



When is flag lighting an intersection a good use of the safety dollar?

Bill Frith, Opus Research
Mike Jackett, Jackett Consulting
Julian Chisnall, NZ Transport Agency

Flag lighting means one to three street lights at a rural intersection



• The crash benefits of flag lighting

- Overseas evidence suggests that flag lighting reduces crashes – in one study by 39%.
- A NZ study (2016) investigated the crash benefits of installing flag lighting on state highways using:
 - a KiwiRAP rural intersection database of 2,860 unlit, 830 flag lit and 490 fully lit intersections
 - CAS crash data (2010-14) matched using a +/- 50m acceptance range on SH Route Position
 - Total number of matched crashes (injury and non injury) was 3,450 with 940 occurring at night.

• **Variables available in the analysis**

- The number of lights at the intersection
- Total lumen output of the lights (limited availability)
- SH and Side road traffic volumes
- Road geometry (“X” or “T” intersection)
- Presence and type of road signs
- Crashes (Day and Night, Injury severity, Crash movement)

• **Method of analysis**

- Night time safety improvements were estimated by changes in the night to day crash ratio
- The influence of individual variables was estimated by use of generalised linear modelling.

• **Summary of findings**

- At T intersections: 23% crash reduction at sites with 1 flag light and 40% at sites with 2 or 3 flag lights
- At Cross intersections no recorded crash reduction at sites with 1 light and 40% at sites with 2 or 3 lights
- Flag lighting most effective for crashes involving hazards, rear end and manoeuvring crashes.
- Flag lighting is not effective in reducing single vehicle lost control type crashes.

• **Benefit cost analysis (BCA)**

- This study uses BCA to target where flag lighting might best be employed
- To do this we must estimate future crashes without flag lighting and use the study results to estimate future crashes with flag lighting.

• Estimating the costs and benefits of flag lighting

- The benefits are the \$ values of crashes saved as estimated in the previous NZ study
- The costs are the real costs of installing and maintaining flag lights as estimated by contractors / consultants
- Individual costs vary greatly and are related to issues such as:
 - the availability of on-site power
 - presence of service poles to support lighting
 - the amount of trenching or cabling required
 - general remoteness of the site
 - the number of luminaires used

• Estimating unit costs

- Costs were clustered into three groups:
 - HIGH unit cost typical of using dedicated slip base columns with underground power supply
 - LOW unit cost typical of using existing service poles and overhead power cabling.
 - A MEDIUM unit cost as a convenient reference point midway between the HIGH and LOW unit cost options.

▸ Total Costs

- The total cost is the product of the unit cost (high, medium or low) and the number of luminaires installed.

The unit cost will usually be determined by site conditions

The number of luminaires is an engineering choice but may also influence the number of crashes saved.

Cost structures

- Cost structures (2016) for a typical two luminaire, LED, flag light installation.

	High cost		Medium cost		Low cost	
	Cost/site	PV	Cost/site	PV	Cost/site	PV
Capital costs	\$24,800	\$24,800	\$14,900	\$14,900	\$5,000	\$5,000
Annual maintenance	\$762	\$11,463	\$562	\$8,454	\$362	\$5,444
Luminaire replacement*	\$1,200	\$374	\$1,200	\$374	\$1,200	\$374
Present value of costs		\$36,637		\$23,728		\$10,818

* after 20 years of service

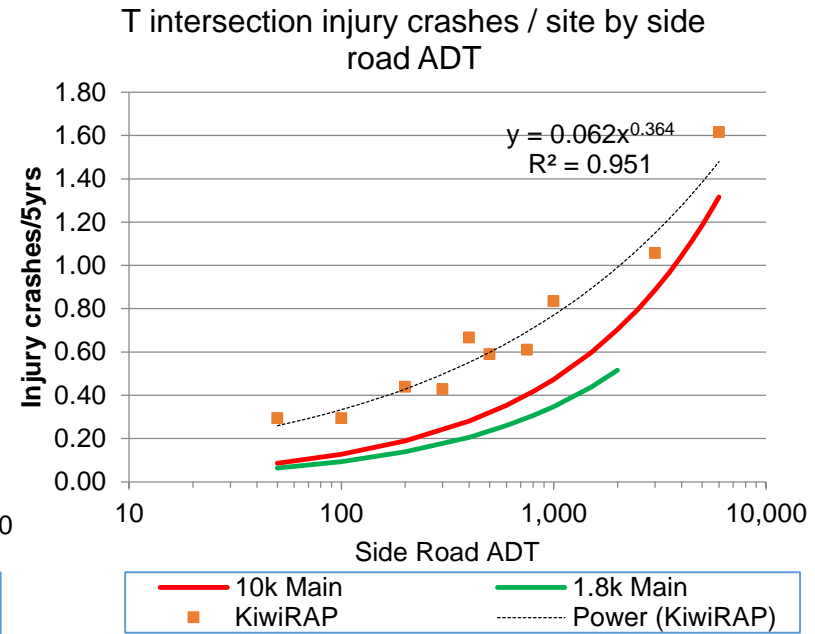
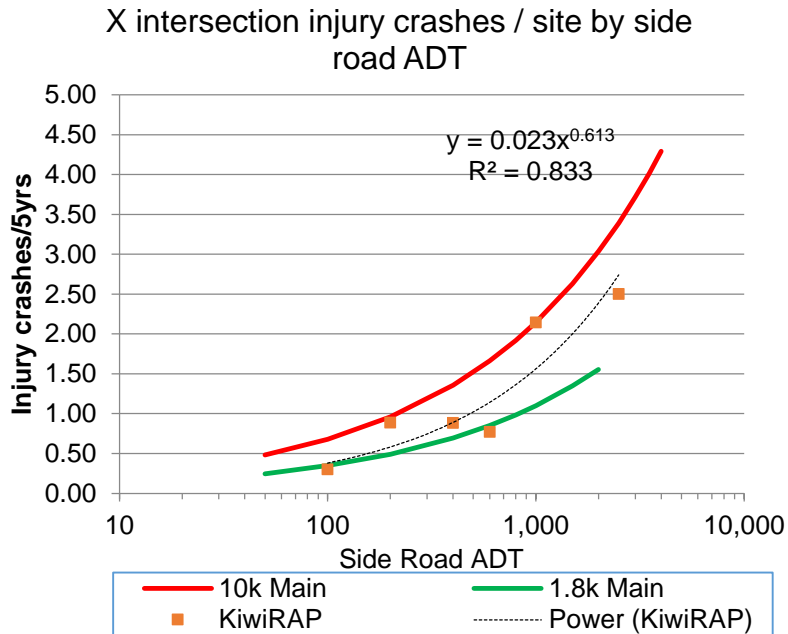
• **Future crash estimation**

- **To estimate future crashes at an intersection you can:**
- Use the existing 5 year crash record and assume it represents the long term mean value of crashes. **Not tenable as crash numbers at these sites are too low for reliable prediction.**

OR

- Predict future crashes from main and side road traffic volumes using:
 - Regression equations from the Economic Evaluation Manual (EEM)
- or
 - The study (KiwiRAP) database

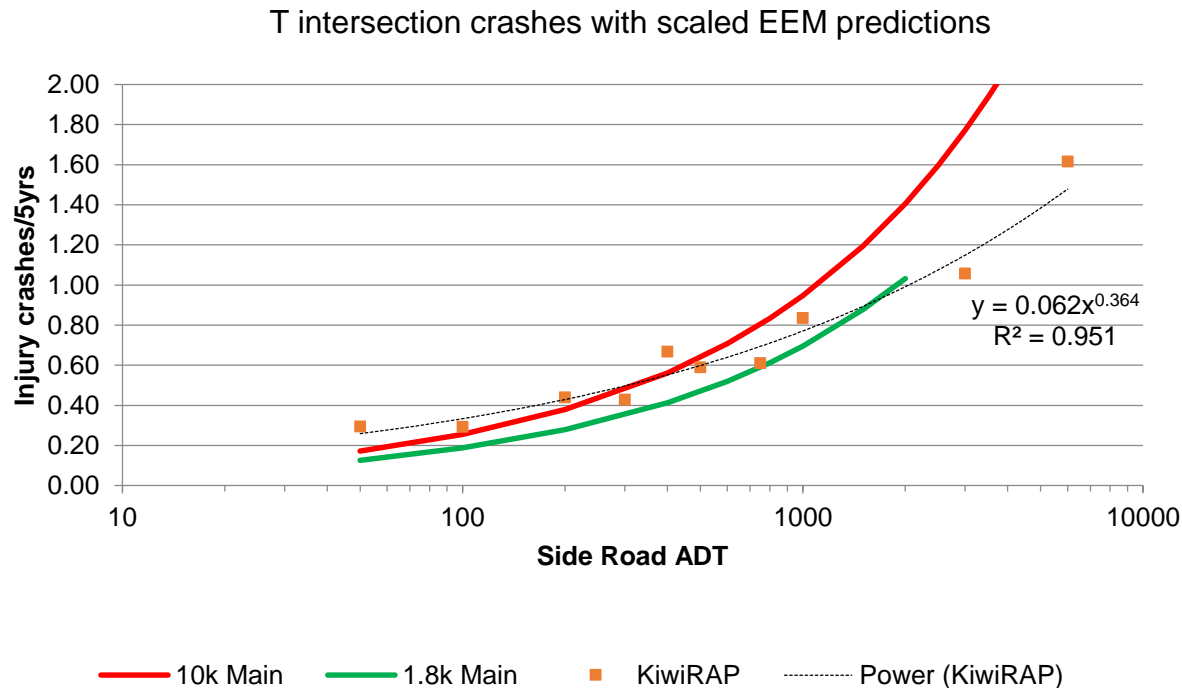
Results of crash predictions



- EEM predictions and this study data (KiwiRAP) align OK.
- BUT there is a scaling difference (~ 2) at “T” intersections between EEM and this study’s data

• EEM predictions for T intersections

- To improve the alignment between EEM and study data EEM predictions for T intersections were scaled by a factor of 2.



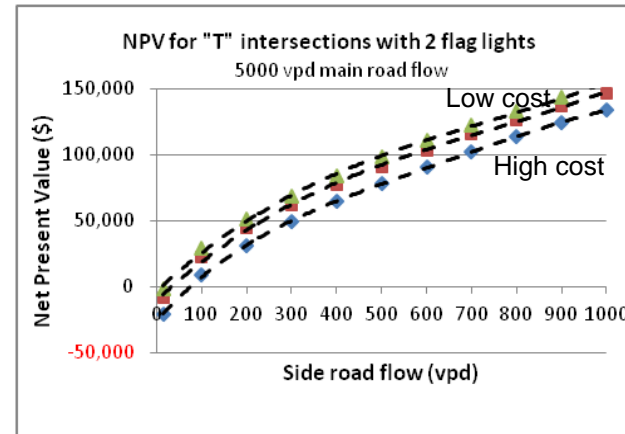
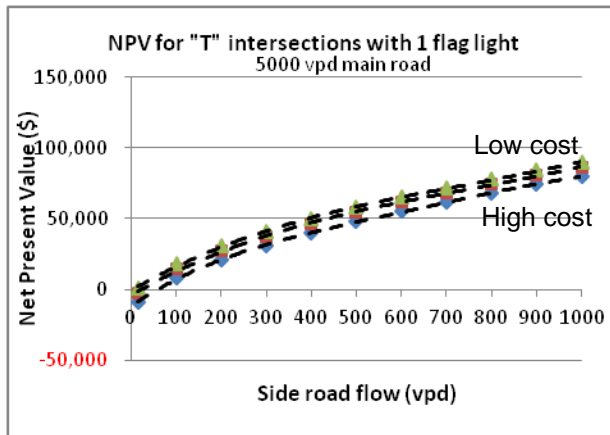
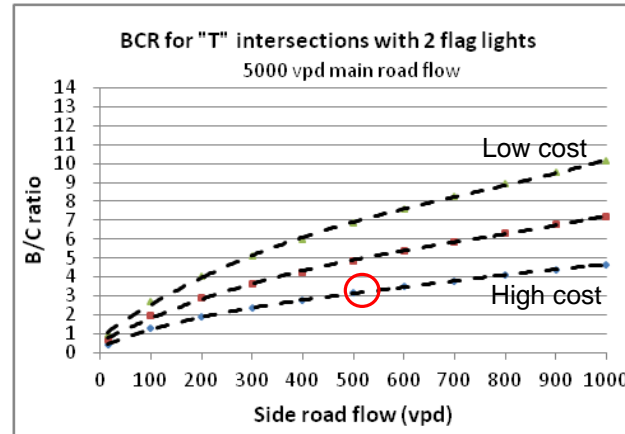
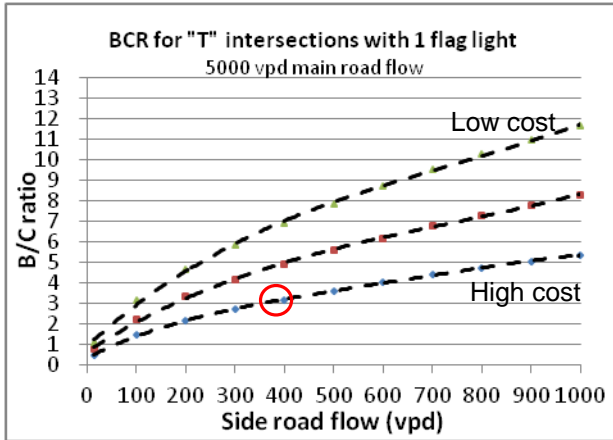
Estimating night crashes with flag lighting

- As only night crashes are saved by flag lighting the volume related crash predictions must be reduced accordingly.
- Adjustment factors from study data (30% for “T”s and 23% for cross roads) were applied to create night crash frequencies.

Intersection type	Total crashes	Night crashes	% at night
T	430	129	30%
X	75	17	23%
Staggered T	20	7	35%
TOTAL	525	153	29.1%

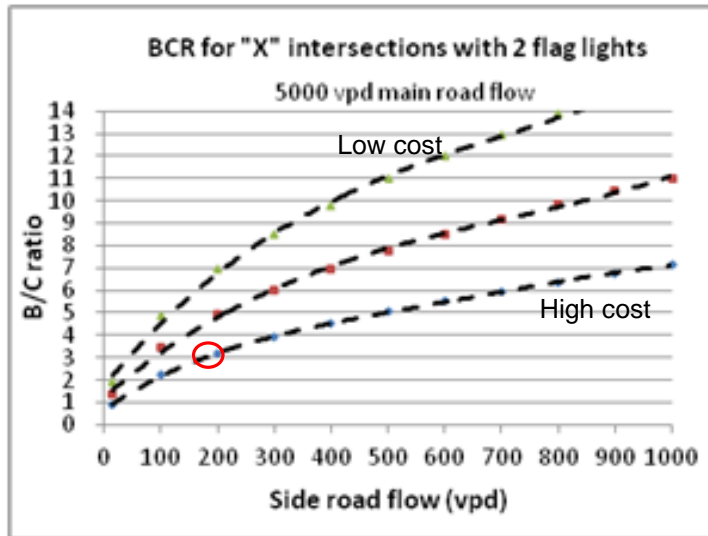
BCR charts for T intersections

- Charts for "T" intersections with 1 and 2 flag lights

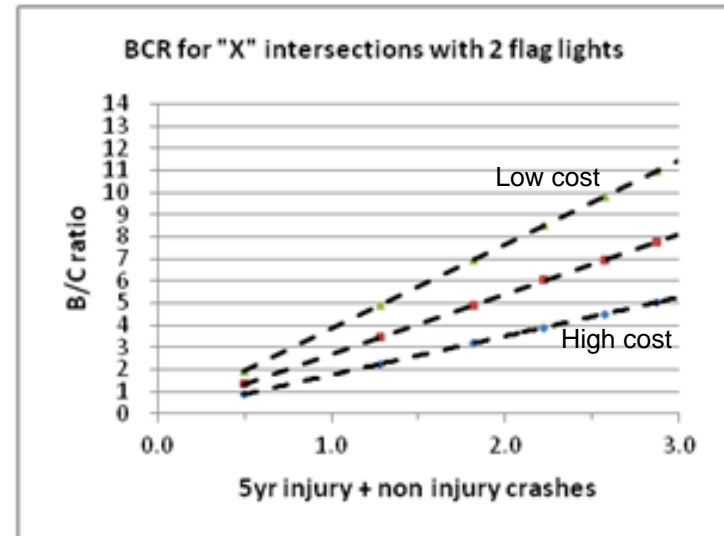


BCR charts for crossroads

BCR related to flows for crossroads with 2 flag lights



BCR related to crashes for crossroads with 2 flag lights



- No charts are presented for crossroad with 1 light as no safety benefits were found in that situation

• In summary

- The BCR charts illustrate how costs, traffic volume and intersections type relate to produce a indicative BCR.
- The BCRs were predictably highest for LOW unit cost options
- The best economic option was usually when 2 or more flag lights was used to light the intersection.
- The study quantified the safety benefits but flag lighting may also have other benefits and dis-benefits.
- Taken together, the results suggest that flag lighting in the right place can be a cost-effective crash counter measure.



• Acknowledgement

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