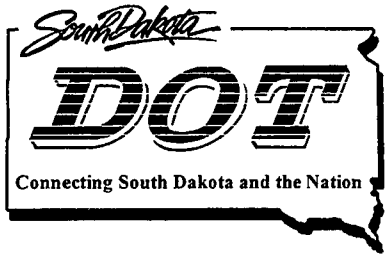

SD98-13-F

SD Department of Transportation
Office of Research

Development of South Dakota Accident Reduction Factors

Study SD98-13
Final Report

Prepared by

Office of Research
South Dakota Department of Transportation
Pierre, South Dakota 57501

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DISCLAIMER

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16. Abstract

This report offers the methodology and findings of the first project to develop Accident Reduction Factors (ARFs) and Severity Reduction Ratios (SRRs) for the State of South Dakota. The ARFs and SRRs of this project focused on Hazard Elimination and Safety (HES) projects located within the state of South Dakota. A literature search for information relating to Accident Reduction Factors was performed at the beginning of the study.

Department researchers used project plans and accident data from each of the HES projects, from 1986 to 1994, in developing Accident Reduction Factors and Severity Reduction Ratios. The technical panel for SD98-13 developed a Severity Reduction Formula which was used to compute Severity Reduction Ratios. A benefit/cost analysis was performed on each project to determine the project's cost effectiveness.

Recommendations were made to use the Accident Reduction Factors and Severity Reduction Ratios to aid in determining the effectiveness of Hazard Elimination and Safety projects. The recommendations were based on the literature review and the results from SDDOT research project, SD98-13.

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Executive Summary

The Federal Highway Administration (FHWA) has encouraged all states to develop Accident Reduction Factors (ARFs) for their roads and highways. In the past, South Dakota relied strongly on ARFs from other states to aid in determining roadway improvement effectiveness.

The South Dakota Department of Transportation (SDDOT) has requested the development of ARFs and Severity Reduction Ratios (SRRs) of its own. An Accident Reduction Factor is a value used to determine the degree to which accidents decrease at a specific improvement location. The Severity Reduction Ratio is a value used to determine the degree to which the severity of accidents have decreased at a specific improvement location. The study focused on Hazard Elimination and Safety projects from 1986 to 1994.

Research Objectives

The technical panel overseeing the research project, SD98-13, defined the following objectives for study:

1) Establish procedures for developing Accident Reduction Factors and Severity Reduction Ratios.
2) Compute Accident Reduction Factors and Severity Reduction Ratios for each HES Project completed since 1986.
3) Compute average Accident Reduction Factors and Severity Reduction Ratios for each HES improvement type used by the SDDOT.
4) Recommend Accident Reduction Factors and Severity Reduction Ratios to be used in HES selections.

Research

The study was started off with a literature search. Information regarding ARFs was gathered from the Federal Highway Administration (FHWA) and state departments of transportation. At the completion of the literature search, the study's focus was turned to developing a list of improvement projects located in South Dakota that took place from 1986 to 1994. Once the list was developed, necessary information regarding each project was obtained and analyzed. Accident Summaries were produced from the SDDOT Office of Accident Records. From these the increase or decrease in type, and total number of accidents per location were computed.

The ARF is calculated for a specific location by dividing three years worth of accidents from after the improvement by three years worth of accidents from before the improvement. An ideal ARF would be less than 1.00. No change is represented by 1.00 and an increase in accidents is represented by any number greater than 1.00. The resulting Accident Reduction Factors were grouped by Improvement Type. The Improvement Type groups were then averaged.

A Severity Reduction Formula was developed to calculate Severity Reduction Ratios. The formula takes the total number of a certain accident severity type and multiplies it by a corresponding factor amount. Once the severities are factored they are added together. The factor-sum of the accidents following the improvement location are divided by the factor-sum of the accidents previous to the improvement location. The quotient is the Severity Reduction Ratio. Like the Accident Reduction Factors, the SRRs were ideally below 1.00, signifying a decrease in severity. No change is represented by 1.00, and an increase in severity is represented by any number greater than 1.00. The resulting Severity Reduction Ratios were grouped by Improvement Type. The Improvement Type groups were then averaged.

A cost/benefit analysis, using the FHWA recommended Bailey Formula, was performed on projects where funding came exclusively from the Hazard Elimination and Safety Program. The analyses help to determine whether a particular project was cost effective.

Conclusions

This study focused on sixty-two (62) Hazard Elimination and Safety projects located throughout the state of South Dakota. These projects were grouped into seventeen (17) different improvement types. Decreases in the ARF are shown in fourteen (14) improvement types. The remaining three types show increased ARFs. Individually, there were fourteen (14) HES projects that showed an increase in ARFs. No change in Accident Reduction Factors occurred at six (6) HES project locations.

South Dakota's improvement type ARFs were compared to ARFs found in the literature search. Eleven (11) improvement type category averages varied from the average of ARFs found in the literature search by more than 10 percent. The remaining six (6) were less than 10 percent.

Severity Reduction Ratios were formulated for each of the sixty-two (62) HES projects. Four (4) improvement type category averages showed an overall increase in severity, while the remaining thirteen (13) showed severity decreases. Individually there were nineteen (19) projects that showed an increase in severity.

A cost/benefit analysis was performed on forty-nine (49) exclusively HES-funded improvement projects. From the analyses, fifteen (15) project locations were found to be beneficial. Thirty-four (34) locations were found to be non-beneficial. Thirteen (13) Hazard Elimination and Safety project locations were not analyzed due to project funding from non-HES sources.

Implementation Recommendations

Based on the results of this research study, the following recommendations are presented to the Research Review Board for their consideration:

1) The South Dakota Department of Transportation should continue to use the procedures established by this study to develop Accident Reduction Factors and Severity Reduction Ratios. The formulas and procedures of this study have been found to be effective and accurate using the current procedures.

2) Future Hazard Elimination and Safety projects should be analyzed and added to the existing data as the projects are completed. This will ensure more accurate Accident Reduction Factors and Severity Reduction Ratios for the state of South Dakota.

3) The SDDOT Office of Local Government Assistance should be responsible for continuing Hazard Elimination and Safety analyses. The Office of Local Government Assistance presently oversees the Hazard Elimination Safety program, because of this it will be possible for that office to directly produce much of the necessary project data.

4) Outstanding results should be scrutinized more closely to understand their effect on overall Accident Reduction Factors and Severity Reduction Ratios. Any one project having an increase in its ARF or SRR or a 100 percent reduction in accidents should be further investigated at the discretion of the Office of Local Government Assistance.

5) South Dakota improvement type Accident Reduction Factor averages should be based on at least ten (10) accident locations before being considered reliable enough to stand alone. The South Dakota Department of Transportation should continue to use Accident Reduction Factors obtained from outside sources until South Dakota Accident Reduction Factors have a minimum of ten (10) accident locations per improvement type.

6) The Microsoft Access™ database used by the researcher should be redesigned to streamline the data-entry and calculation process. The design should include a form to enter and display all relevant data and calculations.

Problem Description

South Dakota, like many other states, has been involved in Hazard Elimination and Safety (HES) projects for many years. The federal government has placed requirements on states to evaluate their HES projects and report the findings to the Federal Highway Administration (FHWA). The states have also been encouraged to produce their own Accident Reduction Factors (ARFs). South Dakota has a need to develop its own ARFs and determine the effectiveness of its HES projects. In the past, South Dakota has relied heavily on resources from other states to aid in preparing information regarding Accident Reduction Factors.

Background Information

An Accident Reduction Factor (ARF) is a value used to determine the degree to which accidents decrease. ARFs usually focus on locations that have been improved in order to lower accident frequency and severity. The number of accidents after the improvement is divided by the number of accidents before the improvement to calculate the ARF. Ideally, and Accident Reduction Factor would be less than 1.00, indicating a decrease in accidents. An ARF of greater than 1.00 indicates an increase of accidents, and an ARF of 1.00 signifies no change in the number of accidents. The percentage decrease of an Accident Reduction Factor is calculated by subtracting the ARF from 1.00. For example, an ARF of .71 is a 29 percent accident reduction. The percentage increase is calculated by subtracting 1.00 from the ARF. For example, an ARF of 1.43 is a 43 percent increase.

Accident Reduction Factors almost always cover the same conditions and accident types. The factors consider driver, weather, and road conditions, collision and improvement types, and time of day/week/month/year. Accident severity was also a major issue in this study. South Dakota classifies accident severity by five different types: fatalities, incapacitating injury, non-incapacitating injury, possible injury, and "property damage only" (PDO). All severity types were considered in this study.

The severity types were used in a Severity Reduction Formula. The Severity Reduction Formula computes a Severity Reduction Ratio (SRR). The SRR is a ratio of overall accident severity before a project takes place to the overall accident severity after that project is completed. Traffic safety specialists can use this ratio to aid in determining the effectiveness of that project.

To calculate the Severity Reduction Ratio, the Severity Reduction Formula multiplies the number of each fatality, incapacitating injury, non-incapacitating injury, possible injury, and PDO severity-type accident by a corresponding factor. The multiplied factors are then added. The three years following an improvement and the three years preceding the improvement are formulated in this way. The following three years' sum is then divided by the sum for the three years before the improvement project. The result is the Severity Reduction Ratio. An ideal ratio is less than 1.00.

Due to the availability of accident severity information and improvement project costs, a cost/benefit analysis was performed on projects where funding came solely from the Hazard Elimination and Safety program. The analyses of these projects help to determine if a particular project has been cost effective. The researcher used the Bailey Formula[1] in computing the cost/benefit. This formula is used and recommended by the FHWA.

To produce fair and accurate Accident Reduction Factors and Severity Reduction Ratios of its own, the South Dakota Department of Transportation requested research based on its Hazard Elimination and Safety projects. Like studies in other states, HES projects from a variety of locations within the study area (South Dakota) were used. HES sites from 1986 to 1994 were included in this study; additional years of data can be added to the study as complete accident data becomes available.

[1] FHWA Technical Advisory T 7570.2; U.S. Department of Transportation, 6/30/1988.

Objectives

The technical panel overseeing the research project, SD98-13, defined the following objectives for study:

1) **Establish procedures for developing Accident Reduction Factors and Severity Reduction Ratios.**

The Federal Highway Administration (FHWA) has long required states to report on the effectiveness of their Hazard Elimination and Safety projects. The FHWA has also encouraged states to produce their own Accident Reduction Factors. South Dakota, not having Accident Reduction Factors or Severity Reduction Ratios of its own, initiated this project to create them.

2) **Compute Accident Reduction Factors and Severity Reduction Ratios for each HES Project completed since 1986.**

The SDDOT Office of Accident Records maintains accident records from 1983 and later. It was decided to study HES Projects that had been started after January 1, 1986 and completed before December 31, 1994 so that complete data could be gathered for each HES Project location. This was necessary so that Accident Summaries from three years before each project and three years after each project could be generated. Additional years of data can be added as the accident information is made available.

3) **Compute average Accident Reduction Factors and Severity Reduction Ratios for each HES improvement type used by the SDDOT.**

To assess the overall safety of a specific improvement type, HES Project Accident Reduction Factors and Severity Reduction Ratios were grouped by type and then averaged. The resulting numbers represent the average ARF and average SRR for each improvement type used by the SDDOT.

4) Recommend Accident Reduction Factors and Severity Reduction Ratios to be used in HES selections.

Once all of the data were gathered and formulated, they were compared to figures found from a literature search performed at the beginning of the study. If the South Dakota ARF data were consistent with ARF data from the literature search, recommendations were made to accept the South Dakota data.

Task Description

Task 1 -- Meet with the project's technical panel to review the project scope and work plan.

The researcher met with the panel before the project began to review the project scope and the proposed work plan. This meeting was intended to provide an opportunity for the panel to ask any questions and provide additional input on the work plan. Any suggested changes which were approved by the panel were incorporated into the work plan.

Task 2 -- Review and summarize literature pertinent to the development of Accident Reduction Factors.

A literature search was conducted using information that was made available to the SDDOT Office of Research via universities, consultants, and various state departments of transportation. The Internet was also used to investigate sites containing useful and valid information. The literature search focused primarily on a report published by the University of Kentucky[2], reports produced by the New York[3] and California[4] Departments of Transportation, information from an Internet site developed by the Missouri Valley Section of the Institute of Transportation Engineers[5], and from Federal Highway Administration data. All of these studies and reports depict the Accident Reduction Factors prepared for various roadway improvement types. A summary of the ARF information from the literature search is shown in Table 2.

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[2] Agent, Kenneth R., Nikiforos Stamatiadis, and Smantha Jones. Development of Accident Reduction Factors. Lexington: University of Kentucky, 1996.
[3] New York Department of Transportation. *Update of Accident Reduction Factors and Average Accident Rates for 1997*. Albany, New York, Safety Program Management Bureau, 1997.
[4] California Department of Transportation. *Accident Reduction Factors for Highway Safety Projects*. Sacremento, California, Office of Traffic Operations, 1998.
[5] Voss, Linda G. "Accident Reduction Factors." MOVITE. 1997.

Task 3 -- Develop a list of South Dakota HES Projects completed since 1986.

A list of sixty-two (62) HES projects from 1986 through 1994, was obtained from the SDDOT Office of Local Government Assistance. The HES project list included the general location, type of improvement, beginning and ending construction dates, project number and PCEMS number for each project.

The researcher initially used HES construction project data pertaining to the years 1993 and 1994. Accident Reduction Factors and Severity Reduction Ratios were computed for all of the projects started and completed in these two years. The results of the 1993 and 1994 study group were submitted for Technical Panel review to look for any problems with the methodology. The calculation process was found to be effective and accurate, so permission was given to the researcher to continue with the years all the way to 1986.

Task 4 -- Define project location boundaries, provide Average Daily Traffic (ADT), and determine the type of improvement for each HES project identified in Task 3.

The researcher worked with the Office of Local Government Assistance (LGA) to determine the project location boundaries and the type of improvement for each HES project. Average Daily Traffic (ADT) figures were gathered from the project plans submitted by LGA and the Office of Road Design. When an accurate ADT was not available from a particular set of plans, the researcher worked with the SDDOT Office of Data Inventory to generate the traffic counts.

Task 5 -- Generate three year before and after HES Accident Summaries for each project identified in Task 3.

In cooperation with the SDDOT Office of Accident Records, the researcher gathered accident summaries for each HES project that was identified by the SDDOT Office of Local Government Assistance. Accident summaries for each of the three years prior to the project and three years following the project were produced.

A list of improvements used by the State of South Dakota and included in the study are shown in Table 2.

Each accident summary detailed the totals of the type of violations (if any), roadway surface conditions, weather conditions and the relations-to-intersection of the accidents. Road alignment and type of vehicles were also listed. The summary also noted whether the operator(s) of the vehicle(s) involved was(were) under the influence of drugs, alcohol, both, or neither. Severity of the accidents was divided into fatality, incapacitating injury, non-incapacitating injury, possible injury and property damage only accidents. Finally, a table showing the relationship of the accident-type to accident-severity was given.

Task 6 -- Using the information from Task 5, compute the increase or decrease in type and total number of accidents per location.

The researcher used a Microsoft Access™ database to compile data and compute totals for each location and determine the increase or decrease for each type of accident. The researcher entered data from the Accident Summaries into the Access™ database. The accident types from the three previous years' totals were compared to accident types of the three following years' totals (Table 1). The database was programmed to calculate the increase or decrease in accident types per location .

TABLE 1

Decrease in Accidents by Accident Type

PCEMS	HeadOn *	Ang-Insec	Ang-No Insec	Rear End	SS-OVTKIN	SS-OPSDIR	OVTINROAD	Ran Off Road	Fixed Object	Pkd Veh	Pedestrian	Animal	Other	Left Turn
0083	0	0	0	0	0	0	0	-6	-9	0	0	0	0	0
157W	0	0	0	-2	0	0	0	0	0	0	0	0	0	-2
1839	3	-2	0	2	1	0	0	-5	4	0	0	17	3	-2
1840	-1	5	1	-3	-10	0	5	-6	-10	2	0	11	4	-2
1919	0	-1	0	-1	0	0	0	0	0	0	0	0	1	-2
2076	0	1	0	-1	1	0	0	0	1	0	0	0	0	-1
2085	1	-3	0	-2	2	0	0	0	0	0	2	2	0	4
2087	0	2	2	-1	-3	-1	0	0	-1	0	0	0	0	-22
2089	0	-5	0	-3	0	0	0	0	-1	0	0	0	2	-9
2095	0	0	0	-2	-1	0	0	0	0	-1	0	0	0	4
2096	1	1	0	0	0	0	0	0	-1	2	0	0	0	5
2097	0	-32	0	1	0	0	0	0	0	0	0	0	2	-1
2113	0	0	-1	0	0	0	0	0	1	0	0	0	0	0
2114	0	-11	0	-2	-2	0	0	0	0	0	1	0	-2	-2
2257	-1	0	0	2	0	0	0	0	1	1	0	1	0	0
2538	7	-4	0	-1	0	-5	-2	-12	-9	0	0	5	-1	5
2574	0	0	0	0	0	0	0	0	0	0	0	0	0	0
291H	0	-1	0	1	0	0	0	0	0	0	-1	0	0	-1
305X	0	1	1	0	-4	0	0	0	-3	0	0	0	-4	7
3093	0	5	0	-3	1	-1	0	0	2	-2	0	0	3	8
3097	0	-54	-2	-81	-1	0	0	0	1	2	0	0	-2	-39
310X	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3113	0	0	0	-2	0	0	0	0	0	0	0	-1	2	1
3114	0	-3	0	-4	0	0	0	0	-2	0	0	0	0	-9
3115	0	1	0	-17	1	0	0	0	0	0	0	0	1	-1
3116	0	-1	0	1	0	0	0	0	0	0	-1	0	0	-1
3118	1	0	0	1	0	0	-1	-1	1	0	0	-3	0	0
3120	0	0	0	-1	0	0	0	0	0	0	0	0	0	0
319X	0	0	0	0	0	0	0	0	-2	0	0	0	0	0
321X	0	0	0	-1	0	0	0	0	-7	0	0	0	-1	0
322X	0	0	0	0	0	0	0	-1	0	0	0	0	0	0

PCEMS	HeadOn *	Ang-Insec	Ang-No Insec	Rear End	SS-OVTKIN	SS-OPSDIR	OVTINROAD	Ran Off Road	Fixed Object	Pkd Veh	Pedestrian	Animal	Other	Left Turn
325X	0	0	0	0	0	0	0	-3	-2	0	0	-1	0	0
330X	0	0	-2	-1	0	0	0	0	2	1	0	0	3	0
334X	0	0	0	2	-1	0	0	0	0	0	0	0	0	-1
335X	0	-11	-2	-5	-1	0	-2	0	0	0	0	0	-1	-14
338X	-1	-3	-3	-2	-4	0	-1	0	1	2	1	0	0	-1
339X	0	2	1	5	0	0	0	0	0	1	0	0	1	3
343X	0	-5	0	4	1	0	0	0	-1	0	0	0	-1	0
344X	0	3	-3	0	-1	-1	0	0	1	-4	0	0	-1	-1
3598	0	-1	0	1	-1	0	0	0	-12	0	0	0	-10	-3
3619	0	3	1	-23	1	2	0	0	-2	-1	2	2	0	-1
3620	0	0	0	-3	0	0	0	0	0	0	0	0	-1	0
3621	0	-4	0	-1	1	0	0	0	-2	0	0	0	0	4
3641	0	-1	0	16	1	0	0	0	-3	0	-1	0	1	-29
3825	0	1	0	0	0	0	0	0	0	0	0	0	0	-1
3830	0	-2	0	-5	1	0	0	0	3	0	0	1	5	0
3832	0	-2	0	1	0	0	0	0	-1	0	0	0	1	-8
3853	-1	13	-1	-22	-6	0	0	0	-2	0	-2	0	3	20
396W	-7	6	1	5	-5	7	16	-29	-11	-1	2	10	-2	-4
3978	0	3	0	-2	0	0	0	0	0	0	0	0	0	-3
3980	0	-4	0	5	0	0	-1	0	0	0	-1	1	-4	2
3991	0	1	0	-8	0	0	0	0	0	0	0	0	-1	-1
4096	-1	0	0	0	0	0	0	0	0	0	0	0	1	0
450X	0	-3	-2	-1	-2	-1	-1	2	0	0	0	0	0	-2
451X	0	14	2	12	3	0	0	0	1	0	1	1	3	11
452X	0	-1	0	0	0	0	0	0	0	0	0	3	0	0
588X	0	-5	0	11	0	0	0	0	1	0	0	0	2	6
589X	0	-4	0	-2	0	0	0	0	0	0	0	0	0	5

* Negative numbers indicate a decrease

HEADON: An accident where the front end of one vehicle collides with the front end of another vehicle, while the two vehicles are traveling in opposit directions.

ANG-INSEC (angular-intersection): A collision in which two vehicles traveling on intersecting paths collide at an intersection.

ANG-NO IN (angular-no-intersection): A collision in which two vehicles traveling on intersecting paths collide somewhere other than an intersection.

REAR END: The front end of one vehicle collides with the rear end of another vehicle, while both vehicles are traveling in the same direction.

SS-OVTKIN (sidswipe-overtaken): One vehicle impacts another traveling in the same direction by "swiping" along the surface with the direction of trav
SS-OPSDIR (sideswipe-opposite direction): Two vehicles traveling in opposite direction "swiping" each other while meeting.
OVTINROAD (overturned in road): An accident that results in at least one vehicle being overturned in the roadway.
RAN OF RD (ran off road): An accident where a vehicle leaves the roadway
FIXED OBJ (fixed object): Involving one vehicle that strikes a fixed object on the highway or on the right-or-way.
PKED VEH (parked vehicle): A collision between two vehicles where one vehicle is not in transport.
PED (pedestrian collision): All vehicle accidents involving a pedestrian.
ANIMAL: All vehicle accidents involving an animal.
OTHER: Any accident that cannot be classified under the other accident types
LEFT TURN: A collision in which two vehicles collide while at least one is in the process of turning.

Task 7 -- Develop Accident Reduction Factors based on the total number of accidents at each location.

An Accident Reduction Factor was computed by using the accident totals at each project location. The total number of accidents following the project was divided by the total from the years previous to the project. The Access™ database was used to calculate the Accident Reduction Factors (See Table 3).

Task 8 -- Group projects by type of improvement, develop Average Accident Reduction Factors for each type of improvement, and compare them with the Average Accident Reduction Factors identified in the literature search.

After regrouping the HES Projects by improvement type, the same data was used to compute a set of average Accident Reduction Factors. Each project was reviewed, sorted and grouped by its accident and improvement type. The researcher worked with LGA to determine the predominant improvement type that was included in the totals and calculations. The project accident-severity type and total number of accidents were computed for three years before the project and three years following the project.

Using the Access™ database, every previous accident, of every project belonging to the same improvement type, was added and then divided by the sum of every following accident of the same improvement type. For example, all previous accidents from project locations with an improvement type of "Traffic Signals" were added together and then were divided by the following accident sum of that improvement type. The Average ARF calculated from South Dakota data was then compared to Average ARF's found in the literary search. All Average ARF's were placed in a Microsoft Excel™ spreadsheet for comparison (See Table 2).

Table 2

Comparisons of "Percent Decrease" for Average Accident Reduction Factors

Improvement Type	Average ARF's (%) for South Dakota	University of Kentucky Average ARF's (%)	NYDOT's Average ARF's (%)	CALTRANS' Average ARF's (%)	MOVITE Average ARF's (%)	FHWA Average ARF's (%)
Install signal w/ turn radii	54.10%	N/A	N/A	N/A	N/A	23.00%
Pavement Marking-Continuous Center Turn Ln.	9.06%	N/A	24.00%	25.00%	N/A	27.00% [a]
Pavement Marking-Left Turn Lane	34.62%	35.00%	45.00%	35.00%	N/A	27.00% [a]
Realignment-Horizontal	100.00%	40.00%	41.00%	N/A	N/A	44.00% [b]
Realignment-Horizontal and Vertical	-11.76%	50.00%	20.00%	N/A	N/A	44.00% [b]
Reconst. Left Turn Lane w/ signal phase	9.30%	N/A	19.00%	35.00%	62.00%	27.00% [a]
Reconstruction-Continuous Center Turn Lane	8.47%	30.00%	24.00%	25.00%	N/A	27.00% [a]
Reconstruction-Increase Turning Radii	100.00%	15.00%	N/A	N/A	N/A	N/A
Reconstruction-Left Turn Lane	30.77%	25.00%	26.00%	35.00%	N/A	27.00% [a]
Reconstruction-Realign Intersection	-14.58%	40.00%	N/A	N/A	N/A	44.00% [b]
Remove Fixed Object	100.00%	30.00%	17.00%	N/A	N/A	22.00%
Roadway Lighting	16.67%	25.00%	9.00%	15.00%	N/A	17.00%
Shoulder Widening	20.00%	20.00%	17.00%	30.00%	N/A	13.00%
Signal Upgrade	33.82%	20.00%	19.00%	20.00%	45.00%	22.00%
Signing	5.20%	35.00%	13.00%	N/A	N/A	16.00%
Slope flattening of approaches	-1.54%	N/A	45.00%	N/A	N/A	25.00%
Traffic Signals	26.06%	25.00%	20.00%	20.00%	45.00%	23.00%

*average for "Traffic Signs" category

[a] based on category: "Turning Lanes & Traffic Channelization

[b] based on category: "Realign Roadway"

Task 9 -- Using the HES Formula, develop a Severity Reduction Formula.

The technical panel overseeing the research project recommended a formula to be used to compute a Severity Reduction Ratio. Included in the formula are five accident severity types, Fatality, Incapacitating Injury, Non-incapacitating Injury, Possible Injury, and Property Damage Only (PDO). These types are standard to the State of South Dakota[6] and are found on each accident report submitted to, and on each accident summary produced by, the SDDOT Office of Accident Records.

A severity type of "Fatality" is where at least one death occurred because of a motor vehicle accident. Other severity types may occur as a result of an accident, these types will also appear on the SDDOT Accident Summary for that accident location. An "Incapacitating Injury" is an instance where at least one victim sustains an incapacitating injury (e.g. lacerations, broken bones, abdominal injuries, etc.). "Non-incapacitating Injuries" (e.g. abrasions, bruises, or minor lacerations, etc.) are less severe than "Incapacitating Injuries". "Possible Injury" types occur if an accident involves a reported or claimed injury which is not fatal, incapacitating, or non-incapacitating (e.g. momentary unconsciousness, claim of injuries not evident, etc.). The least severe accident type is "Property Damage Only". "Property Damage Only" accidents are instances where no bodily harm has been inflicted as a direct result of the accident. A minimum of $500 damage to any one person's property or $1000 per accident must occur before the accident is reported[7].

The Severity Reduction Formula assigns each accident severity type a factor derived from data supplied by the Federal Highway Administration (A summary of the Severity Reduction Factors is shown in Appendix A, Tables III and IV). The Federal data[8]

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[6] South Dakota State Accident Report Form Dictionary, 12/31/1982
[7] South Dakota Codified Law 32-34-7
[8] FHWA Technical Advisory T 7570.2; U.S. Department of Transportation, 10/31/1994.

estimate the amount of money that an individual is willing to spend on improved safety in order to prevent each accident severity-type. A fatality in 1998 is estimated at $2,600,000, an incapacitating injury at $180,000, a non-incapacitating injury at $36,000, a possible injury is estimated at $19,000, and a property damage only accident at $2000. The amounts are adjusted annually by the FHWA.

In order to derive the factor amounts, each accident severity type value was divided by the PDO value. The resulting factor values are 1300, 90, 18, 9.5 and 1 for "Fatality", "Incapacitating Injury", "Non-incapacitating Injury", "Possible Injury", and "Property Damage Only" accidents, respectively. These factor values were multiplied by the number of each accident severity type and then added.

The Severity Reduction Ratios of this study are to be used to determine the effectiveness of past improvement projects, and to help determine the proper action to be taken in planning future improvement projects. To determine the Severity Reduction Ratio, totals were calculated for the three years preceding and the three years following a project, respectively. The following three years' total was divided by the preceding three years' total to derive the Severity Reduction Ratio (Equation 1).

EQUATION 1

Severity Reduction Formula

$$\frac{(F_f * 1300) + (I_f * 90) + (N_f * 18) + (P_f * 9.5) + (PDO_f * 1)}{(F_p * 1300) + (I_p * 90) + (N_p * 18) + (P_p * 9.5) + (PDO_p * 1)}$$

F = Fatality
I = Incapacitating Injury
N = Non-incapacitating Injury
P = Possible Injury
PDO = Property Damage Only

$_f$ = Following three years' totals
$_p$ = Previous three years' totals

Task 10 -- Using the Severity Reduction Formula, determine a Severity Reduction Ratio for each project.

The Severity Reduction Ratio was computed for each project location using the Access™ database.

In order to compute the Severity Reduction Ratios, each project location had its accident severity-type total divided into five different types, as found on the accident summaries. The project totals, based on the three years previous and the three years following the project, were put into the formula, which was programmed into the database. As the formula dictates, each type was given a factor value. The exact factor amounts are highest for fatality accidents and decrease to PDO, which is the lowest. The database then calculated a Severity Reduction Ratio for each project (Table 3).

TABLE 3

Accident Reduction Factor and Severity Reduction Ratios by Project Location

PCEMS #	Previous Three Years' Accident Totals	Following Three Years' Accident Totals	Increase or Decrease by Location*	Accident Reduction Factor**		PCEMS #	Previous SRF Totals	Following SRF Totals	Severity Reduction Ratio**
0083	15	0	-15	0.00		0083	299.0	0.0	0.0
157W	4	0	-4	0.00		157W	29.5	0.0	0.0
1839	44	65	21	1.48		1839	461.5	422.5	0.92
1840	110	106	-4	0.96		1840	8549.0	5492.0	0.64
1919	6	2	-4	0.33		1919	48.5	2.0	0.04
2076	2	3	1	1.50		2076	39.0	3.0	0.08
2085	9	15	6	1.67		2085	176.5	1950.5	11.05
2087	61	37	-24	0.61		2087	1017.0	488.5	0.48
2089	32	16	-16	0.50		2089	423.0	211.0	0.5
2095	13	13	0	1.00		2095	307.5	313.0	1.02
2096	2	5	3	2.50		2096	10.5	22.0	2.1
2097	37	7	-30	0.19		2097	424.0	24.0	0.06
2113	3	3	0	1.00		2113	127.0	47.5	0.37

PCEMS #	Previous Three Years' Accident Totals	Following Three Years' Accident Totals	Increase or Decrease by Location*	Accident Reduction Factor**		PCEMS #	Previous SRF Totals	Following SRF Totals	Severity Reduction Ratio**
2114	37	19	-18	0.51		2114	309.5	302.0	0.98
2257	1	5	4	5.00		2257	1300.0	13.5	0.01
2538	105	88	-17	0.84		2538	15200.5	10059.5	0.66
2574	1	1	0	1.00		2574	1.0	1.0	1.0
264H	37	41	4	1.11		264H	1032.0	908.0	0.88
291H	3	1	-2	0.33		291H	1418.5	36.0	0.03
305X	29	27	-2	0.93		305X	98.0	416.0	4.24
3093	49	62	13	1.27		3093	711.5	711.0	1.0
3097	165	97	-68	0.59		3097	2473.5	1615.5	0.65
310X	759	727	-32	0.96		310X	24065.5	26777.0	1.11
3113	9	6	-3	0.67		3113	223.0	238.0	1.07
3114	27	9	-18	0.33		3114	728.5	256.0	0.35
3115	112	97	-15	0.87		3115	2672.0	1988.5	0.74
3116	3	1	-2	0.33		3116	1418.5	36.0	0.03
3118	10	8	-2	0.80		3118	519.5	392.5	0.76
3120	1	0	-1	0.00		3120	1.0	0.0	0.0
319X	2	0	-2	0.00		319X	1444.0	0.0	0.0
321X	9	0	-9	0.00		321X	9.0	0.0	0.0
322X	1	0	-1	0.00		322X	9.5	0.0	0.0
325X	6	0	-6	0.00		325X	273.0	0.0	0.0
330X	11	14	3	1.27		330X	64.0	14.0	0.22
334X	3	3	0	1.00		334X	199.0	118.5	0.6
335X	40	4	-36	0.10		335X	2726.0	93.0	0.03
338X	64	53	-11	0.83		338X	439.5	529.0	1.2
339X	11	24	13	2.18		339X	28.0	156.5	5.59
343X	14	12	-2	0.86		343X	701.5	235.5	0.34
344X	18	11	-7	0.61		344X	43.5	46.0	1.06
353H	57	53	-4	0.93		353H	3305.5	1850.0	0.56
3598	65	49	-16	0.75		3598	818.5	900.0	1.1
3619	58	42	-16	0.72		3619	673.0	1227.5	1.82
3620	8	4	-4	0.50		3620	60.0	244.5	4.08
3621	15	13	-2	0.87		3621	157.0	183.5	1.17
3641	84	68	-16	0.81		3641	1301.0	991.5	0.76
3825	10	10	0	1.00		3825	440.0	44.0	0.1
3830	27	30	3	1.11		3830	1109.5	3072.0	2.77
3832	17	8	-9	0.47		3832	1251.0	8.0	0.01
3853	115	117	2	1.02		3853	2353.0	2172.5	0.92
396W	360	348	-12	0.97		396W	14501.0	8407.5	0.58
3978	14	12	-2	0.86		3978	66.0	98.0	1.48
3980	16	14	-2	0.88		3980	201.5	225.0	1.12
3991	16	7	-9	0.44		3991	433.5	192.5	0.44
4096	2	2	0	1.00		4096	74.0	2.0	0.03

PCEMS #	Previous Three Years' Accident Totals	Following Three Years' Accident Totals	Increase or Decrease by Location*	Accident Reduction Factor**		PCEMS #	Previous SRF Totals	Following SRF Totals	Severity Reduction Ratio**
429W	74	53	-21	0.72		429W	2073.0	2041.0	0.98
450X	23	13	-10	0.57		450X	82.5	1480.5	17.95
451X	28	76	48	2.71		451X	468.0	2102.0	4.49
452X	2	4	2	2.00		452X	27.5	4.0	0.15
588X	19	34	15	1.79		588X	237.5	487.5	2.05
589X	10	9	-1	0.90		589X	240.0	52.5	0.22
626W	116	108	-8	0.93		626W	3883.0	1604.5	0.41

* Negative (-) denotes decrease

** Value less than 1 is ideal

Task 11 -- Develop Average Severity Reduction Ratios based on the type of improvements.

The projects and their respective previous and following Severity Reduction Factors were grouped by improvement type and then added. The groups of total following SRFs were divided by their respective group-total previous SRFs to obtain an average Severity Reduction Ratio for each improvement type (Table 4).

TABLE 4

Average ARFs and Average SRRs by Improvement Type

Improvement Type	Average ARFs	Improvement Type	Average SRRs
Install signal w/ turn radii	0.46	Install signal w/ turn radii	0.23
Pavement Marking-Continuous Center Turn Ln.	0.91	Pavement Marking-Continuous Center Turn Ln.	0.77
Pavement Marking-Left Turn Lane	0.65	Pavement Marking-Left Turn Lane	0.27
Realignment -Horizontal	0.00	Realignment-Horizontal	0.00
Realignment-Horizontal and Vertical	1.12	Realignment-Horizontal and Vertical	4.10
Reconst. Left Turn Lane w/ signal phase	0.91	Reconst. Left Turn Lane w/ signal phase	0.64
Reconstruction-Continuous Center Turn Lane	0.92	Reconstruction-Continuous Center Turn Lane	1.40

Improvement Type	Average ARFs	Improvement Type	Average SRRs
Reconstruction-Increase Turning Radii	0.00	Reconstruction-Increase Turning Radii	0.00
Reconstruction-Left Turn Lane	0.69	Reconstruction-Left Turn Lane	0.84
Reconstruction-Realign Intersection	1.15	Reconstruction-Realign Intersection	1.30
Remove Fixed Object	0.00	Remove Fixed Object	0.00
Roadway Lighting	0.83	Roadway Lighting	0.29
Shoulder Widening	0.80	Shoulder Widening	0.76
Signal Upgrade	0.66	Signal Upgrade	0.56
Signing	0.95	Signing	0.85
Slope flattening of approaches	1.02	Slope flattening of approaches	0.63
Traffic Signals	0.74	Traffic Signals	1.00

Task 12 -- Make recommendations on the Accident Reduction Factors to be used in South Dakota.

The calculations were completed and are organized in Table 3. The researcher compared the South Dakota research data to data from other state DOT's, and to data obtained from the FHWA (Table 2). The comparisons aid the researcher to highlight any characteristics in South Dakota data that may vary from other published reports. The researcher has submitted, to the technical panel, recommendations on Accident Reduction Factors in South Dakota. The recommendations focus on the most effective type of improvement to be considered for use in the future. In cases where South Dakota ARF's are based on limited data, the researcher may have used data from other states in lieu of South Dakota data (these cases are noted appropriately).

Task 13 -- Prepare a final report and executive summary of the literature review, findings and conclusions.

The researcher has prepared a final report and executive summary of the literature review, research methodology, finding, conclusions, and recommendations. The researcher has

provided spreadsheets and a database used to calculate totals and individual Accident Reduction Factors and Severity Reduction Ratios. The spreadsheets and the database have been designed to allow the input of new information as it becomes available. This makes it possible for the SDDOT to use and analyze accident data in the future.

Task 14 -- Make an executive presentation to the Research Review Board at the conclusion of the project.

The researcher will make an executive presentation to the SDDOT Research Review Board on the results of the Study in Accident Reduction Factor Effectiveness.

Findings and Conclusions

This study included sixty-two (62) Hazard Elimination and Safety projects located throughout the state of South Dakota. Projects were located both in urban and rural areas. The roadways involved were highways and secondary roads. Of these sixty-two projects, there were seventeen (17) improvement types, from signal installation to shoulder widening. Most of the improvement types included three (3) or four (4) project locations. Three (3) improvement types, "Shoulder Widening", "Reconstruction-Increase Turning Radii", and "Remove Fixed Object", included only one project location. The largest improvement type, "Traffic Signals", covers nine (9) project locations.

Decreases in Accident Reduction Factors are shown in fourteen (14) improvement types with three (3) of these types, "Realignment-Horizontal", "Reconstruction-Increase Turning Radii", and "Remove Fixed Object", showing a 100 percent accident reduction. Three (3) improvement types, "Realignment-Horizontal and Vertical", "Reconstruction-Realign Intersection", and "Slope flattening of approaches", show accident increases. The increases in each of the three types could be attributed to one or two locations. No improvement type that showed an overall increase in accidents had all of its project locations increase in accidents. An example of this increase would be the improvement type, "Reconstruction Realign Intersection", which has locations with ARFs of 0.33 (2 accidents after divided by 6 accidents before), 2.50 (5/2), 1.00 (3/3), 0.61 (11/18), and 1.79 (34/19). The final factor's accidents gives the overall ARF an increase to 1.15 (55/48). The Accident Reduction Factor for the improvement type would have been close to .72 if the final factor was not included. This offset effect can be seen in most other improvement types that show an increase.

The accuracy of the results of this study increases with the number of projects studied. Results are more accurate for improvement types with a greater number of project locations. The improvement type "Traffic Signals", which has nine (9) locations, is to be considered the most accurate. The improvement types "Reconstruction-Increase Turning Radii", "Remove Fixed Object", and "Shoulder Widening" are considered least accurate. Each of these improvement types are based on only one HES project. It is curious to note that the improvement type, "Reconstruction-Continuous Center Turn Lane" (comprised of 5 locations), is below the combined average of the University of Kentucky study, the reports from California, New York and MOVITE, and the FHWA data (for that improvement type) by more than 18 percent. Improvement type, "Shoulder Widening" (comprised of one location) is equal to the combined average for its respective improvement type. The lack of uniformity would reinforce the need to update all Accident Reduction Factors so that more accurate results can be obtained.

Accident Reduction Factors for eleven (11) of the seventeen (17) improvement types varied from the average of ARF's found in the literature search by 10 percent or more. Three (3) South Dakota Average ARFs are equal to their respective improvement type combined average calculated from the reports and studies found in the literature search. Two (2) South Dakota ARFs are within 5 percent, and one (1) other is within 10 percent. Two improvement types with negative Accident Reduction Factors, "Realignment-Horizontal and Vertical" and "Slope Flattening of Approaches", vary from the literature search averages by 50 percent and 37 percent, respectively.

A Severity Reduction Ratio (SRR) was calculated for each project location. A Severity Reduction Ratio would ideally be less than 1.00. This represents a lower overall severity of accidents after the completion of the improvement project. A SRR of 1.00 represents no change, and a SRR of greater than 1.00 would indicate an increase in severity. Out of sixty-two (62) individual HES project locations, nineteen (19) showed a Severity Reduction Ratio greater than 1.00. Four (4) improvement types show overall SRR increases; thirteen (13) types have an SRR of 1.00 or less. As with the Accident

Reduction Factors, overall Severity Reduction Ratio increases can be contributed to one or two outstanding project locations per improvement type. No improvement type that showed an overall increase in severity had all of its project locations increase in severity.

A cost/benefit analysis was performed on forty-nine (49) Hazard Elimination and Safety projects. These projects were funded solely by money set aside by the HES program. The Bailey Formula was used to calculate cost/benefits for individual project locations.

The Bailey Formula incorporates improvement cost, accident cost, number and severity of accidents, and Accident Reduction Factors into the Cost/Benefit analysis. The researcher used costs and accident information that was obtained from the Office of Local Government Assistance. The formula shows a benefit by producing a number greater than 1.00.

Fifteen (15) project locations were found to be beneficial with a number greater than 1.00. Thirty-four (34) HES projects were found non-beneficial. And, thirteen (13) Hazard Elimination and Safety project locations were not analyzed due to project funding from non-HES sources (Appendix A, Table 5).

Implementation Recommendations

Based on the results of this research study, the following recommendations are presented to the Research Review Board for their consideration:

1) The South Dakota Department of Transportation should continue to use the procedures established by this study to develop Accident Reduction Factors and Severity Reduction Ratios. The formulas and procedures of this study have been found to be effective and accurate using the current procedures.

2) Future Hazard Elimination and Safety projects should be analyzed and added to the existing data as the projects are completed. This will ensure more accurate Accident Reduction Factors and Severity Reduction Ratios for the state of South Dakota.

3) The SDDOT Office of Local Government Assistance should be responsible for continuing Hazard Elimination and Safety analyses. The Office of Local Government Assistance presently oversees the Hazard Elimination Safety program, because of this it will be possible for that office to directly produce much of the necessary project data.

4) Outstanding results should be scrutinized more closely to understand their effect on overall Accident Reduction Factors and Severity Reduction Ratios. Any one project having an increase in its ARF or SRR or a 100 percent reduction in accidents should be further investigated at the discretion of the Office of Local Government Assistance.

5) South Dakota improvement type Accident Reduction Factor averages should be based on at least ten (10) accident locations before being considered reliable enough to stand alone. The South Dakota Department of Transportation should continue to use Accident Reduction Factors obtained from outside sources until South Dakota Accident Reduction Factors have a minimum of ten (10) accident locations per improvement type.

6) The Microsoft Access™ database used by the researcher should be redesigned to streamline the data-entry and calculation process. The design should include a form to enter and display all relevant data and calculations.

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Appendix A

Supplemental Tables

Table I

HES-Data by PCEM

PCEMS #	County	Improvement Type	ADT	Begin	End	Location Description	Project
0083	Lawrence	Realignment-Horizontal	1850	05/04/87	06/16/87	US385 at MRM 118.8--S. of JCT US85 & US385	HES0385(23)119
157W	Yankton	Reconstruction-Increase Turning Radii	3120	07/16/91	12/01/91	9th & Summit in Yankton to 8th St	M-HES4756(2)
1839	Walworth	Slope flattening of approaches	1834	07/09/86	09/04/86	US12 from S. JCT US83 E. to Ipswich	HES0012(52)214
1840	Pennington	Slope flattening of approaches	1300	09/08/86	05/14/87	US83 from US14 N. to Sully line: from US212 to ND	HES0083(38)138
1919	Beadle	Reconstruction-Realign Intersection	4650	06/12/89	08/26/89	US14 & Lincoln Ave in Huron	HES0014(95)344
2076	Bennett	Roadway Lighting	1500	10/18/88	02/17/89	US18 through Martin	HES0018(87)148
2085	Shannon	Realignment-Horizontal and Vertical	3671	08/14/89	10/01/89	SD407 from NE state line to Pine Ridge	HES0407(2)0
2087	Pennington	Reconst. Left Turn Lane w/ signal phase	15000	09/22/88	12/19/88	SD439 intersection of Campbell & St Patrick in RC	HES0439(8)
2089	Pennington	Traffic Signals	19600	07/23/90	12/15/90	E North St & Spruce	HES2090(10)70
2095	Pennington	Traffic Signals	19600	07/23/90	12/15/90	E North St & Milwaukee St	HES2090(11)70
2096	Pennington	Reconstruction-Realign Intersection	2000	08/07/89	09/05/89	Hillsview Dr. & W. St. Patrick St.	HES1883(1)
2097	Brown	Install signal w/ turn radii	3659	07/13/87	01/15/88	3rd & Dakota S in Aberdeen	HES2306(3)
2113	Union	Reconstruction-Realign Intersection	780	04/12/90	08/01/90	SD50 and county road at Junction City	F-HES0050(35)417
2114	Pennington	Traffic Signals	20995	07/08/91	11/01/91	5th St and Kansas City St in Rapid City	HES1669(27)
2257	Edmunds	Slope flattening of approaches	250	07/09/86	09/04/86	SD253 from US12 N. 9 mi.	HES3253(3)172
2538	Pennington	Slope flattening of approaches	3223	11/04/87	05/05/88	SD79 from Maverick JCT to Rapid City	HES0079(31)26
2574	Bennett	Roadway Lighting	1100	10/18/88	02/17/89	SD73 from Jct US18 1400ft South	HES0073(33)12
264H, 087S	Fall River	Signing	N/A	04/18/94	07/27/94	County roads throughout Fall River county	P000S(114)
291H	Mellette	Roadway Lighting	1500	07/12/93	09/02/93	US83-through the town of White River	PH0083(52)44
305X	Minnehaha	Traffic Signals	14400	10/30/87	06/09/88	Intersection of Cliff Ave & Rice St in Sioux Falls	F-HES1038(8)368
3093	Pennington	Reconstruction-Continuous Center Turn Lane	22775	02/04/92	05/22/92	SD44(3)(Jackson Blvd) from W Main to Mt View RD	HES1741(1)
3097	Minnehaha	Signal Upgrade	28200	06/15/92	10/19/92	SD38-10th & 11th Sts.	PH0038(25)371
310X	Pennington	Signing	N/A	04/28/87	06/24/87	County roads throughout Pennington county	HES6480(3)
3113	Davison	Reconstruction-Left Turn Lane	4115	04/01/91	11/01/91	SD37 & 23rd St in Mitchell	HES0037(46)76
3114	Pennington	Traffic Signals	12400	07/08/91	06/16/92	SD79 & Fairmont Blvd in Rapid City	HES0079(34)75
3115	Pennington	Reconstruction-Continuous Center Turn Lane	21400	11/20/91	09/22/92	Cambell St. from E North St. to SD44	F-HES2016(4)70

PCEMS #	County	Improvement Type	ADT	Begin	End	Location Description	Project
3116	Mellette	Pavement Marking-Continuous Center Turn Ln.	1500	02/14/93	11/03/93	US83-through the town of White River	NH-PH0083(42)44
3118	Bon Homme	Shoulder Widening	1070	04/26/93	11/02/93	SD46-from jct. SD25 east to the Menno Rd.	P-PH0046(40)318
3120	Pennington	Reconstruction-Left Turn Lane	6834	06/18/91	09/23/91	SD79-east entrances at SDSM&T	HES0079(35)77
319X	Minnehaha	Realignment-Horizontal	37	10/23/86	05/27/87	Co. Rd. East of JCT SD11 & Minn Co #115	HES8050(13)
321X	Davison	Remove Fixed Object	8300	02/12/90	11/01/90	Burr St from Douglas Ave to 1st Ave in Mitchell	HES3681(1)
322X	Fall River	Realignment-Horizontal	540	09/02/86	06/05/87	SD71 MRM 30.5 South of Hot Springs	HES3071(6)30
325X	Minnehaha	Realignment-Horizontal and Vertical	225	06/22/87	08/11/87	Township Rd. from SD11 to Palisades Park	HH8050(14)
330X	Meade	Signal Upgrade	9250	11/03/86	06/24/87	SD79 & Douglas in Sturgis	HES0079(29)107
334X	Pennington	Reconstruction-Left Turn Lane	10614	05/05/88	05/27/88	Campbell and North St in Rapid City	HES2090(6)71
335X	Pennington	Reconst. Left Turn Lane w/ signal phase	11620	04/15/88	08/15/88	Intersection of SD44 & Canyon Lake Dr. in RC	HES0044(73)41
338X	Brown	Roadway Lighting	9000	05/11/88	07/01/88	S Main fro US12 to 12th St South in Aberdeen	HES2313(2)
339X	Lawrence	Traffic Signals	10000	08/11/87	12/04/87	Jackson and Main in Spearfish	HES8300(1)
343X	Codington	Install signal w/ turn radii	17515	05/01/87	06/12/87	US212 & 11th St. SE in Watertown	HES0212(67)377
344X	Butte	Reconstruction-Realign intersection	10000	09/16/88	10/21/88	US85 and National St in Belle Fourche	HES0085(32)55
353H, 334S	Corson	Signing	N/A	07/21/94	10/01/94	County roads throughout Corson county	P000S(119)
3598	Pennington	Signal Upgrade	17935	07/08/91	11/01/91	US16 (8th St) and Kansas City St in Rapid City	HES0016(49)68
3619	Pennington	Pavement Marking-Continuous Center Turn Ln.	24300	06/18/91	07/05/91	SD44(W Omaha St)-Mt View Rd to 11th St in RC	HES0044(107)43
3620	Brookings	Traffic Signals	5960	01/01/93	06/01/93	City-intersection of 5th St. S. & Main Ave.	PH3313(8)
3621	Brookings	Traffic Signals	8875	01/01/93	06/01/93	8th St. S & 22nd Ave in Brookings	PH3360(3)
3641	Minnehaha	Reconstruction-Continuous Center Turn Lane	18500	06/28/93	09/14/93	26th St.- from Big Sioux River St. to Cleveland Av	P-PH1368(5)
3825	Pennington	Pavement Marking-Left Turn Lane	17807	06/30/93	07/15/93	City Sts.- intersection of 5th St. & St. Cloud St.	PH1669(28)
3830	Pennington	Reconstruction-Continuous Center Turn Lane	18315	06/08/94	10/27/94	SD44-from Campbell St. southeasterly to Sedivy Ln	PH0044(115)45
3832	Yankton	Signal Upgrade	5085	04/26/93	05/03/93	US81 & SD50 in Yankton	PH0081(64)3
3853	Pennington	Pavement Marking-Continuous Center Turn Ln.	13430	06/30/93	07/15/93	LaCrosse St.-from Anamosa St. S to E North St.	PH1575
396W	Meade	Signing	N/A	09/17/90	10/30/90	County roads throughout Meade county	HES8047(6)
3978	Davison	Signal Upgrade	15130	09/30/94	10/21/94	SD37-(Sanborn Blvd) & 7th Ave in Mitchell	PH0037(67)75
3980	Pennington	Traffic Signals	10270	06/14/93	09/21/93	US16 (8th St) & Cathedral Dr. intersection in RC	PH0016(56)67
3991	Pennington	Pavement Marking-Left Turn Lane	36545	06/30/93	07/15/93	intersection of W Main St. & Cross St. in RC	PH1714(1)

PCEMS #	County	Improvement Type	ADT	Begin	End	Location Description	Project
4096	Buffalo	Roadway Lighting	2144	04/11/94	07/14/94	SD47-through Ft. Thompson	P-PH0047(34)89
429W, 3821	Hughes	Signing	N/A	04/12/94	05/24/94	County roads throughout Hughes county	P000S(108)
450X	Pennington	Reconstruction-Continuous Center Turn Lane	15000	06/28/88	06/29/88	Pennington Co #223, Ellsworth AFB Main Ent.	HES6549(2)52
451X	Pennington	Reconst. Left Turn Lane w/ signal phase	14000	04/04/88	10/03/88	SD238 from Campbell to SD44	HES1804(4)
452X	Hughes	Realignment-Horizontal and Vertical	700	10/18/90	09/01/91	SD1804 From Oahe Dam, North	RS-HES3804(26)256
588X	Minnehaha	Reconstruction-Realign Intersection	31650	04/14/93	11/03/93	City-intersection of Russell St. & Prairie Ave	P-PH1282(1)
589X	Brown	Install signal w/ turn radii	4300	10/11/88	03/13/89	8th Ave NE & Roosevelt St in Aberdeen	HES8007(25)
626W, 3826	Day	Signing	N/A	10/19/93	05/11/94	County roads throughout Day county	P000S(111)

Table II

HES-Data by Improvement Type

PCEMS #	County	Improvement Type	ADT	Begin	End	Location Description	Project
589X	Brown	Install signal w/ turn radii	4300	10/11/88	03/13/89	8th Ave NE & Roosevelt St in Aberdeen	HES8007(25)
343X	Codington	Install signal w/ turn radii	17515	05/01/87	06/12/87	US212 & 11th St. SE in Watertown	HES0212(67)377
2097	Brown	Install signal w/ turn radii	3659	07/13/87	01/15/88	3rd & Dakota S in Aberdeen	HES2306(3)
3619	Pennington	Pavement Marking-Continuous Center Turn Ln.	24300	06/18/91	07/05/91	SD44(W Omaha St)-Mt View Rd to 11th St in RC	HES0044(107)43
3116	Mellette	Pavement Marking-Continuous Center Turn Ln.	1500	02/14/93	11/03/93	US83-through the town of White River	NH-PH0083(42)44
3853	Pennington	Pavement Marking-Continuous Center Turn Ln.	13430	06/30/93	07/15/93	LaCrosse St.-from Anamosa St. S to E North St.	PH1575
3991	Pennington	Pavement Marking-Left Turn Lane	36545	06/30/93	07/15/93	intersection of W Main St. & Cross St. in RC	PH1714(1)
3825	Pennington	Pavement Marking-Left Turn Lane	17807	06/30/93	07/15/93	City Sts.- intersection of 5th St. & St. Cloud St.	PH1669(28)
322X	Fall River	Realignment-Horizontal	540	09/02/86	06/05/87	SD71 MRM 30.5 South of Hot Springs	HES3071(6)30
319X	Minnehaha	Realignment-Horizontal	37	10/23/86	05/27/87	Co. Rd. East of JCT SD11 & Minn Co #115	HES8050(13)
0083	Lawrence	Realignment-Horizontal	1850	05/04/87	06/16/87	US385 at MRM 118.8--S. of JCT US85 & US385	HES0385(23)119
452X	Hughes	Realignment-Horizontal and Vertical	700	10/18/90	09/01/91	SD1804 From Oahe Dam, North	RS-HES3804(26)256
325X	Minnehaha	Realignment-Horizontal and Vertical	225	06/22/87	08/11/87	Township Rd. from SD11 to Palisades Park	HH8050(14)
2085	Shannon	Realignment-Horizontal and Vertical	3671	08/14/89	10/01/89	SD407 from NE state line to Pine Ridge	HES0407(2)0
2087	Pennington	Reconst. Left Turn Lane w/ signal phase	15000	09/22/88	12/19/88	SD439 intersection of Campbell & St Patrick in RC	HES0439(8)
335X	Pennington	Reconst. Left Turn Lane w/ signal phase	11620	04/15/88	08/15/88	Intersection of SD44 & Canyon Lake Dr. in RC	HES0044(73)41
451X	Pennington	Reconst. Left Turn Lane w/ signal phase	14000	04/04/88	10/03/88	SD238 from Campbell to SD44	HES1804(4)
3115	Pennington	Reconstruction-Continuous Center Turn Lane	21400	11/20/91	09/22/92	Cambell St. from E North St. to SD44	F-HES2016(4)70
3830	Pennington	Reconstruction-Continuous Center Turn Lane	18315	06/08/94	10/27/94	SD44-from Campbell St. southeasterly to Sedivy Ln	PH0044(115)45
3641	Minnehaha	Reconstruction-Continuous Center Turn Lane	18500	06/28/93	09/14/93	26th St.- from Big Sioux River St. to Cleveland Av	P-PH1368(5)
450X	Pennington	Reconstruction-Continuous Center Turn Lane	15000	06/28/88	06/29/88	Pennington Co #223, Ellsworth AFB Main Ent.	HES6549(2)52
3093	Pennington	Reconstruction-Continuous Center Turn Lane	22775	02/04/92	05/22/92	SD44(3)(Jackson Blvd) from W Main to Mt View RD	HES1741(1)
157W	Yankton	Reconstruction-Increase Turning Radii	3120	07/16/91	12/01/91	9th & Summit in Yankton to 8th St	M-HES4756(2)
3120	Pennington	Reconstruction-Left Turn Lane	6834	06/18/91	09/23/91	SD79-east entrances at SDSM&T	HES0079(35)77
3113	Davison	Reconstruction-Left Turn Lane	4115	04/01/91	11/01/91	SD37 & 23rd St in Mitchell	HES0037(46)76
334X	Pennington	Reconstruction-Left Turn Lane	10614	05/05/88	05/27/88	Campbell and North St in Rapid City	HES2090(6)71
2096	Pennington	Reconstruction-Realign Intersection	2000	08/07/89	09/05/89	Hillsview Dr. & W. St. Patrick St.	HES1883(1)
2113	Union	Reconstruction-Realign Intersection	780	04/12/90	08/01/90	SD50 and county road at Junction City	F-HES0050(35)417

PCEMS #	County	Improvement Type	ADT	Begin	End	Location Description	Project
588X	Minnehaha	Reconstruction-Realign Intersection	31650	04/14/93	11/03/93	City-intersection of Russell St. & Prairie Ave	P-PH1282(1)
1919	Beadle	Reconstruction-Realign Intersection	4650	06/12/89	08/26/89	US14 & Lincoln Ave in Huron	HES0014(95)344
344X	Butte	Reconstruction-Realign intersection	10000	09/16/88	10/21/88	US85 and National St in Belle Fourche	HES0085(32)55
321X	Davison	Remove Fixed Object	8300	02/12/90	11/01/90	Burr St from Douglas Ave to 1st Ave in Mitchell	HES3681(1)
2574	Bennett	Roadway Lighting	1100	10/18/88	02/17/89	SD73 from Jct US18 1400ft South	HES0073(33)12
2076	Bennett	Roadway Lighting	1500	10/18/88	02/17/89	US18 through Martin	HES0018(87)148
291H	Mellette	Roadway Lighting	1500	07/12/93	09/02/93	US83-through the town of White River	PH0083(52)44
338X	Brown	Roadway Lighting	9000	05/11/88	07/01/88	S Main fro US12 to 12th St South in Aberdeen	HES2313(2)
4096	Buffalo	Roadway Lighting	2144	04/11/94	07/14/94	SD47-through Ft. Thompson	P-PH0047(34)89
3118	Bon Homme	Shoulder Widening	1070	04/26/93	11/02/93	SD46-from jct. SD25 east to the Menno Rd.	P-PH0046(40)318
3097	Minnehaha	Signal Upgrade	28200	06/15/92	10/19/92	SD38-10th & 11th Sts.	PH0038(25)371
3978	Davison	Signal Upgrade	15130	09/30/94	10/21/94	SD37-(Sanborn Blvd) & 7th Ave in Mitchell	PH0037(67)75
3832	Yankton	Signal Upgrade	5085	04/26/93	05/03/93	US81 & SD50 in Yankton	PH0081(64)3
330X	Meade	Signal Upgrade	9250	11/03/86	06/24/87	SD79 & Douglas in Sturgis	HES0079(29)107
3598	Pennington	Signal Upgrade	17935	07/08/91	11/01/91	US16 (8th St) and Kansas City St in Rapid City	HES0016(49)68
626W, 3826	Day	Signing	N/A	10/19/93	05/11/94	County roads throughout Day county	P000S(111)
310X	Pennington	Signing	N/A	04/28/87	06/24/87	County roads throughout Pennington county	HES6480(3)
429W, 3821	Hughes	Signing	N/A	04/12/94	05/24/94	County roads throughout Hughes county	P000S(108)
264H, 087S	Fall River	Signing	N/A	04/18/94	07/27/94	County roads throughout Fall River county	P000S(114)
353H, 334S	Corson	Signing	N/A	07/21/94	10/01/94	County roads throughout Corson county	P000S(119)
396W	Meade	Signing	N/A	09/17/90	10/30/90	County roads throughout Meade county	HES8047(6)
2257	Edmunds	Slope flattening of approaches	250	07/09/86	09/04/86	SD253 from US12 N. 9 mi.	HES3253(3)172
2538	Pennington	Slope flattening of approaches	3223	11/04/87	05/05/88	SD79 from Maverick JCT to Rapid City	HES0079(31)26
1840	Pennington	Slope flattening of approaches	1300	09/08/86	05/14/87	US83 from US14 N. to Sully line: from US212 to ND	HES0083(38)138
1839	Walworth	Slope flattening of approaches	1834	07/09/86	09/04/86	US12 from S. JCT US83 E. to Ipswich	HES0012(52)214
2114	Pennington	Traffic Signals	20995	07/08/91	11/01/91	5th St and Kansas City St in Rapid City	HES1669(27)
3114	Pennington	Traffic Signals	12400	07/08/91	06/16/92	SD79 & Fairmont Blvd in Rapid City	HES0079(34)75
305X	Minnehaha	Traffic Signals	14400	10/30/87	06/09/88	Intersection of Cliff Ave & Rice St in Sioux Falls	F-HES1038(8)368

PCEMS #	County	Improvement Type	ADT	Begin	End	Location Description	Project
3980	Pennington	Traffic Signals	10270	06/14/93	09/21/93	US16 (8th St) & Cathedral Dr. intersection in RC	PH0016(56)67
2089	Pennington	Traffic Signals	19600	07/23/90	12/15/90	E North St & Spruce	HES2090(10)70
2095	Pennington	Traffic Signals	19600	07/23/90	12/15/90	E North St & Milwaukee St	HES2090(11)70
339X	Lawrence	Traffic Signals	10000	08/11/87	12/04/87	Jackson and Main in Spearfish	HES8300(1)
3621	Brookings	Traffic Signals	8875	01/01/93	06/01/93	8th St. S & 22nd Ave in Brookings	PH3360(3)
3620	Brookings	Traffic Signals	5960	01/01/93	06/01/93	City-intersection of 5th St. S. & Main Ave.	PH3313(8)

Table III

Previous Severity Factors

PCEM	Fatal	Fatality Factor	Incap.Inj.	Incap. Inj. Factor	Non-incap. Inj.	Non-incap Inj. Factor	Poss. Inj.	Poss. Inj. Factor	PDO	PDO Factor	Previous Combined SRF
0083	0	0	3	270	1	18	0	0	11	11	299
087S	0	0	8	720	9	162	14	133	17	17	1032
157W	0	0	0	0	1	18	1	9.5	2	2	29.5
1839	0	0	2	180	10	180	7	66.5	35	35	461.5
1840	5	6500	16	1440	22	396	14	133	80	80	8549
1919	0	0	0	0	1	18	3	28.5	2	2	48.5
2085	0	0	1	90	4	72	1	9.5	5	5	176.5
2087	0	0	6	540	15	270	18	171	36	36	1017
2089	0	0	2	180	2	36	20	190	17	17	423
2095	0	0	2	180	3	54	7	66.5	7	7	307.5
2096	0	0	0	0	0	0	1	9.5	1	1	10.5
2097	0	0	2	180	7	126	10	95	23	23	424
2113	0	0	1	90	1	18	2	19	0	0	127
2114	0	0	1	90	3	54	15	142.5	23	23	309.5
2257	1	1300	0	0	0	0	0	0	0	0	1300
2538	10	13000	15	1350	34	612	19	180.5	58	58	15200.5
2574	0	0	0	0	0	0	0	0	1	1	1
264H	0	0	8	720	9	162	14	133	17	17	1032
291H	1	1300	1	90	1	18	1	9.5	1	1	1418.5
305X	0	0	0	0	4	72	0	0	26	26	98
3093	0	0	3	270	11	198	23	218.5	25	25	711.5
3097	0	0	11	990	45	810	61	579.5	94	94	2473.5
310X	10	13000	67	6030	189	3402	121	1149.5	484	484	24065.5
3113	0	0	2	180	0	0	4	38	5	5	223
3114	0	0	7	630	2	36	5	47.5	15	15	728.5
3115	0	0	18	1620	32	576	44	418	58	58	2672
3116	1	1300	1	90	1	18	1	9.5	1	1	1418.5
3118	0	0	5	450	2	36	3	28.5	5	5	519.5
3120	0	0	0	0	0	0	0	0	1	1	1
319X	1	1300	1	90	3	54	0	0	0	0	1444
321X	0	0	0	0	0	0	0	0	9	9	9
322X	0	0	0	0	0	0	1	9.5	0	0	9.5
325X	0	0	2	180	5	90	0	0	3	3	273
334S	2	2600	5	450	4	72	15	142.5	41	41	3305.5
334X	0	0	2	180	0	0	2	19	0	0	199
335X	1	1300	12	1080	13	234	10	95	17	17	2726
338X	0	0	2	180	6	108	11	104.5	47	47	439.5
339X	0	0	0	0	1	18	0	0	10	10	28
343X	0	0	7	630	2	36	3	28.5	7	7	701.5
344X	0	0	0	0	1	18	1	9.5	16	16	43.5
353H	2	2600	5	450	4	72	15	142.5	41	41	3305.5
3598	0	0	5	450	8	144	19	180.5	44	44	818.5
3619	0	0	3	270	11	198	18	171	34	34	673
3620	0	0	0	0	3	54	0	0	6	6	60
3621	0	0	1	90	2	36	2	19	12	12	157
3641	0	0	7	630	26	468	16	152	51	51	1301
3821	1	1300	4	360	19	342	2	19	52	52	2073
3825	0	0	3	270	4	72	10	95	3	3	440
3826	2	2600	8	720	10	180	32	304	79	79	3883
3830	0	0	8	720	12	216	17	161.5	12	12	1109.5

PCEM	Fatal	Fatality Factor	Incap.Inj.	Incap. Inj. Factor	Non-incap. Inj.	Non-incap Inj. Factor	Poss. Inj.	Poss. Inj. Factor	PDO	PDO Factor	Previous Combined SRF
3832	0	0	11	990	13	234	2	19	8	8	1251
3853	0	0	15	1350	33	594	36	342	67	67	2353
396W	5	6500	63	5670	91	1638	50	475	218	218	14501
3978	0	0	0	0	1	18	4	38	10	10	66
3980	0	0	1	90	4	72	3	28.5	11	11	201.5
3991	0	0	4	360	3	54	1	9.5	10	10	433.5
4096	0	0	0	0	3	54	2	19	1	1	74
429W	1	1300	4	360	19	342	2	19	52	52	2073
450X	0	0	0	0	2	36	3	28.5	18	18	82.5
451X	0	0	2	180	9	162	12	114	12	12	468
452X	0	0	0	0	1	18	1	9.5	0	0	27.5
588X	0	0	1	90	5	90	5	47.5	10	10	237.5
589X	0	0	2	180	1	18	4	38	4	4	240
626W	2	2600	8	720	10	180	32	304	79	79	3883

Table IV

Following Severity Factors

PCEM	Fatal	Fatality Factor	Incap.Inj.	Incap. Inj. Factor	Non-incap. Inj.	Non-incap Inj. Factor	Poss. Inj.	Poss. Inj. Factor	PDO	PDO Factor	Following Combined SRF
0083	0	0	0	0	0	0	0	0	0	0	0
087S	0	0	7	630	13	234	2	19	25	25	908
157W	0	0	0	0	0	0	0	0	0	0	0
1839	0	0	1	90	14	252	3	28.5	52	52	422.5
1840	3	3900	11	990	25	450	8	76	76	76	5492
1919	0	0	0	0	0	0	0	0	2	2	2
2085	1	1300	6	540	2	36	7	66.5	8	8	1950.5
2087	0	0	3	270	3	54	15	142.5	22	22	488.5
2089	0	0	1	90	2	36	8	76	9	9	211
2095	0	0	0	0	14	252	6	57	4	4	313
2096	0	0	0	0	1	18	0	0	4	4	22
2097	0	0	0	0	1	18	0	0	6	6	24
2113	0	0	0	0	1	18	3	28.5	1	1	47.5
2114	0	0	2	180	4	72	4	38	12	12	302
2257	0	0	0	0	0	0	1	9.5	4	4	13.5
2538	5	6500	34	3060	20	360	9	85.5	54	54	10059.5
2574	0	0	0	0	0	0	0	0	1	1	1
264H	0	0	7	630	13	234	2	19	25	25	908
291H	0	0	0	0	2	36	0	0	0	0	36
305X	0	0	3	270	4	72	6	57	17	17	416
3093	0	0	3	270	9	162	26	247	32	32	711
3097	0	0	10	900	22	396	27	256.5	63	63	1615.5
310X	10	13000	94	8460	208	3744	120	1140	433	433	26777
3113	0	0	2	180	2	36	2	19	3	3	238
3114	0	0	2	180	4	72	0	0	4	4	256
3115	0	0	11	990	34	612	35	332.5	54	54	1988.5
3116	0	0	0	0	2	36	0	0	0	0	36
3118	0	0	4	360	0	0	3	28.5	4	4	392.5
3120	0	0	0	0	0	0	0	0	0	0	0
319X	0	0	0	0	0	0	0	0	0	0	0
321X	0	0	0	0	0	0	0	0	0	0	0
322X	0	0	0	0	0	0	0	0	0	0	0
325X	0	0	0	0	0	0	0	0	0	0	0
334S	1	1300	3	270	8	144	10	95	41	41	1850
334X	0	0	1	90	1	18	1	9.5	1	1	118.5
335X	0	0	1	90	0	0	0	0	3	3	93
338X	0	0	3	270	4	72	16	152	35	35	529
339X	0	0	1	90	1	18	3	28.5	20	20	156.5
343X	0	0	2	180	1	18	3	28.5	9	9	235.5
344X	0	0	0	0	1	18	2	19	9	9	46
353H	1	1300	3	270	8	144	10	95	41	41	1850
3598	0	0	4	360	14	252	28	266	22	22	900
3619	0	0	11	990	7	126	9	85.5	26	26	1227.5
3620	0	0	2	180	2	36	3	28.5	0	0	244.5

PCEM	Fatal	Fatality Factor	Incap.Inj.	Incap. Inj. Factor	Non-incap. Inj.	Non-incap Inj. Factor	Poss. Inj.	Poss. Inj. Factor	PDO	PDO Factor	Following Combined SRF
3621	0	0	0	0	5	90	9	85.5	8	8	183.5
3641	0	0	4	360	22	396	21	199.5	36	36	991.5
3821	1	1300	4	360	16	288	6	57	36	36	2041
3825	0	0	0	0	1	18	2	19	7	7	44
3826	0	0	11	990	20	360	19	180.5	74	74	1604.5
3830	2	2600	4	360	3	54	4	38	20	20	3072
3832	0	0	0	0	0	0	0	0	8	8	8
3853	0	0	15	1350	18	324	45	427.5	71	71	2172.5
396W	1	1300	52	4680	88	1584	67	636.5	207	207	8407.5
3978	0	0	0	0	4	72	2	19	7	7	98
3980	0	0	1	90	5	90	4	38	7	7	225
3991	0	0	1	90	4	72	3	28.5	2	2	192.5
4096	0	0	0	0	0	0	0	0	2	2	2
429W	1	1300	4	360	16	288	6	57	36	36	2041
450X	1	1300	1	90	4	72	1	9.5	9	9	1480.5
451X	0	0	15	1350	28	504	22	209	39	39	2102
452X	0	0	0	0	0	0	0	0	4	4	4
588X	0	0	3	270	5	90	11	104.5	23	23	487.5
589X	0	0	0	0	0	0	5	47.5	5	5	52.5
626W	0	0	11	990	20	360	19	180.5	74	74	1604.5

Table V

Cost/Benefit Analysis

PCEMS #	Project	Improvement Type	Location Description	Cost/Benefit by location
589X	HES8007(25)	Install signal w/ turn radii	8th Ave NE & Roosevelt St in Aberdeen	0.13
343X	HES0212(67)377	Install signal w/ turn radii	US212 & 11th St. SE in Watertown	0.08
2097	HES2306(3)	Install signal w/ turn radii	3rd & Dakota S in Aberdeen	8.92
3619	HES0044(107)43	Pavement Marking-Continuous Center Turn Ln.	SD44(W Omaha St)-Mt View Rd to West Blvd in RC	2.29
3116	NH-PH0083(42)44	Pavement Marking-Continuous Center Turn Ln.	US83-through the town of White River	N/A
3853	PH1575	Pavement Marking-Continuous Center Turn Ln.	LaCrosse St.-from Anamosa St. S to E North St.	-0.03
3991	PH1714(1)	Pavement Marking-Left Turn Lane	intersection of W Main St. & Cross St. in RC	5.16
3825	PH1669(28)	Pavement Marking-Left Turn Lane	City Sts.- intersection of 5th St. & St. Cloud St.	0
322X	HES3071(6)30	Realignment-Horizontal	SD71 MRM 30.5 South of Hot Springs	0.16
319X	HES8050(13)	Realignment-Horizontal	Co. Rd. East of JCT SD11 & Minn Co #115	2.72
0083	HES0385(23)119	Realignment-Horizontal	US385 at MRM 118.8--S. of JCT US85 & US385	11.34
452X	RS-HES3804(26)256	Realignment-Horizontal and Vertical	SD1804 From Oahe Dam, North	N/A
325X	HH8050(14)	Realignment-Horizontal and Vertical	Township Rd. from SD11 to Palisades Park	N/A
2085	HES0407(2)0	Realignment-Horizontal and Vertical	SD407 from NE state line to Plne Ridge	-0.24
2087	HES0439(8)	Reconst. Left turn Lane w/ signal phase	SD439 intersection of Campbell & St Patrick in RC	2.57
335X	HES0044(73)41	Reconst. Left turn Lane w/ signal phase	Intersection of SD44 & Canyon Lake Dr. in RC	4.64

PCEMS #	Project	Improvement Type	Location Description	Cost/Benefit by location
451X	HES1804(4)	Reconst. Left Turn Lane w/ signal phase	SD238 from Campbell to SD44	-27.19
3115	F-HES2016(4)70	Reconstruction-Continuous Center Turn Lane	Cambell St. from E North St. to SD44	0
3830	PH0044(115)45	Reconstruction-Continuous Center Turn Lane	SD44-from Campbell St. southeasterly to Sedivy Ln	-0.02
3641	P-PH1368(5)	Reconstruction-Continuous Center Turn Lane	26th St.- from Big Sioux River St. to Cleveland Av	N/A
450X	HES6549(2)52	Reconstruction-Continuous Center Turn Lane	Pennington Co #223, Ellsworth AFB Main Ent.	7.15
3093	HES1741(1)	Reconstruction-Continuous Center Turn Lane	SD44(3)(Jackson Blvd) from W Main to Mt View RD	-0.8
157W	M-HES4756(2)	Reconstruction-Increase Turning Radii	9th & Summit in Yankton to 8th St	N/A
3120	HES0079(35)77	Reconstruction-Left Turn Lane	SD79-east entrances at SDSM&T	0.21
3113	HES0037(46)76	Reconstruction-Left Turn Lane	SD37 & 23rd St in Mitchell	0.16
334X	HES2090(6)71	Reconstruction-Left Turn Lane	Campbell and North St in Rapid City	N/A
2096	HES1883(1)	Reconstruction-Realign Intersection	Hillsview Dr. & W. St. Patrick St.	-1.47
2113	F-HES0050(35)417	Reconstruction-Realign Intersection	SD50 and county road at Junction City	N/A
588X	P-PH1282(1)	Reconstruction-Realign Intersection	City-intersection of Russell St. & Prairie Ave	N/A
1919	HES0014(95)344	Reconstruction-Realign Intersection	US14 & Lincoln Ave in Huron	0.26
344X	HES0085(32)55	Reconstruction-Realign intersection	US85 and National St in Belle Fourche	-0.14
321X	HES3681(1)	Remove Fixed Object	Burr St from Douglas Ave to 1st Ave in Mitchell	N/A

PCEMS #	Project	Improvement Type	Location Description	Cost/Benefit by location
2574	HES0073(33)12	Roadway Lighting	SD73 from Jct US18 1400ft South	0
2076	HES0018(87)148	Roadway Lighting	US18 through Martin	-0.28
291H	PH0083(52)44	Roadway Lighting	US83-through the town of White River	0.84
338X	HES2313(2)	Roadway Lighting	S Main fro US12 to 12th St South in Aberdeen	1.07
4096	P-PH0047(34)89	Roadway Lighting	SD47-through Ft. Thompson	N/A
3118	P-PH0046(40)318	Shoulder Widening	SD46-from jct. SD25 east to the Menno Rd.	N/A
3097	PH0038(25)371	Signal Upgrade	SD38-10th & 11th Sts.	1.96
3978	PH0037(67)75	Signal Upgrade	SD37-(Sanborn Blvd) & 7th Ave in Mitchell	0.15
3832	PH0081(64)3	Signal Upgrade	US81 & SD50 in Yankton	2.68
330X	HES0079(29)107	Signal Upgrade	SD79 & Douglas in Sturgis	-0.64
3598	HES0016(49)68	Signal Upgrade	US16 (8th St) and Kansas City St in Rapid City	1.61
626W, 3826	P000S(111)	Signing	County roads throughout Day county	0.19
310X	HES6480(3)	Signing	County roads throughout Pennington county	N/A
429W, 3821	P000S(108)	Signing	County roads throughout Hughes county	2.35
264H, 087S	P000S(114)	Signing	County roads throughout Fall River county	-0.03
353H, 334S	P000S(119)	Signing	County roads throughout Corson county	0.28
396W	HES8047(6)	Signing	County roads throughout Meade county	0.08
2257	HES3253(3)172	Slope flattening of approaches	SD253 from US12 N. 9 mi.	-37.76
2538	HES0079(31)26	Slope flattening of approaches	SD79 from Maverick JCT to Rapid City	2.3
1840	HES0083(38)138	Slope flattening of approaches	US83 from US14 N. to Sully line: from US212 to ND	0.09

PCEMS #	Project	Improvement Type	Location Description	Cost/Benefit by location
1839	HES0012(52)214	Slope flattening of approaches	US12 from S. JCT US83 E. to Ipswich	-2.1
2114	HES1669(27)	Traffic Signals	5th St and Kansas City St in Rapid City	5.09
3114	HES0079(34)75	Traffic Signals	SD79 & Fairmont Blvd in Rapid City	0.45
305X	F-HES1038(8)368	Traffic Signals	Intersection of Cliff Ave & Rice St in Sioux Falls	N/A
3980	PH0016(56)67	Traffic Signals	US16 (8th St) & Cathedral Dr. intersection in RC	0.07
2089	HES2090(10)70	Traffic Signals	E North St & Spruce	0
2095	HES2090(11)70	Traffic Signals	E North St & Milwaukee St	0
339X	HES8300(1)	Traffic Signals	Jackson and Main in Spearfish	-4.56
3621	PH3360(3)	Traffic Signals	8th St. S & 22nd Ave in Brookings	0.13
3620	PH3313(8)	Traffic Signals	City-intersection of 5th St. S. & Main Ave.	0.8