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16. Abstract (Limit 200 words)

Maine was recently ranked 9th in the nation concerning fatalities caused by collisions with utility poles based on Miles of Travel. The number of collisions and fatalities can be reduced significantly with an updated Utility Pole Placement Policy.

Maine's current policy relocates poles only when a section of roadway is reconstructed or rehabilitated. This practice of relocating poles is too slow to reduce the number of vehicle-utility pole collisions.

This study was carried out to identify the common factors involved in vehicle-utility pole collisions and suggest corrective measures to update the current policy to aid in reducing the high number of collisions with utility poles.

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Table of Contents

Appendices

List of Figures

List of Tables

EXECUTIVE SUMMARY

Between the years of 1994 and 1998, Maine had a total of 46 fatalities involving collisions with utility poles according to a report generated by the Federal Highway Administration (FHWA). A more current review of Maine Department of Transportation's (MDOT) database shows that there were 7,544 crashes involving utility poles in this time frame, resulting in 54 fatalities and 4,077 injuries. Based on number of fatalities per hundred million vehicle miles traveled, this ranked Maine 9th nationwide. Maine's Policy on Above Ground Utility Locations addresses pole placement based on three factors - type of project, rural or urban environment, and speed limit. The policy was last updated in January of 1995. This policy safely locates utility poles on construction, reconstruction, restoration, and rehabilitation projects but does not effectively address utility pole placement on structural overlay or light overlay projects, where the majority of utility pole crashes occur. The primary goal of this research is to determine optimal utility pole offset distances for these types of projects and also to identify potential alternative treatments where pole relocation is not possible.

Summary

Four methods were used to determine the nature of the utility pole offset problem and to identify potential solutions:

1. A database of utility pole crashes between 1994 and 1998 was developed to isolate contributing factors for each crash such as light condition, roadway geometry, surface condition, type of shoulder, speed limit, and hour of day / day of week. A second database was generated from the first database to isolate areas that had two or more crashes in any three consecutive years within the five-year study period. The resulting data set was used to conduct visual observations and note contributing factors such as pole offset distance, pavement condition, severity of slope, and type of area beyond utility poles (residential, woods, open, etc.).
2. A questionnaire was sent to all State Transportation Departments requesting information on their current Utility Policy to review and possibly incorporate some of their revisions into our policy.
3. Utility companies were interviewed and asked questions regarding placement of utility poles and suggestions for improvement.
4. Research was conducted to identify and evaluate potential alternative safety structures for possible inclusion in Maine's utility pole placement policy.

Conclusions

Several conclusions have been reached based on the analyses that were conducted. The primary findings are described in the following paragraphs.

1. The Statewide database analyses revealed 74% of utility pole crashes and 87% of fatalities occurred in rural areas. Curved roadways accounted for 38% of utility pole crashes and 59% of the fatalities. Injuries generally were more severe on dry roadways under dark conditions. Excessive speed and driver inattention are the primary contributing factors involved in collisions with utility poles. One third of all crashes and 28% of fatalities occurred on roads posted at 72 km/h (45 mph), which represents 44% of Maine's roadways. Twenty three percent of crashes and 24% of fatalities occurred on roadways posted at 56 km/h (35 mph), which represents 7.2% of Maine's roadways.
2. Visual analysis of crash sites with two or more crashes in three consecutive years in a five year period revealed that over 70% of utility pole crashes occurred on roads with gravel, narrow gravel or no shoulders. Utility poles installed across tee intersections were noted at fifty-three of the sites. Nine areas had utility poles in medians or traffic islands. Seventy-four areas had utility poles installed on slopes greater than 4:1 with 81% of those areas posted at 70 km/h (45 mph) or greater and 80% have gravel or no shoulder. Eight areas had utility poles installed on the roadway side of curbing. Eighteen percent of the road segments reviewed contained poles on both sides of the road, and 38% had guy poles installed on the opposite side of the road. Nearly one third of poles were installed in wooded areas and an additional 31% were located in residential areas where additional right of way may be difficult to obtain. The ratio of collisions per area is much higher on "B" roads (roads not meeting current MDOT standards and recommended for reconstruction) than on "A" roads (roads built to MDOT standards). The average cost per collision is very high when pole offsets in rural areas are at 3.3 - 3.7 m (11 -12 ft). A significant drop in the number of collisions occurs when pole offsets are greater than 4 m (14 ft) in rural areas and greater than 2.4 m (8 ft) in urban areas.
3. Twenty-four states responded to a request for information and/or interviews concerning their Utility Pole Placement Policies. Two states reported a reduction in the number of utility pole collisions since revising their policy, while the remaining states either did not have a database to monitor crashes or their revised policy had not been implemented long enough to notice a change. Fifteen states follow AASHTO's Roadside Design Guide - Clear Zone Guidelines, or a modification of the guidelines, for their utility pole offsets. The three states with the lowest number of fatalities (according to FHWA's report) follow AASHTO's guidelines, have pole offsets of 9 m (30 ft) or more, or have a program in place to review and correct high crash areas. The top nine states with the fewest number of fatalities have offset adjustments for slopes and curves and/or encourage the use of alternative safety structures in urban areas.

4. Three utility companies were interviewed and expressed an interest in cooperating with MDOT to reduce the number of vehicle/utility pole collisions. One company would like more information on alternative safety structures and another expressed interest in locating high crash areas to review and correct the problem.
5. Four alternative safety structures were reviewed and a cost analysis was developed to determine if they could be used in urban areas with limited rights of way to help reduce the severity of injuries at urban high crash locations. All four alternative safety structures were found to be cost-effective.

Recommendations

Results of this research have generated several recommendations to help reduce the number of fatalities caused by collisions with utility poles. The current MDOT Utility Pole Location Policy should be modified to reflect the findings of this research as described below:

1. Review crash records annually to identify high crash areas for possible corrective measures such as relocating poles or using an alternative safety structure. Also review crash records on projects scheduled for structural or light overlay to determine if utility pole offsets should be increased.
2. Utility pole offsets should be greater than 2.4 m (8 ft) on roadways posted at 40 - 55 km/h (25 - 35 mph), greater than 4.3 m (14 ft) on roadways with posted speed limits of 65 - 70 km/h (40 - 45 mph), and greater than 6 m (24 ft) on roadways with speed limits of 80 km/h (50 mph) or greater. Utility poles should be installed at least as far back as on the back slope of all ditch lines and guy wires should always be installed on the backside of utility poles.
3. Eliminate poles in medians, traffic islands, and across from T type intersections or use alternative safety structures when these poles cannot be relocated.
4. Eliminate the use of poles on both sides of the road by grouping all utilities on one line of poles.
5. Reduce the number of poles on outside curves and increase the offset distance when poles are located on slopes greater than 4:1.
6. Wherever utility poles cannot be placed a sufficient distance from the road, consider installing appropriate alternative safety structures. Alternative safety structures that were reviewed as part of this research that were shown to be economically viable include steel-reinforced (breakaway) poles, low-profile concrete barriers, guardrail and soft concrete cushions.

INTRODUCTION

Based on information supplied by the Federal Highway Administration (FHWA) Maine had 46 fatalities involving collisions with utility poles between 1994 and 1998. This ranks Maine 30th in the nation based on total number of utility pole fatalities and 9th in the nation based on utility pole fatality rate (number of fatalities per hundred million vehicle miles traveled). Another summary furnished by the Highway Transportation Administration of California, which excludes Interstates, Freeways and Expressways (no utility poles on these roadways), ranks Maine 12th in the nation based on utility pole fatality rate.

The high number of vehicle-utility pole collisions likely would be reduced through a review of high crash locations for possible corrective measures and an updated utility pole placement policy. The Maine Department of Transportation's (MDOT) current Policy on Above Ground Utility Locations, which was last updated in January of 1995, addresses pole placement based on roadway treatment type (construction, reconstruction, rehabilitation, structural overlay or light resurfacing). Until research is undertaken to determine the most reasonable offset distance, which balances safety with economics and the associated construction problems in the field, the high number of utility pole collisions will likely continue.

SCOPE

This report examines other states' utility pole placement policies and methods of updating their policies as well as evaluating high utility pole collision areas in Maine. Contributing factors to be investigated are utility pole offset distances and locations based on roadway speed limits, geometry and traffic volumes.

METHODOLOGY

Maine's current Policy On Above Ground Utility Locations is determined by three factors - type of project, rural or urban environment, and speed limits (posted for reconstruction or design speed for new construction). Types of projects include Interstate, Freeway or Controlled Access highways, New Construction / Reconstruction, Rehabilitation / Restoration, Structural Pavement Overlay or Light Resurfacing. Each project type specifies a minimum pole offset measured from the face of the pole to the edge of design travel lane (which is the normal edge of pavement for the operating lanes exclusive of widening for passing, acceleration, deceleration or parking lanes, shoulders, drainage, boxed sections, etc.), or to other reference points as noted. Pole offsets are minimum requirements and greater offsets are encouraged where possible. A brief explanation of each type of project and minimum pole offset follow:

Current Policy on Above Ground Utility Locations

Interstate/Freeway or Controlled Access

Generally utility poles are not installed along these highways and will be permitted only under unusual conditions. When allowed, pole installations are to comply with AASHTO's "A Policy on the Accommodation of Utilities on Freeway Rights-of-Way" (Rev. 1989).

New Construction/Reconstruction

These projects are generally constructed to full AASHTO standards for geometrics and safety features.

In rural environments, the minimum offset is 9 meters from the edge of the travel lane.

In urban environments with speeds over 56 km/h (35 mph) the minimum offset is 6 meters from the edge of the travel lane when there is no curb present or 1 meter from the face of the curb when there is curb present.

In urban environments with speeds 56 km/h (35 mph) or less the minimum offset is 1 meter from the edge of the shoulder when there is no curb or 300 millimeters from the face of the curb.

Rehabilitation Restoration

These projects involve less than full reconstruction of the roadway base and relatively minor horizontal and vertical realignment. The geometric standards may be less than full reconstruction when limited by existing physical constraints.

In rural environments the minimum pole offset is 6 meters from the edge of the traveled lane.

In urban areas with speeds over 56 km/h (35 mph) without curb the minimum offset is 2 meters from the edge of the shoulder, with curb the minimum offset is 600 millimeters from the face of the curb.

In urban areas with speed limits of 56 km/h (35 mph) or less the minimum pole offset is 1 meter from the edge of the shoulder when there is no curb or when there is curb 300 millimeters from the face of the curb.

Structural Pavement Overlay

This treatment is designed to add significant additional strength to the pavement. Generally this is an overlay of more than 25 millimeters and is designed to last approximately ten years. Guardrail updating and other roadside improvements are often done in conjunction with a structural pavement overlay.

In rural and urban areas with posted speed limits over 56 km/h (35 mph) with no curb the minimum offset is 2 meters from the edge of the shoulder. When there is a curb the minimum pole offset is 300 millimeters from the face of the curb.

In rural and urban environments with speed limits of 56 km/h (35 mph) or less when there is no curb the minimum pole offset is 1 meter from the edge of the shoulder. When there is a curb, the minimum pole offset is 300 millimeters from the face of the curb.

When a review of crash records indicates a history of run-off-the-road, or pole-related collisions, the Department may require greater pole offsets on Structural Pavement Overlays.

Light Resurfacing - Rural and Urban

Light resurfacing projects are thin pavement overlays (generally 25 millimeters or less, plus required shim) that are intended to restore the riding quality and preserve the pavement structure for approximately five years.

Adjustments to pole locations will be made only if there is a physical conflict with the construction or if a review of crash records indicates a history of run-off-the-road or pole-related collisions.

Poles Behind Guardrail

Poles shall be set back a minimum of 1 meter from the back of the guardrail to the face of the pole. Where space permits, greater setbacks are *encouraged to facilitate snowplowing. This applies to poles in either a rural or urban environment on all highways except Interstate, Freeway or Controlled Access highways.*

Ditch Lines

Poles shall not be set in the flow line of a highway drainage ditch. Poles which would otherwise, by the criteria listed above, be placed within 600 millimeters either side of a ditch line shall be set in the back slope at least 600 millimeters from the flow line.

Other Requirements

Permanent poles shall not be permitted in the center island of a traffic circle. Poles shall not be permitted in any other traffic island if a satisfactory alternative location is available.

To avoid interference with culvert function, and with maintenance activities, poles shall not be permitted closer than 2.5 meters from any point on either end of a culvert.

Pole Relocations Not Connected with MDOT Projects

Utility pole placements made for reasons other than accommodation of an MDOT construction project shall meet the criteria listed above except as follows:

The basic minimum pole offset for all rural and urban highways with posted speed limits over 56 km/h (35 mph), except Interstate, Freeways and Controlled Access Highways, shall be 2 meters from the edge of the shoulder or 3 meters from the edge of the travel lane whichever is farther from the roadway. Greater setbacks are encouraged when space permits.

A questionnaire was sent to all State Transportation Departments requesting information about their current Utility Pole Placement Policies. In addition a literature search was performed on this topic. The results of this survey are discussed later in this report.

Crash report data were queried using the Transportation Information for Decision Enhancement (TIDE) program. TIDE is a tool for accessing, analyzing and reporting data from a data warehouse. The data warehouse includes Maine

Department of Transportation (MDOT) data for all public roads in Maine from Highway, Bridge, Railroad and Pavement Management Divisions, project related information and crash data as reported by the attending police officer. Data from TIDE can be used to generate tables, reports or maps with the use of Geographic Information System (GIS) technology. With the use of TIDE, utility pole collision data and locations can be isolated and evaluated.

MDOT uses an Automated Road Analyzer (ARAN) to collect roadway data such as video, rut depth, roughness and roadway geometry on State Highway and State Aid roads. ARAN video data were used to conduct a detailed inspection of a sample of high crash areas identified through TIDE.

Other state transportation departments were interviewed concerning their Utility Accommodation Policies and methods of determining utility pole placement such as clear zones or control zones.

Utility companies were surveyed for cost of relocating poles, offset distance restrictions, cost of downtime and general information or suggestions.

Alternative safety structures such as Steel Reinforced Safety Poles that fold when struck and protective barriers were also investigated.

DATA ANALYSIS

Data for this project will be divided into six topics:

1. Literature Search
2. Statewide Database Analysis
3. ARAN Video Analysis
4. State DOT Interviews and Utility Pole Policy Review
5. Utility Company Interviews
6. Alternative Safety Structures

1. Literature Search

The literature search revealed a common approach to assessing utility pole collisions. Data was examined for all utility pole collisions within a specific time period, usually 3 to 5 years, using data from police crash reports and/or computer databases. Crash sites were then field evaluated to determine contributing factors such as pole offset distance, roadway geometry, shoulder type and severity of slope, speed limit and traffic volume.

Control Zones or areas restricted to placement of utility poles such as T intersections and traffic islands were incorporated into utility pole policies.

Clear Zones where utility pole offset distances were extended based on factors such as posted speed limit and severity of slope, speed limit and degree of curvature for outside curves, areas beyond ramp lanes when changing from two lanes to one lane, etc. were also incorporated into utility pole policies.

2. Statewide Database Analysis

Utility pole collision data were queried over a 5-year period between 1994 and 1998. Excluding Interstate, Freeways, and Expressways Maine has a total of 21,783 miles of state highway, state aid, and town way roads with 88% of those roads located in rural areas. During this period, there were 7,544 collisions with utility poles resulting in 54 fatalities and 4,131 injuries. Approximately 74% of the 7,544 collisions and 87% of the 54 fatalities occurred in rural areas suggesting the focus of a revised utility accommodation policy should be for rural sections of Maine. A sample of the database is illustrated in Appendix A Table A-1.

FHWA's 1994 - 1998 fatality total of 46 differs from MDOT's total of 54 due to updating of MDOT 1998 data. At the time FHWA requested utility pole crash data for the 1994 - 1998 time period MDOT's 1998 crash data was incomplete.

Using the revised fatality figures based on Vehicle Miles Traveled (VMT) Maine would rank 7th when including Interstate and Other Freeways and Expressways (F & E) and 9th when excluding Interstate and other F & E.

A summary of contributing factors and severity of injuries for each utility pole collision, as reported by the attending officer's report, is illustrated in Table A-2 and Figure 1.

Types of injuries include "K" injuries (fatalities), "A" injuries (bleeding wound, distorted member or had to be carried from scene), "B" injuries (other visible injuries, bruises, abrasions, swelling, limping, etc.), and "C" injuries (no visible injury but had momentary unconsciousness or complaint of pain).

The following sections will briefly summarize each category of Table A-2.

2a. Road Character

According to the data 62% of utility pole collisions occurred on straight roads. This is understandable because there are fewer curved sections of roadway than straight. It should be noted that 59% of the fatalities occurred on curved roadways, suggesting that operators may have difficulty avoiding utility poles on curves after leaving the roadway due to the angle of approach (usually nearly head-on).

2b. Light Conditions

There are more collisions during daylight than darkness possibly due to higher amounts of traffic during daylight hours. Although there are fewer collisions in darkness almost half of the fatalities occur on dark highways with no streetlights, indicating factors like fatigue, condition of driver and visibility of the roadway may contribute to the problem. Visibility of the utility pole at night may also make it difficult for a driver to avoid a collision after running off the road.

2c. Surface Conditions

Looking at the surface condition data 41% of collisions occurred on dry roads and 57% occurred on wet, icy or snow covered roads. The high percentage of crashes on moisture-laden roads could be due to the operator's inability to regain control of the vehicle to avoid a utility pole collision.

Further analysis of surface condition data reveals that the severity of collisions is less during wet roadway conditions, with 70% of fatalities occurring on dry roadways. Perhaps reduced vehicle speed during inclement conditions gives the driver of a vehicle that has run off the road additional time to regain control. In addition, the distance a vehicle travels after losing control is reduced with lower speeds, and its impact severity is thus greatly reduced.

2d. Speed Limit

This data set shows the frequency of collisions with utility poles at posted speed limits as reported by the attending officer. Highways posted at 45 mph (including 45 mph roads that are not posted) have the highest number of collisions at 33% and the majority of fatalities at 28%. Approximately 44% of the 21,783 miles of highways are posted at 45 mph.

On roads posted at 35 mph, 18% of collisions with utility poles and 24% of fatalities occurred. The number and severity of crashes are high considering that 7.2% of Maine's highways are posted at 35 mph. Illegal, unsafe speed is the apparent contributing factor in 29% of these collisions.

Twenty one percent of collisions with utility poles, of which less than 2% were fatalities, were reported on roads posted at 25 mph (including 25 mph roads that are not posted). This is also relatively high since 9.5% of Maine's roads are posted at 25 mph and all are located in urban areas. The relatively high incidence rate may be due to closer utility pole offsets, frequent intersections with poles, and more significant vehicle maneuvering to the roadside to pass left-turning vehicles.

2e. Type of Location

Data for this section differs slightly from the Road Character data set because it includes intersections. For instance a collision at a three-leg intersection that is located on a curve will be excluded from curve data in the Type of Location data set, thereby decreasing the number of collisions on curves.

In this data set, 49% of collisions involving utility poles occur on straight roads and 34% occur on curved roads. Once again this is understandable because there are more straight sections of roadway than curved. The severity of injuries is two times greater on curved roadways with 30 fatalities in 2,550 collisions (one fatality per 85 collisions) compared to 21 fatalities in 3,726 collisions (one fatality per 177 collisions) on straight roadways. The inability of the driver to regain control of the vehicle after leaving the road on curved sections may contribute to the high severity of these crashes. In addition the angle of approach makes it much more likely for a pole on a curve to be struck. Greater offsets, eliminating poles on curves or using Clear Zones would likely reduce the number and severity of UP collisions on curves.

Table 1
Intersection Summary

Type of Intersection	Number of Intersections	Number of Collisions	Number of Injuries
3-Leg	29,626	789	423
4-Leg	4,779	321	154
5-Leg	76	11	4

As illustrated in Table 1, more than 80% of Maine’s intersections are of the three-leg type and as a result have the highest number of collisions and injuries. Utility poles placed across from this type of intersection could also be attributing to the high collision rate.

Thirteen percent of Maine’s intersections are of the four-leg type and have a relatively high number of crashes at 321. Five-leg intersections have a high ratio of crashes per intersection at nearly 1:7. An increase in the number of vehicles entering an intersection, due to the additional leg(s), and poor sight distance may contribute to the high ratio of crashes per intersection.

2f. Day of Week

Collisions by day of week are fairly uniform. Saturday, Sunday and Monday show the higher percentages of collisions at 16.1%, 17.8% and 15.4% respectively with the remaining days at 12% to 13%. Wednesdays experienced 12 of the 54 fatalities (22%).

2g. Type of Crash

This data set lists the type of crash associated with vehicles colliding with utility poles. The major type of crash, in the opinion of the attending officer, is a driver losing control and simply running off the road. Others are caused by collisions with other vehicles or avoiding an obstacle in the road.

The following figures illustrate additional information from Run off the Road type crashes only (which represent nearly 94% of all Types of Crashes).

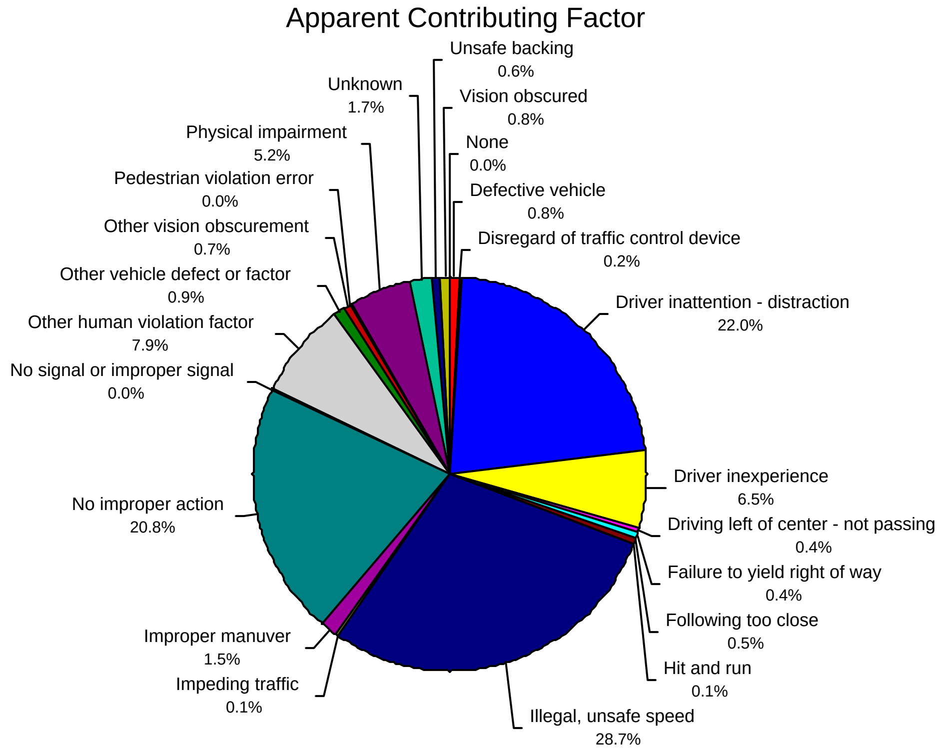

Figure 1. Further Analysis of Run Off the Road Data

Figure 1 illustrates the first of two apparent contributing factors in the opinion of the attending officer. Illegal, unsafe speed is the largest apparent contributing factor followed by driver inattention and no improper action.

Figure 2 illustrates the Driver's Physical Condition. 76.4% of the drivers were in normal condition. A combined 14.3% were either under the influence of alcohol or drugs.

Figure 3 illustrates the number of crashes per age group, including the number of male and female drivers for each age group. 26% of crashes with utility poles occur at the 16 - 20 age group and 15% occur at the 21 - 25 age group. These two age group's account for 41% of all crashes. The number of collisions levels off at around 10% for the next three age groups (26 - 30, 31 - 35, and 36 - 40) and declines at a steady pace from age 41 to 100. Roughly two thirds of each age group is male and one third are female operators.

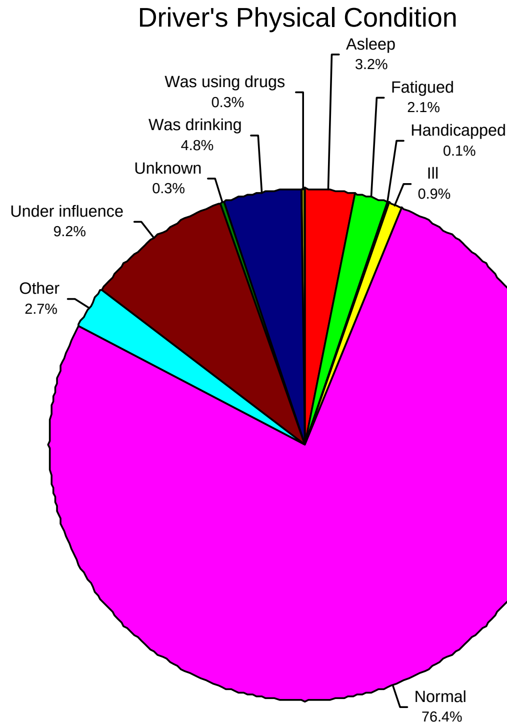

Figure 2. Additional Analysis of Run Off the Road Data

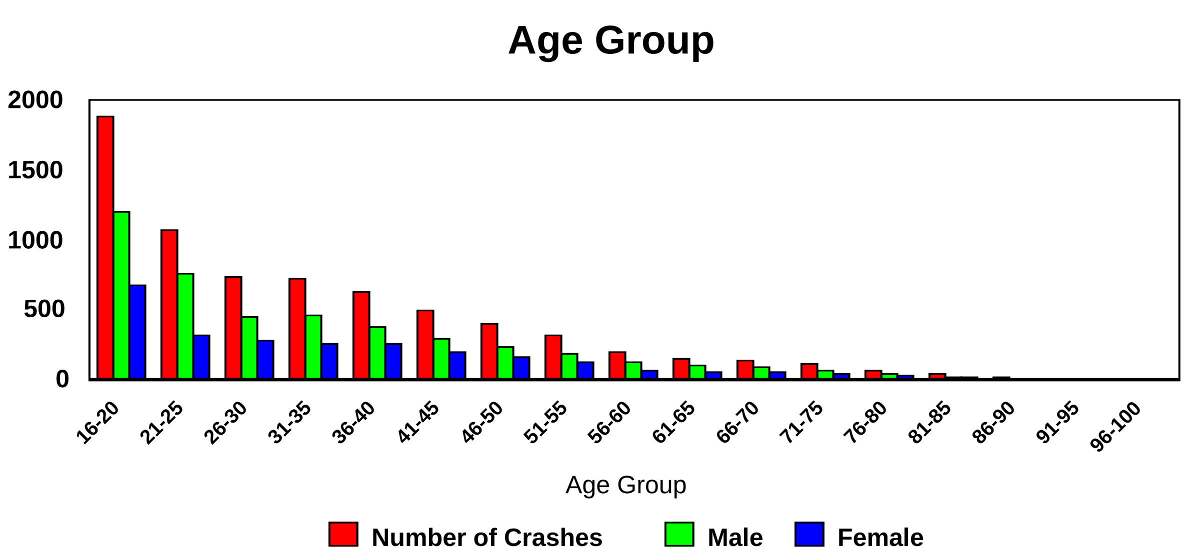

Figure 3. Additional Analysis of Run Off the Road Data

2h. Hour of Day

This data set shows the relationship of collisions involving utility poles with time of day. The majority of these crashes occur between 1:00 p.m. and 5:00 p.m. This may simply be due to the fact that this is the time frame when most vehicle miles are traveled. The time period with the lowest number of crashes is between 3:00 a.m. and 6:00 a.m. apparently due to reduced traffic volumes between these hours.

To determine if there is a specific time of day and day of week with a majority of collisions or high ratio of injuries per collision, Day of Week and Time of Day data were combined and are shown in Table A-3. According to the data, late Friday night and early Saturday morning have a high ratio of injuries per collision and late Saturday night and early Sunday morning have a high number of collisions. This may indicate driver fatigue, impairment, or restricted visibility may be the cause.

Summary of Database Analysis

The following summary highlights contributing factors of crashes involving utility poles in Maine for the period 1994 through 1998:

- There were 7,544 utility pole crashes in Maine resulting in 54 fatalities and 4,077 injuries.
- Utility pole collisions are primarily a rural problem with 74% of utility pole crashes and 87% of fatalities occurring in rural areas.
- Straight roadways account for 62% of utility pole crashes. While only 38% of utility pole crashes occurred on curved roads, they resulted in 59% of the fatalities.
- More collisions occur in daylight than darkness but collisions during darkness tend to be more severe.
- Although utility pole crashes occur less frequently on dry roadways (41%) than on wet roads, they generate 70% of the fatalities.
- One third of all crashes involving utility poles and 28% of fatalities occurred on roads posted at 45 mph, which represents 44% of Maine’s roadways.
- Roadways posted at 35 mph (7.2% of Maine’s highways) yielded 23% of crashes and 24% of fatalities.
- Young male drivers (between the ages of 16 and 25) account for 41% of all collisions with utility poles.
- The majority of crashes with utility poles occur between the hours of 1:00 p.m. and 5:00 p.m.

- Utility pole crashes occur more frequently and result in more injuries during late Saturday night and early Sunday morning.
- Excessive speed and Driver Inattention (28.7% and 22.0%, respectively) are the primary contributing factors to Run Off Road crashes involving utility poles.

3. ARAN Video Analysis

Another method of evaluating crash sites is to use ARAN videotapes. The ARAN collects Right of Way (ROW) video data from a wide-angle camera mounted in a way that the viewing angle is directly ahead of the vehicle. ROW video can be used to inspect each crash site to determine such factors as shoulder type, type of surrounding area (woods, residential, open fields or industrial), utility pole location, approximate pole offset distance, and shoulder slope beyond edge of pavement.

TIDE uses links, nodes, segments, and routes to specify locations along roadways (see Figure 4). Features along a route are assigned a node number. Node numbers are used to locate intersections, urban lines, state lines, city lines, town lines, bridges, railroad crossings, and other points of interest. Nodes are connected by links.

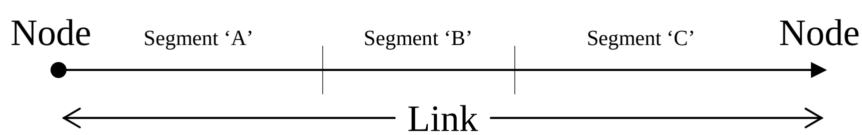

Figure 4. Node, Link, Segment Layout

Many attribute values may change along a link, such as the number of lanes, width of pavement, type of shoulder, etc. Links are therefore broken into separate segments, which are the basic units by which roadway attributes are managed in TIDE. Segments can range in length from .01 mi to more than a mile.

The location of a crash site or utility pole involved in a collision is recorded on each crash report as an estimated distance from a node. Consequently the location of one utility pole involved in more than one collision could be recorded at different offsets from the same node, making it difficult to evaluate the exact pole involved in each collision. To eliminate the error in estimating the location of each utility pole, route segments were used to query and locate high crash areas for videotape inspection.

When crash sites were queried using TIDE route segments, there were a total of 6,073 route segments with 7,544 collisions between 1994 and 1998. Because it would be too time consuming to evaluate each crash segment, the results were filtered to include only segments containing 2 or more crashes in any consecutive three-year period between 1994 and 1998. This resulted in 1,046 segments with a total of 2,511 collisions. Of these, 777 segments involving 1,896 collisions occurred on State Highway and State Aid roads that were filmed by the ARAN test vehicle. Due to poor film quality and collisions involving light poles instead of utility poles, only 771 of the 777 segments were rated, representing 1,883 collisions. Segments ranged in length from 0.02 km (0.01 mi) (intersections) to 5.84 km (3.63) mi. Since the actual utility pole or poles involved in each collision on each segment couldn't be located accurately, the entire length of each segment was evaluated.

Characteristics for each segment were noted. The characteristics include Pavement Management Rating (mentioned later), shoulder type, minimum and maximum pole offset from traveled way, offset from curb face, pole location (on curve, both sides of road, at T intersection or on an island), presence of guy poles on opposite sides of the roadway, road geometry (if curves or hills are present), pavement condition summary (rating of 0-5), shoulder slope greater than 4:1, and surrounding area beyond right of way. A sample of the ARAN Video Analysis Database is illustrated in Appendix B Table B-1.

MDOT Pavement Management Division rates segments with an "A", "B", or "0". An "A" segment is geometrically and structurally sufficient for current traffic loads. A "B" segment is not geometrically and structurally sufficient for current traffic loads and is part of MDOT's reconstruction backlog. A "0" segment is not rated.

Table B-2 illustrates a summary of each characteristic of the Video Analysis. The following sections contain highlights of each characteristic.

3a. Type of Shoulder

Roadways with gravel shoulders accounted for 37% of the 1,883 utility pole collisions evaluated using ARAN videotapes. More than 70% occurred on roadways with gravel, narrow gravel or no shoulder. This suggests that drivers may have difficulty regaining control of the vehicle on gravel or grass shoulders after veering off the roadway.

3b. Utility Pole Locations

The proportion of 72% rural and 28% urban crashes involving utility poles in this data set compares well with statewide rural/urban crash proportions of 74% and 26% respectively.

T Intersections

Fifty-three segments, or nearly 7%, contain utility poles installed across from T intersections. Relocating the poles, developing Control Zones that are void of utility poles, or installing some form of barrier could significantly reduce the number of collisions with utility poles in these locations.

Medians or Islands

Nine segments had utility poles located in medians or islands. Collisions in these locations can be significantly reduced or eliminated with the development of Control Zones or relocation of the poles themselves.

Outside Curves

The number of segments with poles located on outside curves is 433, or 56%, of which 85% are located in rural areas.

Although 56% of the segments have poles located on outside curves this may not be a problem location if the pole offsets are great enough to allow drivers to avoid a collision or bring their vehicles to a stop before contact. Again development of suitable Control Zones, Clear Zones, or pole relocation may be required to achieve this.

There were 112 segments rated by Pavement Management Division as “A” roads, 224 rated “B” roads and 97 were not rated. Nearly 52% of segments with poles on outside curves are not geometrically or structurally sufficient for current traffic loads. Reconstructing these segments to an “A” rating, thereby increasing the offset distance, is not possible in a short period of time. Problem areas can be addressed in a timely fashion if a query of high crash locations were brought to the attention of the utility companies.

Poles on Both Sides of Road

Segments with poles on both sides of the road provide an out of control vehicle more chances for a collision. Nearly 18% of the segments had pole locations of this type. This can be corrected by combining utilities on one pole, thus eliminating the need for poles on both sides of the road and reducing the number of utility poles a vehicle could collide with.

Guy Poles

Almost 38% of the segments have guy poles installed across the roadway from utility poles. Guy poles are poles connected to the utility pole by a cable extending above and across the roadway and are used to help straighten or hold in place a utility pole that is leaning away from the roadway. Offset distance from the traveled way for these poles may at times be less than the offset distance of the utility pole it is intended to support. Guy poles should be eliminated wherever possible or installed at a greater offset distance than the utility pole they are intended to support.

Slopes Greater than 4:1 Ratio

A total of 74 segments had utility poles placed on slopes steeper than 4:1. Ninety-six percent of these segments are located in rural locations. The Pavement Management Division rated 38% of these segments as “A” roads, 42% as “B” roads and 20% are not rated. “A” roads had 67 collisions, “B” roads had 91 and “0” roads had 33.

Nearly 80% of these segments have gravel or no shoulder. Drivers may have difficulty regaining control of their vehicles after leaving the roadway.

Eighty-one percent of the segments have posted speed limits of 70 km/h (45 mph) or more, implying that high speed combined with the side slope increases the likelihood of a collision with a utility pole.

Roadways With Curb

Curb was present on 120 segments. The average utility pole offset from the curb is 0.7 m (2.35 ft). By increasing the offset distance, installing barriers or "breakaway" type poles the number or severity of collisions with poles could be reduced in these areas.

Poles on Inside of Curb

Eight segments, all in urban locations, had at least one utility pole installed on the roadway side of the curb. There were 17 collisions with these utility poles and the majority of these collisions could be prevented if poles were placed beyond the curb or at a greater offset from the curb.

3c. Surrounding Area Beyond Utility Pole

Utility poles are generally placed within the highway right-of-way. If poles were to be relocated, additional right-of-way may at times need to be purchased.

The majority of the segments studied contain wooded areas beyond the poles. Relocating poles in wooded areas could be costly due to the fact that trees would have to be cut down to accommodate the poles and tree limbs would have to be trimmed on a scheduled basis to make room for wires running between poles.

Nearly 32% of the utility poles are located in residential segments. Additional right-of-way would have to be purchased to relocate poles in these areas as well.

3d. Minimum Utility Pole Offset Information

ARAN films were used to examine each of the 771 segments to determine minimum and maximum utility pole offset distance per segment. Offsets were measured from the edge of designed traveled way. Although the difference between minimum and maximum offset distance can vary within a segment by as much as 5.8 m (19 ft) and collisions on a segment may have occurred with a pole whose offset distance was greater than the minimum offset distance for that segment, the minimum offset distance was used for this data set to emphasize the hazard of utility poles placed close to the roadway.

According to the data 25% of the 1,883 utility pole collisions occurred on segments with minimum pole offsets between 4.0 and 4.3 m (13 and 14 ft). Of that minimum offset group, 16% of the crashes occurred on “A” rated roads, 64% occurred on roads rated “B”, and 20% of the segments were not rated. Further analysis reveals that nearly 47% of the 1,883 collisions occurred on “B” roads and 39% occurred on “B” roads with pole offsets of 4.3 meters (14 ft) or less. This suggests that utility pole offsets on “B” roads, or roadways that are part of MDOT’s reconstruction backlog, may not be adequate. With the help of TIDE a survey of high crash locations can be evaluated and corrective measures can be taken to reduce the number of collisions on these types of roadways prior to their scheduled reconstruction.

A significant drop in the number of collisions and the ratio of collisions per segment occurs when pole offsets are greater than 4.3 m (14 ft) on roadways with posted speed limits of 55, 65, 70, and 80 km/h (35, 40, 45 and 50 mph).

23% of the segments have utility poles installed on outside curves and nearly 16% of the segments have guy poles on the opposite side of the roadway, creating additional targets for an out of control vehicle to collide with.

3e. Rural/Urban Minimum Offset Information

This section compares rural and urban utility pole minimum offset data such as average segment posted speed limit, average factored AADT, and total cost of collisions.

Cost of collisions is based on FHWA estimated cost per injury type and cost for each vehicle. “K” injuries cost $2,600,000, “A” injuries = $180,000, “B” injuries = $36,000, “C” injuries = $19,000, and Property Damage = $2,000. The computed cost for each crash includes the cost(s) for each personal injury type and cost(s) for each vehicle.

Rural Locations

Posted speed limits in rural areas are, on average, 65 km/h (40 mph) or greater.

Nearly 31% of the segments have minimum pole offsets of 4.0 to 4.3 meters (13 to 14 feet). This offset distance also has the greatest number of collisions. Although this offset has the most collisions, the average cost per collision is $40,324. This is significantly lower than the average cost per collision for the 3.4 to 3.7 meter (11 to 12 foot) offset of $100,247. Utility pole offsets in rural areas with speed limits of 65 km/h (40 mph) or more should be greater than 4.3 m (14 ft) from the edge of the traveled way.

When the average speed combined with the average AADT increases, the average cost per collision increases. Such is the case for offsets of 5.2 - 5.5 m (17 - 18 ft) and 7.0 - 7.3 m (23 - 24 ft). Offsets greater than 7.3 m (24 ft) should be considered for roadways posted at 80 km/h (50 mph) or more.

Urban Locations

Posted speed limits in urban areas are generally less than 65 km/h (40 mph).

A significant reduction in collisions occurs when the utility pole offset is greater than 2.4 m (8 ft). A reduction in cost per collision occurs when offsets are greater than 1.8 m (6 ft). Offsets in urban areas should be greater than 2.4 m (8 ft) where permissible. Barriers, “breakaway” type poles that detach at the base and suspend by the adjoining poles when struck (mentioned later), or reflective markers could be used in urban areas with restricted rights of way to help reduce the number or severity of collisions.

The average cost per collision is high for the 4.6 - 4.9 m (15 - 16 ft) utility pole offset. These offsets tend to be located at rural/urban transition areas where speed limits increase, thereby increasing the severity of a collision with utility poles. “Breakaway” type utility poles could be used in these transition areas to reduce collision severity.

3f. Posted Speed Limit Summary

Table B-3 groups roadways by Posted Speed Limits to illustrate the costs associated with collisions and pole placement locations for each minimum pole offset distance.

On roadways posted at 40 km/h (25 mph), the number of collisions per segment drops when the pole offset is greater than 2.4 m (8 ft). Since most of these segments are located in urban areas it may be difficult to increase the offset distance. Installing alternative safety structures (mentioned later) in these areas may decrease the number of collisions and severity of injuries.

On roadways with posted speed limits of 50 to 80 km/h (30 to 50 mph) the number of crashes per segment drops when the pole offset is greater than 4.3 m (14 ft) from the edge of the traveled way. A majority of these segments are located in rural areas where the offset distance could be increased or poles could be moved to a less hazardous location.

Roadways posted at 65 km/h (40 mph) have the highest average cost per collision. The average cost drops significantly when pole offsets are greater than 3.7 m (12 ft) and collision ratios drop at offsets greater than 4.3 m (14 ft) suggesting offsets should be greater than 4.3 m (14 ft) on roadways posted at 65 km/h (40 mph).

The majority of collisions occur on roadways posted at 70 km/h (45 mph) suggesting attention should be focused in these areas. As mentioned earlier the number of crashes per segment drops when the offset is greater than 4.3 m (14 ft) and the average cost per collision drops when the pole offset is greater than 3.7 m (12 ft). The high number of collisions may be attributable to the large number of segments with guy poles and poles located on outside curves. Relocating these poles and increasing the offset to 4.3 m (14 ft) should help reduce the number and severity of collisions.

3g. Additional Observations

A number of the road segments that were reviewed indicate that utility poles were installed on the roadway side of ditch slopes. A reduction in the number of collisions could occur if poles were located to the back slope of ditch lines.

Guy wires were noticed on the roadway side of three utility poles. This is very dangerous and should be avoided completely.

Summary of ARAN Database Analysis

The following summary highlights contributing factors of the utility pole crashes that were evaluated using ARAN videotapes.

- A total of 771 segments were evaluated, representing 1,883 collisions.
- More than 70% of the collisions occurred on roads with gravel, narrow gravel or no shoulders.
- 72% of the collisions occurred in rural areas.
- Fifty-three segments had poles placed across from T intersections
- Nine segments had poles installed in medians or traffic islands.
- There were 433 segments with poles located on outside curves and more than half of these were on “B” roads (roads not meeting current standards and recommended for reconstruction).
- 18% of the segments had poles installed on both sides of the road and 38% had guy poles that are installed on the opposite side of the road, creating more objects for out of control vehicles to hit.
- 74 segments have utility poles installed on slopes with a slope greater than 4:1. Eighty-one percent of these segments have posted speed limits of 70 km/h (45 mph) or higher and 80% have gravel or no shoulder.
- The average offset from a curb is 0.7 m (2.35 ft).
- Eight segments had poles located on the roadway side of curbing and all were in urban areas.
- Nearly one third of the segments contain woods beyond the utility poles. Extending the offset distance and maintaining a clear path through the woods for transmission lines would create an added expense.
- Nearly 31% of the segments are located in residential areas where added ROW may have to be purchased to extend the offset distance.
- The ratio of collisions per segment is much higher on “B” roads than on “A” roads.
- The average cost per collision is very high when pole offsets in rural areas are at 3.4 - 3.7 meters (11 - 12 feet).
- A significant drop in the number of collisions per segment occurs when pole offsets are greater than 4.3 meters (14 feet) in rural areas and greater than 2.4 meters (8 feet) in urban areas.
- Utility poles should be installed on the back slope of all ditch lines and guy wires when used should always be located on the backside of utility poles.

Appendix E contains photos extracted from ARAN videotapes showing a number of typical hazardous utility pole locations around the state.

4. State DOT Interviews and Utility Pole Policy Review

Twenty-four states responded to a request for information about their current Utility Pole Placement Policies. Table C-1 contains a summary of information collected from that request.

Most states did not know if their revised policy decreased the number of collisions with utility poles. Indiana and Mississippi were the only two states that did report a reduction in the number of collisions. An effort was made to learn if there was a reduction in the number of utility pole collisions on Maine roadways after a section of roadway was reconstructed. The lack of historical data and the relatively small and infrequent number of collisions prior to and after reconstruction in the past eight years made it difficult to determine if a reduction was realized.

Fifteen states follow AASHTO's Roadside Design Guide - Clear Zone Guidelines, or a modification of the guidelines, for their utility pole offsets. The three states with the lowest number of fatalities (North Dakota, Wyoming, and Montana) follow AASHTO's Clear Zone Guidelines or have pole offsets of 9 m (30 ft) or more, or have a program in place to review and/or correct high collision areas. Those three steps alone could help reduce the number of collisions with utility poles in Maine and reduce the severity of injuries caused by those collisions.

The top nine State DOT's also have offset adjustments for slopes and curves and/or encourage the use of breakaway type poles in urban areas. Maine roads have steep slopes and curves in many areas of the state and could benefit with a similar form of utility pole offset adjustment for slopes and curves.

Six states review crash records involving collisions with utility poles for possible corrective measures or relocation of the poles. Maine's Policy on Above Ground Utility Locations states in part, …"Pursuant to Title 35-A, M.R.S.A., Sections 2301 through 2306 and 2501 through 2503 pursuant to utility charters and franchises, utilities may be located within public rights-of-way. Nothing in the Policy is intended to be used to initiate an arbitrary demand for wholesale relocation of existing facilities on existing highways. If, through accident reports or public complaints, an individual pole or facility is identified as an impediment to the free and safe flow of traffic, the Utility Engineer will consult the owner(s) of the facility and consider possible means of reducing the impediment. Alteration of the utility facility may be required pursuant to Title 35-A, M.R.S.A., Section 2503."… Crash reviews have been conducted and poles have been relocated but only if requested. With the use of TIDE, locations with an unusually high number of utility pole collisions can now be readily reviewed for possible corrective measures.

5. Utility Company Interviews

Three of Maine's largest power companies, Central Maine Power (CMP), Maine Public Service (MPS), and Bangor Hydro (BH), were contacted to get an idea of the costs associated with relocating utility poles and to determine if there are limits to the number of utilities allowed on one pole or if there are offset restrictions. The following five questions were asked:

1. Are you restricted as to how many utilities can be used on a single pole without cross arms? If so, how many?
   The purpose of this question was to determine if poles with no cross arms can be used in urban areas with sidewalks or narrow rights of way. Cross arms generally cannot be used over sidewalks, because the cross arms would extend into private property. This results in poles being installed close to the roadway with cross arms extending over the road. If utilities can be attached without the use of cross arms, poles can be placed further from the roadway. Also, utility poles without cross arms tend to be more stable so the use of guy wires can be reduced.
   Answers:
   CMP - We have no restrictions
   MPS - Up to five with an inverted L shape cross arm.
   BH - We follow the National Safety Board guidelines.

2. Are there any offset distance restrictions when locating poles?
   This question was asked to determine if the utility companies have maximum pole offset distances based on equipment limitations or some other factor, and if so what is the offset distance.
   Answers:
   CMP - We have no restrictions, it is based on what MDOT dictates.
   MPS - Current vehicles have a 7-meter (23-foot) side reach. Our company has purchased vehicles to maintain utilities as the distance increases.
   BH - We like to stay within ROW or 13 meters (42 feet).

3. Have you used breakaway type poles or installed protective barriers in high vehicle/pole collision areas?
Answers:
CMP - No.
MPS - No.
BH - No, we install a higher-class pole (stronger).

Installing higher-class poles can be dangerous to vehicle occupants and should be avoided when possible.

4. What is the estimated cost of your downtime while fixing or replacing a damaged pole?
Answers:
CMP - There are so many variables it is hard to estimate.
MPS - We have 300 to 500 and up to 800 customers on a line. Depending on the time of day and an average bill of $100 per month per customer the downtime costs would equal between $42 and $111 per hour.
BH - We don't know.

5. What is your estimated cost of relocating a pole?
Answers:
CMP - $1000 to $3000
MPS - $1200 to $5000 depending on three phase or five phase power line. Average costs would be $2500 to $2800 per pole.
BH - $1000 to $5000. An average of $1500.

Additional comments:
CMP doesn't have a crash database but would like to know where the high crash areas are to review and correct the problem.
MPS would like more information about "breakaway" type poles.

All three companies were interested in reducing the amount of vehicle/utility pole collisions and expressed a willingness to cooperate with the MDOT.

6. Alternative Safety Structures

Most urban areas and some rural areas have very little ROW, limiting available utility pole offset distance. Consequently poles are located close to the roadway, thus reducing an operator's reaction time and increasing the severity of injuries and increasing utility maintenance costs when a collision occurs. Four alternative safety structures, the Steel Reinforced Safety Pole (SRSP), Low Profile Barrier (LPB), Guardrail Extruder Terminal (ET-2000)/Collision Performance Side Impact (CPSI), and the Advanced Dynamic Impact Extension Module (ADIEM) were reviewed for possible use in these areas to reduce the severity of injuries and decrease maintenance costs.

6a. Steel Reinforced Safety Pole (SRSP)

This safety structure consists of a wooden utility pole resting on a steel base with a steel upper connection about midway up the pole that folds when struck (see Figures 1a - 1c). A steel cable is attached to the pole above the steel upper connection and to adjacent poles. In the event of a collision, the steel base separates and the upper connection folds, allowing the pole to be suspended in the air by steel cables, consequently reducing the severity of injuries. The cost for this type of pole modification is around $3000 installed.

The pole can be unfolded and restored in an hour or two without disrupting power to customers. According to Morgan and Ivey [2] an unmodified class 4 utility pole that does not break when struck at speeds between 30 and 65 km/h (20 and 40 mph) for pickups and 30 to 95 km/h (20 to 60 mph) for automobiles will stop these vehicles with deceleration rates averaging 20 g’s, an intolerable event for occupants. Even if the pole does break at those speeds the velocity change can be hazardous. When a SRSP is struck and folds the deceleration rate is reduced to 6 g’s, a non injury-producing event.

Lateral load tests performed by Massachusetts Electric Company [2] estimated that a new SRSP should withstand wind speeds of 240 km/h (150 mph), compared to a new unmodified pole, which should withstand 160 km/h (100 mph) wind speeds. When comparing conventional poles that have a reduced safety factor due to exposure, ground rot or minor collisions the wind resistance is estimated to be reduced to 110 km/h (70 mph) but the SRSP is estimated to withstand wind speeds over 160 km/h (100 mph). The modified poles are estimated to be 250% stronger than unmodified wood poles in resisting wind and ice loads. Four states - Kentucky, Massachusetts, Texas and Virginia have used these types of poles and the experience has been entirely favorable.

The next three safety structures do not involve modifications to the pole but are ground level barrier type structures.

6b. Low Profile Barrier

The Low Profile Barrier (LPB)(see Figure 2a, 2b) is a portable precast reinforced concrete barrier 6.1 m (20 ft) in length and 0.5 m (20 in) high with a base width of 0.7 m (26 in) and a top width of 0.7 m (28 in). Two sections totaling 12.2 m (40 ft) in length can be bolted together to protect poles from traffic coming from one direction or four sections totaling 24.4 m (80 ft) in length can be bolted together to shield poles from two way traffic. Each section can be cast for about $25 per foot. Low Profile Barriers are acceptable for use as an NCHRP Report 350 TL-2 temporary barrier on the National Highway System (NHS) where there are few trucks, the highest impact speeds are expected to be in the 70 km/h (45 mph) range, and its use is requested by a state agency. However, when a sloped concrete end section is used, as in Figure 2a, this type of end terminal has not been tested to the minimum matrix recommended in NCHRP Report 350 for any test level as of March, 1996 and is not considered to be a crashworthy end treatment at the present time. It is recommended that, until the appropriate test series has been run with acceptable results, the LPB be terminated outside the appropriate clear zone or shielded with a crashworthy device when used on the NHS. Low Profile Barriers have been used extensively in construction zones in Texas to protect utility poles from damage.

An alternative for this safety feature is to use Jersey Barriers placed at an angle to deflect out of control vehicles away from utility poles.

6c. Guardrail Extruder Terminal (ET-2000)/Collision Performance Side Impact (CPSI)

The ET-2000 is a guardrail extruder terminal designed to deflect a vehicle away from the pole. The CPSI is composed of wing plates and a steel cylinder that is attached to the front of the ET-2000 extruder head (see Figure 3). This is designed to reduce the severity of injuries in the event of a side impact. The ET-2000 and guardrail installation costs about $1800. The CPSI would add another $200 to the cost.

6d. Advanced Dynamic Impact Extension Module (ADEIM)

This is a 9 by 0.6 meter (30 by 2 foot) soft concrete crash cushion (see Figure 4a, 4b) that qualifies under NCHRP Report 350 Level 3. Of the three barrier type safety solutions, this device takes the least space but is the most costly at about $10,000 per installation. Figure 6 illustrates a prototype Level 2 ADEIM device. When a Level 2 ADEIM has been qualified the cost is expected to be around $5000. Sand filled barrels can be used as an option to this device and might be more cost effective.

6e. Cost Comparison

Table 2 illustrates a cost comparison of the alternative safety structures, including no action taken. Relocation of the pole was not included because of the limited ROW problem in urban areas. Estimated total costs for the initial cost of installation, maintenance costs per collision, cost per hour for loss of service and crash costs per collision are illustrated using three scenarios: one pole struck once in a five-year period, three poles struck within a span of five poles in a five-year period, and five poles struck within a span of twenty poles in a five-year period. To simplify the economic terms, inflation and liability costs are not included in the total costs.

The estimated cost for loss of service is based on $100 per hour service loss plus parts and labor costs of $160 per hour. Estimates for Crash Costs are based on average Crash Costs for the 1994 - 1998 time period in urban areas posted at 60 km/h (35 mph) or less. In the No Action group the Crash Cost per Collision is based on the average cost of property damage plus “A” “B” and “C” type injuries. Crash Costs for Safety Structures are based on property damage plus “B” and “C” type injuries in view of the fact that the safety structure is designed to deflect the vehicle or reduce vehicle impact thereby reducing or possibly eliminating injuries. This could also reduce or eliminate the potential liability costs.

With the exception of the ADIEM alternative involving five collisions with twenty poles over a five-year period, all alternatives were less costly than the “No Action” alternative. Table 2 illustrates that the LPB barrier was cost effective for all three scenarios. It should be noted, however, that the LPB barrier is acceptable by NCHRP 350 only on a temporary basis under limited circumstances. The SRSP safety structure was the second cost effective measure closely followed by the ET-2000 guardrail structure. The

ADIEM costs were higher than the No Action group when used in the five crashes per twenty-pole scenario.

Keep in mind that one application, although more costly than another, may not be appropriate for certain situations. For example a tree just beyond a SRSP would not improve safety or a pole close to a driveway or intersection may not have enough room to install an ET-2000 or LPB.

If liability costs were included the total cost of doing nothing would be much higher due to the likelihood of injuries being more serious than if an alternative safety structure was installed to reduce or deflect the impact.

Table 2
Cost Summary of Alternative Safety Structures

						Total Costs Over a Five Year Period		
Action	1 Cost of Safety Structure	2 Maintenance Cost Per Collision	3 Loss of Service Per Collision	4 Crash Cost Per Collision	Potential Liability Per Collision	One Collision One pole involved [1+2+3+4]	Three Collisions Five poles involved [(1x5)+(2x3)+(3x3)+(4x3)]	Five Collisions 20 poles involved [(1x20)+(2x5)+(3x5)+(4x5)]
No Action	$0	$0	$780*	$33,219**	$200,000	$33,999	$101,997	$169,995†
SRSP (Breakaway)	$3,000	$1,000	$0	$15,054‡	$0	$19,054	$63,162	$140,270
LPB (Concrete)	$2,000	$200	$0	$15,054‡	$0	$17,254	$55,762	$116,270
ET-2000 (Guardrail)	$3,000	$2,000	$0	$15,054‡	$0	$20,054	$66,162	$145,270
ADIEM (Soft Concrete)	$5,000	$2,000	$0	$15,054‡	$0	$22,054	$76,162	$185,270

* Estimated $260.00 per hour for three hours

** Average crash cost for type “A” “B” and “C” injuries plus property damage located in urban areas posted at 35 mph or less

† This total could be higher if poles were replaced at an average cost of $3000 per pole

‡ Average crash cost for property damage plus “B” and “C” type injuries located in urban areas posted at 35 mph or less

DISCUSSION OF RESULTS

Based on the information presented, it is apparent that Maine has a high incidence of utility pole collisions, more so in rural than urban locations. Specific measures can be taken to reduce or eliminate the number of collisions with utility poles.

A query should be generated to determine the location of high crash areas and if these areas are not scheduled for rehabilitation, reconstruction, resurfacing or some form of maintenance, utility owners should be contacted to implement corrective measures to reduce the number of collisions. Particular attention should be given to curves and “B” rated roads. When relocating poles, attention to AADT, posted speed limits, severity of slope, type of shoulder and condition of road should be considered to determine the placement and offset. For urban areas with little ROW to relocate poles, installation of barriers or “breakaway” type poles should be utilized or reflectors should be attached to increase the visibility of utility poles.

If a section of road is scheduled for some type of maintenance or surface treatment a query should be conducted well in advance to determine if there are high incidents of collisions with utility poles and if so, utility pole owners should be contacted to determine the corrective action to be taken paying attention to the position of poles in ditch lines, location of guy wires, location of support poles, severity of slope and offset distance.

Greater offset distances should be considered, when possible, to reduce collisions and severity of injuries. Single pole applications should also be encouraged to reduce the number of poles along roadways. All poles located on islands, medians or across from T intersections should be relocated if possible or “breakaway” type poles should be used.

CONCLUSIONS

The current Utility Pole Placement Policy is somewhat effective at safely placing utility poles on reconstruction, rehabilitation, and structural overlay projects but doesn’t safely relocate poles on resurfacing projects. To use the current policy to relocate hazardous poles on a statewide basis would take a very long time. MDOT should upgrade the current policy to relocate poles safely and attempt to relocate poles in high crash areas. Policy changes should include:

- Minimum pole offsets should be greater than 2.4 m (8 ft) where possible on roadways posted at 40 - 55 km/h (25 - 35 mph).
- Minimum pole offsets should be greater than 4.3 m (14 ft) on roadways with posted speed limits of 65 - 70 km/h (40 - 45 mph).
- Minimum pole offsets should be greater than 6 m (24 ft) on roadways with posted speed limits of 80 km/h (50 mph) or higher.
- Eliminate poles in medians, traffic islands and across from T intersections.
- Place poles on the back slope side of ditches.

- Eliminate or reduce the number of poles on outside curves.
- Eliminate or increase the offset distance of poles on slopes greater than 4:1.
- Eliminate the use of poles on both sides of the road by grouping utilities on one pole.
- Encourage the use of alternative structures in high crash urban areas with limited ROW. Alternatives that were reviewed and appear to be cost-effective include steel-reinforced safety poles, low-profile concrete barriers, guardrail and soft concrete crash cushions.

Utility companies expressed an interest in identifying high crash areas to evaluate the area and possibly relocate poles or apply another type of safety option. To reduce the number and severity of utility pole collisions MDOT should adopt a program to locate these high utility pole crash sites and ask the utility companies to review the sites and indicate their preferred plan of action. If sufficient resources exist, MDOT could also review the sites using ARAN tapes or conduct field inspections to determine the cause and corrective measure(s) to be taken. The review should be performed annually to keep ahead of changing roadway conditions, posted speed limits and increased traffic use.

Typical photos of dangerously placed utility poles were extracted from ARAN tapes and can be seen in Appendix E.

Photo E-1 is located at the junction of Route 101 and Frost Hill Road in the town of Eliot. This photo is taken looking east on Route 101, Frost Hill Road is on the left. The posted speed limit is 35 mph. This is a Y type intersection with a utility pole placed in the crotch of the Y. There were 3 collisions with this pole between 1994 and 1998.

Photo E-2 is located on the northbound lane of Route 209 in Bath. This is an urban location with a posted speed limit of 25 mph. The pole on the right with a reflective hazard sign is placed on the roadway side of the curb and in the middle of an inside curve. Between 1994 and 1998 there have been two reported collisions with this pole.

Photo E-3 is located at the junction of Clifford and Water Streets in Biddeford. This is an urban area with 25 mph speed limits. The photograph is taken from the northbound lane of Clifford Street looking downhill at Water Street. This is a steep hill with a stop sign at the bottom and a utility pole across the intersection. This pole has been struck twice in five years.

Photo E-4 is on Route 136 in Auburn. This area has had 17 vehicle-utility pole collisions between 1994 and 1998. This road is posted at 45 mph and has many curves. The pole offsets range between 5 and 13 feet. In this photo the pole on the left side of the road is offset at five feet from the edge of traveled way and just beyond the curve making it a potential target for an out of control vehicle.

Photo E-5 is taken on Montello Street in Lewiston. This road is in an urban area and is posted at 25 mph. The pole on the left is on the roadway side of the curb and on an outside downhill curve. This pole has been struck 3 times in five years.

Data from this report were presented to panel members and the Utility Section of the Bureau of Project Development. A draft Utility Accommodation Policy has been written and is located on MDOT's website at http://www.state.me.us/mdot/utility/laws.htm double-click on Maine Utility Accommodation Policy (Draft).

REFERENCES

1. Chester, R.N. and Turner, D.S. “Characteristics of Vehicle-Utility Pole Accidents in the State of Alabama”, 1998 Transportation Research Board 77th Annual Meeting

2. Ivey, D.L. and La Belle, D.M. “Utilities May Improve Roadside Safety in Cost Effective Ways”, Texas Transportation Institute, Paper No. 980457.

Appendix A

Table A-1

Statewide Utility Pole Crash Locations
1994-1998

Crashes	Link #	Offset (mi)	Node #	Crash #	Crash Date	Day of Week	Hour of Day	Crash Type	Light Condition	Road Character	Surface Condition	Traffic control device	Type of Location	Weather Condition	Non-int node crash	Speed Limit (mph)	Num K inj	Num A inj	Num B inj	Num C inj	Num non-inj	Inj crash	Construct-maint	Crash cost
1	050079701935	0.1		14711	11-May-95	Friday	22	Ran off road	Dark (street lights on)	Level straight	Wet	None	Straight road	Rain	0	35	0	0	0	1	0	Y	None	21,000
1	050398907456	0.07		47286	22-Dec-94	Friday	16	Ran off road	Daylight	Level straight	Dry	None	Straight road	Clear	0	35	0	0	0	0	1	N	None	2,000
1	030743207433	0.5		16593	7-May-98	Friday	21	Ran off road	Dark (no street lights)	On grade straight	Wet	None	Straight road	Rain	0	55	0	0	1	0	0	Y	None	38,000
1	010597905983	0.1		16541	7-May-98	Friday	19	Ran off road	Daylight	Level straight	Wet	None	Straight road	Cloudy	0	25	0	0	1	0	1	Y	None	38,000
1		0	1506038	16420	6-May-98	Friday	18	Ran off road	Daylight	Level straight	Wet	Stop sign - other	3-leg intersec	Rain	0	25	0	0	0	0	1	N	None	2,000
1	090713707138	0.3		18128	22-May-97	Friday	9	Ran off road	Daylight	Level straight	Dry	None	Straight road	Clear	0	50	0	0	0	0	1	N	None	2,000
1	270169701698	1.3		18191	22-May-97	Friday	18	Head-on/sideswipe	Daylight	On grade curved	Wet	None	Curved road	Clear	0	45	0	0	0	0	1	N	None	2,000
1	170203407413	0.1		18135	22-May-97	Friday	18	Ran off road	Daylight	Level straight	Dry	None	Straight road	Cloudy	0	35	0	0	1	0	0	Y	None	38,000
1	250107705057	0.1		18138	22-May-97	Friday	6	Ran off road	Dawn (morning)	Level straight	Dry	None	Straight road	Clear	0	2	0	0	0	0	2	N	None	2,000
1	030625406255	0.1		47207	22-Dec-94	Friday	8	Ran off road	Daylight	On grade curved	Ice, packed snow-not sanded	Curve warning sign	Curved road	Clear	0	55	0	1	0	0	0	Y	None	182,000
1	190603306034	0.2		17423	15-May-97	Friday	23	Ran off road	Dark (no street lights)	Top of hill curved	Dry	None	Curved road	Clear	0	50	0	0	0	1	0	Y	None	21,000
1	090143601443	0.6		19814	22-May-97	Friday	17	Ran off road	Daylight	On grade straight	Dry	None	Straight road	Clear	0	35	0	0	0	0	1	N	None	2,000
1	190736307590	0.01		47281	22-Dec-94	Friday	14	Ran off road	Daylight	Level straight	Dry	None	Straight road	Clear	0	1	0	0	0	0	1	N	None	2,000
1	190615106152	1.1		47319	22-Dec-94	Friday	8	Ran off road	Daylight	Bottom of hill curved	Ice, packed snow-not sanded	None	Curved road	Clear	0	50	0	0	0	1	0	Y	None	21,000
1	310350605631	0.1		18196	22-May-97	Friday	23	Ran off road	Dark (street lights on)	Top of hill curved	Dry	None	Curved road	Clear	0	45	0	0	1	0	0	Y	None	38,000
1	090509305094	0.09		18153	22-May-97	Friday	10	Ran off road	Daylight	Level curved	Dry	None	Curved road	Cloudy	0	1	0	0	0	0	1	N	None	2,000
1	150188906080	1.2		18186	22-May-97	Friday	2	Ran off road	Dark (no street lights)	Level curved	Dry	None	Curved road	Clear	0	35	0	0	0	2	0	Y	None	40,000
1		0	0507037	18848	29-May-97	Friday	15	Ran off road	Daylight	Level straight	Dry	Traffic signals (stop and go)	3-leg intersec	Clear	0	35	0	0	0	0	1	N	None	2,000
1	190506509480	0.1		16509	7-May-98	Friday	12	Ran off road	Daylight	Level straight	Wet	None	Straight road	Rain	0	35	0	0	1	0	0	Y	None	38,000
1	110618406186	0.7		17355	15-May-97	Friday	8	Ran off road	Daylight	Bottom of hill straight	Dry	No passing zone	Straight road	Clear	0	50	0	0	0	2	2	Y	None	40,000
1	290110307023	0.1		47831	28-Dec-94	Friday	10	Ran off road	Daylight	Level straight	Dry	None	Straight road	Clear	0	2	0	0	0	0	2	N	None	2,000
1	250116701168	0.1		43872	12-Dec-96	Friday	9	Ran off road	Daylight	Level straight	Wet	None	Driveways	Rain	0	25	0	0	0	0	2	N	None	2,000
1	190176605072	1.4		6876	15-Feb-96	Friday	18	Ran off road	Dark (no street lights)	Level curved	Dry	None	Curved road	Clear	0	40	0	0	0	0	1	N	None	2,000
1	050086401017	0.4		1129	5-Jan-95	Friday	7	Ran off road	Dawn (morning)	Level straight	Ice, packed snow-sanded	None	Straight road	Clear	0	40	0	0	1	0	0	Y	None	38,000
1	130605906060	0.1		1045	5-Jan-95	Friday	9	Ran off road	Daylight	On grade curved	Snow, slush-sanded	None	Curved road	Clear	0	45	0	0	0	0	1	N	None	2,000
1	050102201024	0.5		1152	5-Jan-95	Friday	20	Ran off road	Dark (no street lights)	On grade straight	Dry	None	Straight road	Clear	0	40	0	0	0	0	1	N	None	2,000
1	110709107365	0.2		1019	5-Jan-95	Friday	22	Ran off road	Dark (no street lights)	On grade straight	Dry	None	Straight road	Clear	0	99	0	0	0	0	1	N	None	2,000
1	170609306094	0.3		1068	5-Jan-95	Friday	17	Ran off road	Dark (no street lights)	On grade straight	Dry	None	Straight road	Clear	0	50	0	0	0	0	1	N	None	2,000
1	010443404437	1.3		6950	15-Feb-96	Friday	15	Ran off road	Daylight	On grade straight	Snow, slush-not sanded	None	Curved road	Cloudy	0	45	0	0	0	1	1	Y	None	21,000
1	310278603553	0.5		6866	15-Feb-96	Friday	10	Ran off road	Daylight	Level straight	Ice, packed snow-sanded	None	Straight road	Cloudy	0	40	0	0	0	0	1	N	None	2,000
1	110703807379	0.09		16123	1-May-97	Friday	22	Ran off road	Dark (street lights on)	Level straight	Wet	None	Straight road	Rain	0	25	0	0	0	0	1	N	None	2,000
1	090225802261	0.3		48133	29-Dec-94	Friday	17	Ran off road	Dark (no street lights)	On grade curved	Dry	None	Curved road	Clear	0	45	0	0	1	0	0	Y	None	38,000
1	090722207223	0.8		16113	1-May-97	Friday	13	Ran off road	Daylight	Level curved	Dry	None	Curved road	Cloudy	0	45	0	0	0	1	0	Y	None	21,000
1	110710107102	0.2		36441	15-Oct-98	Friday	9	Ran off road	Daylight	Level straight	Wet	None	Straight road	Rain	0	25	0	0	0	1	0	Y	None	21,000
1	090506805072	0.1		16760	8-May-97	Friday	2	Ran off road	Dark (street lights on)	On grade curved	Wet	None	Curved road	Rain	0	40	0	0	1	0	0	Y	None	38,000
1		0	1905204	37336	22-Oct-98	Friday	16	Intersection movement	Daylight	Level straight	Dry	Stop sign - other	4-leg intersec	Cloudy	0	25	0	0	2	0	3	Y	None	78,000
1		0	3105454	37342	22-Oct-98	Friday	16	Ran off road	Daylight	Level straight	Dry	Stop sign - other	3-leg intersec	Clear	0	25	0	0	0	0	1	N	None	2,000
1	110200206043	0.3		37282	22-Oct-98	Friday	11	Other	Daylight	Level straight	Dry	Curve warning sign	Driveways	Clear	0	45	0	0	0	0	1	N	Maintenance area	2,000
1	030729408223	0.06		48109	29-Dec-94	Friday	9	Ran off road	Daylight	Level curved	Ice, packed snow-sanded	None	Curved road	Snow	0	25	0	0	0	0	1	N	None	2,000
1	190717707178	0.1		18840	29-May-97	Friday	14	Ran off road	Daylight	Level straight	Dry	None	Straight road	Clear	0	35	0	0	1	0	1	Y	None	38,000
1	130189201893	1.2		46073	15-Dec-94	Friday	17	Ran off road	Dusk (evening)	Level curved	Other	None	Curved road	Clear	0	2	0	0	0	0	1	N	None	2,000
1	310278603553	0.4		6865	15-Feb-96	Friday	10	Ran off road	Daylight	Level straight	Ice, packed snow-sanded	None	Straight road	Cloudy	0	40	0	0	1	0	0	Y	None	38,000
1		0	0107415	40415	12-Nov-98	Friday	16	Ran off road	Daylight	On grade straight	Dry	None	3-leg intersec	Clear	0	25	0	0	0	0	3	N	None	2,000
1	230108301085	0.7		43831	1-Dec-94	Friday	8	Ran off road	Daylight	Level curved	Dry	None	Curved road	Clear	0	2	0	0	0	0	1	N	None	2,000

TABLE A-2

Utility Pole Collision Summary

1994-1998

Collisions / Road character

Road Character	Collisions	Num injured	Num of K injuries	Num of A injuries	Num of B injuries	Num of C injuries	Num of non injuries
Unknown	25	13	1	0	10	2	33
Top of hill curved	113	69	2	8	32	27	105
Bottom of hill curved	114	79	1	8	36	34	88
Top of hill straight	146	81	1	11	40	29	142
Bottom of hill straight	159	88	0	10	27	51	139
On grade curved	1251	762	15	71	375	301	1146
Level curved	1338	803	14	96	383	310	1236
On grade straight	1358	702	7	70	331	294	1380
Level straight	3040	1534	13	138	726	657	3223

Collisions / Type of location

Type of location	Collisions	Num injured	Num of K injuries	Num of A injuries	Num of B injuries	Num of C injuries	Num of non injuries
Bridges	2	0	0	0	0	0	3
Interchanges	6	4	0	0	3	1	4
Unknown	9	5	0	1	3	1	15
5-leg intersec	11	4	0	0	2	2	12
Driveways	130	41	0	7	20	14	191
4-leg intersec	321	154	1	16	77	60	434
3-leg intersec	789	423	2	32	186	203	899
Curved road	2550	1516	30	171	721	594	2306
Straight road	3726	1984	21	185	948	830	3628

Collisions / Light conditions

Light conditions	Collisions	Num injured	Num of K injuries	Num of A injuries	Num of B injuries	Num of C injuries	Num of non injuries
Unknown	6	2	0	1	1	0	6
Other	20	11	0	0	8	3	16
Dark (street lights off)	143	91	0	8	43	40	137
Dusk (evening)	266	154	4	11	74	65	292
Dawn (morning)	329	158	1	14	72	71	278
Dark (street lights on)	1143	660	7	65	339	249	1101
Dark (no street lights)	1551	937	25	108	477	327	1408
Daylight	4086	2118	17	205	946	950	4254

Collisions / Day of week

Day of week	Collisions	Num injured	Num of K injuries	Num of A injuries	Num of B injuries	Num of C injuries	Num of non injuries
Unknown	2	1	0	0	1	0	1
Monday	1160	688	7	84	324	273	1207
Tuesday	987	549	3	52	265	229	918
Wednesday	1018	517	12	45	244	216	1003
Thursday	924	496	7	46	211	232	869
Friday	894	506	8	49	242	207	845
Saturday	1215	624	9	59	296	260	1222
Sunday	1344	750	8	77	377	288	1427

Collisions / Surface condition

Surface condition	Collisions	Num injured	Num of K injuries	Num of A injuries	Num of B injuries	Num of C injuries	Num of non injuries
Unknown	1	0	0	0	0	0	1
Oily	5	2	0	0	2	0	4
Muddy	10	1	0	0	1	0	16
Debris	13	8	0	0	3	5	12
Other	75	49	1	8	19	21	77
Ice, packed snow-sanded	614	265	0	25	119	121	706
Snow, slush-sanded	834	289	1	23	108	157	928
Wet	895	576	9	51	286	230	830
Ice, packed snow-not sanded	962	420	4	24	180	212	1021
Snow, slush-not sanded	1015	383	1	30	145	207	1148
Dry	3120	2138	38	251	1097	752	2749

Collisions / Type of collision

Type of collision	Collisions	Num injured	Num of K injuries	Num of A injuries	Num of B injuries	Num of C injuries	Num of non injuries
Pedestrians	0	0	0	0	0	0	0
Bike	1	3	0	0	2	1	0
Jacknife	3	1	0	0	0	1	5
Deer	9	4	0	0	3	1	9
All other animals	10	5	0	0	3	2	10
Object in road	35	9	0	1	4	4	39
Intersection movement	40	28	0	4	18	6	91
Rear end/sideswipe	50	13	0	2	4	7	82
Rollover	51	46	1	5	30	10	32
Other	110	39	0	4	14	21	122
Head-on/sideswipe	176	121	2	20	59	40	193
Ran off road	7059	3862	51	376	1823	1612	6909

Collisions / Speed limit

Posted speed limit	Collisions	Num injured	Num of K injuries	Num of A injuries	Num of B injuries	Num of C injuries	Num of non injuries
0 (unknown)	1	4	0	0	2	2	1
1 (25 mph not posted)	365	146	0	18	66	62	424
2 (45 mph not posted)	525	283	2	30	130	121	506
5	1	0	0	0	0	0	5
10	0	0	0	0	0	0	0
15	17	10	0	0	8	2	18
20	6	6	0	0	3	3	9
25	1196	545	1	53	253	238	1326
30	360	207	3	18	100	86	367
35	1338	808	13	77	416	302	1296
40	456	271	5	29	129	108	414
45	1959	1064	13	107	475	469	1899
50	675	398	9	44	180	165	621
55	336	217	7	22	114	74	314
65	5	4	0	0	2	2	3
99 (unknown)	304	168	1	14	82	71	289

Collisions / Hour of day

Hour of day	Collisions	Num injured	Num of K injuries	Num of A injuries	Num of B injuries	Num of C injuries	Num of non injuries
1	240	185	10	22	86	67	183
2	297	187	4	24	108	51	242
3	194	135	0	17	70	48	143
4	122	71	1	6	38	26	97
5	125	60	2	4	32	22	85
6	173	82	1	9	34	38	138
7	274	121	1	11	52	57	236
8	425	207	1	12	99	95	383
9	364	173	0	12	76	85	351
10	320	138	1	15	57	65	333
11	346	155	0	14	74	67	356
12	372	169	3	11	83	72	414
13	442	214	1	25	87	101	492
14	378	219	2	34	94	89	391
15	458	264	3	20	118	123	485
16	484	281	2	29	126	124	581
17	413	218	1	21	99	97	454
18	372	188	4	16	84	84	424
19	344	194	3	16	85	90	342
20	282	148	0	18	78	52	292
21	276	161	4	18	68	71	286
22	299	189	3	16	103	67	283
23	275	176	3	16	98	59	271
24	267	195	4	25	111	55	228
99 (unknown)	2	1	0	1	0	0	2

SUMMARY

Utility pole collisions from 1994 - 1998	7544
Total number of injuries	4131
Total K injuries (fatalities)	54
Total A injuries (bleeding wound, distorted member or had to be carried from scene)	412
Total B injuries (other visible injuries, bruises, abrasions, swelling, limping, etc.)	1960
Total C injuries (no visible injury but had momentary unconsciousness or complaint of pain)	1705
Total non-injuries (driver, passengers, pedestrians or others)	7492

Table A-3

Utility Pole Collisions by Day of Week and Hour of Day

	Monday			Tuesday			Wednesday			Thursday			Friday			Saturday			Sunday		
Hour	Collisions	Injuries	Non-Injuries	Collisions	Injuries	Non-Injuries	Collisions	Injuries	Non-Injuries	Collisions	Injuries	Non-Injuries	Collisions	Injuries	Non-Injuries	Collisions	Injuries	Non-Injuries	Collisions	Injuries	Non-Injuries
1	62	41	47	21	12	22	15	17	7	25	18	22	30	29	24	28	32	15	59	36	46
2	70	46	58	19	8	14	21	12	24	30	19	23	29	23	16	46	24	36	82	55	71
3	62	44	59	16	10	14	16	9	13	13	11	5	13	8	8	27	24	11	47	29	33
4	32	24	27	12	6	10	9	2	9	11	5	7	13	8	9	17	8	12	28	18	23
5	21	11	13	18	11	12	17	6	15	19	6	14	12	7	5	15	11	6	23	8	20
6	29	19	21	25	10	18	21	9	13	21	17	17	20	8	16	32	10	32	25	9	21
7	27	14	25	36	16	36	40	15	36	51	23	34	40	12	41	47	21	43	33	20	21
8	29	16	18	86	39	95	68	38	62	63	23	66	68	40	57	78	39	59	33	12	26
9	54	20	52	46	23	39	46	17	45	60	29	58	61	28	59	38	26	39	58	30	58
10	34	10	46	48	23	49	37	17	34	50	27	43	43	15	48	52	21	54	56	25	59
11	72	33	83	51	21	45	43	23	48	44	19	42	30	16	25	45	15	49	61	28	64
12	62	26	77	40	19	37	49	33	48	53	30	51	38	21	41	51	15	54	79	25	106
13	68	32	82	57	39	46	58	20	66	60	32	54	43	14	47	62	25	71	94	52	126
14	61	39	82	47	23	47	57	33	51	43	33	26	39	17	46	60	24	62	70	49	77
15	61	50	72	69	43	64	71	37	73	50	28	49	57	31	56	75	35	79	75	40	92
16	65	42	82	69	38	73	66	38	83	52	30	66	55	37	63	96	44	118	81	52	96
17	71	42	80	60	36	60	65	35	67	40	19	49	54	35	53	67	21	84	56	30	61
18	55	33	63	51	24	53	66	26	71	40	22	39	47	30	51	59	25	68	54	28	79
19	47	34	37	44	21	52	45	28	32	50	25	61	42	28	33	53	30	51	63	28	76
20	38	22	48	33	22	27	37	9	44	33	13	34	33	15	29	41	29	36	67	38	74
21	40	22	54	37	29	20	52	30	52	29	16	27	30	24	32	44	16	53	44	24	48
22	36	23	28	40	30	37	58	28	55	29	17	29	36	18	44	52	37	43	48	36	47
23	36	26	32	31	27	25	35	17	35	23	14	16	35	21	27	67	36	83	48	35	53
24	28	19	21	31	19	23	25	17	20	35	20	37	26	21	15	63	56	64	59	43	48

2 injuries and 3 non-injuries are not included due to unknown hour or day on accident report.

APPENDIX B

Table B-1

Utility Pole Crash Locations (2 or more / segment)
1994-1998

Route	BMP	EMP	Length	Town name	Rural/Urban	Crashes	Cost	Factored AADT	Capacity (hourly)	MPH	HMVM	ARAN tape	ARAN file	Cnty	Segment #	Jurisdiction	ARAN route	ABMP	AEMP	ABN	Shldr	Pole Offset from Traveled Way: Min (ft)	Pole Offset from Traveled Way: Max (ft)	Offset from Curb (ft)	Pole Location: Outside Curve	Pole Location: Both Sides	Pole Location: T	Pole Location: Island	Guy poles	Geometrics: Curves	Geometrics: Hills	Pave cond.	Shoulder steeper than 4:1	Area
ST RTE 0104	28.57	29.05	0.48	Fairfield	Rural	2	$59,000.00	1857	1800	45	0.003253	7083	78D02700	25	374740	State aid	-			B	Bad video													
US 201A	13.11	13.25	0.14	Madison	Urban	2	$23,000.00	8262	1920	25	0.004222	7085	78E06200	25	374976	State hwy	0148x	5.91	6.05	A	Light poles only													
RD INV 60621 05	1.28	1.51	0.23	Portland	Urban	2	$61,000.00	14957	2320	30	0.012556	8092	88P0R000	05	318779	State aid	-			A	No Rating													
ST RTE 0104	30.02	30.70	0.68	Skowhegan	Rural	2	$4,000.00	1897	1800	45	0.004708	7083	78D02700	25	374742	State aid	-			B	Bad video													
US 202	73.20	73.21	0.01	Lewiston	Urban	2	$4,000.00	29021	3800	25	0.001059	8099	8931G000	01	308183	State hwy	0011X	91.72	91.73	A	Light poles only													
MAINT C438N DIV 6	3.66	3.80	0.14	South Portland	Urban	3	$27,000.00	3817	1920	25	0.001950	8094	88R0J000	05	326530	State aid	-			A	No Rating													
US 1	76.37	76.43	0.06	Brunswick	Urban	2	$95,000.00	33771	3800	35	0.007396	8088	88J0W000	05	324706	State hwy	-			A	NC	1		1		Y						4.5		R
ST RTE 0196	18.45	18.51	0.06	Lewiston	Urban	4	$8,000.00	18552	3800	25	0.004063	8095	88V0I000	01	308401	State hwy	-			A	NC	1		1		Y						4		I
ST RTE 0196	18.54	18.67	0.13	Lewiston	Urban	2	$23,000.00	19107	3800	25	0.009066	8095	88V0I000	01	308403	State hwy	-			A	NC	1		1	Y	Y				Y		4		I
US 1	75.68	75.82	0.14	Brunswick	Urban	2	$76,000.00	25412	3800	35	0.012986	8088	88J0W000	05	329852	State hwy	-			A	NC	1		1					Y			4.5		R
ST RTE 0196	17.22	17.26	0.04	Lewiston	Urban	2	$4,000.00	18928	3800	30	0.002763	8095	88V0I000	01	308376	State hwy	-			A	NC	1		1							Y	4		I
ST RTE 0196	17.66	17.75	0.09	Lewiston	Urban	2	$25,000.00	21147	3800	30	0.006947	8095	88V0I000	01	308385	State hwy	-			A	NC	1		1		Y						4		I
MAINT C422M DIV 5	4.02	4.66	0.64	Camden	Rural	2	$4,000.00	781	1600	45	0.001824	8102	89G0V000	13	347640	State aid	-			0	N	1	9		Y					Y	Y	2.5	Y	W
US 1A	11.39	11.45	0.06	Rockland	Urban	2	$2,784,000.00	9240	1920	30	0.002024	8101	89G0O000	13	349309	State aid	2170M	1.10	1.04	A	NC	2		2	Y						Y	4		R
MAINT C541J DIV 2	0.00	0.12	0.12	Bucksport	Urban	2	$4,000.00	1600	1040	25	0.000701	7006	76402A00	09	337787	State aid	-			0	N	2									Y	3		R
ST RTE 0011S	2.11	2.12	0.01	Auburn	Urban	2	$184,000.00	7587	2320	25	0.000277	8097	8920P000	01	308146	State hwy	3440O	0.74	0.75	A	NC	2		1		Y						3.5		R
US 201	49.94	49.99	0.05	Winslow	Urban	2	$4,000.00	22935	1920	25	0.004186	7094	78K06100	11	345854	State hwy	0100X	82.15	82.20	A	PC	2		2		Y						4.5		R
ST RTE 0011	88.60	88.85	0.25	Auburn	Urban	2	$184,000.00	14006	3800	35	0.012780	8097	8920P000	01	308718	State hwy	3440O	2.26	2.01	A	NC	2		1					Y			3.5		R
ST RTE 0009	43.31	43.69	0.38	Saco	Urban	2	$76,000.00	1185	1400	35	0.001644	8036	85J04G00	31	388972	State aid	-			A	NG	2	8		Y				Y	Y		4		R
US 202	71.79	71.91	0.12	Auburn	Urban	2	$44,000.00	17492	2360	25	0.007662	8097	8920F000	01	308110	State hwy	0004X	74.36	74.48	A	NC	2		2								4		I
ST RTE 0208	6.30	6.90	0.60	Biddeford	Urban	2	$184,000.00	2750	1400	25	0.006023	8034	85I02D00	31	387217	State aid	-			A	N	2	4		Y				Y	Y		5		R
US 202	72.42	72.52	0.10	Auburn	Urban	2	$4,000.00	22365	3800	25	0.008163	8097	8920P000	01	308153	State hwy	3440O	0.10	0.00	A	NC	2		1		Y						3.5		R
RD INV 60365 05	0.24	0.29	0.05	Portland	Urban	2	$4,000.00	11660	2320	30	0.002128	8093	88Q0W000	05	331061	Townway	-			A	NC	2		2								4		R
US 2A	2.21	2.27	0.06	Old Town	Urban	3	$80,000.00	17079	2320	25	0.003740	7157	7BI04300	19	365680	State hwy	-			A	N	2			Y	Y				Y		3.5		R
ST RTE 0009	60.06	60.11	0.05	Portland	Urban	2	$6,000.00	25049	3800	40	0.004571	8092	88Q03000	05	327420	State aid	-			A	NC	2		2		Y						3.5		R
ST RTE 0011	88.07	88.21	0.14	Auburn	Urban	2	$4,000.00	13044	3800	40	0.006665	8097	8920P000	01	308714	State hwy	3440O	2.79	2.65	A	NC	2		1					Y			3.5		R
ST RTE 0011	88.85	88.91	0.06	Auburn	Urban	2	$4,000.00	14006	3800	35	0.003067	8097	8920P000	01	308719	State hwy	3440O	2.01	1.95	A	NC	2		1								3.5		R
US 302	3.42	3.48	0.06	Portland	Urban	2	$42,000.00	16569	2320	30	0.003629	8092	88P0Q000	05	329344	State hwy	-			A	NC	2		2	Y	Y				Y		3.5		R
RD INV 60563 05	0.00	0.10	0.10	Portland	Urban	2	$6,000.00	11880	3800	30	0.004336	8093	88Q0X000	05	329281	State aid	-			A	NC	2		2								3.5		R
ST RTE 0011	88.47	88.60	0.13	Auburn	Urban	2	$114,000.00	14827	3800	35	0.007035	8097	8920P000	01	308722	State hwy	3440O	2.39	2.26	A	NC	2		1					Y			3.5		R
ST RTE 0011	145.22	145.27	0.05	Waterville	Urban	2	$256,000.00	17353	1920	35	0.003167	7091	78J0CE00	11	346158	State hwy	-			A	NC	2		2						Y	Y	4.5		R
ST RTE 0004	76.02	76.07	0.05	Auburn	Urban	3	$63,000.00	27545	3800	35	0.005027	8097	89210000	01	308446	State hwy	-			A	NC	2		2								4		I
ST RTE 0126	1.19	1.24	0.05	Lewiston	Urban	2	$4,000.00	15521	3800	30	0.002833	8099	8931H000	01	308066	State hwy	-			A	NC	2		2		Y						5		R
US 202	72.00	72.01	0.01	Auburn	Urban	3	$44,000.00	34666	3800	25	0.001265	8097	8920P000	01	308118	State hwy	3440O	0.52	0.51	A	NC	2		1	Y					Y		3.5		R
ST RTE 0011	88.21	88.38	0.17	Auburn	Urban	4	$118,000.00	13441	3800	40	0.008340	8097	8920P000	01	308715	State hwy	3440O	2.65	2.48	A	NC	2		1					Y			3.5		R
ST RTE 0009	127.80	127.84	0.04	Augusta	Urban	3	$44,000.00	24268	3040	30	0.003543	7102	79806700	11	346074	State hwy	-			A	NC	2		2	Y					Y		4		W
ST RTE 0011	89.71	89.81	0.10	Auburn	Urban	3	$42,000.00	14292	3800	30	0.005217	8097	8920P000	01	308732	State hwy	3440O	1.15	1.05	A	NC	2		1		Y						3.5		R
ST RTE 0011	90.08	90.11	0.03	Auburn	Urban	3	$78,000.00	15174	3800	25	0.001662	8097	8920P000	01	308738	State hwy	3440O	0.78	0.75	A	NC	2		1								3.5		R
ST RTE 0126	2.57	2.62	0.05	Lewiston	Urban	3	$99,000.00	15164	3800	35	0.002767	8099	8931H000	01	307893	State hwy	-			A	NC	2		2								4		R
ST RTE 0009	127.84	127.89	0.05	Augusta	Urban	4	$27,000.00	24279	3040	30	0.004431	7102	79806700	11	346075	State hwy	-			A	NC	2		2	Y					Y		4		W
MAINT C525M DIV 5	1.93	2.20	0.27	West Bath	Rural	2	$23,000.00	1453	1600	45	0.001432	8005	84M06B00	23	369681	State aid	-			0	G	2	5		Y				Y	Y	Y	3.5		RW
US 201	32.18	32.24	0.06	Augusta	Urban	2	$61,000.00	26772	3060	25	0.005863	7094	78K06300	11	345794	State hwy	0009X	128.32	128.38	A	NC	2		2		Y						2.5		R
ST RTE 0009	37.77	37.82	0.05	Saco	Urban	2	$150,000.00	24061	1400	25	0.004391	8036	85J04A00	31	702097	State aid	-			A	NC	3		2	Y					Y	Y	4.5		R
US 1 SB	1.07	1.09	0.02	Rockland	Urban	2	$40,000.00	11689	2320	30	0.000853	8101	89G0D000	13	349662	State hwy	-			A	NC	3		1								3.5		R
US 1A	3.17	3.23	0.06	York	Urban	2	$42,000.00	5572	1400	25	0.001220	8032	85E04K00	31	390838	State hwy	-			A	NC	3		1								4.5		R
RD INV 50063 31	1.62	1.68	0.06	Saco	Urban	4	$44,000.00	1924	1400	25	0.000421	8036	85J04100	31	394840	Townway	-			A	NC	3		1		Y	1			Y		4		R
RD INV 20388 01	0.00	0.09	0.09	Lewiston	Urban	2	$4,000.00	3315	1920	25	0.001089	8096	8910V000	01	307238	State aid	-			B	P	3									Y	3		R
ST RTE 0009B	2.59	2.79	0.20	Wells	Rural	2	$76,000.00	3018	1600	45	0.002203	8026	85C0E300	31	388598	State aid	-			0	NG	3	7		Y					Y		3.5		R
US 1	137.85	138.03	0.18	Camden	Urban	2	$220,000.00	10029	2320	35	0.006589	8102	89G0X000	13	349756	State hwy	-			A	PC	3	8	i								4		R
ST RTE A196	0.66	0.74	0.08	Lewiston	Urban	2	$4,000.00	11133	2320	30	0.003251	8095	89101000	01	308406	State hwy	-			A	PC	3		1								5		O
MAINT C423M DIV 5	5.45	5.72	0.27	Rockport	Rural	2	$23,000.00	3957	1800	45	0.003900	8101	89G0B000	13	349715	State aid	-			A	N	3	12		Y	Y				Y		5		R
RD INV 10063 31	0.85	0.98	0.13	Biddeford	Urban	2	$76,000.00	3142	1400	25	0.001491	8034	85I02M00	31	393190	Townway	-			A	NC	3		1								3		R
MAINT C495N DIV 6	0.60	1.41	0.81	Brunswick	Urban	2	$4,000.00	3074	1000	25	0.009088	8089	88K01000	05	322042	State aid	-			0	G	4	13		Y					Y		5		R
ST RTE 0009	98.50	99.88	1.38	Sabattus	Rural	4	$8,000.00	3562	2400	45	0.017942	8077	87902K00	01	303709	State aid	-			A	NG	4	9		Y				Y	Y	Y	3		M
MAINT C453N DIV 6	3.63	4.00	0.37	Falmouth	Urban	3	$44,000.00	4445	1920	25	0.006003	8086	88I0C000	05	324398	State aid	-			B	N	4	9		Y				Y	Y		3.5		R
MAINT C396N DIV 6	1.25	1.57	0.32	Poland	Rural	4	$63,000.00	2379	1600	45	0.002779	8011	84R02H00	01	303993	State aid	-			0	G	4	5		Y							2		W
RD INV 10079 01	0.80	1.12	0.32	Auburn	Urban	2	$40,000.00	15664	1920	25	0.018296	8097	8920B000	01	699230	State aid	-			A	NC	4	18	3						Y	Y	4	Y	RO
ST RTE 0131	22.38	24.10	1.72	Warren	Rural	3	$44,000.00	1751	1800	45	0.010993	8100	89E01000	13	349499	State aid	-			B	N	4	13		Y				Y	Y	Y	4		M
US 2A	4.22	4.23	0.01	Old Town	Urban	2	$23,000.00	12503	2320	25	0.000456	7157	7BI04300	19	361960	State hwy	-			A	NC	4		2		Y	1					3.5		R
ST RTE 0123	0.31	0.39	0.08	Brunswick	Urban	2	$4,000.00	8813	1400	25	0.002573	8088	88J0X000	05	326188	State aid	-			A	NPC	4		1								4		R
US 2A	4.32	4.41	0.09	Old Town	Urban	3	$25,000.00	12148	2320	25	0.003991	7157	7BI04300	19	365700	State hwy	-			A	NC	4		2							Y	3.5		R
ST RTE 0015	10.00	10.66	0.66	Deer Isle	Rural	2	$23,000.00	3021	1800	50	0.007278	7003	76204400	09	338309	State hwy	-			B	NR	4								Y		4		O
RD INV 20147 05	0.00	0.28	0.28	Cape Elizabeth	Rural	2	$4,000.00	1006	1800	45	0.001028	8090	88O00000	05	319307	Townway	-			B	NG	4	7		Y		1			Y		4.5		RW
RD INV 10299 01	0.21	0.74	0.53	Auburn	Urban	2	$40,000.00	2228	1920	25	0.004310	8097	89205000	01	306171	Townway	-			B	N	4	8		Y				Y	Y	Y	3.5		R
US 302	15.63	16.03	0.40	Windham	Urban	2	$186,000.00	20864	3800	30	0.030461	8082	87F02600	05	330533	State hwy	0035X	42.95	43.35	A	PC	4		4		Y				Y		4.5		R
ST RTE 0136	18.56	18.58	0.02	Auburn	Urban	2	$25,000.00	22286	1920	25	0.001627	8099	8931F000	01	307664	State hwy	-			A	P	4			Y					Y		3.5		R
MAINT C325N DIV 6	2.47	2.90	0.43	Standish	Rural	2	$4,000.00	1628	1800	45	0.002555	8015	84S06700	05	319361	State aid	-			B	NG	4	8						Y			4.5		W
ST RTE 0003	108.39	108.47	0.08	Mt Desert	Rural	2	$40,000.00	1705	1800	25	0.000498	7033	7780A600	09	338359	State aid	-			A	PC	4	6	1							Y	4.5		R
RD INV 20024 01	0.53	0.69	0.16	Lewiston	Urban	2	$4,000.00	8137	1920	25	0.004752	8095	8910G000	01	307781	State aid	-			A	PC	4		1						Y	Y	4		R
RD INV 10168 23	2.37	2.42	0.05	Bath	Urban	2	$23,000.00	7430	1400	25	0.001356	8006	84M06J00	23	370813	Townway	-			A	PC	4	10	i								4		R
ST RTE 0136	17.72	17.92	0.20	Auburn	Urban	2	$59,000.00	5250	1920	25	0.003833	8099	8931B000	01	307642	State aid	-			A	N	4			Y					Y		4		R
ST RTE 0026	25.81	26.70	0.89	Poland	Rural	2	$46,000.00	5635	2400	55	0.018305	8011	84R02E00	01	308613	State hwy	-			B	G	4	14		Y					Y	Y	4		M
ST RTE 0035	22.95	23.98	1.03	Hollis	Rural	2	$23,000.00	2297	1800	45	0.008636	8079	87E02300	31	386361	State aid	-			B	NG	4	9		Y				Y	Y		4		M
MAINT C434O DIV 7	0.78	1.34	0.56	Auburn	Rural	3	$6,000.00	3450	1800	45	0.007052	8099	89319000	01	308913	State aid	-			A	N	4			Y				Y	Y		4	Y	W
MAINT C518N DIV 6	21.53	22.20	0.67	Biddeford	Rural	3	$78,000.00	1686	1600	45	0.004123	8029	85D04400	31	387520	State aid	-			0	G	5	9		Y				Y	Y		4		M
ST RTE 0009	25.33	25.73	0.40	Kennebunkport	Rural	2	$23,000.00	2575	1800	25	0.003760	8033	85I02C00	31	387055	State aid	-			B	NG	5	13		Y					Y		3.5		R
ST RTE 0209	0.22	0.24	0.02	Bath	Urban	2	$23,000.00	10090	1400	25	0.000737	8006	84M06H00	23	370912	State aid	-			B	PC	5		i	Y					Y		4		R
MAINT C460N DIV 6	7.52	8.02	0.50	Freeport	Rural	2	$6,000.00	2369	1800	45	0.004323	8087	88J00000	05	327483	State aid	-			B	NG	5	13		Y					Y		4		W
ST RTE 0213	1.88	4.60	2.72	Jefferson	Rural	3	$25,000.00	542	1800	45	0.005381	8024	85B02900	15	351974	State aid	-			B	G	5	13		Y				Y	Y	Y	3.5		M
ST RTE 0009	37.18	37.23	0.05	Biddeford	Urban	2	$118,000.00	10043	1400	25	0.001833	8034	85I02H00	31	389326	State aid	-			A	PC	5		1								4		R
ST RTE 0209	0.04	0.08	0.04	Bath	Urban	2	$4,000.00	9577	1400	25	0.001398	8006	84M06H00	23	371030	State aid	-			B	PC	5		i								4		R

Table B-2

Vehicle / Utility Pole Collisions
1994 - 1998 (2 or more collisions)
Segment evaluation using ARAN video tapes

Total statewide segments	6073
Total statewide collisions with UP's	7544
Number of segments on state aid & state hwy roads (2 or more collisions)	1046
Number of collisions on state hwy and state aid roadways (2 or more)	2511
Number of segments filmed by ARAN video	777
Number of collisions represented by ARAN video	1896
Segments rated using ARAN video	771
Number of collisions rated using ARAN video	1883

UP locations	# of segments	% of segments	# of collisions
Rural areas	549	71.2%	1352
Urban areas	222	28.8%	531
UP's opposite T intersections	53	6.9%	
UP's in medians or islands	9	1.2%	
UP's located on outside curves	433	56.2%	
UP's on both sides	138	17.9%	
Guy poles on opposite side	292	37.9%	
Shoulders steeper than 4:1	74	9.6%	
With curb	120	15.6%	
UP's on inside of curb	8	1.0%	
Average offset from curb	2.35 ft		

Shoulder types	# of segments	% of segments	# of collisions	% of collisions
Paved (P)	118	15.3%	270	14.3%
Paved w/ curb (PC)	70	9.1%	158	8.4%
Narrow paved (NP)	5	0.6%	13	0.7%
Narrow paved w/ curb(NPC)	1	0.1%	2	0.1%
Gravel (G)	276	35.8%	701	37.2%
Narrow gravel (NG)	120	15.6%	298	15.8%
No shoulder (N)	131	17.0%	321	17.0%
No shoulder w/ curb (NC)	49	6.4%	118	6.3%
No shoulder w/ guard rail (NR)	1	0.1%	2	0.1%

Surrounding area beyond Utility Poles	# of segments	% of segments	# of collisions
Woods (W)	247	32.0%	603
Open (O)	122	15.8%	275
Mixed - woods & open (M)	125	16.2%	325
Residential (R)	238	30.9%	571
Industrial (I)	9	1.2%	25
Residential + (RW,RO,RM)	30	3.9%	84
Industrial + (IW, IO, IM)	0	0.0%	0

Utility Pole Offset

Minimum Pole Offset	# of Segments	# of Collisions	% of Collisions	"A" Roads # Segments/ # Collisions	"B" Roads # Segments/ # Collisions	"0" Roads # Segments/ # Collisions	Segments w/ poles on outside curves *	Segments w/ poles on both sides *	Segments w/ guide poles *	Segments w/ poles at T intersections *
1 - 2 ft.	36	85	4.5%	33 / 79	0 / 0	3 / 6	11	13	8	0
3 - 4 ft.	32	74	3.9%	20 / 46	9 / 20	3 / 8	15	4	7	3
5 - 6 ft.	87	238	12.6%	28 / 69	41 / 125	18 / 44	50	13	21	6
7 - 8 ft.	81	201	10.7%	37 / 89	29 / 80	15 / 32	34	15	19	5
9 - 10 ft.	94	228	12.1%	8 / 16	57 / 139	29 / 73	60	22	37	7
11 - 12 ft.	95	231	12.3%	55 / 133	29 / 71	11 / 27	48	23	31	2
13 - 14 ft.	196	474	25.2%	32 / 75	121 / 304	43 / 95	126	32	95	21
15 - 16 ft.	39	89	4.7%	20 / 45	15 / 35	4 / 9	23	7	19	1
17 - 18 ft.	42	97	5.2%	27 / 59	12 / 32	3 / 6	29	2	18	3
19 - 20 ft.	44	112	5.9%	6 / 12	28 / 76	10 / 24	25	5	22	2
21 - 22 ft.	2	5	0.3%	2 / 5	0 / 0	0 / 0	2	0	2	0
23 - 24 ft.	21	45	2.4%	21 / 45	0 / 0	0 / 0	9	2	12	3
25 - 26 ft.	2	4	0.2%	0 / 0	1 / 2	1 / 2	1	0	1	0
27+ ft.	0	0	0.0%	0 / 0	0 / 0	0 / 0	0	0	0	0
Totals	771	1883		289 / 673	342 / 884	140 / 326	433	138	292	53

Rural / Urban Utility Pole Offset

	Rural locations						Urban locations					
Minimum pole offset	# of segments	Ave posted mph	Ave factored AADT	# of collisions	Total cost of collisions	Ave cost of collision	# of segments	Ave posted mph	Ave factored AADT	# of collisions	Total cost of collisions	Ave cost of collision
1 - 2 ft.	2	45.0	1117	4	$27,000.00	$6,750.00	34	30.4	17314	81	$4,795,000.00	$59,197.53
3 - 4 ft.	12	44.6	2784	30	$360,000.00	$12,000.00	20	26.3	9685	44	$1,057,000.00	$24,022.73
5 - 6 ft.	45	42.2	2583	131	$3,455,000.00	$26,374.05	42	29.9	9162	107	$5,723,000.00	$53,485.98
7 - 8 ft.	43	42.4	3865	101	$4,969,000.00	$49,198.02	38	27.6	10237	100	$3,480,000.00	$34,800.00
9 - 10 ft.	78	44.2	2502	193	$6,498,000.00	$33,668.39	16	29.1	6883	35	$491,000.00	$14,028.57
11 - 12 ft.	67	43.6	4888	166	$16,641,000.00	$100,246.99	28	32.9	10901	65	$1,251,000.00	$19,246.15
13 - 14 ft.	168	45.2	3392	410	$16,533,000.00	$40,324.39	28	37.0	10219	64	$1,569,000.00	$24,515.63
15 - 16 ft.	32	45.3	3446	75	$2,573,000.00	$34,306.67	7	35.0	9671	14	$718,000.00	$51,285.71
17 - 18 ft.	37	48.8	4041	86	$8,094,000.00	$94,116.28	5	40.0	8219	11	$134,000.00	$12,181.82
19 - 20 ft.	41	47.3	3865	104	$2,402,000.00	$23,096.15	3	28.3	4836	8	$126,000.00	$15,750.00
21 - 22 ft.	2	42.5	6972	5	$245,000.00	$49,000.00	0	0.0	0	0	$0.00	$0.00
23 - 24 ft.	20	48.8	6715	43	$3,621,000.00	$84,209.30	1	35.0	9507	2	$76,000.00	$38,000.00
25 - 26 ft.	2	52.5	5961	4	$44,000.00	$11,000.00	0	0.0	0	0	$0.00	$0.00
27+ ft.	0	0.0	0	0	$0.00	$0.00	0	0.0	0	0	$0.00	$0.00
Totals	549			1352	$65,462,000.00	$48,418.64	222			531	$19,420,000.00	$36,572.50

Table B-3

Vehicle / Utility Pole Collisions
1994 - 1998 (2 or more collisions)
Utility pole offset data using ARAN video tapes

25 MPH posted speed limit

Minimum pole offset (ft)	# of segments	# of collisions	Ave factored AADT	Total Cost	Ave cost	Segments w/ poles on outside curves	Segments w/ poles on both sides	Segments w/ poles at end of T intersection	Segments w/ poles in islands or medians	Segments w/ guy poles
1 - 2	12	29	17173	$718,000.00	$24,758.62	4	7	0	0	1
3 - 4	17	38	8335	$647,000.00	$17,026.32	6	2	2	0	2
5 - 6	28	70	5507	$1,762,000.00	$25,171.43	13	4	1	0	4
7 - 8	30	81	9179	$2,945,000.00	$36,358.02	10	4	4	0	5
9 - 10	12	27	3522	$310,000.00	$11,481.48	4	0	0	0	1
11 - 12	10	23	8946	$628,000.00	$27,304.35	4	5	0	0	0
13 - 14	8	19	9152	$516,000.00	$27,157.89	0	1	0	1	2
15 - 16	4	8	7462	$160,000.00	$20,000.00	0	0	0	0	1
17 - 18	0	0	0	$0.00	$0.00	0	0	0	0	0
19 - 20	2	6	4045	$122,000.00	$20,333.33	0	1	1	0	0
21 - 22	0	0	0	$0.00	$0.00	0	0	0	0	0
23 - 24	0	0	0	$0.00	$0.00	0	0	0	0	0
25 - 26	0	0	0	$0.00	$0.00	0	0	0	0	0
>27	0	0	0	$0.00	$0.00	0	0	0	0	0

30 MPH posted speed limit

Minimum pole offset	# of segments	# of collisions	Ave factored AADT	Total Cost	Ave cost	Segments w/ poles on outside curves	Segments w/ poles on both sides	Segments w/ poles at end of T intersection	Segments w/ poles in islands or medians	Segments w/ guy poles
1 - 2 ft.	10	24	16778	$2,982,000.00	$124,250.00	4	4	0	0	0
3 - 4 ft.	3	6	14562	$230,000.00	$38,333.33	0	1	0	0	0
5 - 6 ft.	4	9	7702	$270,000.00	$30,000.00	2	3	0	0	1
7 - 8 ft.	7	15	7802	$3,074,000.00	$204,933.33	3	1	0	0	1
9 - 10 ft.	3	6	7973	$139,000.00	$23,166.67	1	1	0	0	1
11 - 12 ft.	9	20	11091	$209,000.00	$10,450.00	3	2	1	0	2
13 - 14 ft.	6	15	6787	$650,000.00	$43,333.33	2	1	1	0	1
15 - 16 ft.	1	2	4768	$42,000.00	$21,000.00	1	1	0	0	0
17 - 18 ft.	1	3	1761	$25,000.00	$8,333.33	1	0	0	0	0
19 - 20 ft.	1	4	4678	$27,000.00	$6,750.00	1	0	0	0	1
21 - 22 ft.	0	0	0	$0.00	$0.00	0	0	0	0	0
23 - 24 ft.	0	0	0	$0.00	$0.00	0	0	0	0	0
25 - 26 ft.	0	0	0	$0.00	$0.00	0	0	0	0	0
27+ ft.	0	0	0	$0.00	$0.00	0	0	0	0	0

35 MPH posted speed limit

Minimum pole offset	# of segments	# of collisions	Ave factored AADT	Total Cost	Ave cost	Segments w/ poles on outside curves	Segments w/ poles on both sides	Segments w/ poles at end of T intersection	Segments w/ poles in islands or medians	Segments w/ guy poles
1 - 2 ft.	9	20	18141	$967,000.00	$48,350.00	1	1	0	0	4
3 - 4 ft.	1	2	10029	$220,000.00	$110,000.00	0	0	0	0	0
5 - 6 ft.	13	34	10397	$1,139,000.00	$33,500.00	6	1	2	0	4
7 - 8 ft.	10	26	8613	$634,000.00	$24,384.62	2	5	1	0	2
9 - 10 ft.	9	24	5821	$342,000.00	$14,250.00	4	4	2	1	3
11 - 12 ft.	17	41	6779	$1,301,000.00	$31,731.71	7	8	1	1	2
13 - 14 ft.	13	34	10138	$3,491,000.00	$102,676.47	6	3	2	0	8
15 - 16 ft.	4	9	5084	$382,000.00	$42,444.44	2	0	0	0	2
17 - 18 ft.	3	7	7554	$2,673,000.00	$381,857.14	2	1	0	0	1
19 - 20 ft.	1	2	6418	$4,000.00	$2,000.00	1	0	0	0	0
21 - 22 ft.	1	2	4519	$203,000.00	$101,500.00	1	0	0	0	1
23 - 24 ft.	1	2	9507	$76,000.00	$38,000.00	1	1	1	0	0
25 - 26 ft.	0	0	0	$0.00	$0.00	0	0	0	0	0
27+ ft.	0	0	0	$0.00	$0.00	0	0	0	0	0

40 MPH posted speed limit

Minimum pole offset	# of segments	# of collisions	Ave factored AADT	Total Cost	Ave cost	Segments w/ poles on outside curves	Segments w/ poles on both sides	Segments w/ poles at end of T intersection	Segments w/ poles in islands or medians	Segments w/ guy poles
1 - 2 ft.	3	8	17178	$128,000.00	$16,000.00	0	1	0	0	2
3 - 4 ft.	0	0	0	$0.00	$0.00	0	0	0	0	0
5 - 6 ft.	4	9	13922	$2,747,000.00	$305,222.22	1	0	0	0	0
7 - 8 ft.	3	6	12723	$120,000.00	$20,000.00	1	0	0	0	0
9 - 10 ft.	5	12	2107	$2,935,000.00	$244,583.33	4	1	1	0	2
11 - 12 ft.	7	16	6417	$3,392,000.00	$212,000.00	3	2	0	0	2
13 - 14 ft.	13	29	6184	$771,000.00	$26,586.21	6	3	1	1	6
15 - 16 ft.	5	13	4311	$430,000.00	$33,076.92	4	0	0	0	3
17 - 18 ft.	1	3	9775	$42,000.00	$14,000.00	0	0	0	1	0
19 - 20 ft.	0	0	0	$0.00	$0.00	0	0	0	0	0
21 - 22 ft.	0	0	0	$0.00	$0.00	0	0	0	0	0
23 - 24 ft.	3	6	9892	$103,000.00	$17,166.67	0	0	1	0	1
25 - 26 ft.	0	0	0	$0.00	$0.00	0	0	0	0	0
27+ ft.	0	0	0	$0.00	$0.00	0	0	0	0	0

45 MPH posted speed limit

Minimum pole offset	# of segments	# of collisions	Ave factored AADT	Total Cost	Ave cost	Segments w/ poles on outside curves	Segments w/ poles on both sides	Segments w/ poles at end of T intersection	Segments w/ poles in islands or medians	Segments w/ guy poles
1 - 2 ft.	2	4	1117	$27,000.00	$6,750.00	2	0	0	0	1
3 - 4 ft.	9	24	2561	$251,000.00	$10,458.33	8	1	1	0	5
5 - 6 ft.	36	111	3366	$3,159,000.00	$28,459.46	27	4	3	0	12
7 - 8 ft.	22	53	1878	$1,272,000.00	$24,000.00	13	5	0	0	8
9 - 10 ft.	49	118	2151	$2,402,000.00	$20,355.93	36	8	3	1	25
11 - 12 ft.	34	89	4292	$10,984,000.00	$123,415.73	22	2	0	1	16
13 - 14 ft.	110	259	2964	$7,570,000.00	$29,227.80	79	13	12	1	57
15 - 16 ft.	11	24	4019	$723,000.00	$30,125.00	6	1	0	0	8
17 - 18 ft.	16	41	3661	$1,640,000.00	$40,000.00	10	0	0	0	9
19 - 20 ft.	21	51	2647	$1,329,000.00	$26,058.82	10	0	1	0	12
21 - 22 ft.	0	0	0	$0.00	$0.00	0	0	0	0	0
23 - 24 ft.	6	12	5407	$210,000.00	$17,500.00	5	0	0	0	3
25 - 26 ft.	0	0	0	$0.00	$0.00	0	0	0	0	0
27+ ft.	0	0	0	$0.00	$0.00	0	0	0	0	0

50 MPH posted speed limit

Minimum pole offset	# of segments	# of collisions	Ave factored AADT	Total Cost	Ave cost	Segments w/ poles on outside curves	Segments w/ poles on both sides	Segments w/ poles at end of T intersection	Segments w/ poles in islands or medians	Segments w/ guy poles
1 - 2 ft.	0	0	0	$0.00	$0.00	0	0	0	0	0
3 - 4 ft.	1	2	3021	$23,000.00	$11,500.00	0	0	0	0	0
5 - 6 ft.	2	5	2017	$101,000.00	$20,200.00	1	1	0	0	0
7 - 8 ft.	8	17	6871	$398,000.00	$23,411.76	5	0	0	0	3
9 - 10 ft.	15	39	4029	$677,000.00	$17,358.97	11	7	1	1	5
11 - 12 ft.	15	34	6591	$1,140,000.00	$33,529.41	8	3	0	0	9
13 - 14 ft.	42	105	4119	$4,898,000.00	$46,647.62	29	9	2	0	18
15 - 16 ft.	8	20	4483	$931,000.00	$46,550.00	6	3	1	0	3
17 - 18 ft.	9	18	3557	$453,000.00	$25,166.67	7	0	1	0	3
19 - 20 ft.	16	42	4479	$797,000.00	$18,976.19	11	4	0	0	6
21 - 22 ft.	1	3	9425	$42,000.00	$14,000.00	1	0	0	0	1
23 - 24 ft.	4	10	7577	$149,000.00	$14,900.00	1	0	1	0	3
25 - 26 ft.	1	2	6448	$4,000.00	$2,000.00	1	0	0	0	0
27+ ft.	0	0	0	$0.00	$0.00	0	0	0	0	0

55 MPH posted speed limit

Minimum pole offset	# of segments	# of collisions	Ave factored AADT	Total Cost	Ave cost	Segments w/ poles on outside curves	Segments w/ poles on both sides	Segments w/ poles at end of T intersection	Segments w/ poles in islands or medians	Segments w/ guy poles
1 - 2 ft.	0	0	0	$0.00	$0.00	0	0	0	0	0
3 - 4 ft.	1	2	5635	$46,000.00	$23,000.00	1	0	0	0	0
5 - 6 ft.	0	0	0	$0.00	$0.00	0	0	0	0	0
7 - 8 ft.	1	3	4640	$6,000.00	$2,000.00	0	0	0	0	0
9 - 10 ft.	1	2	10399	$184,000.00	$92,000.00	0	1	0	0	0
11 - 12 ft.	3	8	12836	$238,000.00	$29,750.00	1	1	0	0	0
13 - 14 ft.	4	13	7700	$206,000.00	$15,846.15	4	2	1	0	3
15 - 16 ft.	6	13	3566	$623,000.00	$47,923.08	4	2	0	0	2
17 - 18 ft.	12	25	5485	$3,395,000.00	$135,800.00	9	1	1	0	5
19 - 20 ft.	3	7	8850	$249,000.00	$35,571.43	2	0	0	0	3
21 - 22 ft.	0	0	0	$0.00	$0.00	0	0	0	0	0
23 - 24 ft.	7	15	5983	$3,159,000.00	$210,600.00	2	1	0	0	5
25 - 26 ft.	1	2	5473	$40,000.00	$20,000.00	0	0	0	0	1
27+ ft.	0	0	0	$0.00	$0.00	0	0	0	0	0

Costs

Posted speed limit	# of segments	# of collisions	Total Cost	Cost / segment	Cost / collision
25	123	301	$7,808,000.00	$63,479.67	$25,940.20
30	45	104	$7,648,000.00	$169,955.56	$73,538.46
35	82	203	$11,432,000.00	$139,414.63	$56,315.27
40	44	102	$10,668,000.00	$242,454.55	$104,588.24
45	316	786	$29,567,000.00	$93,566.46	$37,617.05
50	122	297	$9,613,000.00	$78,795.08	$32,367.00
55	39	90	$8,146,000.00	$208,871.79	$90,511.11

APPENDIX C

Table C-1

Summary of Utility Pole Placement Policies

State	Source of information[1]	Utility Pole Fatalities (1994 - 1998) Rank by state	Utility Pole Fatalities (1994 - 1998) Fatalities	Fatalities Per 100 Billion Vehicle Miles (1994 - 1998) Rank by state	Fatalities Per 100 Billion Vehicle Miles (1994 - 1998) Fatalities per 100-B VMT	Policy last revised	Revised policy decreased collisions	Policy based on[2]	Clear Zone Guidlines RDG CZ Figure 3.1	Clear Zone Guidlines RDG CZ Table 3.1	Clear Zone Guidlines Modified RDG Figure	Clear Zone Guidlines Modified RDG Table	Locate UP's at or near ROW line	Adjustments for slope and/or curves	Control Zones (prohibit UP's)	Fixed Rural Offsets based on[2]	Fixed Urban Offsets based on[2]	Fixed offsets at limited ROW areas	Minimum offset from curb (m)	Promote joint use single pole construction	Reflective Markers	Distance behind guard rail	Guidelines for ditch lines	Review accident records for UP relocation	Encourage breakaway poles	Use crash cushions	Exsisting pole requirements
North Dakota	E, I	51	1	51	3	1987		DS, DA	Y				Y	Y		R			1		Guys						1956 law states: State road min. offset 30 m, County road min offset 23 m.
Wyoming	E	50	3	50	8				Y						Y					Y				Y	Y		In most cases there is no problem with space. Use 30 ft clear zone as a guide.
Montana	E	48	4	49	9	1995		RU	Y							PU			0.6			0.6		Y			"Fast process" in place to fix hazardous situations or adjust utilities. Also use CZ or Clear Recovery Area whichever is greater.
Michigan	E	22	93	39	21			PS						Y		PS	D		0.6						Y		
Kansas	E, P	33	37	35	29	1997		DS, DA		Y				Y			PS		1.8	Y			Y		Y		
Oklahoma	E	27	58	34	29	1997							Y														No space restrictions.
Iowa	P	32	40	33	30	1990		R, A		Y				Y			PS								Y		
Missouri	E	23	91	32	30			P					Y														
Virginia	E	16	110	30	32			A, AA, DS				Y		Y				Y			Y				Y		
Texas	E	6	302	29	32	1989			Y				Y														
Arkansas	E	29	47	27	35	1996	N						Y						0.3								
Illinois	E, F, I	11	182	26	38	1992		P, DS, DA	Y		Y								0.3						Y	Y	
Vermont	P	43	14	24	44	1997		RU				Y						Y	0.5	Y	Y		Y	Y	Y	Y	
New York	E, I	7	281	22	48	1996		DS, DA	Y						Proj Review						Optional			Y			When utilities retire old poles the DOT reviews the area and makes recomendations.
Florida	P, I	4	330	19	51	1999		P, PS, DA				Y		Y	Y					Y				Y			
Indiana	E, I	12	178	17	54	1990	Y	DA, DS			Y			Y					0.6								Close to ROW as possible.
Connecticut	E, F	25	80	15	57	1977		DA, DS	Y									Y	0.3			0.6		Y			
Mississippi	E	21	98	11	63	1973	Y	A, DS								A, DS	A, DS		0.6						Y		
Massachusetts	E	13	175	10	71	Currently							Y							Y	Y						
Maine	P	30	46	9	71	1995	?	P,RU,PS								PS	PS					0.6	Y	Y ?			
New Jersey	E	8	265	6	85	1998	N	P					Y						0.5								May relocate poles showing signs of being hit.
Rhode Island	E	34	32	4	88				Y										0.5								
West Virginia	E	24	81	3	91								Y														
Tennesee	E	5	328	1	113	Currently			Y				Y														

1
- E EMail response
- F Fax information
- I Phone interview
- P Reviewed states policy

2
- A ADT
- AA AADT
- D Population density
- DA Design AADT
- DS Design speed
- P Project type
- PS Posted speed
- PU Paved or unpaved road
- R Roadway type
- RU Rural or Urban

APPENDIX D

Figure 1a. Full SRSP

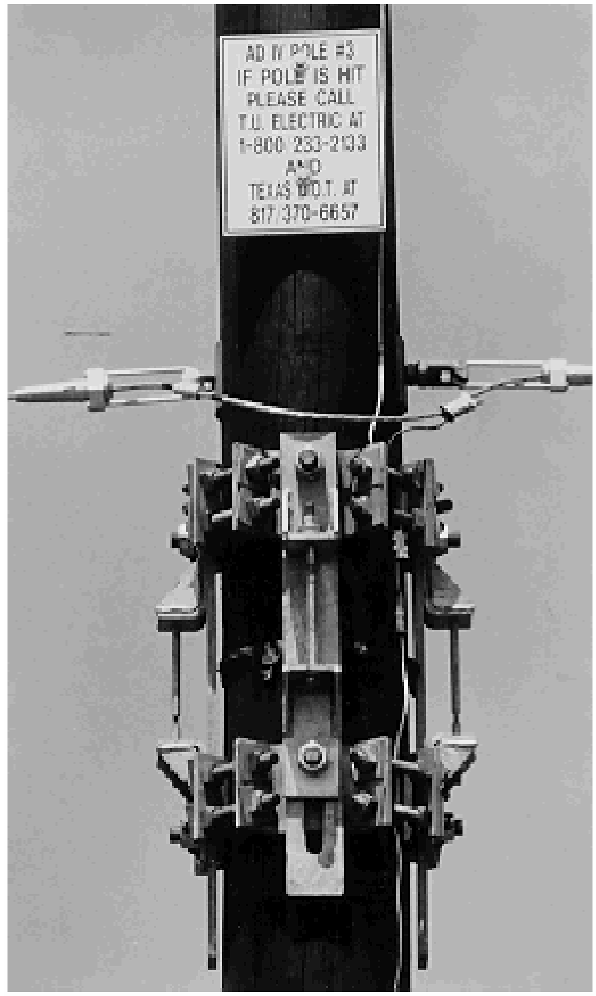

Figure 1b. Steel Upper Connection

Figure 1c. Steel Base

Figure 2a. Low Profile Barrier

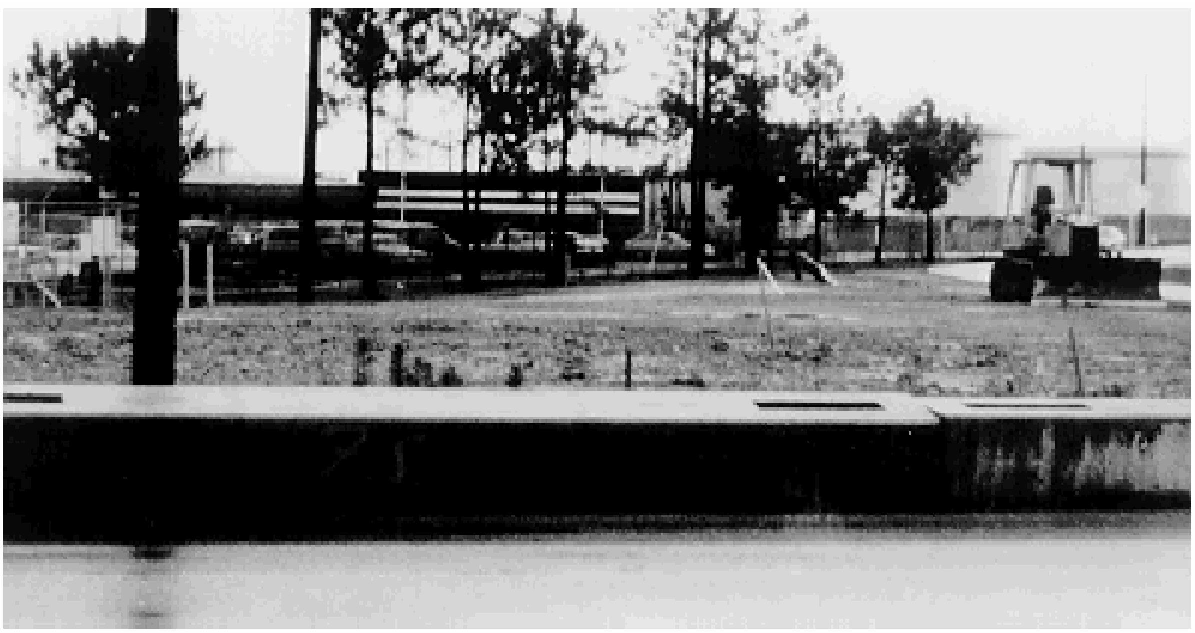

Figure 2b. LPB showing joint detail

Figure 3. ET-2000/CPSI

Figure 4a. ADIEM, Level 2(soft concrete crash cushion)

Figure 4b. ADIEM, (shorty) 9 ft. concrete crash cushion

APPENDIX E

Photo E-1

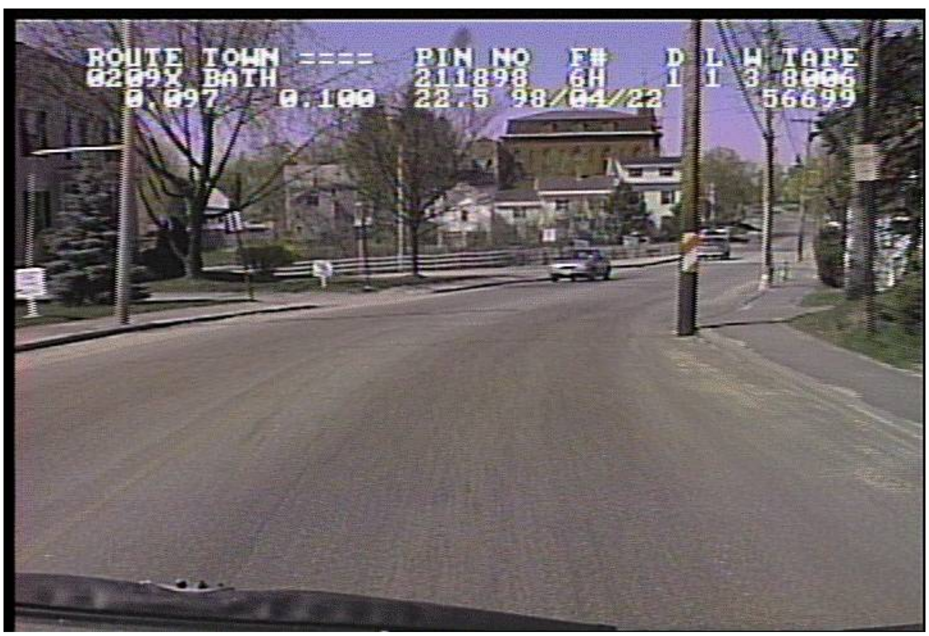

Photo E-2

Photo E-3

Photo E-4


Route Town PIN File D L W TAPE
20286 LEWISTON 211899 0J00 4 1 2 8095
1.704 1.710 30.5 98/09/01 200366

Photo E-5