2, but it does intersect with road 2 in both proposed options resulting in additional crash predictions. The remaining differences, some of which increase predicted crashes and some of which decrease predicted crashes, are the results of things such as taking away a thru lane of traffic (Road 1, existing - 68.78, option 2 – 84.79), or adding turn lanes (Road 1, existing – 68.78, option 1 – 59.29).

This information can then be used to quantify a percentage that the proposed changes to the roadway alignment will increase or decrease predicted crashes. In this example, Option 1 increases predicted crashes by 9.8% (169.55 / 154.40) and Option 2 increases predicted crashes by 20.7% (186.38 / 154.40). So the conclusion would be that if the Army wanted to build option 2 they would be responsible for a greater portion of the construction costs than they would be if they built option 1 because of the increased strain of traffic.

Summary

The software appears to have the basis for future improvements that will help the DoD administer the DAR Program. However, at this time the software is not mature enough to be relied upon. The test cases were inconclusive in determining that crash experience could be predicted within a defined tolerance. As was shown in the sample test case included, crash experience appeared to be linear when a crash history was supplied and rarely reported significant crash expectancy when crash histories were not included. In addition, the construction of the model and available required inputs exceed the typical information available through the environmental document and DAR feasibility report process. The requirement usage of this model could potentially lead to higher contractor procurement costs and elongated time lines for engineering report completion.

Conclusion: The IHSDM Software is not appropriate for use by the DAR Program at this time.

3.3.2 Surrogate Safety Assessment Model (SSAM)

The SSAM is being developed and researched by the US Department of Transportation's Federal Highway Administration Safety Research and Development Program at the Turner-Fairbanks Research Center.

Program Architecture

This software accepts outputs from microsimulation software in a trajectory file format and then uses a post processor to analyze the batch of files. The software analyzes vehicle-to-vehicle interactions to identify conflict events and catalogs all events found. For each event the SSAM calculates several surrogate safety measures including:

- Minimum time-to-collision
- Minimum post-encroachment
- Initial deceleration rate
- Maximum speed.

The output of the analysis is provided as a table of conflicts identified, a summary of conflicts by type, a filtering mechanism that allows for isolation areas, statistical comparisons, and a location map with visual depictions.[6]

Minimum Inputs

Trajectory output files from one of four microsimulation software packages; VISSIM, AIMSUN, Paramics, and TEXAS.

Evaluation

On January 5, 2010 the study team conducted a telephone interview with representatives from the Federal Highway Administration about the SSAM software.

Interview Attendees:

[6] FHWA Publication No. FHWA-HRT-08-049

- Mr. Clayton Chen, FHWA SSAM Project Manager
- Mr. Joe Bared, FHWA SSAM Project Representative
- Mr. Darryl Hampton, SDDC
- Mr. Mark Metil, Gannett Fleming Project Manager
- Mr. Eric Rensel, Gannett Fleming

Below is a summary of the significant outcomes of the interview.

- The SSAM was released to the public in May 2008
- The SSAM relies completely on the calibration of the microsimulation tool in use and assumes that trajectory files represent calibrated data
- The SSAM does not predict crashes
- The SSAM evaluates the interval and density of potential conflicts
- The SSAM does not report results for areas where vehicle conflicts are not present

Summary

The Surrogate Safety Assessment Model has a mission to identify a hierarchy of concentrated vehicle conflict points when planning or modifying a travel corridor. It does not predict crash rates.

Conclusion: The SSM Software is not appropriate for use by the DAR Program at this time.

3.3.3 Ohio State University Project on Predicting Crashes and Crash Causes on Ohio Roadways

In 2006, the Ohio State University published a report on the evaluation of five years worth of crash history obtained from the Ohio State Highway Patrol (OHSP). The goal of the project was to help the OHSP effectively allocate its resources to reduce crash rates on the states highway road network.

Program Architecture

A central database was developed to house historical crash information from several sources and to locate the crashes at the appropriate location on the roadway network. Once the crashes were matched to the roadway locations, statistical analysis was used to fit the crash data into trend lines for the state highway road network.

Minimum Inputs

The inputs that were required for this statistical model were the five years of complete crash history from 2001-2005, and the characteristics of the roadway network.

Evaluation

On December 17, 2009 the study team conducted a phone interview with the Ohio State University to discuss their predictive model.

Interview Attendees:

- Dr. Christopher Holloman, Ohio State University

- Mr. Mark Metil, Gannett Fleming Project Manager
- Mr. Eric Rensel, Gannett Fleming

Below is a summary of the significant outcomes of the interview.

- This evaluation was not an engineering evaluation, it was a statistical project
- This model is not transportable, it is valid only for the State of Ohio
- The results were mixed.

Summary

The Ohio State University predictive model is not applicable to the DoD as a whole. It may have some usability near installations in the State of Ohio.

Conclusion: The Ohio State University predictive model is not appropriate for use by the DAR Program at this time.

3.3.4 Miscellaneous Statistical Models

Throughout the literature review, other statistical software was identified as having a predictive nature, such as GENSTAT, SAS, R, and others. All of these dealt with some form of a linear regression model to achieve the predictability. In all cases results were either mixed or were developed for a one time use.

3.4 Summary

There has been wide experimentation with statistical modeling within the transportation research field to try and predict future crash locations and frequency. In recent years the dedication of US DOT research funding has increased the sophistication of experimental software being developed. However, at this time the conclusion of the safety evaluation is that there is not a software or other method to predict the likelihood of crashes near military installations to the degree necessary for determination of fair share cost offsetting. The common limitations among literature that promotes crash analysis is the dependency on a demonstrated crash history, while the most common limitation on tools in the toolbox are reliability of results, the degree of difficulty and time consuming nature of setting up and validating the model as well as the possibility of significantly increasing the cost of engineering studies and analysis during the project evaluation phases.

4 Operations Evaluation

Although safety as it relates to crash predictability is not mature enough to be included in the DAR Program at this time, studies have proven that safety can be enhanced when favorable operating conditions apply.

In 2008 an article was published in the Journal of the Transportation Research Board that examined how quality or level of service affected the crash experience[7]. The article hypothesized that up until that time the focus of research efforts had been on statistical technique and underlying probability distribution. It went on to say that very little had been done to address the systematic component. To test the theory that level of service and crash rate were connected, the authors analyzed data sets from California, Colorado and Texas. As a conclusion, the research team did find that for urban interstates the average crash rate did increase as the level of service was degraded.

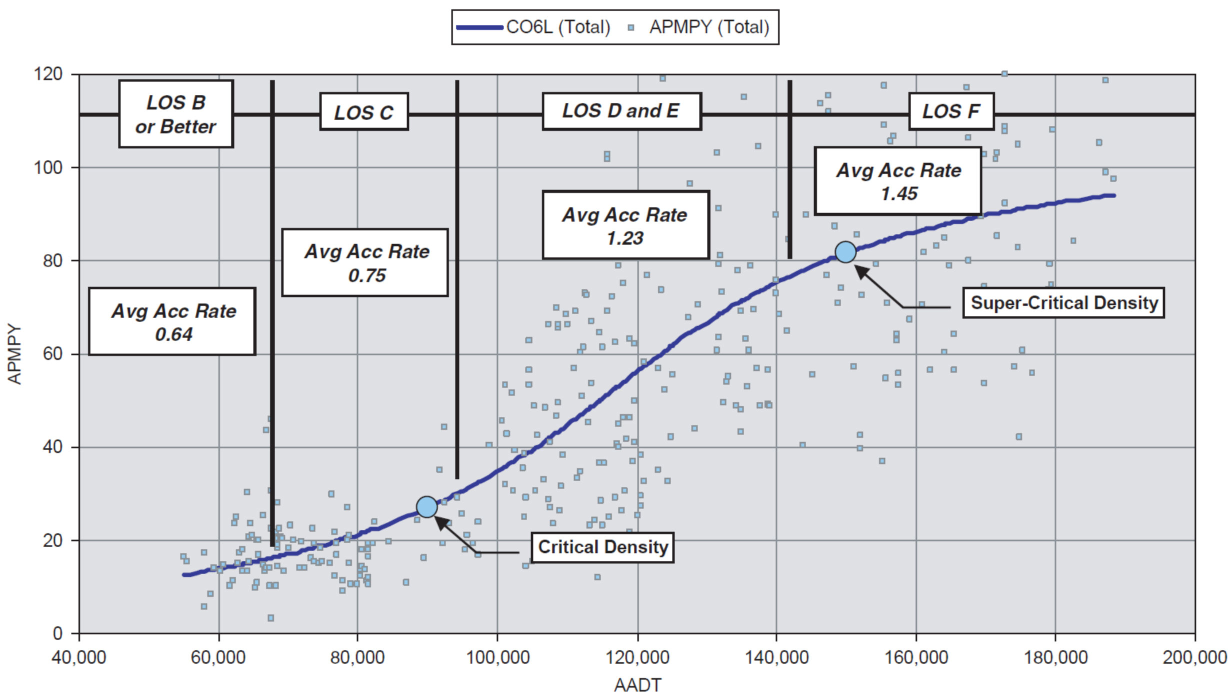

FIGURE 9 Six-lane total crashes SPF: changes in accident rates with LOS.

7 Relationships Between Safety and Both Congestion and Number of Lanes on Urban Freeways, *Journal of the Transportation Research Board*, 2008, Kononov, Bailey and Allery

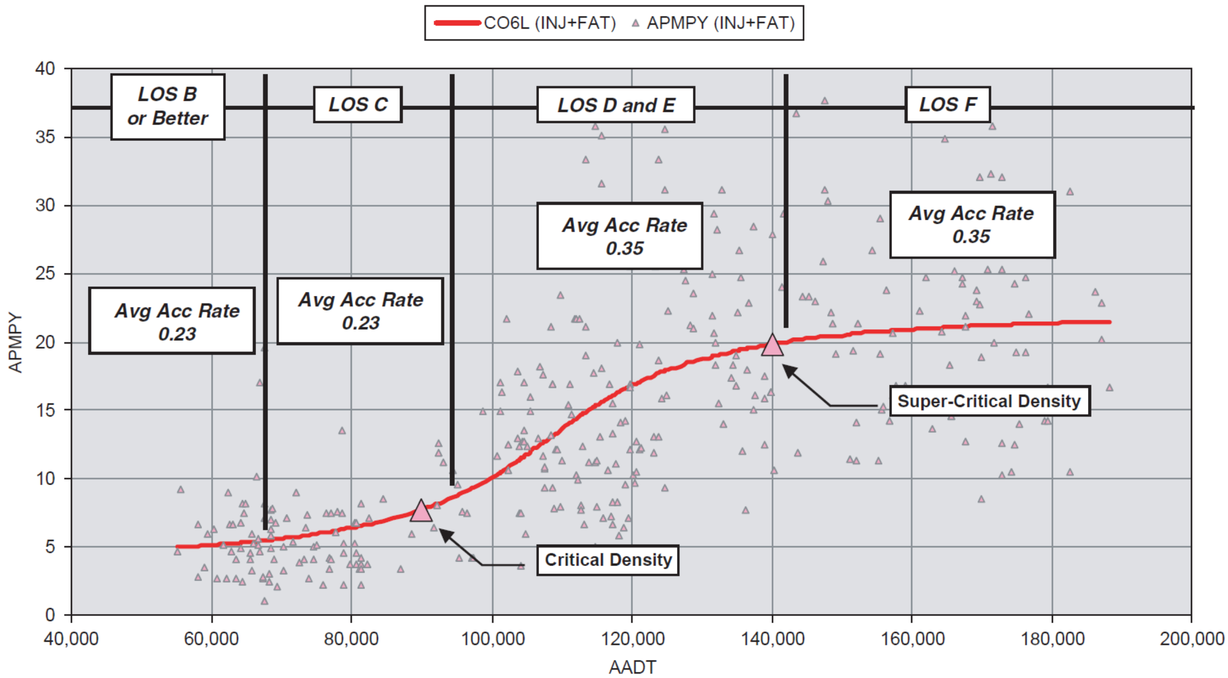

FIGURE 10 Six-lane injury and fatal crashes: changes in accident rates with LOS.

Although this study focused on interstates, some of the major factors included traffic volumes. Likewise, the ITE Traffic Engineering Handbook indicates that traffic volumes are a significant part of calculating crash rates at an intersection. This, combined with the knowledge that level of service is also greatly dependent on volume, makes it logical that intersection level of service would have an effect on crash rates as well. Therefore, it can be deduced that operational and capacity enhancements that improve level of service should have a positive impact on safety.

4.1 Literature Review

The operational impacts of traffic on intersections and road segments are typically defined by states through their transportation agency. These rules and requirements are typically implemented through the traffic impact analysis process whereby a property developer must determine how much traffic will be generated. Periodically ITE publishes the Trip Generation Handbook, which is used to determine how many vehicles are expected to travel to and from a certain land use type. The handbook also provides assumptions for the number of vehicles expected to arrive/depart the land use at different times of day. From the trips that are generated, a qualified individual must distribute them onto the roadway network. Typically, if the distributed traffic has a pre-identified affect on the roadway network, the State transportation agency will require the developer to implement changes to the transportation network that are designed to mitigate the burden. To identify common practices, the study team evaluated the sources of traffic impact analysis requirements as shown in the table below.

Agency	Study Area Criteria	Level of Service Criteria
Institute of Transportation Engineers	The influence area might be defined as extending to the most distant intersections at which a measurable impact can be found - such as an increase in an approach volume of at least 100 vph, a 5 percent increase in an approach volume, or a change in the V/C ratio of 2 percent or more	Desirable LOS D for communities over 25,000 population
Pennsylvania Department of Transportation	Use guidance provided by the Institute of Transportation Engineers	No overall LOS drop: mitigation is not required LOS drop and increase of delay ≤ 10 sec.: mitigation is not required LOS drop and increase of delay > 10 seconds: mitigation required to return to no-build LOS No-build LOS F: build delay must be no worse than no-build delay
Virginia Department of Transportations	< 100 peak hour trips: within 1,000 ft. of site 100 - 499 peak hour trips: within 2,000 ft. of site and any roadway on which 50 or more of the new peak hour vehicle trips are distributed (not to exceed one mile) 500 - 999 peak hour trips: within 2,000 ft. of site and any roadway on which 10% or more of the new vehicle trips are distributed (not to exceed two miles(> 999 peak hour trips: to be determined by VDOT and local agency	Improvements shall be in accordance with the geometric standards contained within the Road Design Manual
California Department of Transportation	Existing LOS A or B - >100 peak hour trips Existing LOS C or D - 50 to 100 peak hour trips Existing LOS E or F - <50 peak hour trips	Target LOS at the transition between LOS C and D If less than target LOS, the LOS should be maintained

Agency	Study Area Criteria	Level of Service Criteria
New Jersey Department of Transportation	Locations exceeding both 100 new half-trips during the critical peak hours and 10 percent of the anticipated daily site traffic	For urban locations: Signalized Intersections All movements operating at LOS A thru E under the no-build condition, deterioration by 25 percent of the difference between the no-build condition to the bottom of LOS E (60 seconds) will be allowed. If a traffic movement or lane group on all approaches operates under the no-build condition at LOS F, no deterioration will be allowed. Unsignalized Intersections If no-build LOS is A or B, movement delay may be increased to 15 seconds If no-build LOS is C thru E, movement delay may be increased by 5 seconds to a maximum of 45 seconds If no-build LOS is F, the build delay must be no worse than the no-build delay Uninterrupted Flow If no-build LOS is A or B, decrease of the V/C ratio to the midpoint of LOS C will be allowed If no-build LOS is C thru E, increase in the V/C ratio of 0.1 will be allowed, provided the LOS does not drop below LOS E If no-build LOS is F, no increase in the V/C ratio will be allowed
Maryland State Highway Administration	A Traffic Impact Study may be required for any development that generates more than 50 peak hour trips (there is no definition for study area)	All intersections and/or links resulting in a LOS worse than D must be identified and improvements recommended
Idaho Transportation Department	Any streets that will experience a directional increase of 250 ADT or 25 vehicles in the peak hour up to ½ mile	When an intersection or link is identified as operating at a LOS equal to or below the minimum level specified in local transportation plans or ITD's Congestion Management System Work Plan mitigation measures shall be developed to bring the LOS back to an acceptable level
Kentucky Transportation Cabinet	Includes all proposed access points to the development and shall extend to the first full median opening or signalized access point within 4,800 feet in all directions along the intersecting roadway	Average intersection delay shall not exceed 80 seconds and shall not increase more than 30 percent over the no-build condition. In such case where intersection delay exceeds 80 seconds for the no-build condition, delay shall not increase.

Agency	Study Area Criteria	Level of Service Criteria
Arizona Department of Transportation	<500 peak hour trips: adjacent signalized and/or major unsignalized intersections 500 - 1,000 peak hour trips: all intersections within ½ mile >1,000 peak hour trips: all intersections within 1 mile	Where the highway will operate at arterial LOS C or better without the development, the traffic impact of the development on the highway shall be mitigated to arterial LOS C. Mitigation to LOS D may be acceptable in urban areas of over 50,000 population at the discretion of the Regional Traffic Engineer and with the concurrence of the affected municipality. Where the highway will operate below arterial LOS C without the development, the traffic impact of the development shall be mitigated to provide the same LOS.
Delaware Department of Transportation	As determined by DelDOT	For developed, developing, or planned development area: Signalized Intersections Deterioration up to 55 seconds (the bottom of LOS D) will be allowed Unsignalized Intersections The maximum allowable delay for each movement shall be 35 seconds (bottom of LOS D) Uninterrupted Flow An increase to the low point of LOS D (approaching LOS E) will be allowed

4.2 Operations Summary

As can be seen from the table there are some common requirements identified as part of the traffic impact process including those shown below.

- A development must occur in an area that warrants a traffic impact study
- The study area must be defined
- Data collection requirements must be defined, and
- Traffic analysis requirements must be defined.

5 Development of New Criteria

Previous sections of this report have identified a link between congestion and safety. Since a reliable predictive model does not exist at the present time to develop criteria based on the safety aspects of a transportation system, a congestion based criteria was explored for urban areas.

5.1 Cost of Congestion

According to the Texas Transportation Institute[8], congestion caused urban Americans to travel 4.2 billion hours more and to purchase an extra 2.8 billion gallons of fuel for a congestion cost of $87.2 billion in 2007. On an individual basis, this equates to an average of 36 hours of annual delay per motorist, with the number of urban areas with 40$^+$ hours of delay per peak traveler increasing from 10 in 1997 to 23 in 2007. As might be expected, the levels are generally worse in larger urban areas. For instance, the average annual delay per motorist in the Washington D.C. area is 62 hours.

The Automobile Association of America commissioned a study to compare the costs of congestion versus safety for urban areas[9]. The key findings indicate that based on 2005 data the cost of traffic crashes is nearly two and a half times the cost of congestion, and that improving safety may improve congestion since 40 to 50 percent of all nonrecurring congestion is associated with traffic incidents. This information, as well as information presented earlier in this report, demonstrates the link between congestion and safety.

Considering the data, the impact to the travelling public is obvious in economic and quality of life terms. However, military personnel are also using the same roadways to support the installations function, whether it be commuting to and from the base on a day-to-day basis, or the movement of goods or equipment from fort to port. Therefore, a sound and efficient transportation system is critical to the installation and DoD mission, which may result in the need to reduce congestion and/or improve safety.

5.2 The Urban Environment

The purpose of identifying potential new criteria results from the need to address those installations in urban areas that may have an impact on the surrounding roadway network based on mission change, BRAC, or other factors, but will not cause a doubling of traffic volume because of high levels of existing traffic volume.

While there are many ways to define an urban area, most approaches relate the designation to population. The Federal Highway Administration requires that a Congestion Management Process (CMP) be adopted for each Transportation Management Area (TMA) in the nation to address current and future congestion challenges. The FHWA defines a TMA as an urbanized area with a population over 200,000. Therefore, for the purposes of this study, it seems prudent to adopt an urban classification definition that is consistent with metropolitan transportation planning as practiced by FHWA.

[8] 2009 Urban Mobility Report, July 2009, Texas Transportation Institute
[9] Crashes vs. Congestion: What's the Cost to Society, March 2008, Cambridge Systematics

5.3 Identifying Traffic Impacts

According to the Institute of Transportation Engineers, traffic access and impact studies are conducted to assess the transportation impacts of proposed developments and other land use changes. This may include new facilities or changes in land use resulting from the redevelopment of an existing area. When considering installation growth related to mission change, BRAC, or other factors, ultimately the traffic impacts experienced are a result of the activity associated with new or modified facilities. In that way installation impacts are almost identical in nature to that of the construction of a new office building or shopping center by a land developer. Therefore, it makes sense to use the same policies and procedures in identifying the transportation impacts of a military installation that apply to land development.

The development of a traffic impact analysis generally follows the following process:

- Identify the need for a traffic impact analysis
- Identify the study area
- Collect transportation data
- Project future demand
- Assess the impact of changes in demand
- Suggest ways for mitigating adverse effects.

Based on the similarities described above, it is proposed that the new DAR criteria follow a similar process.

5.4 Study Area

The study area is typically identified based on an estimate of the impact of the proposed facility, and may be defined by the most distant intersection at which a measurable impact is experienced. According to ITE, the study area should include all portions of the transportation network that are likely to perceive a change in the existing level of service. They have defined this as any location that will experience an increase of 100 or more new peak direction trips during the adjacent roadway's or development's peak hours based on the following rational:

- One hundred vehicles per hour are of a magnitude that can change the level of service of an existing intersection approach
- Left- or right-turn lanes may be needed to accommodate site traffic satisfactorily without adversely affecting through (nonsite) traffic.

This is generally consistent with the literature review results of State agencies traffic impact analysis requirements as summarized in Section 4.1. In addition, many identify a maximum distance from the development access point, ranging from 1,000 feet to two miles, with a few using the one mile threshold value. For this reason, it is proposed that the new DAR criteria establish a study area based on an increase in approach volume of at least 100 vehicles per hour up to a maximum of one mile from the installation access points.

6 Recommended Criteria

6.1 General

The Defense Access Road Program may be used for urgently needed improvements of existing highways in urban areas upon which new traffic has substantially increased due to expansion a permanent military installation. All traffic impact studies will be conducted in a manner consistent with methodologies identified in SDDCTEA Pamphlet 55-17.

For highly urbanized areas where doubling of traffic is impossible, the new criteria will consider population density, traffic volume, and delay to determine eligibility. Given these factors, the potential new DAR criteria may include the following:

- Military installation is within highly urbanized area: population greater than 200,000
- Proposed project is within a mile of military facility perimeter
- Proposed project area operates below a Level of Service D after the military impact
- Proposed project area has a minimum increase of 100 peak hour DOD trips

The final criteria definition will be established during the criteria internal DOD modification vetting process.

6.2 Evaluation

From the analysis of safety and operations the following elements were identified as essential for evaluation of a potential DAR projects.

- Traffic Impact Study Warrant
- Study Area
- Data Collection
- Analysis Year
- Background Traffic
- Installation Generated Traffic
- Traffic Analysis

6.2.1 Traffic Impact Study Warrant

A Traffic Impact Study (TIS) shall be required for those installations located in urban areas that expect a significant increase in new installation-related traffic. An installation is considered to be located in an urban area if it is within or abuts a population center of 200,000 or more as defined by the latest Bureau of the Census information.

6.2.2 Study Area

The study area shall be defined as extending to the most distant intersection that will experience an increase in an approach volume from new installation-related traffic of at least 100 vehicles per hour, up to a maximum of one mile from each of the installations access points. The definition of study intersections may also include ramp junctions and weaving areas of interchanges. The study area will be confirmed in consultation with SDDCTEA.

6.2.3 Data Collection

Traffic data should be collected for all study intersections during the morning and evening peak periods as defined by installation personnel in consultation with SDDCTEA. In some instances, midday period data collection may be required based on installation activity and function. In general, data should be collected for three hours during each peak period in order to accurately identify the peak hours for each timeframe.

6.2.4 Analysis Year

The analysis year shall be defined as the year when the full effect of the installation expansion or growth will be experienced.

6.2.5 Background Traffic

A background traffic growth rate shall be used to account for generalized growth that is not specific to planned development in the area. This background growth shall be compounded based on the analysis year and applied to the existing traffic volumes. In addition, traffic from planned development that will impact the study area shall be included to achieve the no-build condition for the analysis year.

6.2.6 Installation Generated Traffic

New installation generated traffic shall be estimated for the analysis peak hours based on information supplied by installation personnel. This new traffic shall be added to the no-build traffic volumes for the study intersections based on anticipated origins and destinations to achieve the build condition.

6.2.7 Traffic Analysis

Capacity analyses shall be conducted of the study intersections for the no-build and build Levels of Service (LOS) using an agreed upon software package. In any case, the methodology to be used must follow the most recent edition of the Highway Capacity Manual (HCM). Both conditions should include any known or programmed transportation improvements. The build condition shall then be compared to the no-build condition to determine if mitigation is required based on the following:

> If build LOS is A, B, C, and D, deterioration to LOS D will be permitted.
> If build LOS is E or F, no deterioration will be permitted (based on delay time) for any peak period.

For signalized intersections, the above analysis will be based on overall intersection LOS and delay.

The following scenarios shall be provided for each intersection within the study area to SDDC for consideration when reviewing requests for Defense Access Road funds:

- Existing – Analysis that demonstrates the existing operational condition of the study area.

- Future without site development traffic (No Build) – Analysis that indicates what the operational condition of the study area will be if the installation does not add additional traffic.
- Future with site development traffic (Build) – Analysis that indicates what the operational condition of the study area will be if the installation adds traffic to the study area and improvements are not made.
- Future with site development traffic and improvements (Build with Improvements) – Analysis that indicates what the operational condition of the study area will be if the installation adds traffic and needed improvements are identified and modeled.

7 FAIR-SHARE ANALYSIS

For all DAR projects, SDDC conducts an analysis to determine the fair share that should be funded by DoD. This analysis considers the military impact to traffic on the subject roadway subject and mitigation required to address the impact. The appropriate military funding share is then determined based on the installations proportion of the total traffic which utilizes the subject roadway segment. For large complex projects involving military and non-military impacts, other factors (such as overall project scope, total project cost and funding available from other sources) are taken into consideration.

For example, if:

- 2020 no-build traffic volume for subject roadway segment = 5,000 vehicles
- New installation generated traffic volume for subject roadway segment = 1,500 vehicles
- 2020 build traffic volume for subject roadway segment = 6,500 vehicles

  Fair-share = 1,500 ÷ 6,500 = 0.23 = 23%

The DoD fair-share would then be 23% of the cost to improve the subject roadway segment.

A similar fair-share analysis shall be conducted for projects found eligible for DAR funding using the criteria recommended in this study. The recommended project will, at a minimum, restore the level of service or delay time to levels which existed prior to the military action.

8 Case Studies

Case studies were developed to identify the potential impacts of the proposed criteria. An analysis was conducted for several locations experiencing installation growth with readily available traffic data, including the following:

- Andrews Air Force Base
- Bethesda National Naval Medical Center
- Marine Corps Base Quantico
- Fort Belvoir

The results of this analysis are provided in the Appendix to this document. The Transportation Research Board (TRB), National Research Council publishes the Highway Capacity Manual (HCM). The most recent version of the HCM was published in 2000 and it defines the amount of intersection delay that can be experienced and the corresponding letter grade used to define that delay.

Level of Service (LOS)	Intersections controlled by stop signs, two-ways or all-ways (seconds)	Total allowable intersection delay for signal controlled intersections (seconds)
A	0-10	≤10
B	>10-15	>10-20
C	>15-25	>20-35
D	>25-35	>35-55
E	>35-50	>55-80
F	>50	>80

The criteria shown in the table above was used to determine what LOS to assign to intersections evaluated.

It should be noted that in many instances the LOS designation may remain the same, however, because there is an increase in delay time, roadway segment operations are affected which may result in the need for mitigation.

Appendix
Case Studies

Andrews Air Force base is located on the border of the southeast quadrant of the Washington, D.C. city limits. In addition to its mission as the primary embarking and disembarking point for the President, it is host to approximately 16 major tenants. In 2009, a transportation management plan was completed to assess vehicular and pedestrian travel, parking conditions, transit services and to identify transportation needs for the future addition of personnel associated with BRAC 2005. The primary goal of the plan was to identify and validate transportation needs to better serve the Andrews populous with an intended side benefit of reduced single-occupant vehicle commuting index and reduction of vehicular trips in and around the NCR complex.

In addition to other work that was completed as part of this project, the study team also evaluated 11 off-base intersections to determine the impact of three key changes in traffic patterns affecting off-base travel:

- Construction of the National Capital Readiness Center
- Construction of a National Guard Readiness Center
- Closure of one Entry Control Facility

The construction of the two new facilities was expected to generate 997 new trips during peak times and the closure of the entry control facility caused the need to redistribute a peak volume of 509 vehicles.

Step one: Determine if the installation is within or abuts an urban area
The western boundary of Andrews AFB abuts the Washington, DC city limits. The population of Washington, DC was 591,833 as of July 2008 (US Census Bureau) which is greater than 200,000.

Yes, the installation is in an urban area.

Step two: Determine Study Area
The study intersections were identified at the outset of the project by Andrews AFB and included the progression of traffic between the entry control facilities and Interstate 495, Maryland Route 4 and Maryland Route 5.

The proposed DAR criteria states:

"The study area shall be defined as extending to the most distant intersection that will experience an increase in an approach volume from new installation-related traffic of at least 100 vehicles per hour, up to a maximum of one mile from each of the installations access points. The definition of study intersections may also include ramp junctions and weaving areas of interchanges. The study area will be confirmed in consultation with SDDCTEA."

- Of the eight intersections chosen for analysis by Andrews AFB, one of them did not meet the criteria as stated.
- One intersection of the existing study area boundary had more than 100 vehicles departing and was within 1 mile of the entry control facility
    - There are only local road access points for the remainder of the one mile criteria limit that would have likely been eliminated by the SDDCTEA confirmation portion of the criteria
- Other external intersections are set at the appropriate boundary points for this criteria

The Andrews AFB Traffic management would have included 7 external intersections due to new traffic generated by use of this criteria.

Step three: Conduct traffic impact to operations for study intersections
The proposed DAR criteria for LOS states:

- If build LOS is A, B, C, and D, deterioration to LOS D will be permitted.
- If build LOS is E or F, no deterioration will be permitted (based on delay time).

Below is the LOS chart that was completed as part of the study. For the study that was completed, a zero percent civilian growth rate was chosen for traffic outside of the base by the team due to economic conditions and uncertainty of external growth. Therefore, for this case study the no build condition would be the same as the existing condition.

Intersection	Existing		No Build		Build		Notes
	AM LOS	PM LOS	AM LOS	PM LOS	AM LOS	PM LOS	
(Int 1)Allentown & Forestville Roads	A	A	A	A	A	A	
(Int 2)Allentown Road & I-95/495 NB Off Ramp	C	A	C	A	E	A	A total of 236 trips were added to the NB and EB approaches
(Int 3)Allentown Rd & Westover/Suitland	C	F	C	F	F	F*	A total of 593 trips were added to the NB, SB and EB approaches
(Int 4)EB MD 4 & Dowerhouse Road	A	F	A	F	A	F*	A total of 300 trips were added to the SB and NB approaches
(Int 5)I-95 SB Ramp & Forestville Road	D	E	D	E	E	E*	A total of 143 trips were added to the SB and EB approaches
(Int 6)Suitland Road & I-95 SB Ramp	A	A	A	A	A	A	
(Int 8)WB MD 4 & Dowerhouse Road	F	A	F	A	F*	A	A total of 130 trips were added to the WB and NB approaches
* Although the LOS did not change, an increase in the overall intersection delay is expected since additional military traffic is added.							

Shaded cells in the table above indicate where the deterioration occurred that falls within the criteria. As can be seen from the chart, five of the intersections deteriorated beyond the allowable limits of the proposed criteria during at least one peak period.

Based on the proposed criteria the DoD may have determined that contributions to the improvement of five intersections was appropriate.

Step four: determine the DoD's fair share contribution to improvements

The proposed criteria states that a fair-share analysis shall be conducted to identify the installations potential contribution to roadway improvements necessary to maintain acceptable operating conditions as defined earlier. This fair-share contribution will be based on the installations proportion of the total traffic volume added at each study intersection. Below is the proportion of traffic added to each intersection. For intersections where both peak periods had impacts, the worst case scenario was analyzed for the purposes of this case study.

- Intersection 2
  - Existing traffic volume = 2571
  - No-Build traffic volume = 2571
  - New installation generated traffic volume = 236
  - Build intersection traffic volume = 2807
  - Fair-share = (236/2807) * 100 = 8.4 percent
  - Estimated DoD contribution = $700,000 *.084 = $58,800

- Intersection 3
  - Existing traffic volume = 3832
  - No-Build traffic volume = 3832
  - New installation generated traffic volume = 593
  - Build intersection traffic volume = 4425
  - Fair-share = (593/4425) * 100 = 13.4 percent
  - Estimated DoD contribution = $1,200,000 *.134 = $160,800

- Intersection 4
  - Existing traffic volume = 1775
  - No-Build traffic volume = 1775
  - New installation generated traffic volume = 300
  - Build intersection traffic volume = 2075
  - Fair-share = (300/2075) * 100 = 14.5 percent
  - Estimated DoD contribution = $800,000 * 0.145 = $116,000

- Intersection 5
  - Existing traffic volume = 1525
  - No-Build traffic volume = 1525
  - New installation generated traffic volume = 143
  - Build intersection traffic volume = 1668
  - Fair-share = (143/1668) * 100 = 8.5 percent
  - Estimated DoD contribution = $560,000 *.085 = $47,600

- Intersection 8
  - Existing traffic volume = 1927
  - No-Build traffic volume = 1927
  - New installation generated traffic volume = 130
  - Build intersection traffic volume = 2057
  - Fair-share = (130/2057) * 100 = 6.3 percent
  - Estimated DoD contribution = $800,000* 0.063 = $50,400

Based on a summation of the costs associated with individual intersection improvements identified above, the DoD contribution to off-base improvements as part of the Andrews AFB TMP may have been $433,600

The Bethesda Naval Hospital is located just northwest of Washington DC in Bethesda, Maryland. The National Naval Medical Center (NNMC) is one of the nation's largest and most renowned military medical centers, best known for its history of providing care to war heroes and presidents alike for the past 65 years. People go there to heal, to stay healthy, to help others, to teach the next generation, to practice quality medicine, and take part in cutting-edge clinical research. NNMC is comprised of nearly 4,500 professionals that may have varying jobs, yet all work together to accomplish the vision of the medical center. That vision is to be the Flagship of Force Health Protection and operational readiness; to deliver outstanding customer service; maintain outstanding opportunities in graduate medical and dental education and research; and always deliver world-class health care within an integrated system.

In 2008, a transportation study was completed as part of an Environment Impact Study (EIS) to analyze the impact of services and functions being relocated to NNMC from the Walter Reed Army Medical Center.

In addition to other work that was completed as part of this project, the study team evaluated 27 off-base intersections.

Step one: Determine if the installation is within or abuts an urban area
The NNMC resides within Montgomery County Maryland. According to the US Census Bureau, the population of Montgomery County Maryland was 950,680 as of July 2008 which is greater than 200,000.

Yes, the installation is in an urban area.

Step two: Determine Study Area
The study intersections were identified at the outset of the project by NNMC and included the progression of traffic between the entry control facilities and the outside road network. The study intersections were primarily located along Rockville Pike, Old Georgetown Road, and Connecticut Avenue.

The proposed DAR criteria states:

"The study area shall be defined as extending to the most distant intersection that will experience an increase in an approach volume from new installation-related traffic of at least 100 vehicles per hour, up to a maximum of one mile from each of the installations access points. The definition of study intersections may also include ramp junctions and weaving areas of interchanges. The study area will be confirmed in consultation with SDDCTEA."

- Of the 27 intersections chosen for analysis by NNMC, three of them had less than 100 entering vehicles and were also beyond one mile.
- Ten of the intersections were within 1 mile but had less than 100 entering vehicles.

The NNMC Traffic Study would have included 14 external intersections due to new traffic generated by use of this criteria, a reduction of the study area by nearly 50 percent.

Step three: Conduct traffic impact to operations for study intersections
The proposed DAR criteria for LOS states:

- If build LOS is A, B, C, and D, deterioration to LOS D will be permitted.
- If build LOS is E or F, no deterioration will be permitted (based on delay time).

Below is the LOS chart that was completed as part of the study:

Intersection	Existing		No Build		Build		Notes
	AM LOS	PM LOS	AM LOS	PM LOS	AM LOS	PM LOS	
Int. 4 Rockville at Pooks Hill	E	D	E	D	E*	D	A total of 189 trips were added to the NB and SB approaches
Int. 5 Rockville at West Cedar	F	F	F	F	F*	F*	A total of 254 trips were added to all approaches
Int. 6 Old Georgetown at West Cedar	C	E	D	F	D	F*	A total of 494 trips were added to the NB, WB and SB approaches
Int. 7 West Cedar at West	A	A	A	A	A	A	
Int. 8 Rockville at North	E	C	E	C	F	D	
Int. 9 Rockville at North Wood	B	D	B	D	D	E	
Int. 10 Rockville at Wilson	D	E	D	E	D	E*	A total of 157 trips were added to the NB and SB approaches
Int. 11 Rockville at South Wood	B	B	B	B	C	C	
Int. 12 Rockville at Jones Bridge	D	E	D	F	D	F*	A total of 161 trips were added to the NB, WB and SB approaches
Int. 16 Connecticut at Jones Bridge	F	F	F	F	F*	F*	A total of 203 trips were added to the NB, WB and SB approaches
Int. 20 Rockville at Woodmont	B	B	B	B	B	B	
Int. 21Rockville at Battery	A	A	A	A	A	A	
Int. 22 Rockville at Cordell	A	A	A	A	A	A	
Int. 23 Rockville at Cheltenham	A	A	A	A	A	A	
* Although the LOS did not change, an increase in the overall intersection delay is expected since additional military traffic is added.							

Shaded cells in the table above indicate where the deterioration occurred that falls within the criteria. As can be seen from the chart, eight of the intersections deteriorated beyond the allowable limits of the proposed criteria during at least one peak period.

Based on the proposed criteria the DoD may have determined that contributions to the improvement of eight intersections were appropriate.

Step four: determine the DoD's fair share contribution to improvements

The proposed criteria states that a fair-share analysis shall be conducted to identify the installations potential contribution to roadway improvements necessary to maintain acceptable operating conditions as defined earlier. This fair-share contribution will be based on the installations proportion of the total traffic volume added at each study intersection. Below is the proportion of traffic added to each intersection. For intersections where both peak periods had impacts, the worst case scenario was analyzed for the purposes of this case study.

- Intersection 4
  - Existing traffic volume = 5612
  - No-Build traffic volume = 5801
  - New installation generated traffic volume = 189
  - Build intersection traffic volume = 5990
  - Fair-share = (189/5990) * 100 = 3.1 percent
  - Estimated DoD contribution = $200,000 *.031 = $6,200

- Intersection 5
  - Existing traffic volume = 6751
  - No-Build traffic volume = 7007
  - New installation generated traffic volume = 254
  - Build intersection traffic volume = 7261
  - Fair-share = (254/7261) * 100 = 3.5 percent
  - Estimated DoD contribution = $35,000,000 *.035 = $1,225,000

- Intersection 6
  - Existing traffic volume = 4534
  - No-Build traffic volume = 5028
  - New installation generated traffic volume = 494
  - Build intersection traffic volume = 5522
  - Fair-share = (494/5522) * 100 = 8.9 percent
  - Estimated DoD contribution = $10,000,000 *.089 = $890,000

- Intersection 8
  - Existing traffic volume = 5382
  - No-Build traffic volume = 5479
  - New installation generated traffic volume = 107
  - Build intersection traffic volume = 5586
  - Fair-share = (107/5586) * 100 = 1.9 percent
  - Estimated DoD contribution = $2,000,000 *.019 = $38,000

- Intersection 9
  - Existing traffic volume = 4935
  - No-Build traffic volume = 5032
  - New installation generated traffic volume = 101
  - Build intersection traffic volume = 5133
  - Fair-share = (101/5133) * 100 = 2.0 percent
  - Estimated DoD contribution = $2,000,000 *.02 = $40,000

- Intersection 10
  - Existing traffic volume = 3801
  - No-Build traffic volume = 3928
  - New installation generated traffic volume = 157
  - Build intersection traffic volume = 4085

  - Fair-share = (157/4085) * 100 = 3.8 percent
  - Estimated DoD contribution = $120,000 *.038 = $4,560

- Intersection 12
  - Existing traffic volume = 5844
  - No-Build traffic volume = 6013
  - New installation generated traffic volume = 161
  - Build intersection traffic volume = 6174
  - Fair-share = (161/6174) * 100 = 2.6 percent
  - Estimated DoD contribution = $5,000,000 *.026 = $130,000

- Intersection 16
  - Existing traffic volume = 6497
  - No-Build traffic volume = 6699
  - New installation generated traffic volume = 203
  - Build intersection traffic volume = 6902
  - Fair-share = (203/6902) * 100 = 2.9 percent
  - Estimated DoD contribution = $36,000,000 *.029 = $1,044,000

Based on a summation of the costs associated with individual intersection improvements identified above, the DoD contribution to off-base improvements as part of the Bethesda EIS may have been $3,377,760

Since its inception in 1917, Marine Corps Base, Quantico, has been the "frontline of innovation." Marine concepts, doctrine, training, and equipment of the future are initiated aboard the Base. The techniques of amphibious warfare, for which the Corps is renowned, were conceived and perfected here. The tactics of close-air support and vertical envelopment using helicopters were also developed within its borders. As attention is focused on future battlefields, the Marine Corps and other branches of Service are looking to Quantico to lead the way with technological advances as well as creative and innovative thinking. Quantico also serves as the focal point for professional military education. The Marine Corps University provides the academic platform the Corps uses to shape and hone leaders at every milestone of their professional lives. Officers in the Marine Corps begin their careers at the Officer Candidates School and The Basic School. Enlisted marines receive additional leadership training at the University's Staff Non-Commissioned Officers Academy. The Marine Corps War College, School of Advanced Warfighting and Amphibious Warfighting School are also part of the University, training officers in the United States Armed Forces and international officers from designated foreign countries in the art of war.

In 2008, a transportation study was completed as part of an Environment Impact Study (EIS) to analyze the impact of changes due to the Base Realignment and Closure Act 0f 2005.

In addition to other work that was completed as part of this project, the study team evaluated 14 off-base intersections.

Step one: Determine if the installation is within or abuts an urban area
Marine Corps Base Quantico resides within Prince William, Stafford and Fauquier Counties in Virginia. According to the US Census Bureau, the combined population of these counties was 573,626 which is greater than 200,000.

Yes, the installation is in an urban area.

Step two: Determine Study Area
The study intersections were identified at the outset of the project by Marine Corps Base Quantico and included the progression of traffic between the entry control facilities and the outside road network. The study intersections were primarily located along US 1, the I-95 corridor ramps, Russell Road, VA 610, VA 637 and VA 619.

The proposed DAR criteria states:

"The study area shall be defined as extending to the most distant intersection that will experience an increase in an approach volume from new installation-related traffic of at least 100 vehicles per hour, up to a maximum of one mile from each of the installations access points. The definition of study intersections may also include ramp junctions and weaving areas of interchanges. The study area will be confirmed in consultation with SDDCTEA."

- Of the 12 intersections chosen for analysis by Marine Corps Base Quantico, one of them had more than 100 entering vehicles, but was beyond one mile.
    - Four of the intersections were within 1 mile but had less than 100 entering vehicles.

The Marine Corps Base Quantico Traffic Study would have included six external intersections due to new traffic generated by use of this criteria.

Step three: Conduct traffic impact to operations for study intersections
The proposed DAR criteria for LOS states:

- If build LOS is A, B, C, and D, deterioration to LOS D will be permitted.
- If build LOS is E or F, no deterioration will be permitted (based on delay time).

Below is the LOS chart that was completed as part of the study:

Intersection	Existing		No Build		Build		Notes
	AM LOS	PM LOS	AM LOS	PM LOS	AM LOS	PM LOS	
Int. 1 US Route 1 at Co Rd 637	A	B	C	E	C	E*	A total of 179 trips were added to the NB, SB and EB approaches
Int. 2 Co Rd 610 at Mine	E	E	F	F	F*	F*	A total of 108 trips were added to the NB, SB and EB approaches
Int. 3 Co Rd 610 at Onville	C	D	E	F	E*	F*	A total of 133 trips were added to the WB, SB and EB approaches
Int. 4 I-95 NB Off at Russell	C	F	F	F	F*	F*	A total of 343 trips were added to the NB and WB approaches
Int. 5 I-95 NB On at Russell	A	C	A	D	A	D	
Int. 6 I-95 SB at Russell	F	F	F	F	F*	F*	A total of 997 trips were added to the SB and WB approaches
* Although the LOS did not change, an increase in the overall intersection delay is expected since additional military traffic is added.							

Shaded cells in the table above indicate where the deterioration occurred that falls within the criteria. As can be seen from the chart, five of the intersections deteriorated beyond the allowable limits of the proposed criteria during at least one peak period.

Based on the proposed criteria the DoD may have determined that contributions to the improvement of five intersections was appropriate.

Step four: determine the DoD's fair share contribution to improvements

The proposed criteria states that a fair-share analysis shall be conducted to identify the installations potential contribution to roadway improvements necessary to maintain acceptable operating conditions as defined earlier. This fair-share contribution will be based on the installations proportion of the total traffic volume added at each study intersection. Below is the proportion of traffic added to each intersection. For intersections where both peak periods had impacts, the worst case scenario was analyzed for the purposes of this case study.

- Intersection 1
  - Existing traffic volume = 2684
  - No-Build traffic volume = 3775
  - New installation generated traffic volume = 179
  - Build intersection traffic volume = 3954
  - Fair-share = (179/3954) * 100 = 4.5 percent
  - Estimated DoD contribution = $2,000,000 *.045 = $90,000

- Intersection 2
  - Existing traffic volume = 4241
  - No-Build traffic volume = 5150
  - New installation generated traffic volume = 108
  - Build intersection traffic volume = 5258
  - Fair-share = (108/5258) * 100 = 2.1 percent
  - Estimated DoD contribution = $350,000 *.021 = $7,350

- Intersection 3
  - Existing traffic volume = 3120
  - No-Build traffic volume = 3275
  - New installation generated traffic volume = 133
  - Build intersection traffic volume = 3408
  - Fair-share = (133/3408) * 100 = 3.9 percent
  - Estimated DoD contribution = $2,000,000 *.039 = $78,000

- Intersection 4
  - Existing traffic volume = 858
  - No-Build traffic volume = 975
  - New installation generated traffic volume = 343
  - Build intersection traffic volume = 1318
  - Fair-share = (343/1318) * 100 = 26.0 percent
  - Estimated DoD contribution = $5,000,000 *0.26 = $1,300,000

- Intersection 6
  - Existing traffic volume = 740
  - No-Build traffic volume = 925
  - New installation generated traffic volume = 997
  - Build intersection traffic volume = 1922
  - Fair-share = (997/1922) * 100 = 51.9 percent
  - Estimated DoD contribution = $6,000,000 *.519 = $3,114,000

Based on a summation of the costs associated with individual intersection improvements identified above, the DoD contribution to off-base improvements as part of the Marine Corps Base Quantico EIS may have been $4,589,350.

In September of 2005, the Defense Base Closure and Realignment Commission (BRAC) recommended numerous realignment or closure actions for domestic military installations. The Preferred Alternative Land Use Plan was chosen as one of four options to implement the mandatory BRAC initiative to consolidate military personnel.

In 2007, an Environmental Impact Study was performed to evaluate how the implementation of the BRAC recommendations might affect the surrounding environment.

In addition to other work that was completed as part of this project, the study team evaluated and recommended 13 transportation improvements if the preferred alternative was selected to be the choice of consolidation.

Step one: Determine if the installation is within or abuts an urban area
Fort Belvoir resides within Fairfax County, Virginia. According to the US Census Bureau, the population of Fairfax County Virginia was estimated to be 1,037,605 in 2009, which is greater than 200,000.

Yes, the installation is in an urban area.

Step two: Determine Study Area
The study intersections were identified by the study team as intersections that would likely be affected by the increase in traffic due to the BRAC initiative. The study intersections were primarily located along Franconia-Springfield Parkway, Fairfax County Parkway, and Route 1.

The proposed DAR criteria states:

"The study area shall be defined as extending to the most distant intersection that will experience an increase in an approach volume from new installation-related traffic of at least 100 vehicles per hour, up to a maximum of one mile from each of the installations access points. The definition of study intersections may also include ramp junctions and weaving areas of interchanges. The study area will be confirmed in consultation with SDDCTEA."

- Nine intersection improvements fell within the required DAR criteria.

Step three: Conduct traffic impact to operations for study intersections
The proposed DAR criteria for LOS states:

- If build LOS is A, B, C, and D, deterioration to LOS D will be permitted.
- If build LOS is E or F, no deterioration will be permitted (based on delay time).

Below is the LOS chart that was completed as part of the study:

Intersection	Existing		No Build		Build		Notes
	AM LOS	PM LOS	AM LOS	PM LOS	AM LOS	PM LOS	
1: Interstate 95 and Fairfax County Parkway	D	F	D	F	F	F*	A total of 545 trips were added to the EB and WB approaches
8.1: US 1/Backlick-Pohick	C	F	D	F	F	F*	A total of 975 trips were added to the WB and EB approaches
8.2: US 1/Fairfax Co. Pkwy	D	C	D	D	E	D	
8.3: US 1/ Belvoir Rd	B	B	C	F	F	F*	A total of 1010 trips were added to the WB, NB and EB approaches
8.4: Franconia Springfield Pkwy EB Ramp/Frontier Dr.	C	D	C	D	C	E	
8.5: Franconia Springfield Pkwy WB Ramp/Frontier Dr.	C	F	C	F	D	F*	A total of 260 trips were added to all approaches
8.6: Franconia Springfield Pkwy/Beulah St	E	F	F	F	F*	F*	A total of 4525 trips were added to all approaches
10: Fairfax Co. Pkwy/John J. Kingman Rd	D	F	D	F	D	F*	A total of 980 trips were added to all approaches
11: Franconia Springfield Pkwy/Neuman St	E	E	F	F	F*	F*	A total of 855 trips were added to all approaches
* Although the LOS did not change, an increase in the overall intersection delay is expected since additional military traffic is added.							

Shaded cells in the table on the previous page indicate where the deterioration occurred that falls within the criteria. As can be seen from the chart, all of the intersections deteriorated beyond the allowable limits of the proposed criteria during at least one peak period.

Based on the proposed criteria the DoD may have determined that contributions to the improvement of nine intersections were appropriate.

Step four: determine the DoD's fair share contribution to improvements

The proposed criteria states that a fair-share analysis shall be conducted to identify the installations potential contribution to roadway improvements necessary to maintain acceptable operating conditions as defined earlier. This fair-share contribution will be based on the installations proportion of the total traffic volume added at each study intersection. Below is the proportion of traffic added to each intersection. For intersections where both peak periods had impacts, the worst case scenario was analyzed for the purposes of this case study.

- Improvement 1
    - No Action 2011 projected traffic volume = 8635
    - New installation-generated traffic volume (difference) = 545
    - Build projected traffic volume = 9180
    - Fair-share = (545/9180) * 100 = 5.9 per cent
    - Estimated DoD contribution = $75,000,000 * .059 = $4,453,000

- Improvement 8*
    - Intersection 8.1
        - No Action 2011 projected traffic volume: 5130
        - New installation-generated traffic volume (difference): 975
        - Build projected traffic volume: 6105
    - Intersection 8.2
        - No Action 2011 projected traffic volume: 5060
        - New installation-generated traffic volume (difference): 1230
        - Build projected traffic volume: 6290
    - Intersection 8.3
        - No Action 2011 projected traffic volume: 4450
        - New installation-generated traffic volume (difference): 1010
        - Build projected traffic volume: 5460
    - Intersection 8.4
        - No Action 2011 projected traffic volume: 3725
        - New installation-generated traffic volume (difference): 290
        - Build projected traffic volume: 4015
    - Intersection 8.5
        - No Action 2011 projected traffic volume: 4675
        - New installation-generated traffic volume (difference): 260
        - Build projected traffic volume: 4935
    - Intersection 8.6
        - No Action 2011 projected traffic volume: 3840
        - New installation-generated traffic volume (difference): 4525
        - Build projected traffic volume: 8365
    - Total new installation-generated traffic volume: 8290
    - Total build projected traffic volume: 35170
    - Fair-share = (8290/35170)*100 = 23.6 per cent
    - Estimated DoD contribution = $90,000,000 * .236 = $21,240,000

*Improvement 8 grouped six intersections together to provide one estimated cost of improvement of $90 mil. Because of this grouping, one Fair Share contribution was calculated as a weighted average of those six intersections (above).

- Improvement 10
    - No Action 2011 projected traffic volume = 4330
    - New installation-generated traffic volume (difference) = 980
    - Build projected traffic volume = 5310
    - Fair-share = (980/5310) * 100 = 18.5 per cent
    - Estimated DoD contribution = $30,000,000 * .185 = $5,550,000

- Improvement 11
    - No Action 2011 projected traffic volume = 7555
    - New installation-generated traffic volume (difference) = 855
    - Build projected traffic volume = 8410
    - Fair-share = (855/8410) * 100 = 10.2 per cent
    - Estimated DoD contribution = $50,000,000 * .102 = $5,083,000

Based on a summation of the costs associated with individual intersection improvements identified above, the DoD contribution to off-base improvements for the BRAC Preferred Alternative may have been $36,277,000.
In addition to the above improvements, an interchange to access the EPG development from Interstate 95, costing $36,000,000 was previously approved under existing DAR criteria. Because the DoD accounts for 100% of the traffic at this interchange, the total DoD contribution to off-base improvements for the BRAC Preferred Alternative may have been $72,277,000.

In order to identify the potential financial impact of the revised DAR criteria based on the number of qualifying installations, a rough order-of-magnitude cost was developed utilizing the possible DoD fair-share contributions for each cased study as compared to the anticipated increase in installation population. While this approach does not consider the specifics of each installation relative to mission, existing traffic conditions, and existing roadway conditions, it does provide a method of extrapolating the case study data to other installations located in urban areas.

For the four case studies, the total potential DoD fair share contribution, and associated increase in installation population, is summarized below:

Installation	Population Increase	Estimated DoD Contribution	Calculation	Contribution per 1,000 Installation Population Increase
Andrews AFB	4,729	$433,600	433,600 / 4.729	$91,690
Fort Belvoir	21,407	$72,277,000	72,277,000 / 21.407	$3,376,326
Bethesda NNMC	4,000	$3,377,760	3,377,760 / 4.000	$844,440
MCB Quantico	8,043	$4,589,350	4,589,350 / 8.043	$570,602
Total	**38,179**	**$80,677,710**	**80,677,710 / 38.179**	**$2,113,144**

The case studies result in an estimated DoD fair-share contribution of $2,113,144 per 1,000 increase in installation personnel. Applying this factor to those remaining installations that fall within urban areas as defined earlier and will experience in increase in installation population results in the following:

Installation	Population Increase	
Fort Carson	32,719	
Fort Meade	26,025	
Fort Bragg	29,998	
Fort Bliss	60,781	
Fort Sam Houston	39,692	
Fort Lewis	24,335	
Total	**213,550**	
213.550 x $2,113,144 per 1,000 population = $451,261,901		

Therefore, considering the above, the total potential DoD fair-share contribution could be as high as $531,939,611 ($80,677,710 + $451,261,901). Again, this is a very rough extrapolation of the case study data, and is not based on a detailed analysis of each of the installations specific site conditions.