

# **Quarterly Progress Report**

To the

National Cooperative Highway Research Program  
(NCHRP)

**On Project 22-27**

## **ROADSIDE SAFETY ANALYSIS PROGRAM (RSAP) UPDATE**

Limited Use Document

This Quarterly Progress Report is furnished only for review by members of the NCHRP project panel and is regarded as fully privileged. Dissemination of information included herein must be approved by NCHRP

For period

October 1 through December 31, 2011

From

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## ***Introduction***

As stated in the original project solicitation and the research proposal, the objectives of this project are to rewrite the software, update the manuals, improve the user interface, and update the embedded default data tables of the Roadside Safety Analysis Program (RSAP).

This report will describe the progress achieved in this project in the previous quarter with respect to the eight tasks identified in the work plan. The following sections will describe the task-by-task progress identifying work items accomplished and any problems encountered in the research. A section describing the contractual status of the project (i.e., funding, schedule, etc.) appears at the end of the report and the progress summary tables and plots appear in [Attachment A](#).

Comments received regarding the last Quarterly Progress Report are addressed in [Attachment B](#). This quarterly report and attachments can be found on the World Wide Web at <http://rsap.roadsafellc.com/QPR>.

## ***Task 1: Literature Review***

### ***Statement of Work***

*Conduct a literature review for updating the algorithms, procedures, and built-in data of RSAP, including the severity indices and encroachment rates.*

This task is complete.

## ***Task 2. Survey of Practice***

### ***Statement of Work***

*Conduct a survey of users in the United States and Canada, with follow-up interviews as necessary, to identify and catalog problems and perceived shortcomings of RSAP. The survey shall include, as a minimum, user inputs regarding default data values, ease of use, and output formats.*

This task is complete.

## ***Task 3. Revised Work Plan***

### ***Statement of Work***

*Develop a revised work plan for updating RSAP, based on the findings of Tasks 1 and 2 and the research agency's experience that will accomplish the subtasks outlined below.*

This task is complete.

#### **Task 4. Interim Report**

Statement of Work

Submit an interim report that presents the findings of Tasks 1 through 3 with recommendations and estimated costs.

*Note: The recommendations of the interim report need not be limited to the available funds. Costs for major tasks associated with updating the software and revising the severity indices shall be broken out separately.*

This task is complete. The final version of the interim report is posted on the project website at <http://rsap.roadsafellc.com/QPR/InterimReport.pdf>.

#### **Task 5. Interim Report Review**

Statement of Work

Meet with the NCHRP panel to review the Task 4 interim report approximately 1 month after its submittal. Submit a revised interim report addressing the panel's review comments.

This task is complete.

#### **Task 6. Execute the Plan**

Statement of Work

Execute the revised work plan approved by the NCHRP at the interim meeting.

Consistent with the January 26, 2010 Interim Report, this task consists of 14 subtasks which are listed below with a brief description of the work performed in each task this quarter.

Task 6A1 – Program Architecture

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*Develop a detailed program architecture including flow charts and key software module descriptions.*

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This task is continuing in conjunction with Task 6A4 (Re-write the software) and will be fully documented in the Programmer's Manual.

### Task 6A2 – Develop Data Table Specifications

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*Identify all the data tables that must be created based on the program architecture developed in Task 6A1. Specify what variables will be used by the program to search the data tables and what values the program will read back from the data tables. Expand the number of adjustment factors to represent a wider range of highway geometries (i.e., lane width, shoulder width and type, rumble strips, horizontal curvature, grade, etc.). Represent all data in the form of external text files that can be easily updated without changes to the computational engine. Allow users to substitute user-defined data tables for any of the data tables and adjustment factors used in RSAP.*

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Look-Up Data Table specifications were created and are documented in [Attachment D](#) of the 7<sup>th</sup> QPR. This task is complete.

### Task 6A3 – Pseudo-Code Documentation

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*Prior to writing the actual code, write a complete pseudo-code for the computation portion of the program. This will create documentation for the program that will be included in the programmer's Manual that will make de-bugging and maintaining the code in the future much easier.*

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This task is continuing in conjunction with Task 6A4 (Re-write the software).

### Task 6A4 – Re-Write the Software

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*Re-code RSAP using vb.net and target the application to a Windows user interface. Use vb.net wpf for the user interface and C or C# for the computational engine. Allow for the importation of highway characteristics using the Land XML data exchange language.*

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This task was the major focus of the project in the last quarter. The coding of RSAPv3 was completed this quarter and the alpha version of the software was released for testing on January 21<sup>st</sup> at the TRB Annual Meeting. We expect to make some additional minor coding changes in response to alpha and beta test comments but the coding efforts in this task are complete. Any changes needed to address alpha/beta comments will be taken care of as a part of Task 7. This task is now complete; further coding changes will be handled as part of the Alpha and Beta Testing.

### Task 6A5 – Verification

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*Develop and execute a debugging plan that ensures that the calculations performed by RSAP are correct. The plan should be developed and executed in parallel with the development of the code such that each subroutine and module can be independently validated. The check should include the full range of data input expected as well as erroneous and false input to make sure the program detects incorrect or inconsistent input as well as correctly processes data across the full range of valid input.*

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The project team initiated this task during the coding of the software. Several examples were developed that could be used to verify each step of the calculation process. These verification examples are being assembled and will be included as part of the Engineer's Manual.

Task 6B1 – Convert Existing Data to Conforming Data Tables

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*Convert the data models and default data in the existing RSAP into data tables conforming to the specifications developed in Task 6A2.*

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This subtask is now complete and is documented in [Attachment D](#) of the 7<sup>th</sup> QPR.

Task 6B2 – Encroachment Model Updates

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*Re-model the Cooper encroachment data using more appropriate and modern statistical techniques to develop a more correct and robust encroachment model. Obtain and assess the data bases used in the development of the HSM AFMs and use these data to model encroachments and lateral extents of encroachments. Use the Washington State cable median barrier data to model encroachments and lateral extent of encroachments.*

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This sub-task is now complete.

Task 6B3 – Multi-lane Adjustment Factor

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*Eliminate the lane-by-lane simulation of encroachments and replace it with a multilane adjustment factor that is applied to the base encroachment rate.*

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This sub-task is complete.

Task 6B4 – Updated Severity Indices

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*Develop a method for estimating crash severity based on observable crash data consistent with the probability of injury approach suggested in the RSAP EM. Use the new method to develop new severity models for at least the basic eight types of features in RSAP.*

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This sub-task is complete and the final write-up is being revised and will be included in the next QPR.

Task 6B5 – Penetration of Features

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*Replace the method used for determining if a hazard has been penetrated using the impact severity with a probability of penetration based on observable crash data.*

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This task was completed during the quarter. [Attachment C](#) contains a description of the method used to predict and account for penetrations in RSAPv3.

### Task 6B6 – Driver Input and Curvilinear Paths

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*Modify the Monte Carlo method to include driver braking and steering input. Create the facility to pass the driver inputs, terrain geometry and encroachment conditions to a look up table. The lookup table can then return the curvilinear geometry of the trajectory and indicate whether or not a rollover has occurred.*

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This sub-task is complete.

### Task 6C1 – Benchmark Cases

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*Develop at least five bench mark cases that will be used to validate the program as well as serve as example problems in the Roadside Design Guide.*

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This subtask is complete. In preparation for the Alpha test workshop the research team developed a document with all six benchmark cases and this is included here as [Attachment D](#).

### Task 6C2 – Validation

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*Validate the updated RSAP code using the benchmarks developed in Task 6C1. Validate the benchmark examples using actual crash data and document the results of the validation effort.*

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This subtask is essentially complete. Using the benchmark cases developed in Task 6C1, which contained crash data, the research team has shown the results produced by RSAPv3 agree with crash data. This effort is partially documented in the Benchmark Case (i.e., [Attachment D](#)) but a discussion the discussion of validation will be expanded shortly.

### Task 6C3 – Compare RSAP and HSM

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*Use the benchmark cases developed in Task 6C1 to compare the updated RSAP to the IHSDM CPM (i.e., the computer implementation of the HSM).*

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This subtask is complete. Several of the benchmark cases developed in Task 6C1 were used to compare RSAPv3 to all of the published Highway Safety Manual (HSM) Safety Performance Functions (SPFs) and the corresponding Crash Modification Factors (CMFs). Only one of the available SPFs has been implemented in the IHSDM, therefore manual calculations were used to compare the full breath of the HSM road types to RSAPv3. These results are documented in [Attachment E](#).

## **Task 7. Alpha and Beta Testing**

### *Statement of Work*

*Conduct Alpha and Beta testing to validate the full range of updated RSAP capabilities, and revise/validate software accordingly.*

The team spent considerable effort in preparing for the Alpha workshop scheduled for Sunday January 21<sup>st</sup> at the TRB Annual Meeting. Attendees were provided with a thumb drive that included:

- An auto-installer for the software and files,
- The alpha version of the software,
- The draft User Manual,
- The draft help files,
- A survey of user impressions,
- A document describing six example problems, two of which are validation problems and
- Six macro-enabled worksheets with the example problems already formatted and run.

The Alpha Test Workshop was held on January 21<sup>st</sup> and about 55 people attended the session. Attendees were asked to complete an on-line survey when they returned to their offices and were also asked to use the software and pass along any comments or suggestions. The next quarterly progress report will summarize the survey and also any comments/suggestions received since the Alpha Test Workshop.

The development team is tentatively planning on scheduling the Beta Test Workshop sometime in early to mid-March. We anticipate holding the workshop as a webinar. All the Alpha Test participants will be invited to attend and the development team will also expand the list by emailing invitations to other interested people.

## **Task 8. Final Report**

### *Statement of Work*

*Submit a final report documenting the entire research effort with appendices that include the user's manual, revised RDG Appendix A, and appropriate sections of RDG Chapter 2. The user's manual shall include several example problems with various levels of complexity. The executable software shall be submitted free of defects and viruses on DVD- or CD-ROM, with documentation and user's manual, and all source code in text file format.*

This task has not been initiated.

### **Contractual**

The project was initiated on March 1, 2009, the Interim Report was submitted January 25, 2010 and authorization to proceed into Phase II was received on February 25, 2010. The research team and panel requested an additional \$200,000 from AASHTO SCOR and this request was approved on March 25, 2010. The contract modification was signed on 26 August 2010. A second contract modification was executed in December

2010 making a simple change of contractors from Malcolm H. Ray, P.E., Ph.D. to RoadSafe LLC. A third contract modification was executed on June 23, 2011 extending the project end date to June 30, 2012. A summary of the progress and fiscal status of the project is shown in [Attachment A](#). We plan to finish the project in June 2012 as scheduled.

Sincerely,

A handwritten signature in black ink, appearing to read 'M. H. Ray', with a long horizontal stroke extending to the right.

Malcolm H. Ray, P.E., Ph.D.

- Attachment A: [Progress and Fiscal Summary](#)
- Attachment B: [Responses to Panel Comments](#)
- Attachment C: [Hazard Penetration Considerations](#)
- Attachment D: [Benchmark Cases](#)
- Attachment E: [Comparison of HSM SPF versus RSAPv3](#)