

**SPATIALLY REFERENCED CRASH DATA SYSTEM  
FOR APPLICATION TO COMMERCIAL  
MOTOR VEHICLE CRASHES**

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## **Abstract**

The Maryland Spatial Analysis of Crashes (MSAC) project involves the design of a prototype of a geographic information system (GIS) for the State of Maryland that has the capability of providing online crash information and statistical information for commercial vehicle crashes. MSAC is deployed over the Internet. The system is capable of displaying crash data such as specific geographic locations, period and time of crash, crash severity including the number of fatalities, contributing factors, and the cost per crash, among others. The prototype features a unique horizontal drill capability whereby the users can either drill down to narrow the scope of search or drill up to expand the scope of search. The mapping, querying and reporting capabilities are integrated in MSAC.

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## 1.0 INTRODUCTION

In the year 2000, commercial vehicles in Maryland were involved in 7506 crashes, causing 3,458 injuries and 72 deaths. According to the U.S. Department of Transportation, in 1998 and 1999, 10 percent of fatal crashes involved a large truck. In Maryland, the figure was around fifteen percent. These figures motivated the design of a spatially referenced data system for commercial vehicle crashes known as the Maryland Spatial Analysis of Crashes (MSAC).

The MSAC project involves the design of a prototype of a geographic information system (GIS) for the State of Maryland that has the capability of providing online crash information and statistical information for commercial vehicle crashes. The system is capable of displaying crash data such as specific geographic locations, period and time of crash, crash severity including the number of fatalities, contributing factors, and the cost per crash, just to name a few.

The MSAC design may achieve measurable improvements for commercial motor carrier enforcement personnel. Crash data will significantly aid the Maryland State Police (MSP) and Maryland Transportation Authority Police (MdTAP) in their efforts to efficiently and effectively deploy resources and the State Highway Administration (SHA) to manage highway development and repair.

The MSAC project responds to the Federal Motor Carrier Safety Administration's (FMCSA) goal to reduce the number of deaths and injuries in truck and bus crashes. Specifically, the proposal addresses FMCSA's objective to design

roadway systems that are "Optimized for Commercial Motor Vehicle Safety". The FMCSA 2010 Strategy draft document states the following safety initiative:

"To improve highway infrastructure at high-crash locations, FMCSA will work with the FHWA and States to ensure that commercial vehicles are fully considered in the Highway Safety Improvement Program. These efforts will seek to assure that high-crash locations for commercial motor vehicles are identified and specific countermeasures for heavy vehicles are proposed, and that the planning and selection of potential projects will include a factor that recognizes the value of addressing locations where the crashes are prevalent."

MSAC, therefore, is primarily designed as a system that will allow state agencies, such as Maryland State Police, the Maryland Transportation Authority Police and the Maryland Department of Transportation, to quickly and easily access, manipulate, and display commercial vehicle crash data in a comprehensive manner to develop a prevention and maintenance plan.

MSAC is a map-based computer information system capable of displaying data on a screen, based on users' queries. It allows users to manipulate and narrow the focus of such queries to arrive at the desired information. For example, users will be able to see the distribution of commercial vehicle crashes across state highways. Furthermore, users will understand how the number of commercial vehicles on the highway, the types of roads they frequent, and the time of day, can, individually or conjunctly, contribute to a crash. These data are also available in a form that can be accessed and manipulated by other applications. The GIS is a powerful system that can access and display large amounts of data through the use of tables or overlays upon the mapping interface in a meaningful

and intuitive manner determined by the user. The ability to tailor these displays and alter them at will makes MSAC easy to use and very adaptable.

Because the actual interface of the GIS is spatial, information can also be displayed in terms of densities. While a table or chart can display statistics from several different regions, a GIS will allow users to view different regions with a pictorial representation of data involving crashes according to the density of such events in relation to other regions. Such visual and statistical comparisons can also be made in relation to changes in data over time, within the same geographic area.

Iowa State University's implementation of a similar system replaces a PC-based paradigm that required users to maintain paper lists of reference (node) numbers. With the GIS, users abandon such lists in favor of a map interface, using a mouse. Initially, benefits from speed and ease of use were the developers' sole objectives. Development and implementation, however, revealed that data can be displayed in themes to differentiate types of crashes in various areas. These themes can be laid over other themes to reveal a unique type of data display and analysis. In addition, physical features of highways, such as sharp grades or curves are displayed alongside these overlays. This adds an additional layer of information for interpretation.

This new-found power of the Iowa system led the developers to examine applications specifically in terms of rural areas. Data considering the age of involved drivers, types of vehicles involved and the type of road (i.e. gravel,

paved, etc.) upon which the crash occurred were all included in the GIS database and allowed for a far more complete view of data trends across geographic areas. This particular project is primarily concerned with crashes involving commercial vehicles but, obviously, GIS are powerful enough to accommodate a wide variety of data.

Another system in North Carolina is more related to this project's goal. Tracking data for commercial vehicle crashes, the North Carolina system includes data related to crashes as well as supplementary information such as the relative proximity of trauma centers to different crash concentrations. Population data also allows their system to track changes in crash density across regions as populations change over time. The ability to pinpoint such trends allows enforcement to anticipate future problem areas and upgrade enforcement or development accordingly.

## **2.0 SYSTEM CAPABILITIES**

The MSAC prototype can be viewed at <http://mdaccident.morgan.edu/cvo>. Because the prototype uses real-world data, MSAC is password protected. The system interface is built with three major capabilities: mapping, drilling and reporting. Each adds to the system functionality and flexibility with unlimited manipulation options. Figure 2 provides the user-interfaces corresponding to these three capabilities. The prototype features a unique horizontal drill capability whereby the users can either drill down to narrow the scope of search

or drill up to expand the scope of search. The mapping, querying and reporting capabilities are integrated in MSAC.

## **2.1 MAPPING CAPABILITIES**

The mapping capability allows the user to see the crash locations on a map interface. Several mapping functions allow the user to go to different map locations. These include, zoom in, zoom out, panning, etc. The user is able to visualize crashes on the maps based on crash parameters. Using the identify tool, the user is able to obtain data on crashes occurring at a specific location.

## **2.2 DRILLING CAPABILITIES**

The drilling capability is built on a multi-layer schema, executed through drop-down lists or check box window menus for each item category. Users can expand their queries up to nine independent layers of depth. The layers represent sub-categories of categories that are attributes of a given crash. The drilling capability allows either the single or multiple selections of menu items, thereby facilitating comparison possibilities.

## **2.3 REPORTING CAPABILITIES**

The system is capable of generating four types of reports. Reports are tabular representation of information in the form of text and figures; they offer a synoptic view of query results. The four types of reports generated by the system are:

Summary Report, Factor Analysis Report, Crash Information Report, and Identified Crash Report.

### **2.3.1 THE SUMMARY REPORT**

A summary report is a basic report that summarizes query results in terms of numbers and percentages; the system will generate this report each time a selection is made and executed (Figure 5). This report will not only summarize the crashes based on selected criteria, it also includes a comparison for example, when a user clicks a route on a map and queries the types of crashes that occurred on that specific route at dusk in the month of November, 1999, the report will not only present the result for the specific item and its attributes, but it will also compare these crashes to similar crashes in Maryland on routes of the same type and to similar crashes in Maryland for all route types. This becomes a basis for a proper comparison.

This report express cost per crash in terms of comprehensive costs for the whole year. These costs not only include the economic costs (medical costs, emergency services, vocational rehabilitation, market productivity, household productivity, insurance administration, workplace cost, legal/court cost, premature funeral cost, travel delay, and property damage) of a motor vehicle crash, but also the intangible consequences of these events to individual families such as pain, suffering and loss of life. These are calculated in terms of 'willingness-to-pay' and are an order of magnitude higher than the economic costs of injuries. The costs reported are weighted based on costs for each

severity level. These economic costs were obtained from the National Public Services Institute Research Institute for year 2000 and are as follows based on severity levels: 'Not Injured' was \$2,854; 'Possible Injury' was \$28,408; 'Injured' was \$57,785; 'Disabled' was \$212,143; and 'Fatality' was \$3,870,641.

### **2.3.2 FACTOR ANALYSIS REPORT**

The Factor Analysis Report, goes one step further. It is a powerful decision-making tool that focuses primarily on the comparison of costs for all values of a contributing factor (Figure 14). The system will evaluate the cost for all items in the selected category, and compare and derive the cost differential. The 10 factors addressed in this report are: day of the week, driver/pedestrian condition, lighting, fixed objects, intersection, junction, month, weather, and year of the crash.

### **2.3.3 CRASH INFORMATION REPORT**

A Crash Information Report is a detailed report that contains comprehensive data on a specific crash (Figure 13). Crash information on the time, date, location (route and area), first and second harmful events (if applicable), vehicle body type, and conditions such as weather, lighting and road surface, the number of pedestrians and drivers/occupants killed or injured, are reported.

### **2.3.4 THE IDENTIFIED CRASH REPORT**

The Identified Crash Report is a tabular view of critical attributes of crashes taking place at a specific location (Figure 12). This allows for the formation of concepts related to crashes occurring at a certain location (e.g., are the crashes occurring when one vehicle is making a left turn?) This report is generated by the user first clicking on the identifier tool () located on the map tool bar, and then clicking on a location on the map. This report lists all crashes at a specific location. Details on a specific crash can be obtained through the Crash Information Report described in Section 2.3.3.

### **3. 0 SYSTEM DESCRIPTION**

MSAC has been conceived as a user-friendly environment. The interface has been designed to provide easy-to-use tools that permit single or multiple selections of menus and menu items at the click of a mouse. The concept is based on selection principle; the users need not enter any data since the queries are based upon predefined values of the selection criteria.

Once users enter the site, they will be directed to a main user interface. The user interface consists of a single window partitioned into three main sections: the Menu Frame, the Map Frame, and the Report Frame. This single window approach allows the users to conveniently access query tools and view query results in a single window. An additional window will open up automatically only if the users require detailed information. A user manual on the usage of MSAC is provided in Appendix A.

## **4.0 SOFTWARE OVERVIEW**

At the heart of the MSAC is the integration of several software packages. The integration is carried out by means of development tools and programming and scripting languages. The system operates on a Windows 2000 server, the web pages are served through Internet Information Server (IIS) communicating with ServletExec, a Servlet Engine for java-based pages, and with Oracle 8i as a back-end relational database management system. The core of the geographical information system is designed and supported through ArcGIS, a proprietary software suite which consists of ArcView, ArcSDE and ArcIMS. A quick overview of these different GIS tools is given below to highlight the key features, and functionality of these tools.

### **4.1 ArcSDE**

ArcSDE functions as the GIS gateway; it serves as an interface between the relational database and the rest of the GIS. ArcSDE permits spatial data representation capabilities and provides a mechanism for managing feature geometry. It is compatible with several database management systems as Oracle, Informix, DB2 and Microsoft SQLServer. ArcSDE is a scalable application that can be customized to fit the size of the user data. This software is a server for spatial geographical information systems. ArcSDE offers two configurations: direct connection and server-based. The direct connection platform enables the connection of each client-user to a local DBMS. This architecture offers ease of installation and administration. The server-based configuration, on the other hand, is faster and provides higher performance.

ArcSDE also allows the transfer of spatial data between database management systems without loss. For example, the system will preserve the integrity of geographical data and will delineate ill-formed features. The data portability feature allows application developed with ArcSDE Application Program Interface to invariably run on different physical schemas.

## **4.2 ArcView**

ArcView is the desktop model of the ArcGIS suite. It is the point of entry to the ArcGIS platform. It provides visualization, analysis and integration of basic geographical information systems. ArcView includes other tools such as ArcCatalog that serves a function similar to Windows Explorer for spatial data. ArcView adds the capabilities of creating and editing shape files and simple features in geodatabases.

## **4.3 ArcIMS**

ArcIMS is a web-based mapping system that permits the development and deployment of GIS data and services within an intranet or on the World Wide Web. This tool enables the integration of data from various sources and also provides scalability for a collaborative multi-user environment. ArcIMS is compatible with clients that can communicate in ArcXML, the ArcIMS language. Some of these clients, such as HTML and Java are shipped with the software; others are part of the ArcGIS suite while others are wireless or customized clients. Other ArcIMS features are map services, enhanced GIS capabilities and Geographical Network access. The map service facilitates the design of customizable maps; the enhanced GIS capabilities favor enhanced image

rendering, data query, extraction, and sharing; and the geographical network facilitates the access to unlimited number of maps, such as roadmaps.

#### **4.4 ServletExec**

Servlets function as dynamic interfaces between the web server and the browser. When a user requests a page from a web site, for example, a command is sent to the server to locate the designated page. Servlets will play the role of translators between the user's computer and the computer on which the web page is located. They provide better performance and scalability than other programs such as scripting languages. They are more reliable and easy to implement. Servlets operate on servers known as containers or ServletEngines. Several versions of ServletEngines exist. ServletExec is a proprietary software that can run on all major web servers, such as Microsoft IIS, Netscape, and Apache; it is supported by such platforms as Windows NT/2000, SPARC, Solaris, Linux, and many other systems. ServletExec provides web application security, resource monitoring, general performance enhancement and a straightforward installation and configuration process. The application server runs as a stand-alone process, separate from the web server, which adds to its flexibility and performance.

#### **5. 0 CONCLUSION**

Maryland Spatial Analysis of Crashes was conceived as a user-friendly prototype for systems that will aid in the analysis of crashes. Several outcomes have

resulted from the design of the system. First, the system has been well received by the major stakeholders for crashes (Maryland Department of Transportation, State Highway Administration, and vehicle enforcement personnel). Second, the prototype system has advanced knowledge on drilling mechanisms in the design of user-friendly systems. This study proposes a horizontal drilling schema, whereby, users can either drill down by narrowing the search, or drill up by expanding the scope of the search. This searching mechanism, as proposed in the design, leads to flexibility in order to form concepts on crashes.

While this prototype represents the best of the breed for spatial crash analysis, the technology is yet to be deployed. There are numerous hurdles for the deployment of such technologies: the privacy of data and information, access to information technology services, coordination among agencies not directly involved with commercial vehicles, etc. Using the prototype as a benchmark, it may be possible to overcome the hurdles to deploy a production version of the system. This would entail the transfer of crash technologies amongst several state agencies that have a stake in Commercial Motor Vehicle Operations (CVO). The Motor Carrier's Inter Agency Coordinating Group (IACG) has been at forefront for effective coordination between agencies through a Memorandum of Understanding. The success of the IACG implies that the necessary processes exist in the state for the effective transfer of such technologies. Moreover, the system can easily be extended to all motor vehicle crashes thereby significantly increasing the utility of such systems.

The technology transfer will involve analysis of privacy issues and geocoding processes, study of data upload systems, design and analysis of data download

systems, analysis and design of user interfaces, and coding of enhancements to MSAC. These efforts are continuing and the prototype is in a continual state of enhancements based on available resources.

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## **APPENDIX A: USER MANUAL**

This user manual will guide you through navigating the MSAC system. Examples in each section will show you a systematic process based on your searches. These examples do not constitute mandatory selections for arriving at specific results. Sequences in each search are either beginning or continuation processes and may vary accordingly.

### **A.1.0 THE HOME PAGE**

The home page consists of the flag and the map of the state of Maryland (Figure 1).

### **A.1.1 LOGGING ONTO THE SYSTEM**

To log on the system, make sure that your monitor display screen is adjusted to 1024x768. If your screen is already adjusted to the advised size, click on the flag in the center of the home page.

### **A.1.2 ADJUSTING THE RESOLUTION**

In order to view the MSAC web site, you must set the display size of the monitor to 1024x768. Click on the message box 'Recommended for Display Size: 1024X768' which will open an instruction window to guide you as described in the steps below for Windows 95/98.

- Click **Start** on the bottom left hand corner of the computer screen.
- Go to Settings > Control Panel.

- Double click the icon labeled **Display**.
- Click the **Settings** tab.
- Under **Desk Area**, drag the slider until the resolution is set to 1024x768.
- Log on to the system by clicking on the flag.

## **A.2.0 THE USER INTERFACE**

When you click on the flag, you are directed to a screen as shown in Figure 2.

The window is divided into three main categories: Menu Frame, Map Frame, and the Report Frame. The Menu Frame allows you to build selection criteria (SELECTIONS) and apply the selection criteria to the map (FUNCTIONS). The SELECTION menus include the following menus: Area, Route Types, Vehicle Body Type, Severity, Time Period, Collision Type, Contributing Factors, Environment and Junction. The FUNCTION menus allows you to update the maps and reports based on selection criteria and to apply renderings to the map by selecting an appropriate rendering criteria.

The Map Frame is the area of the window where all maps and corresponding legends are displayed. This frame also consists of mapping tools that enable a user to zoom in, or zoom out, pan to another location in the map, print maps, change the map extent, and identify events on the map by clicking on it. The Map Frame is the spatial component of MSAC.

The Report Frame is the area of the window where all a tabular representation of information is generated. The type of a report generated will be based on the state of the system. Initially, this frame will contain the basic navigation help

(Figure 4). Once the user selects a search criteria and updates the map, this frame will be populated by summary cost information on the selected criteria. If the user clicks on a location in the map that has a crash, this frame will be populated by basic information on crashes occurring at that location. The data contained in each report will vary to match the search criteria.

### **A.3.0 MENUS AND SUBMENUS**

Menu selection is performed by clicking on a selection item on the Menu Frame. Submenu selection is performed primarily through the use of a mouse, either by selecting an item in a drop-down list or by clicking on a checkbox item. You may select only one item at a time in a drill-down list. The menu frame is the entry point to the analysis of crashes. User-interfaces, drop-down lists and checkboxes are discussed next.

**Drop-down lists** are selection menus that only allow a single selection from that specific list. For example, you can select only one district from the **District** drop-down list in the **Area** sub-menu. In many instances, the user will be allowed to select only one criterion from multiple drop-down lists. As an example, if the user selects a **District**, the prior selection of **State Map**, **County** and **Municipality** will be erased. This feature is present for all drop-down lists of the **Area** sub-menu, five drop-down lists of **Route Type** sub-menu, and five drop-down lists for **Contributing Factors** sub-menu.

**Check-boxes** allow you to make multiple selections in each category. You may check any number of items in the boxes listed.

Selection of Ellipses (...) in drop-down lists and '**All**' in check boxes implies not selecting a specific value for that choice. These are the default settings for MSAC. **Not Applicable**, **Other**, and **Unknown** values are placed in appropriate drop-down lists whenever they appear in the database. You may need to select one of these based on your desired analysis.

### **A.3.1 AREAS (REGIONS)**

**Areas** includes all regions in the state of Maryland. These regions are administrative territories that are based on the SHA delineation. The **Area** selection features the entire state of Maryland, seven Districts numbered from one to seven; and Municipalities and Counties ordered alphabetically. **Area** is the default window of the user interface (Figure 3). To select Baltimore County as the area of interest:

- Click the drop-down list **County** in the Selection frame, below the main menu.
- Select 'Baltimore' from the drop-down list. A map of Baltimore County will automatically be generated. (Clicking Update is not required for items in the **Area** category).

### **A.3.2 ROUTE TYPE**

The **Route Type** submenu includes seven alternative ways to specify route selections (Figure 4). Selecting a choice from 'All Routes' will allow you to select all routes in Maryland that are of the selected choice type of routes. For example, selecting 'Interstate' from this drop-down list and then clicking on 'Update Map', all the Routes in Maryland that are of type 'Interstate' will be

displayed and analyzed. The next set of selections allows you to perform analysis on a specific route e.g., Interstate Route 95. You may select specific routes of types: Maryland Routes, U.S. Routes, Interstate Routes, County Routes, or you may even pick your own route from nine pre-selected route types. For example, to select US Route 1,

- Click **Route** from the main menu.
- Choose '1' in the drill-down menu **US Routes**.
- Click **Update Map** to apply your selection.

To select a route not listed, select the route type from the drop-down list in the 'or Pick Your Own Route' area, and then manually enter the route number e.g., '204' in the box provided next to the route type selections. Click **Update Map** to apply your selection. The user may optionally select an appropriate direction from the 'Lane of Accident' drop down list. These directions correspond to South, North, East and West.

### **A.3.3 VEHICLE TYPE**

This selection allows you to choose from six commercial body types: Single Truck 2 Axles, Single Truck 3 Axles, Truck, Truck Tractor, Transit Bus, Cross Country Bus, and School Bus. (Figure 5). To select body type Transit Bus, for example,

- Click **Vehicle Type** on the main menu.
- Check 'Transit Bus' in the Vehicle Body Type sub-menu and then click on **Update Map**.

On the Map Frame, the current map extent will show transit bus crash locations. Transit Bus crash analysis will be displayed in the Report Frame. To perform

analysis on all the vehicle types, do not uncheck the 'All' box that has been checked by default.

#### **A.3.4 SEVERITY**

The check boxes in the **Severity** category display six crash severity levels (Figure 6). You may select one or more of the checkboxes labeled 'Fatalities', 'Disabilities', 'Injuries', 'Possible Injuries', 'Not Injured', or 'Unknown'.

Extending the example described in the previous section (Vehicle Type), you may be interested in transit bus crashes that resulted in either a fatality or a disability. In this case, click the **Update Map** menu only after you have selected all the conditions to build the search criteria. Follow the steps below.

- Click **Severity** from the main menu.
- Click on the 'Fatalities' and the 'Disabilities' check boxes making sure that they are checked.
- Click **Vehicle Type** on the main menu.
- Check 'Transit Bus' in the Vehicle Body Type sub-menu.
- Finally, click the **Update Map** menu from the FUNCTIONS menu items.

The new map generated will display transit bus crashes that resulted in a fatality and/or a disability. The Report Frame will show the number and the cost per crash for transit bus crashes that resulted in a fatality and/or a disability. To perform analysis on all the vehicle types, do not uncheck the 'All' box that has been checked by default.

### A.3.5 TIME PERIOD

**Time Period** (Figure 7) allows you to select any combination of eight years (1994 through 2001), 12 months (January through December), seven days of a week (Monday through Sunday), and six four-hourly time intervals of a day (12 AM – 4 AM through 8 PM – 12 AM). For example, if you want to view the number of fatal transit bus crashes that occurred between 4PM and 12AM, on Fridays in 1995, do the following:

- Click **Time Period** from the main menu.
- Check '1995' from the **Year** check-box menu.
- Select 'Friday' in the drop-down list.
- Check '4 PM – 8 PM' and '8PM – 12 AM' from the **Time Interval** check boxes making sure that they are checked.
- Click **Severity** from the main menu.
- Click on the 'Fatalities' check box making sure that it is checked.
- Click **Vehicle Type** on the main menu.
- Check 'Transit Bus' in the Vehicle Body Type sub-menu.
- Click the **Update Map** menu from the FUNCTIONS menu items.

The new map generated will display transit bus crashes that resulted in a fatality on Fridays between 4PM – 12 AM in 1995. The Report Frame will show the number and the cost per crash for the above criteria. To perform analysis on all the vehicle types, do not uncheck the 'All' box that has been checked by default. You may add Months for analysis if you wish.

- Click **Month** in the check box then select the desired month.
- Click the **Update Map** menu from the FUNCTIONS menu items

### A.3.6 COLLISION TYPE

This drill-down menu offers you the selection of vehicle movement and direction (Figure 8). You may select movements, such as 'Acceleration', 'Moving Constant Speed', and directions such as, 'Head On', 'Head On Same Direction', etc. To select all head on crashes that occurred when a vehicle was moving at constant speed, do the following.

- Click **Collision Type** from the main menu.
- Select **Movement** and choose 'Constant Speed'
- Select **Direction** choose 'Head On'
- Click the **Update Map** menu from the FUNCTIONS menu items.

### A.3.7 CONTRIBUTING FACTORS

The drop-down lists in this menu category permit you to select one from five types of contributive factors: 'Driver/Pedestrian/Cyclist', 'Pedestrian/Cyclist', 'Environment Effect', 'Vehicle Defect', and 'Road Condition'. Optionally, you may select a value from the **First Harmful Event** drop-down list. To select or add a Contributing Factor to a selection,

- Click **Contributing Factors** on the main menu.
- Select one factor from the first five drop-down lists and choose only one element in that list.
- Click the **Update Map** menu from the FUNCTIONS menu items.

### A.3.8 ENVIRONMENT

The **Environment** drop-down menu allows you to select one of three types of environmental conditions: **Lightning**, **Weather**, and **Road Surface Condition** (Figure 10). For example, if you are interested in the analysis of foggy weather,

- Click **Environment** on the Main Menu.
- Select 'Foggy' from the **Weather** sub-menu drop-down list.
- Click the **Update Map** menu from the FUNCTIONS menu items.

### A.3.9 JUNCTION

The **Junction** Menu permits the selection of **Junction** or **Intersection** related crashes. The **Junction** list allows the selection of six junction types while the **Intersection** list permits the selection of a 'Yes' or 'No' value. You may select from both the **Junction** and the **Intersection** drop-down lists. You may choose a junction type and state whether or not the crash occurred at an intersection. For example:

- Click **Junction** from the main menu.
- Select 'Driveway Access' from the **Junction** drop-down list in the sub-menu.
- Select 'Yes' from the **Intersection** drop-down list.
- Click the **Update Map** menu from the FUNCTIONS menu items.

### A.3.10 RENDERERS

Renderers allow you to specify the display of crash locations based on the values of an attribute. Renderers are conceptually similar to legends since they add visibility and clarity to the identification and differentiation of crash locations. You

can view the crash locations for nine rendering attributes: Body Type, Time of Crash, Surface Condition, Driver Condition, Day of the Week, Lightning, First Harmful Event, Road Division, and Weather. For example, if you wish to display the crashes in terms of crash severity, do the following.

- Click **Renderers** from the main menu.
- Select 'Crash Severity' from the Sub-menu.
- Click the **Update Map** menu from the FUNCTIONS menu items

The map will be rendered in terms of crash severity; different types of crash severities will be displayed in different colors.

### **A.3.11 UPDATE MAP**

The **Update Map** menu item enables the selection of any selected criteria to take effect. This button is similar to the 'go', or 'submit' button with a submit function. Except for **Area** category, the Update Map menu item must be activated each time you complete a selection criteria. For example, to select all crashes on U.S. Route number 1,

- Click **Route** from the main menu.
- Choose '1' in the drill-down menu **US Routes**.
- Click **Update Map** to apply your selection.

A new map will be generated. The 'Retrieving Map' message precedes each map generation to let the user know that the system is responding to the request. The Report Frame will display the statistics associated with the selected criteria.

### A.3.12 RESET

This button simply resets to the default interface. The **Reset** link will erase all the prior selections made by you. This feature is useful to start a new analysis. To start a new analysis,

- Click **Reset** from the main menu. The system will interrupt any other tasks to set you back to the default interface.

### A.3.13 HELP

The system features three types of help aids: navigation help, user manual (this manual), and sub-menu/report frame help.. The navigation help appears on the Report Frame when MSAC loads for the first time and provides a first time user with necessary guidelines to use the system. The sub-menu/report frame help links are similar to the user guide; these aid you in understanding the navigation issues with the specific sub-menu/report. These are hyperlinked to the appropriate definitions when available. When clicked, these hyperlinks will take you to the Definition Lists (Appendix A). Definition Lists are alphabetic arrangement of terminology used in the MSAC documentation. As an example, to obtain help on using Route Type, do the following.

- Select Route from the main menu and click on **Help** located on the right on the Route Selection sub-menu frame. You will be directed to a new window that explains how you can use this sub-menu.
- If you click the hyperlink 'Lane of Accident', you will be directed to the Definition List that will define the 'Lane of Accident' as used in MSAC.

#### A.4.0 MAP FRAME

The map frame is a dynamic environment consisting of a map, a tool bar and a legend that are functionally related.

#### A.4.1 MAP

The map in the MSAC represents regions, routes, and crashes in the state of Maryland. By default, only the major U.S. Highways, Interstates routes, Municipalities, County borders, and Water are shown on the map. By default, identifying names do not appear on the map. Crashes are shown in red only when the user selects and updates a search criterion. Route names appear only when the user zooms in close enough in the map.

#### A.4.2 TOOL BAR

The **tool bar** offers you directional manipulation, zooming manipulation, identifying map locations, printing capabilities, and overview map display. The following tools appear in the **tool bar** from left to right (see below): Toggle Overview Map, Zoom In, Zoom Out, Zoom to Full Extent, Back to Last Extent, Pan, North Pan, South Pan, West Pan, East Pan, Identifier, Clear Selection and Printer.



To manipulate a map object using the tool bar,

- Click on the appropriate Tool on the **tool bar** menu. A red colored border surrounds the tool signifying that the tool is active.
- For Zoom In, Zoom Out, Pan, and Identify tool, position the cursor on to the map. The cursor will change into a cross. Click on the Map for the effect to take place. For all other tools, clicking on the tool will achieve the effect.

The **toggle map overview**  located on the top left of the map frame, toggles the overview map on and off at each click of that tool. The overview map appears in the small rectangle located in the top left corner of the map area.

Use **Zoom In** tool  to zoom in to view more details on the map. When the **Zoom in** tool is active, each click on the map will zoom in to a greater depth. You may zoom in to any depth level by repeatedly clicking on the map. This tool also allows you to zoom to any specific zoom level by using the mouse, as described below.

- Click on the **Zoom In** tool. A red colored border surrounds the tool signifying that the tool is active.
- Position the cursor on any area of the map that you would like to zoom in.
- Press the left mouse button.
- Drag the mouse over to a new location while the left mouse button is pressed. A red colored rectangle defines the zoom in area.
- Release the left mouse button.

Use the **Zoom Out** tool  to zoom out to get a birds-eye view of the map area. When the **Zoom Out** tool is active, each click on the map will zoom out to a lesser depth. You may zoom out to any depth level by repeatedly clicking on the map. This tool also allows you to zoom out to any specific zoom depth level by using the mouse, as described below.

- Click on the **Zoom Out** tool. A red colored border surrounds the tool signifying that the tool is active.
- Position the cursor on any area of the map that you would like to zoom out.
- Press the left mouse button.
- Drag the mouse over to a new location while the left mouse button is pressed; red colored rectangle defines the zoom out area.
- Release the left mouse button.

Click  (**Zoom to full extent**) tool to zoom to the full extent of the map i.e., the entire state of Maryland will be visible by using this tool.

Click  (**Revert to the last extent**) tool to zoom to the extent that appeared on the previous map.

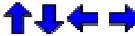
Use the  (**Identify**) tool to view details on crashes that have taken place in a specific map location. The use of this tool is described below.

- Click on the **Identify** tool. A red colored border surrounds the tool signifying that the tool is active.
- Click on a location on the map where the crashes are visible.

The **Report Frame** will now contain the **Identified Crashes** report and a large red circle will appear on the clicked area on the map. If you clicked on a map location where no crashes took place, the message “No features from Accidents were selected” will appear in the **Report Frame**.

The  (**pan**) tool is used to move the map around in the map frame. In addition to moving North, South, East, and West, this tool allows you to move in any direction without changing the zoom level.

- Click on the  (**pan**) tool on the **tool bar** menu. A red colored border surrounds the tool signifying that the tool is active.
- Position the cursor on any area of the map that you would like to move around. The cursor will change into a cross.
- Press the left mouse button
- While the left mouse button is pressed, drag the mouse over to a new location.
- Release the left mouse button.

Click the **Pan**  tools to move the map North, South, East, or West on the map frame. This tool does not change the zoom level.

The  (**Clear selection**) tool clears the selection made to the map when the user has either used the identify tool or the rendering features. The Identify or the rendering features changes the manner in which the crashes are displayed. For instance, the **clear selection** tool clears the large red circle by applying the  (**identify**) tool.

Use the  (**printer**) tool to print only the map.

- Click on the  (**printer**) tool. A red colored border surrounds the tool signifying that the tool is active.
- A **Print Map** window pops up. Type an appropriate title to be displayed on the map in the Print Form window.
- Click on **Create Print Page** button to open a new map window that contains the map, overview map, and the legend. You can print this by using the Print menu of your browser.

### A.4.3 LEGENDS

A legend is a symbolic representation of an object to add clarity to a map. The legend identifies the patterns and colors assigned to a category on the map. Legends identify crashes, highway types, water, municipalities, etc. Used in conjunction with **Renderers**, the legend will identify crashes by each value of that renderer. For instance, when you select a renderer such as Weather, the crashes are shown on the map in a pre-selected color scheme based on the value of weather.

### A.5.0 REPORT FRAME

This section of the screen will generate the following four different types of report based on your search: Summary Report, Factor Analysis Report, Identified Crash Report and Crash Information Report.

## A.5.1 SUMMARY REPORT

A summary report is a basic report that presents crash data in a summarized tabular format. This report compares the occurrences and dollar costs of a crash for a specified criteria with data of similar crashes for all Maryland routes of similar type as specified in the criteria and with all Maryland routes regardless of route types for the same criteria (Figure 5). The table consists of four columns and two rows of data. The column labeled 'Factors' consists of a drop-down list that permits the selection of contributing factors. Pressing the 'Analyze' button below the drop-down menu will activate a selection from the factor drop-down list and produce a Factor Analysis Report. Data for a specific crash criteria, comparative data for similar route types in Maryland, and the data for similar criteria for all Maryland routes are featured respectively in columns labeled 'Your Criteria...', 'All Maryland.. Route Type', and 'All Maryland...Criteria...'. The number of crashes and the cost per crash for the selected criteria are respectively displayed in the 'Total...' and the 'Cost Per Crash' columns. To view a summary report, as an example, for I-695 in Baltimore County,

- Click **Area** from the main menu and select 'Baltimore' in the **County** drop-down list.
- Click **Route Types** from the main menu and select '695' from the **Interstate Route** drop-down list.
- Click Update Map

A summary report that will be generated will display crash data on I-695. The column 'Your Criteria' will display the figures for I-695 in Baltimore County. The column, 'All Maryland with Criteria (Routes of Type IS Routes)' column will display the corresponding figures for all Interstate routes in Maryland. The last column 'All Maryland With Criteria (All Routes)' will display all crashes in Maryland, regardless of route type.

## A.5.2 FACTOR ANALYSIS REPORT

A **Factor** Analysis Report is a detailed report that displays crash cost data (Figure 14). Accessed from the Summary Report (Figure 3) by clicking on the **Analyze** button, this report appears in a separate window. The report is a tabular format consisting of four main columns that parallel specific crash data with data of similar crashes in Maryland.

The column labeled 'Factors' features one of 10 selectable contributing factors: Day of the Week, Driver/Pedestrians Condition, Fixed Object Involvement, Intersection, Junction, Lighting, Month of Crash, Time of Crash, Weather, and Year of Crash. The column labeled 'Selection Criteria', from left to right, features the percentage and dollar cost for each sub-category of the selected criteria. For the criterion 'Day of The Week', for example, the report will feature data for each day of the week from Monday through Sunday. The column 'Maryland Route of Type: ...' compares data for the all routes for the selected route type with data from the previous 'Selection Criteria' column. Finally, in the 'Cost Differential' column, the cost differential between the average cost for the selected criteria

and the selected criteria for same route types is displayed. The table will feature as many rows as possible to accommodate the sub-categories of each selected factor. An example of generating a Factor Analysis report is given below.

- Click **Areas**, and select 'Baltimore' in the **County** drop-down list.
- Click **Route Types** from the main menu and select **695** from the **Interstate Route** drop-down list.
- Add as many criteria as you desired and click **Update Map** on the main menu. Go to the summary report in the Report Frame.
- In the **Factor Analysis** column of the Summary Report, click the **Analyze** button.

A report with the heading 'Factor Analysis (Cost Per Crash)' will be generated along with a day stamp located below the title. Pressing the **Print** button located in the upper right corner allows the user to print the report.

### **A.5.3 IDENTIFIED CRASH REPORT**

The **Identified Crash** report is a detailed report that displays crash data in seven dimensions (Figure 12). Below the title 'Identified Crash' in the report, the name of the selected Area (one of either County, Municipality, or District) is displayed. From left to right, the columns displayed are the route, date, time, lighting condition, collision type, vehicle body type, and events contributing to the crash. The number of displayed rows of data varies based on the number of crashes for the selected criteria. Moreover, for crashes that involve more than one vehicle, multiple lines will be displayed. Each line for a specific crash lists the vehicle type and the event contributing to the crash for that vehicle. Crashes that

resulted in at least an injury are displayed in red color fonts. Before viewing an Identified Crash Report, make sure the map elements are visible for you to point-and-click at a specific location on the map. You may adjust the visibility by using the navigation functions on the tool bar, such as the magnifier. To generate an Identified Crash Report for a location in Baltimore County do the following:

- Click **Area** from the main menu.
- Select 'Baltimore' from the **County** drop-down menu.
- Now click the **Identifier**  button on the tool bar in the Map Frame, and then click on a point on the map where you see crashes.

The crash data for the selected location will be displayed in the Identified Crash Report. If you desire to obtain more information, click the blue 'More' hyperlink on the far right of the report.

#### **A.5.4 CRASH INFORMATION REPORT**

The **Crash Information** report is a detailed report that contains comprehensive crash data (Figure 13). Presented in a text and tabular format, this report features many attributes of a crash. Located in the upper side of the report, the text portion displays crash information, such as the time, date, location (route and area), the first and second harmful events (if applicable), vehicle body type, and conditions such as weather, lighting and road surface.

The second portion of the report is a table that lists the number of pedestrians and drivers/occupants killed or injured. Apart from the title line, this table consists of two main parts. From left to right, the first two columns contain data on the number of pedestrians killed or injured while the last two columns lists the

number of drivers/occupants killed or injured. To view a Crash Information Report for Baltimore County, do the following:

- First, click the **Area** button on the main menu.
- Select 'Baltimore' from the **County** drop-down list. A map of Baltimore County will be generated.
- Click the **identifier**  button located on the tool bar in the map frame and then point to a crash location on the map. Click on the crash location. The Identified Crash Report will be generated in the Report Frame.
- Click the 'More' hyperlink to view the Crash Information Report.



**DEFINITION HELP  
SCREEN**

**-ACCIDENT**

**Accident** refers to a Motor Vehicle Accident. A motor vehicle accident is one in which a motorized device used for transit is involved in an unintentional loss or property damage. This technical definition insists on the following four elements: a motor vehicle, traffic, trafficway and an accident.

**Motor Vehicle** is a motorized device used for transport. To qualify, the vehicle must be in motion, ready for motion or improperly parked where traffic is intended to move. **Traffic** is associated with the road location where motor vehicles are intended to travel. **Trafficway** is any land way open to the public for moving persons or property from one place to another. **Accident** is an unintentional event that results in loss or property damage.

**-ACCIDENT DATE**

**The Accident Date** identifies the date, year, month and day of the week in which the accident occurred. If the day is unknown, the accident is attributed to the first of the month.

**-ACCIDENT TIME**

**Accident Time** specifies the time of the accident. Accident time is difficult to determine and is often estimated incorrectly. However, six time groups can be selected: the default selection for time is All. Below are the possible time categories.

ACCIDENT TIMES	
12:00 AM - 4:00AM	12:00 AM - 4:00 PM
4:00 AM - 8:00 AM	4:00 PM - 8:00 PM
8:00 AM - 12:00 PM	8:00 PM - 12:00 PM

**-ACCIDENT AREA (LOCATION)**

**Accident Location** specifies the geographic location where the accident occurred. These locations are classified on an administrative basis according to their importance, such as in the following example.

**County:** Frederick County

**District:** Salisbury

**Municipality:** Ocean City

## -BODY TYPE

The **Body Type** includes the type of vehicle involved in the accident, such as a school bus, a two-axle truck, or a motorcycle. The table presents the possible vehicle body types.

BODYTYPES	
Not Applicable	School Bus
Motorcycle	Ambulance/Emergency
Automobile	Ambulance/Non-Emergency
Station Wagon	Fire Vehicle/Emergency
Limousine	Fire Vehicle/Non-Emergency
Single Truck 2 Axles	Police Vehicle/Emergency
Single Truck 3 Axles	Police Vehicle/Non-Emergency
Truck Tractor	Moped
Recreational Vehicle	Pick-up Truck
Farm Vehicle	Van
Transit Bus	Other
Cross Country Bus	Unknown

## -COLLISION TYPE

**Collision Type (Direction)** describes vehicle movement directions. The movement direction of a vehicle is usually, but necessarily, the same as its orientation direction. For instance, a *Head On* collision type (><) would be the correct definition for one vehicle going forward and striking another vehicle backing. Following are the possible collision types.

COLLISION TYPES	
Not Applicable	Straight Movement Angle
Same Dir Both Left Turn	Angle Meets Right Turn
Head On	Angle Meets Left Turn
Head On Left Turn	Angle Meets Left Head On
Same Dir Rear End	Opposite Dir Both Left
Same Dir R-End Right Turn	Single Vehicles
Same Dir R-End Left Turn	Other
Opposite Dir Sideswipe	
Same Dir Sideswipe	
Same Dir Right Turn	

## **-COMMERCIAL VEHICLES**

**Commercial Vehicles** are classified on the basis of their number of "Total Axles" and total weight rating.

**Total Axles** include axles from the power unit plus any trailer axles.

**Gross Weight:** is the total of all units of the vehicle including any trailers or semi-trailers as mentioned on the manufacturer's specification plate mounted on the vehicle.

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## **-CONTRIBUTING CIRCUMSTANCES**

These are circumstances that contribute to the accident. The code options for **Contributing Circumstances** divided into four categories:

**Driver, Pedestian, or Cyclist Condition or Actions** are human conditions such blurred vision due to substance abuse or action such as crossing a road that favor the occurrence of the accident.

**Environment Effects** refer to any non-human conditions that make the use of the trafficway less practical and increase the likelihood of an accident.

**Vehicle Defects** include all vehicle conditions that may cause the operation of the vehicle hazardous.

**Road Condition** (*see definition under road condition*)

The following table displays the codes for each category of contributing circumstances

<b>CONTRIBUTING CIRCUMSTANCES</b>	
<b>DRIVER PEDESTR. CYCLIS. COND/ACT.</b>	<b>DRIVER PEDESTR. CYCLIS. COND/ACT.</b>
Under influence of drugs	Failed to stop for school bus
Under the influence of alcohol	Wrong way on one way road
Under the influence of medication	Exceeded speed limit
Under combined influence	Too fast for conditions
Physical/Mental Difficulty	Followed too closely
Fell asleep	Improper turn
Failed to drive full time with total attention	Improper lane change
Did not comply with license restrictions	Improper backing
Failed to yield right of way	Improper passing
Failed to obey stop sign	Improper signal
Failed to obey traffic signal	Improper parking
Failed to obey other traffic control devices	Interference/Obstruction by passenger
Failed to keep right of center	
<b>PEDESTRIAN, CYCLIST ACTION ONLY</b>	<b>VEHICLE DEFECT</b>
Illegally in roadway	Brakes
Bicycle violation	Tires
Clothing not visible	Steering
	Lights
	Windows/Windshield
	Wheel(s)
	Trailer coupling
	Cargo
<b>ENVIRONMENT EFFECT</b>	<b>ROAD CONDITION</b>
Smog, smoke	Wet
Sleet, hail, freezing rain	Icy or snow-covered
Blowing sand, soil, dirt	Debris or Obstruction
Severe crosswinds	Ruts, holes, bumps
Rain, snow	Road under constr./mainten.
Animal	Traffic control device inoperative
Vision obstru.(incl. Blinded by sun lights)	Shoulders low, soft, high

**-CONSTRUCTION or MAINTENANCE ZONE**

'Yes' or 'No' marks the presence or absence of Construction or Maintenance Zone. These are zones that are at the site of the accident.

**-FIRST HARMFUL EVENT**

**First Harmful Event** is generally known as the most significant, the most harmful event on which the classification of the accident is based. These harmful events are summarized in the table below.

<b>FIRST HARMFUL EVENT</b>	
<b>COLLISION WITH DESCRIPTION</b>	
Other Motor Vehicle in transport	Another motor vehicle in transport
Parked Motor Vehicle	Another motor vehicle not in transport
Pedestrian	Person on foot or on a not-motorized conveyance that is not a pedal cycle.
Bicycle	A two-wheel pedal cycle driven by human power.
Other Pedal Cycle	Pedal cars, unicycles, and tricycles
Other Conveyance	Person on a non-motorized conveyance that is not a pedal cycle
Railway Train	Self-explanatory
Animal	Domestic or wild animal
Fixed Object	An object such as an electrical pole struck by the first harmful event.
Other Object	All objects that are not under the collision classification
<b>NON COLLISION</b>	
Overturn	Vehicle overturn
Spilled Cargo	Injury or damage resulting from a cargo spill
Other non-collision	All other Harmful Event including gas inhalation, explosion, and fire

---

**-FIXED OBJECT**

A **Fixed Object** is classified as a non-moving object that is struck when a harmful event occurs. The table presents a list of possible fixed object categories.

FIXED OBJECTS	
Not applicable	Light Support
Bridge-Overpass	Sign support Pole
Building	Other Pole
Culvert-Ditch	Tree-Shrubbery
Curb	Construction Barrier
Guardrail-Barrier	Crash Attenuator
Embankment	Other
Fence	Unknown

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**-INJURY SEVERITY**

**Injury Severity(Accident Type)** represents the physical impact on the individuals involved in the accident. Five categories of severity are known that depict the extent of the accident based on observations made at the scene of the accident or reported by EMS providers. The following are the possible categories:

**Not Injured/** implies that no injury was evident, or the person in question departed from the crash site (but was not transported by EMS as an injured person).

**Possible Injury** is any reported or claimed injury that is not a fatal injury, incapacitating injury, or non-incapacitating evident injury.

**Injury, Not Incapacitating** is any injury, other than a fatal injury or an incapacitating injury, which is evident to observers at the scene of the accident in which the injury occurred.

**Disabled (incapacitating)** is any injury, other than a fatal injury, which prevents the injured person from walking, driving, or normally continuing the activities he was capable of performing before the injury occurred.

**Fatality** is any injury that results in death. Fatality is applicable only if the person is officially declared dead at the location of the accident.

## **-JUNCTION**

A **Junction** identifies the location where the First Harmful Event occurred with respect to the roadway. "Intersection Related" is not actually a location type but a judgment about the effect of intersection and their traffic control upon traffic and accident causation. If the accident is deemed to have occurred as a result of backed up traffic from an intersection, the junction relationship is "Intersection Related". The table displays the possible categories of junction related elements.

<b>JUNCTIONS</b>
Not Applicable
Non-Intersection
Intersection
Intersection Related
Driveway Access
Other
Unknown

## **-LANE**

A **Lane** is identified as a section of the road on which the accident occurred. Each road is either Northbound-Southbound with North and South lanes or Eastbound-Westbound with East and West lanes. Using the centerline line as the point of orientation, lanes are identified as (N,E,S,W) 1, (N,E,S,W) 2, referring to the lane direction and number. Special lanes are identified in terms of Right, Left, Turn, Acceleration, and Deceleration. Accident locations outside any lane boundary are noted Shoulder, Off Road, Median, Crossover, and Gore.

The table summarizes the vehicle location coding at the time of the accident:

<b>LANES</b>	
<b>DIRECTION</b>	<b>LANE</b>
North	Lane Number
East	Right Turn
West	Left Turn
South	Acceleration
Parking	Deceleration
	Shoulder
	Crossover
	Off Road
	Gore
	Median
	Parking Lot

## **-LIGHT**

**Light** describes the lighting condition at the time of the accident. This can be natural light, such as sunlight or man-made, such as head lights from a vehicle.

**Daylight:** refers to the natural sunlight; this describes accidents that occur during the day.

**Dawn/Dusk:** describes accidents that occur at dawn – the early hours of the day – or at *dusk*- the late hours of the day. These denote reduced visibility.

**Dark - Light On:** represents accidents that occurred at night under man-made lighting condition, such as streetlights or headlights

**Dark - No Lights:** identifies accidents that occur at night in the total absence of light.

The possible codes for Lighting conditions are:

<b>LIGHTING</b>
Not Applicable
Daylight
Dawn/Dusk
Dark-Lights On
Dark-No Lights
Other
Unknown

**-MOVEMENT**

**Movement** describes the maneuver of the vehicle or the action of the pedestrian immediately prior to the accident; the table outlines Vehicle Movement and Pedestrian Movement.

<b>MOVEMENTS</b>	
<b>VEHICLE MOVEMENT</b>	<b>PEDESTRIAN MOVEMENT</b>
Not Applicable	Cross/Enter at Intersection
Moving Constant Speed	Cross/Enter Not at Intersection
Acceleration	Walking/Riding w/Traffic
Slowing or Stopping	Walk/Ride Against Traffic
Starting from Lane	Playing
Starting from Parked	Standing
Stopped in Traffic Lane	Getting On/Off Vehicle
Changing Lanes	Push/Work On Vehicle
Passing	Other Working
Parking	Hitchhiking
Parked	Approach/Leave School Bus
Backing	Other
Making Left Turn	Unknown
Making Right Turn	
Right Turn on Red	
Making U-Turn	
Skidding	
Driverless Moving Vehicle	

**-NUMBER OF PEDESTRIAN/DRIVER KILLED/INJURED**

**Driver Killed/Injured** is the reported number of vehicle driver or passenger(s) killed or injured in the accident.

**Pedestrians Killed/Injured** includes the number persons, afoot, not passengers of the vehicle, killed or injured in the accident.

---

### -ROAD CONDITION

**Road Condition** describes the character of the road that may have contributed to the accident. The table displays the possible road condition categories.

ROAD CONDITIONS	
Not Applicable	Obstruction Not Lighted
No Defects	Obstruction Not Signaled
Shoulder defect	View Obstructed
Holes/Ruts	Other
Foreign Materials	Unknown
Loose Surface Material	

---

### -ROAD SURFACE CONDITIONS

The Road Condition refers to the effect of climatic elements on the surface of the road the accident occurred on at the time of the accident. The following codes represent the possible characters of the road surface.

ROAD SURFACE CONDITIONS	
Not Applicable	Ice
Wet	Mud
Dry	Other
Snow	Unknown

---

### -ROUTE NUMBER

**Route Number** refers to the route on which the accident occurred. **Route Number** consists of two leading alphabetical characters that indicate the route type, followed by numerals for vehicles traveling on roads of different classes, the highest class road is selected to determine which road will be listed. The lowest route number is used where multiple routes of the same class are marked.

**Examples:** 1) At the intersection of US 40(called "Main Street" locally) with MD 17(Maryland State Route 17), US 40 used. 2) Where multiple routes of the same class are marked (US 40 and US 211), US 40 is used.

**-ROUTE TYPE**

**Route Type** identifies to the road type on which the accident occurred. These roads are classified according to their importance into several categories

ROUTE TYPES			
ROUTE TYPE		ROUTE NUMBER	COMMON ROAD SUFF.
<b>IS</b>	Interstate	NNNNN	<b>AL</b> Alternate
<b>US</b>	United States	Use 1 to 5 Numerals	<b>BU</b> Business
<b>MD</b>	Maryland State		<b>SC</b> Scenic
<b>CO</b>	County		<b>TL</b> Toll
<b>MU</b>	Municipal		<b>UL</b> Ultimate
<b>GV</b>	Government		
<b>SR</b>	Service Road		*Other suffixes may apply and may not consist of only one character
<b>OP</b>	Other Public Road		
<b>UU</b>	Unknown		

**-WEATHER**

**Weather** represents the condition that may have contributed to the accident. Following are the possible categories.

WEATHER	
Not applicable	Snow/Sleet
Clear/Cloudy	Severe Winds
Foggy	Other
Raining	Unknown

Figure 1. Opening Screen of MSAC

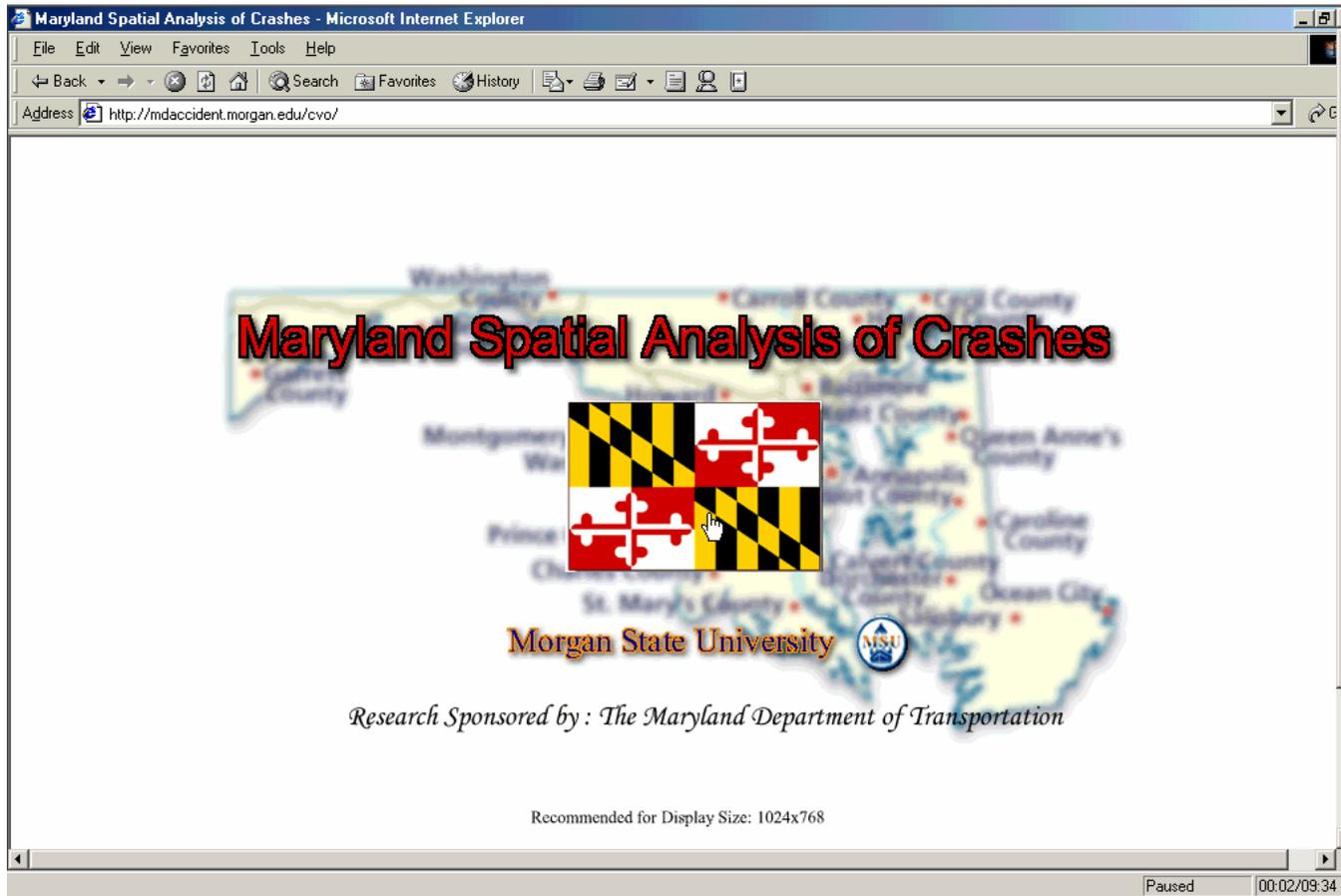


Figure 2. User Interface for MSAC

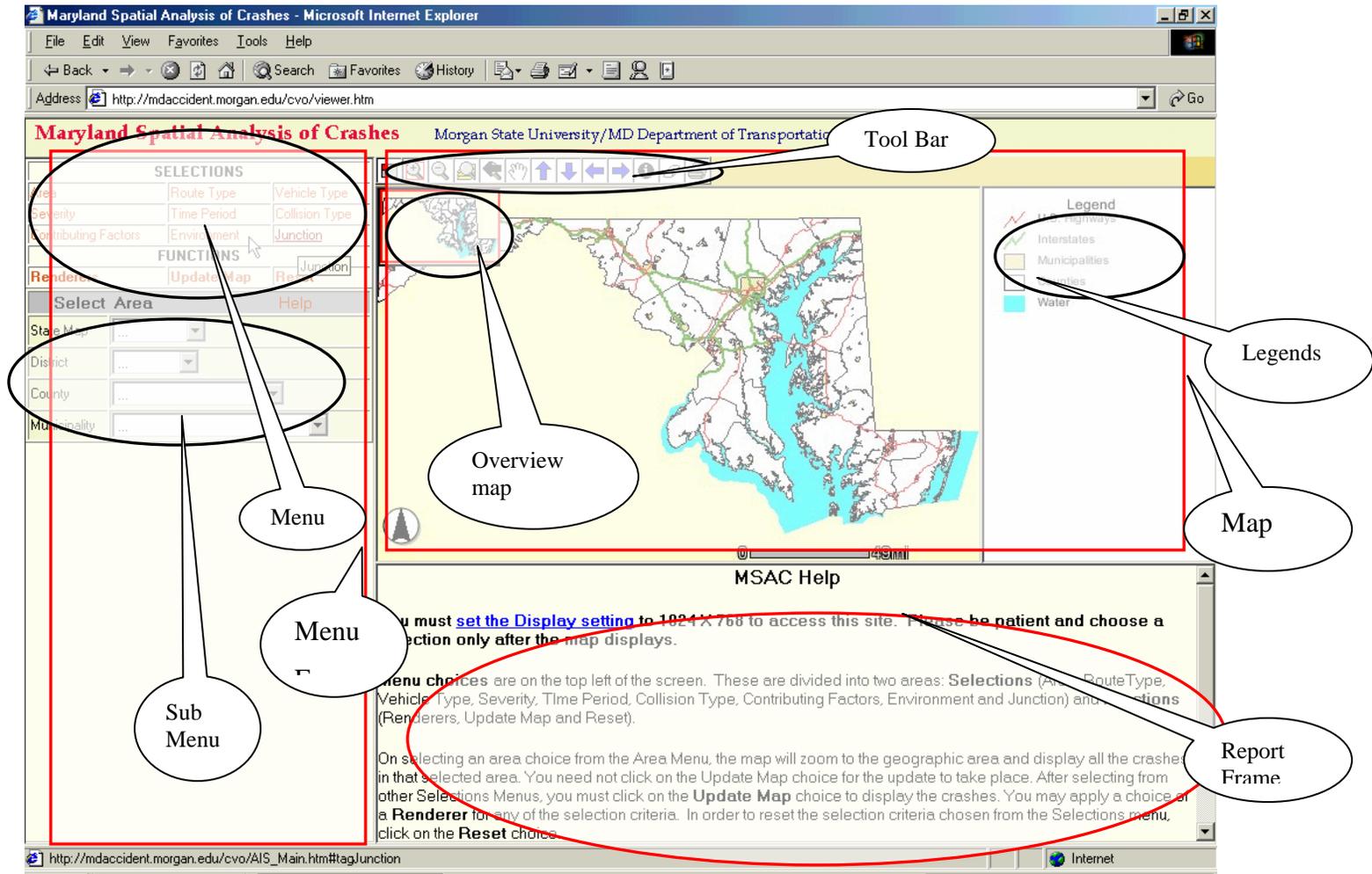


Figure 3. Area Submenu

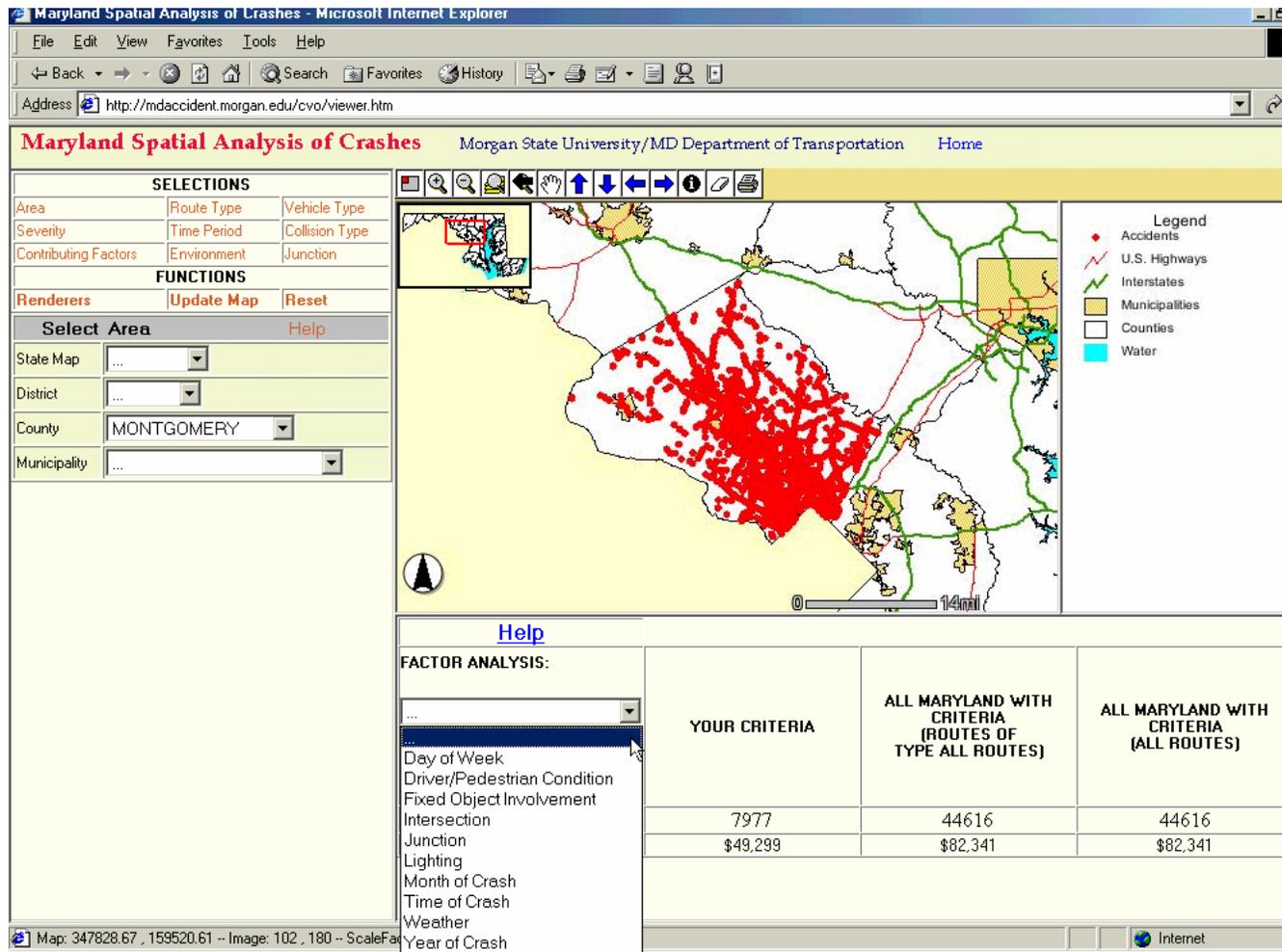


Figure 4. Route Submenu

**Maryland Spatial Analysis of Crashes** Morgan State University/MD Department of Transportation Home

**SELECTIONS**

Area	Route Type	Vehicle Type
Severity	Time Period	Collision Type
Contributing Factors	Environment	Junction

**FUNCTIONS**

Renderers Update Map Reset

**Route Selection Help**

All Routes: [Dropdown]

Maryland Route: [Dropdown]

U.S. Route: [Dropdown]

Interstate Route: [Dropdown]

County Route: [Dropdown]

or Pick your own Route: [Dropdown]

Lane of Accident: [Dropdown]

**Legend**

- U.S. Highways
- Interstates
- Municipalities
- Counties
- Water

**MSAC Help**

You must [set the Display setting](#) to 1024 X 768 to access this site. Please be patient and choose a selection only after the map displays.

**Menu choices** are on the top left of the screen. These are divided into two areas: **Selections** (Area, RouteType, Vehicle Type, Severity, Time Period, Collision Type, Contributing Factors, Environment and Junction) and **Functions** (Renderers, Update Map and Reset).

On selecting an area choice from the Area Menu, the map will zoom to the geographic area and display all the crashes in that selected area. You need not click on the Update Map choice for the update to take place. After selecting from other Selections Menus, you must click on the **Update Map** choice to display the crashes. You may apply a choice of a **Renderer** for any of the selection criteria. In order to reset the selection criteria chosen from the Selections menu, click on the **Reset** choice.

Figure 5. Vehicle Body Type Submenu

**SELECTIONS**

Area Route Type Vehicle Type  
 Severity Time Period Collision Type  
 Contributing Factors Environment Junction

**FUNCTIONS**

Renderers Update Map Reset

**Vehicle Body Type** Help

All

Single Truck 2 Axles  Single Truck 3 Axles

Truck Tractor  Transit Bus

Cross Country Bus  School Bus

**Legend**

- Accidents
- U.S. Highways
- Interstates
- Municipalities
- Counties
- Water

**Factor Analysis Table:**

FACTOR ANALYSIS:	YOUR CRITERIA	ALL MARYLAND WITH CRITERIA (ROUTES OF TYPE 'IS')	ALL MARYLAND WITH CRITERIA (ALL ROUTES)
Total Number of Crashes	4901	10454	44616
Cost Per Crash	\$90,411	\$92,196	\$82,341

Figure 6. Accident Severity Submenu

**Maryland Spatial Analysis of Crashes** Morgan State University/MD Department of Transportation Home

**SELECTIONS**

Area Route Type Vehicle Type  
 Severity Time Period Collision Type  
 Contributing Factors Environment Junction

**FUNCTIONS**

Renderers Update Map Reset

**Accident Severity Type** Help

All

Fatalities  Disabilities

Injuries  Possible Injuries

Not Injured  Unknown

**Legend**

- Accidents
- U.S. Highways
- Interstates
- Municipalities
- Counties
- Water

**FACTOR ANALYSIS:**

	YOUR CRITERIA	ALL MARYLAND WITH CRITERIA (ROUTES OF TYPE 'IS')	ALL MARYLAND WITH CRITERIA (ALL ROUTES)
Total Number of Crashes	4901	10454	44616
Cost Per Crash	\$90,411	\$92,196	\$82,341

Figure 7. Accident Time Period Submenu

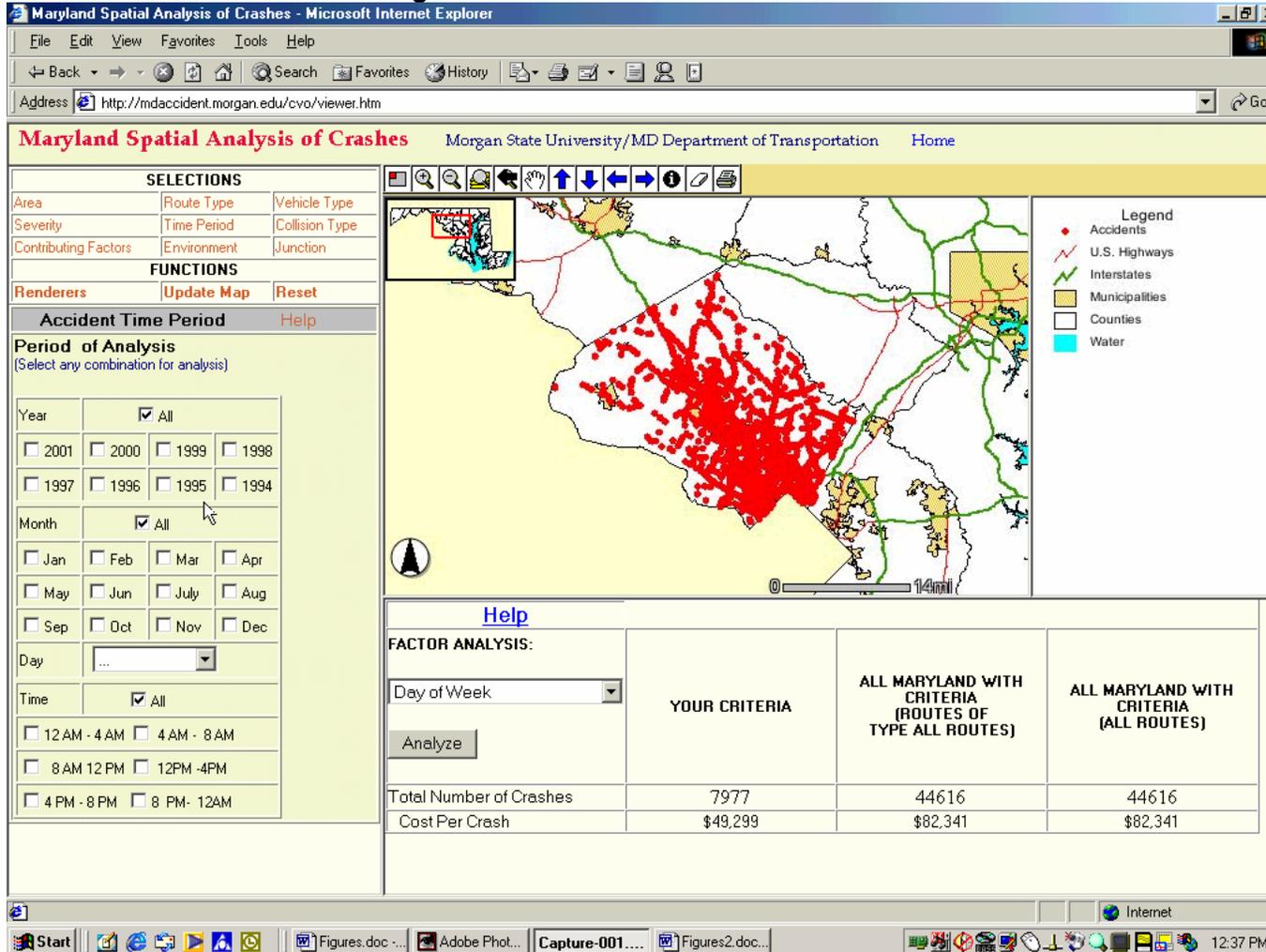


Figure 8. Collision Type Submenu

Maryland Spatial Analysis of Crashes - Microsoft Internet Explorer

Address: http://mdaccident.morgan.edu/cvo/viewer.htm

Maryland Spatial Analysis of Crashes Morgan State University/MD Department of Transportation Home

**SELECTIONS**

Area Route Type Vehicle Type

Severity Time Period Collision Type

Contributing Factors Environment Junction

**FUNCTIONS**

Renderers Update Map Reset

**Collision Type** Help

Movement: ...

Direction: ...

- Head On
- Head On Left Turn
- Same Dir Rear End
- Same Dir Rend Right Turn
- Same Dir Rend Left Turn
- Opposite Dir Sideswipe
- Same Direction Sideswipe
- Same Direction Right Turn
- Same Direction Left Turn
- Same Dir Both Left Turn
- Straight Movement Angle

**Legend**

- Accidents
- U.S. Highways
- Interstates
- Municipalities
- Counties
- Water

[Help](#)

**FACTOR ANALYSIS:**

... **YOUR CRITERIA** **ALL MARYLAND WITH CRITERIA (ROUTES OF TYPE 'IS')** **ALL MARYLAND WITH CRITERIA (ALL ROUTES)**

Analyze

Total Number of Crashes	4901	10454	44616
Cost Per Crash	\$90,411	\$92,196	\$82,341

Map: 190590.16 , 124589.62 -- Image: 7 , 161 -- ScaleFactor: 770.1272277559962

Internet

Figure 9. Contributive Factors Submenu

Maryland Spatial Analysis of Crashes - Microsoft Internet Explorer

Address: http://mdaccident.morgan.edu/cvo/viewer.htm

Maryland Spatial Analysis of Crashes Morgan State University/MD Department of Transportation Home

**SELECTIONS**

Area Route Type Vehicle Type  
 Severity Time Period Collision Type  
 Contributing Factors Environment Junction

**FUNCTIONS**

Renderers Update Map Reset  
 Contributive Factors Help

Select one from below

Driver/Pedestrian/Cyclist  
 Pedestrian/Cyclist  
 Environment Effect  
 Vehicle Defect  
 Road Condition

Optionally Select from below

First Harmful Event

**Legend**

- ◆ Accidents
- U.S. Highways
- Interstates
- Municipalities
- Counties
- Water

[Help](#)

FACTOR ANALYSIS:	YOUR CRITERIA	ALL MARYLAND WITH CRITERIA (ROUTES OF TYPE 'S')	ALL MARYLAND WITH CRITERIA (ALL ROUTES)
<p>...</p> <p>Analyze</p>			
Total Number of Crashes	4901	10454	44616
Cost Per Crash	\$90,411	\$92,196	\$82,341

Map: 190590.16 , 124589.62 -- Image: 7 , 161 -- ScaleFactor: 770.1272277559962

Start Maryland Spatial Anal... 11:54 AM

Figure 10. Environment Submenu

**Maryland Spatial Analysis of Crashes** Morgan State University/MD Department of Transportation Home

**SELECTIONS**

Area	Route Type	Vehicle Type
Severity	Time Period	Collision Type
Contributing Factors	<b>Environment</b>	Junction

**FUNCTIONS**

Renderers Update Map Reset

**Environment Conditions** Help

Lighting: ...

Weather: ...

Surface Condition: ...

**Legend**

- Accidents
- U.S. Highways
- Interstates
- Municipalities
- Counties
- Water

**FACTOR ANALYSIS:**

	YOUR CRITERIA	ALL MARYLAND WITH CRITERIA (ROUTES OF TYPE 'S')	ALL MARYLAND WITH CRITERIA (ALL ROUTES)
Total Number of Crashes	4901	10454	44616
Cost Per Crash	\$90,411	\$92,196	\$82,341

Figure 11. Renderer Selection

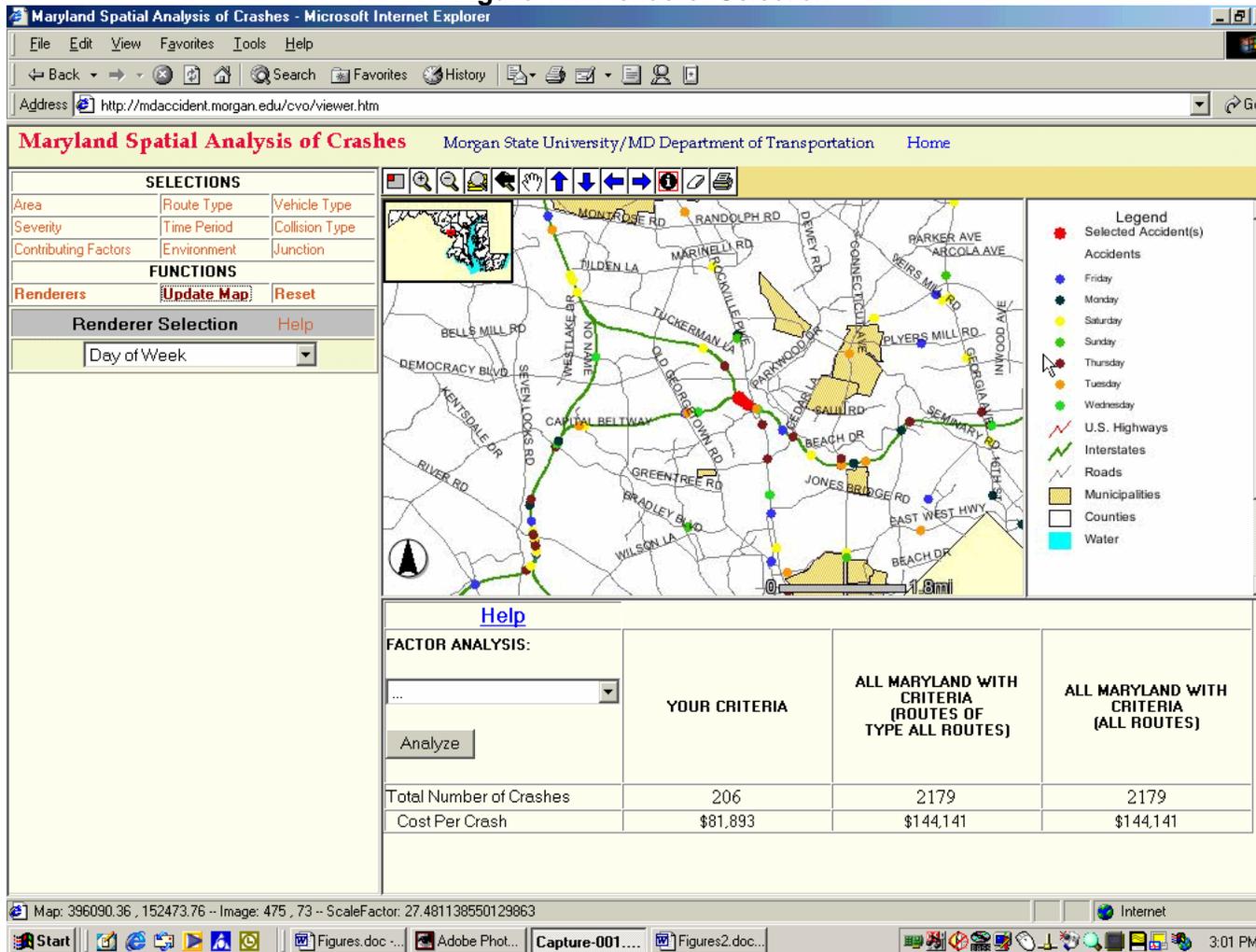


Figure 12. Identified Crash Report

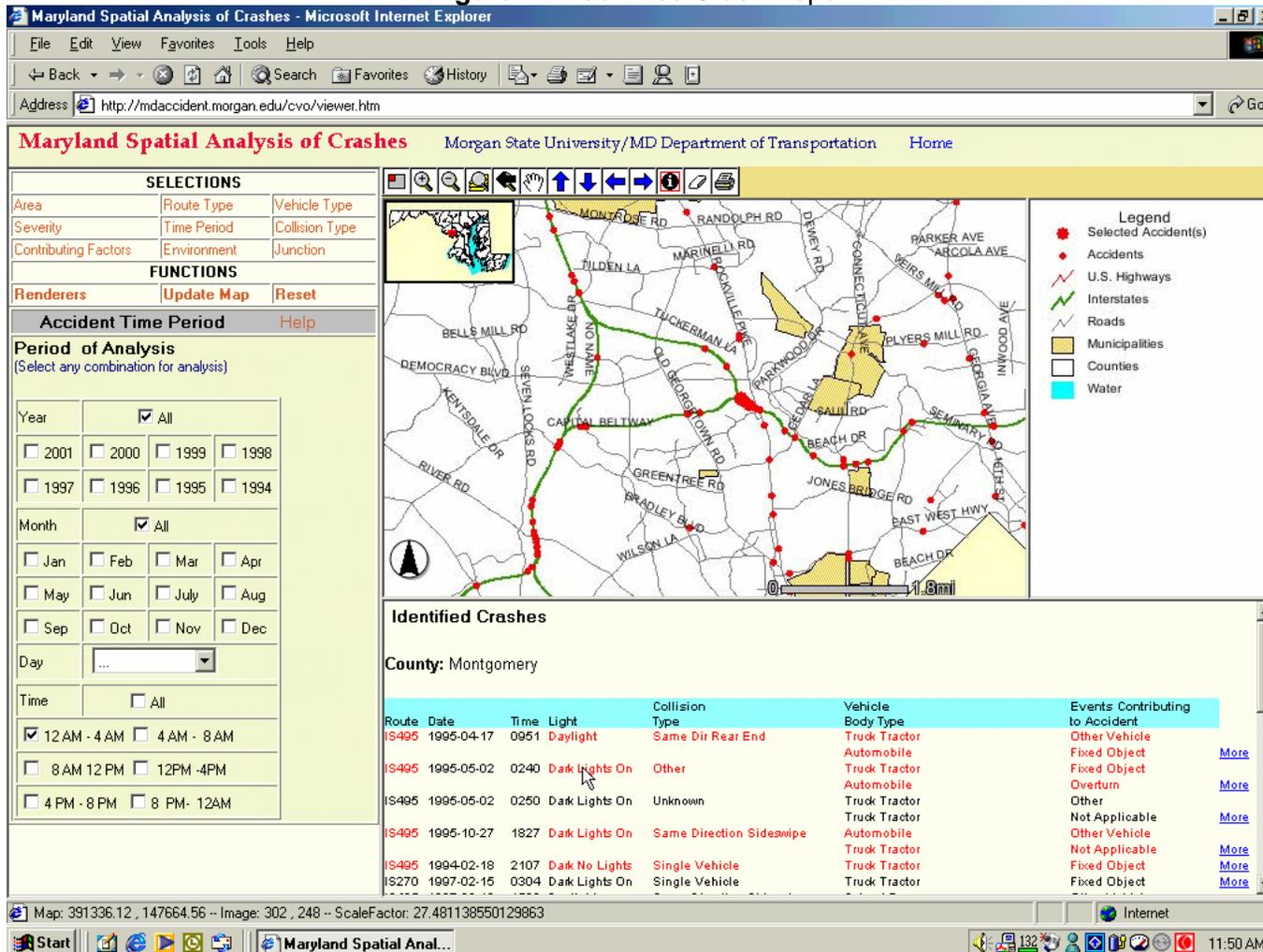


Figure 13. Crash Information Report

**Crash Information**

Date Generated 11/8/2001

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**County:** Montgomery  
**Route:** IS-495 Lane: West lane 3

**Date:** 1995-04-17      **Time:** 0951      **Day of Week:** mon

**Vehicle Body Type:** Truck Tractor      **Type of Vehicle Movement:** Skidding  
**Vehicle Body Type:** Automobile      **Type of Vehicle Movement:** Moving Constant Speed

**Collision Type:** Same Dir Rear End

**First Harmful Event Contributing to the Accident:** Other Vehicle  
**Second Harmful Event Contributing to the Accident:** Fixed Object

**Fixed Object Involvement in Accident:** Guardrail or Barrier

**First Contributing Circumstance:** DRIVER PEDESTRIAN CYCLIST, Too fast for conditions  
**Second Contributing Circumstance:** DRIVER PEDESTRIAN CYCLIST, Failed to give full time and attention

**Weather:** Foggy      **Light:** Daylight      **Road Surface Condition:** Wet

Number of Fatalities/Injuries			
Pedestrian		Drivers/Occupants	
Injured	Killed	Injured	Killed
0	0	2	0

Figure 14. Factor Analysis Report

