


Purpose


- Using case studies demonstrate:
 - **Safety and Human Factors Considerations and Techniques**
 - **Performance Criteria Measurements**
 - **Safety Influence on VE Results and Decision-Making**





Selected Case Studies


- Highway 402 WB
(Bluewater Bridge Approach)
- Highway 11/562 Intersection
(New Liskeard)



Case Study

Highway 402 WB–Bluewater Bridge Approach

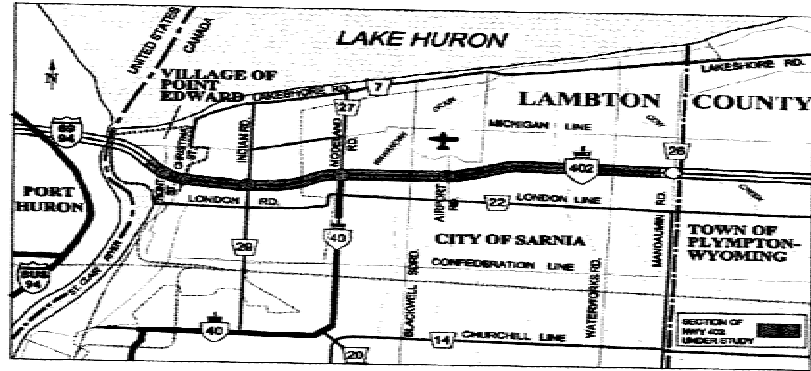
- Significant westbound truck queuing
- An on-going study focused on operational concerns
- Base Case
 - 4 WB lanes with “Trucks in the Middle”
 - Basket weave structures at Hwy 40 IC and east limits





Study Area

Highway 402 WB




Highway 402 WB

BASE CASE TYPICAL SECTION (WB)



- Lane 1 – US Bound Cars/FAST Trucks
- Lane 2 – US Bound Trucks
- Lane 3 – US Bound Trucks
- Lane 4 – Local Traffic
- BU – Buffer Zones





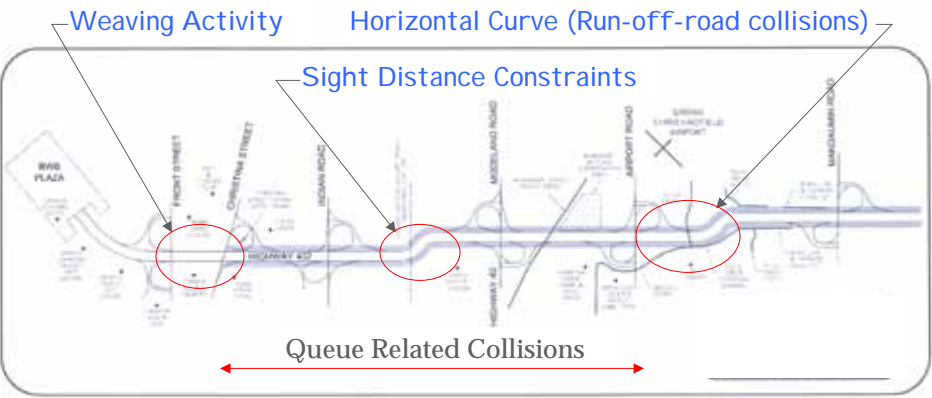
Collision Analysis

- A collision analysis & diagram (2002-2004)
- 122 collisions (3Fatal; 23Injury; 96PDO)

Major Safety Issues


- Queue-related rear-end collisions
- Truck involvement
- Higher severity – west end
- Weaving between Lane 1 and IC exit/entry points



← Weaving Activity Horizontal Curve (Run-off-road collisions) →

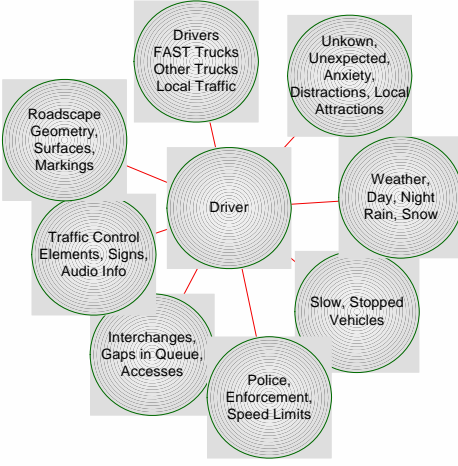
← Sight Distance Constraints →



← Queue Related Collisions →



Driver Decision-Making/Environment Interaction

- A Human Factors brainstorming session
 - how a driver interacts with driving environment
 - how drivers make decisions
- The diagram to the right illustrates the thoughts




Highway 402 WB

Safety Performance Criteria Measures

- Road User Safety (SI)
 - *those alternatives which significantly reduce all potential collision types receive a high Safety Performance Measurement, and vice versa*
- Positive Guidance and Delineation (DI)
 - *those alternatives which are consistent and predictable, while at the same time provide an appropriate information processing opportunity, receive a high Positive Guidance & Delineation Performance Measure, and vice versa.*





Highway 402 WB

Roadway User Safety

- Roadway user safety = the number of expected collisions
- Collision Modification Factors (CMF) = effectiveness of various collision countermeasures
 - CMF's indicate the reduction the increase or reduction to the expected number of collisions after the implementation of a selected countermeasure
- Through the use of CMF's or engineering judgment, the change in estimate of collision will determine the relative safety performance measurement for each alternative



Highway 402 WB

Calculation:

- A. Queue Related collisions (rear-ends, run-off road, sideswipe)
- B. Weaving Related Collisions (sideswipe, rear-ends)
- C. Alignment Related Collisions (run-off road)
- D. Speed Differential Related Collisions (rear-end, sideswipe)

$$SI = [(A+B+C+D)/12] \times 10 \quad (Max = 10)$$

- 3 = High (>25 %) reduction in expected collisions
- 2 = Moderate (10 – 25%) reduction in expected collisions
- 1 = Low or no rear-end collision reductions
- 0 = Increase in expected collisions





Highway 402 WB

Positive Guidance & Delineation

- If roadways are designed according to driver limitations and expectations, there is an increase in likelihood of driver's responding to situations and information correctly and quickly
- Roadways should be **Predictable/Consistent**
- Traffic Control Devices should allow quick and accurate **Information Processing**
 - Primacy
 - Spreading
 - Redundancy




Highway 402 WB

Calculation

$$DI = 1 + A + B + C \quad (\text{Max} = 10)$$

- A. Predictability/Consistency
 - 3 = High Predictability & Consistency with adjacent sections
 - 1 = Not consistent with adjacent section of Hwy 402
- B. Information Processing
 - 3 = Clear and obvious routing of vehicles
 - 1 = Unclear, vague routing of vehicles
- C. Driver Workload
 - 3 = Minimal
 - 1 = High







Highway 402 WB

Safety Influence on VE Results


- Limited safety benefits of basket weave structure at east limits
- Safety benefit of buffer zones
- Lane balance considerations at Hwy 40 IC



Highway 402 WB

Safety Influence on Decision-Makers

- Additional Safety Enhancements :
 - ITS applications (Overhead Variable Message Signs or Incident Management)
 - Speed Management (signing / pavement markings)
 - “Share the Road” & “No-Zone” awareness (US Education Program)
 - Roadside/Landscape changes to encourage slower speeds
 - Surface treatment and anti-icing methods (tire/surface friction)
- Human factors included in follow-up detail design study, on-going





Case Study

Highway 11 and 562 Intersection, New Liskeard

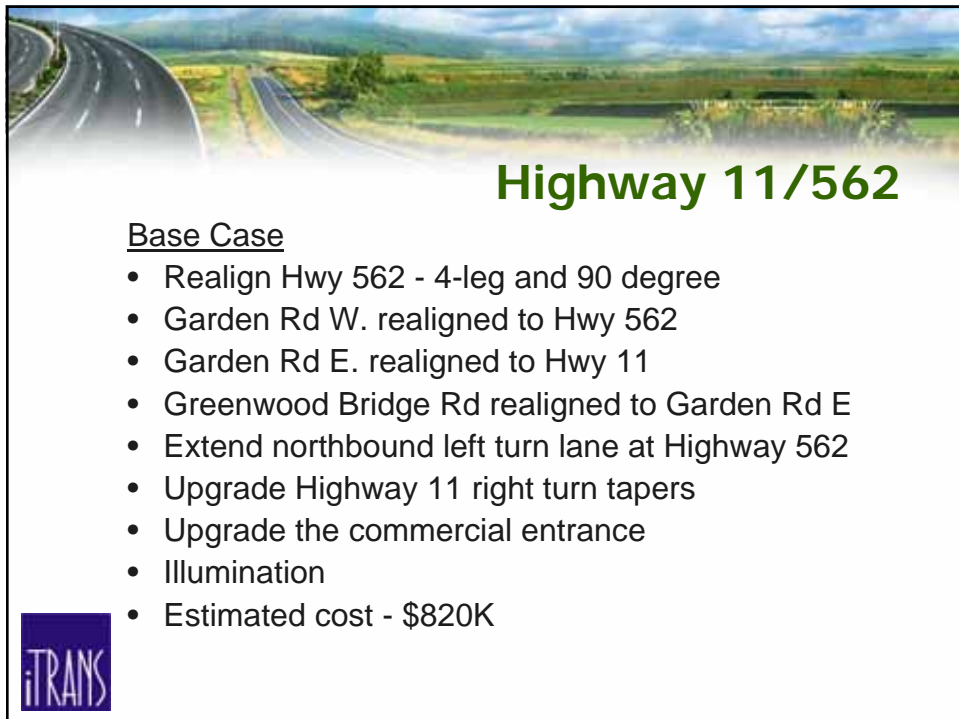
- 6-leg intersection at Highway 11 and Highway 562 -19.3 km north of New Liskeard.
 - **two township roads, a concession road and Highway 562 converging to intersect Hwy 11**
- A commercial entrance on the west side of Highway 11 (Highway 562 and Garden Road West)
- Construction contract package completed in 1995
- Implementation halted due to incomplete property negotiations

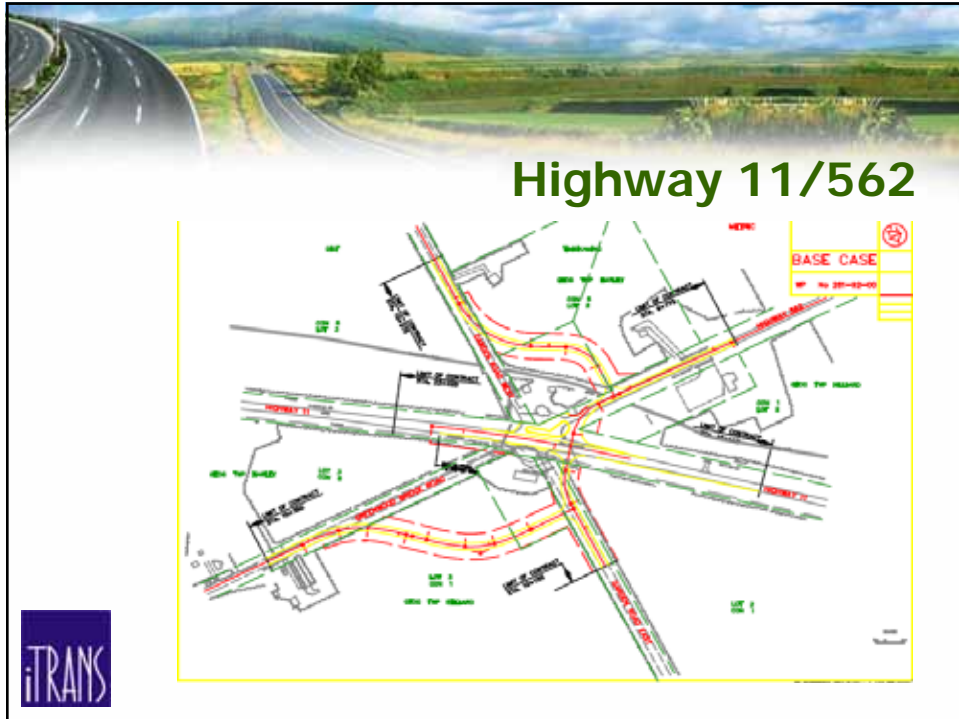


Highway 11/562

Project Location







Highway 11/562

Safety Review – Collision Analysis

- The intersection has a “high” potential for operational improvement
- Collision History (2000-2004)
 - 15 collisions
 - 89% NB vehicles
 - Impact type
 - Angle at the intersection
 - 67% single-vehicle within 500 m of the intersection, and at the church on Hwy 562
 - 1Fatal (head-on); 6Injury; 8PDO
 - 80% clear and dry; 90% daytime
- 8,000 veh/day on Hwy 11 and 350 veh/day on Hwy 562
- Unusual intersection configuration



Highway 11/562

Field Observations

- Intersection inconspicuous and unexpected
- Signage not visible
- Seriously restricted and obstructed sightlines
- Skew approaches
- High speed corridor – loaded/multi-axle trucks
- Conflicts between local and through traffic
- Vulnerable users
- Convenience shop (built 1920's)



Highway 11/562



Along Hwy 562 Looking east across Hwy 11





Highway 11/562




Looking south on Hwy 11 – gas station to the right



Highway 11/562

- Base Case - Safety effects
 - Greater conspicuity of the intersection
 - Better sightlines
 - Reduction in unexpected “avoidance maneuvering”
 - Expected reduction in single-vehicle and angle collisions
- No provision for “turning refuge” at high speeds
- Confusion/conflict with gas station and high speed through movements
- Local roads realignments very tight curves
- Conflicts with buses at Hwy 562






Highway 11/562

Performance Criteria Measures – Roadway User Safety


- The Roadway User Safety Index (RUSI) for each scenario calculated as follows:
$$\text{RUSI} = \sum S_i \quad (i_{\text{Max}}=10)$$
- The RUSI scale recognizes that a higher ranking awarded to alternatives with higher expected overall safety performance



Highway 11/562

Performance Criteria Measures – Roadway User Safety

- S1: Management of access near unsignalized intersections.
- S2: Geometric design improvements related to conflicts
- S3: Sight distance at unsignalized intersections.
- S4: Availability of gaps in traffic and assist drivers in judging gap sizes
- S5: Driver awareness of intersections as viewed from the intersection approach.
- S6: Intersection control
- S7: Driver compliance with traffic control devices and traffic laws
- S8: Operating speeds on specific intersection approaches
- S9: Guide motorists through complex intersections.
- S10: Consistency along corridor






Highway 11/562

Performance Criteria Measures – Roadway User Safety

For each of the 10 safety criteria, the following score is applied:


- S=0.00 Significant decrease in expected safety performance
- S=0.25 Moderate decrease in expected safety performance
- S=0.50 No change in expected safety performance
- S=0.75 Moderate increase in expected safety performance
- S=1.00 Significant increase in expected safety performance

$$RUSI = \sum S_i$$


Highway 11/562

Safety Influence on VE Results

- The expanded explicit safety assessment assisted in differentiating between similar alternatives
- Safety concerns related to direct Highway 11 access to the gas bar addressed in the various alternatives
- Community safety concerns related to school buses addressed in in the various alternatives.






Highway 11/562

Safety Influence on Decision-Makers


- Allowed for consideration of stand-alone traffic enhancements:
 - Improved signing
 - Illumination
 - Centreline and shoulder rumble strips
 - Paved shoulders
 - Property for daylighting
- Gas station access to Highway 11 to be closed, with only access off Hwy 562.



Conclusions

Explicit Safety in VE Benefit the Decision-Making Process

- Systematic consideration of road user safety implications for existing conditions, base case and developed alternatives, and the proposed improvements do not create new operational issues.
- Quantitative safety assessment approach allows for more accurate comparison between existing conditions, base case and developed alternatives than a qualitative assessment.
- While not an exact science, incorporating safety in a consistent manner into the VE Study provides decision-makers with a much better understanding of the trade-off between cost and safety.





THANK YOU

Questions?

