Welcome to: “Elements of road safety engineering workshop”

I would like to thank the CAREC Institute and the ADB for initiating this workshop, and all of you for giving your time.

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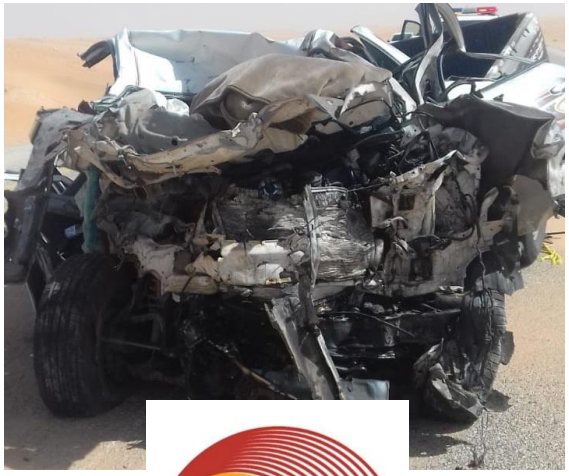

HOW TO INVESTIGATE BLACKSPOTS

ELIMINATING HIGH CRASH LOCATIONS FROM YOUR ROADS AND HIGHWAYS

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Road Safety INTERNATIONAL

This presentation outlines:

- The need for good crash data
- How to investigate blackspots
- Examples of “blackspots”

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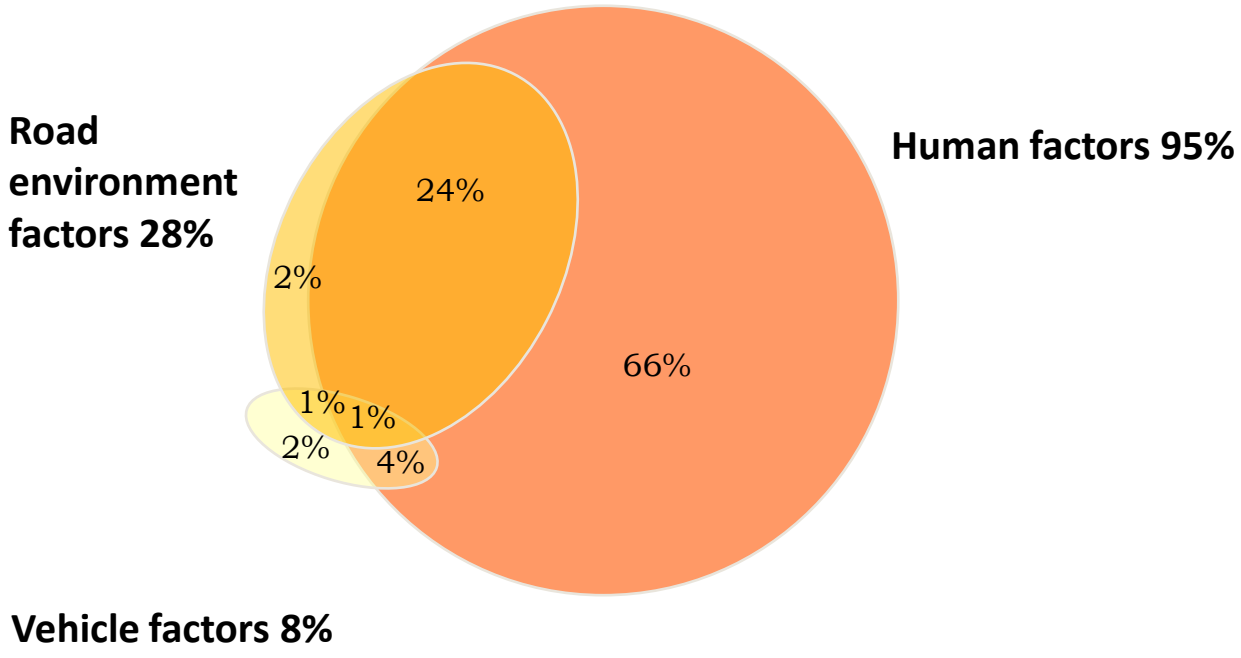
Eliminating hazardous road locations

- The *road* plays a role in road safety
- We can identify blackspots and black lengths – maybe not “perfectly”
- Police gather crash data
- We can investigate blackspots – carefully and thoughtfully – day and night
- Engineers can install logical, low cost countermeasures.
- Crashes can be reduced – Police and engineers working together
- And we must not build new blackspots! Road safety audit

The factors involved with crashes



Based on British and American research

- Road user error is the major contributing factor to road crashes.
- But it is easier for road users to make an error on a “bad” road (with poor alignment, inadequate signing, lacking traffic control).
- It is also easier for more serious injuries after an error on a road with unsafe roadsides (trees, poles, unsatisfactory barriers).
- Remedying such defects is an economical and effective way of reducing the cost of road trauma in your country.

YOU CAN SAVE LIVES

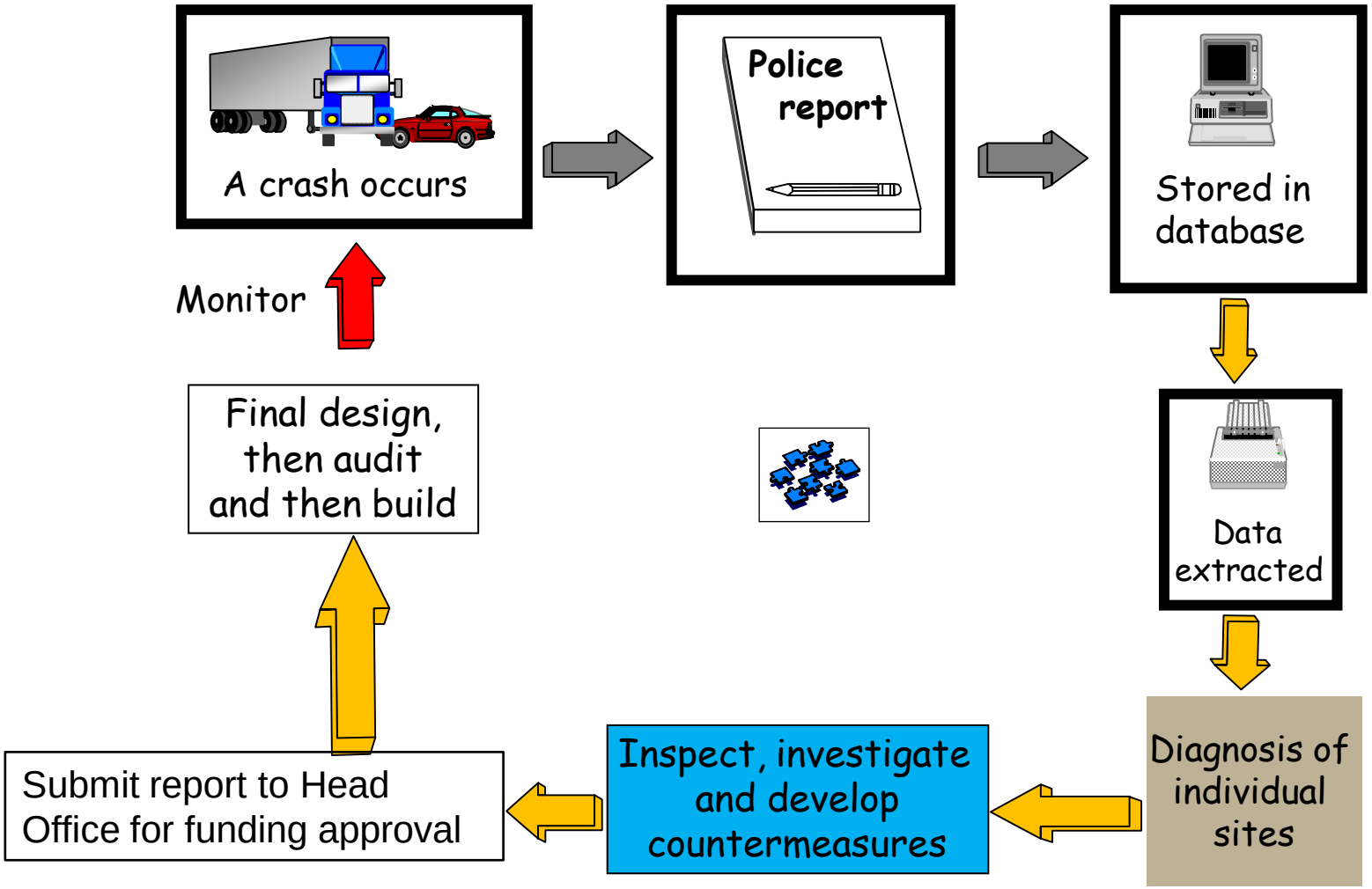
WHAT IS A BLACKSPOT ?

- A blackspot is any site with many casualty crashes
- Casualty crash means a fatal crash, or a crash in which at least one person is injured (serious or slight).
- Intersections, short lengths, or curves = blackspot
- Road length of 1km = black length

What is a Blackspot ?

A blackspot is a location which has a high number of crashes – fatal, serious or minor. It may be an intersection or it may be a length of road.

- When the Victorian blackspot program started in 1980, a location needed 12 casualty crashes in 3 years to be a “blackspot”.
- Today it is 3 casualty crashes in 5 years.
- There has been great success over 40 years (an 85% reduction in crashes according to our definition)


A crash occurs
Police report
Stored in database
Monitor
Final design, then audit and then build
Data extracted
Submit report to Head Office for funding approval
Inspect, investigate and develop countermeasures
Diagnosis of individual sites

Police gather……

Date/time/location/directions
Names/addresses/ages/sex of all involved
Alcohol/drugs
Vehicle types/registration
Injury levels
Any other information needed to prosecute the offender
More

In countries with good road safety records, Police record the crashes, store it in a database and share it with government stakeholders

Engineers need good crash data

Engineers do need to know:

- Where the crash happened (accurately)
- When it happened (day/night)
- What road users were involved – from which direction
- Conditions at the time – rain, wind, fog, snow, sun

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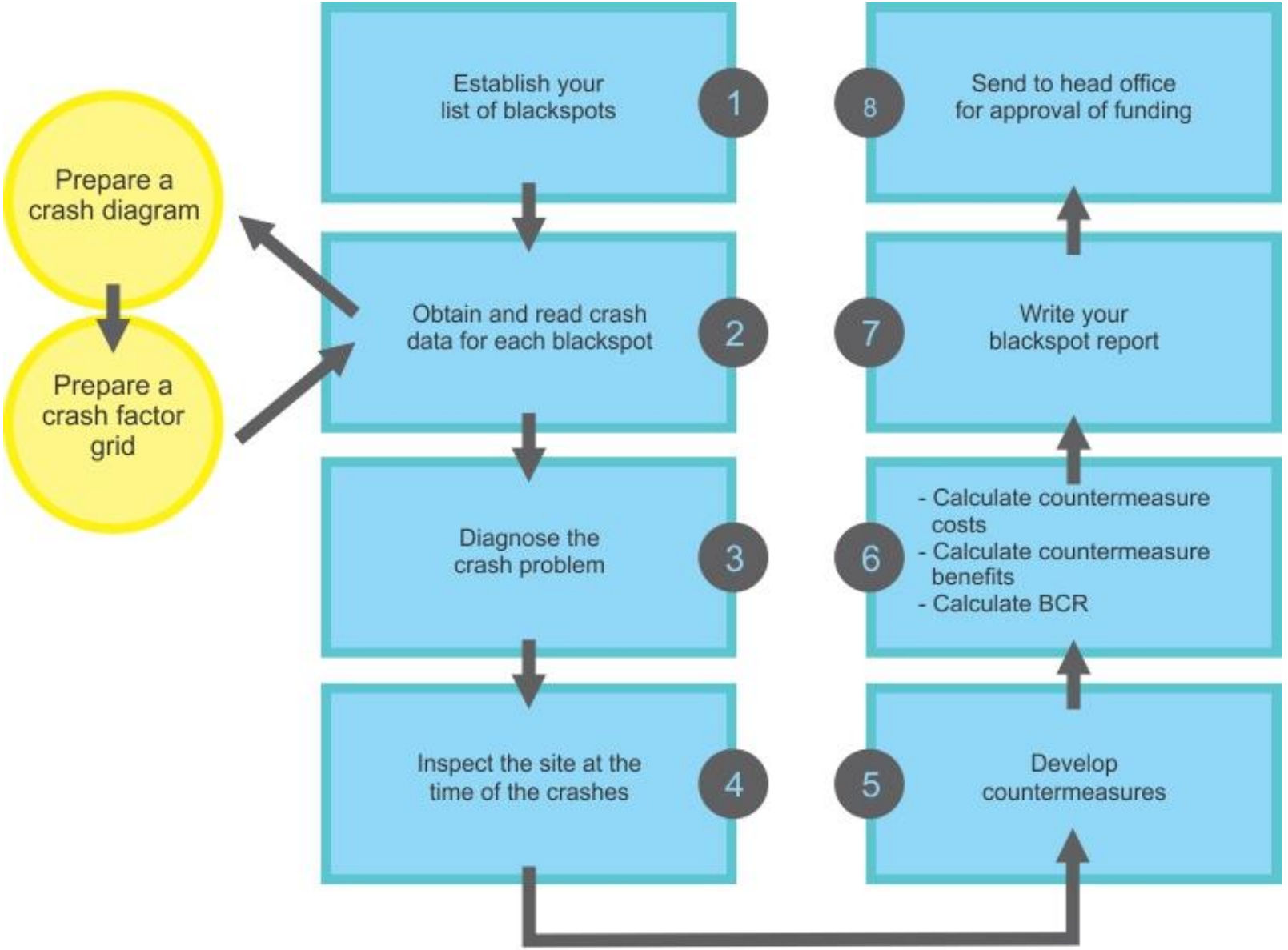
Engineers need good crash data

Engineers do not need:

- Names, addresses of people involved
- Vehicle registration details
- Police prosecution information (alcohol, speed or drugs)

Engineers look for patterns in the crashes

- Gain a “picture” of the crash history of the site.
- Work with Police – ask them for details of the crashes that may not be written in the reports.



Steps in the blackspot process

1 Decide your list of blackspots

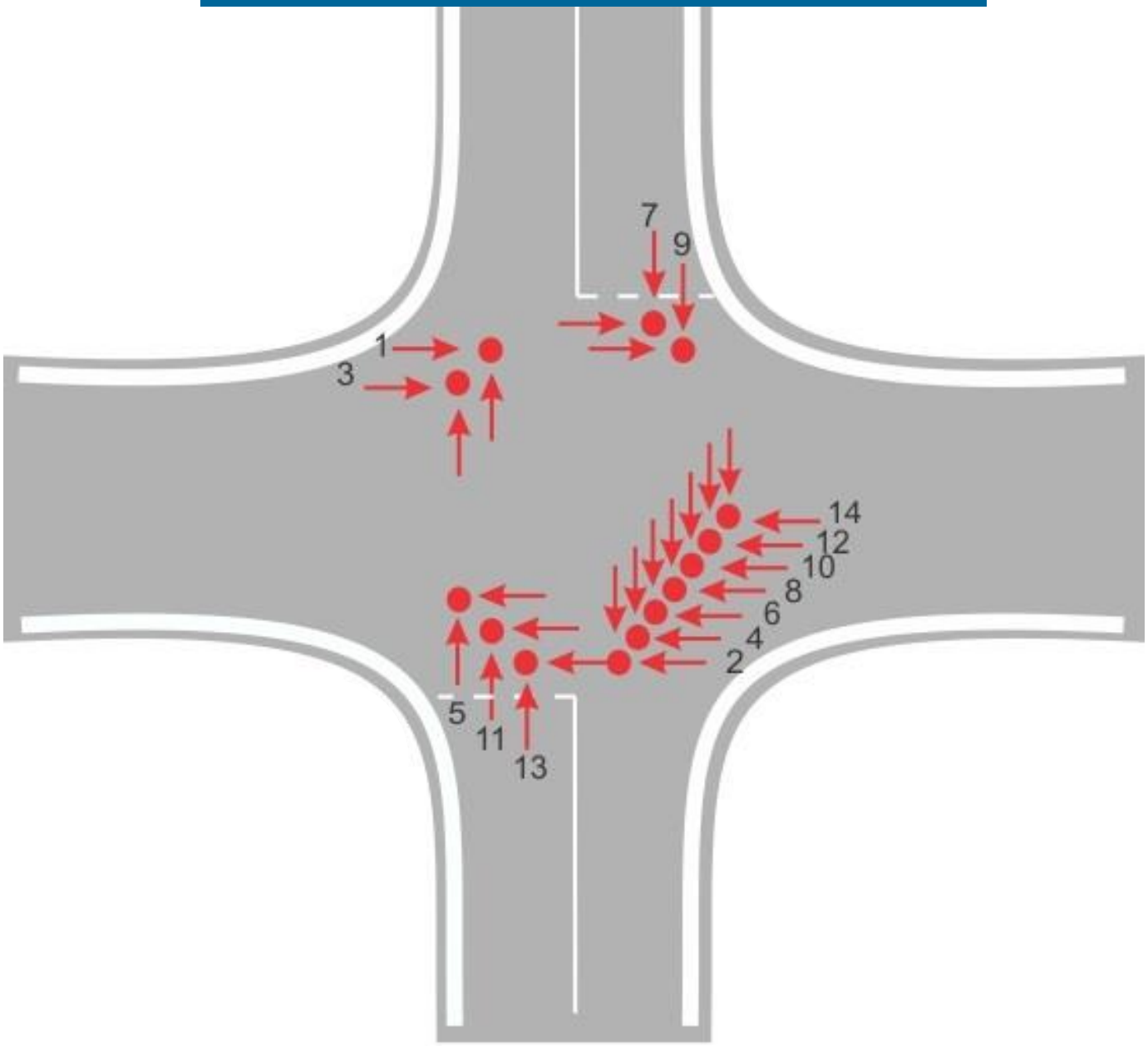
How?

- National level or city level
- Locations with most fatalities?
- Locations with most crashes?
- A point system 10 for F, 5 for SI, 1 for PD.
- Always have more sites than you can fund as some will not be able to be changed.

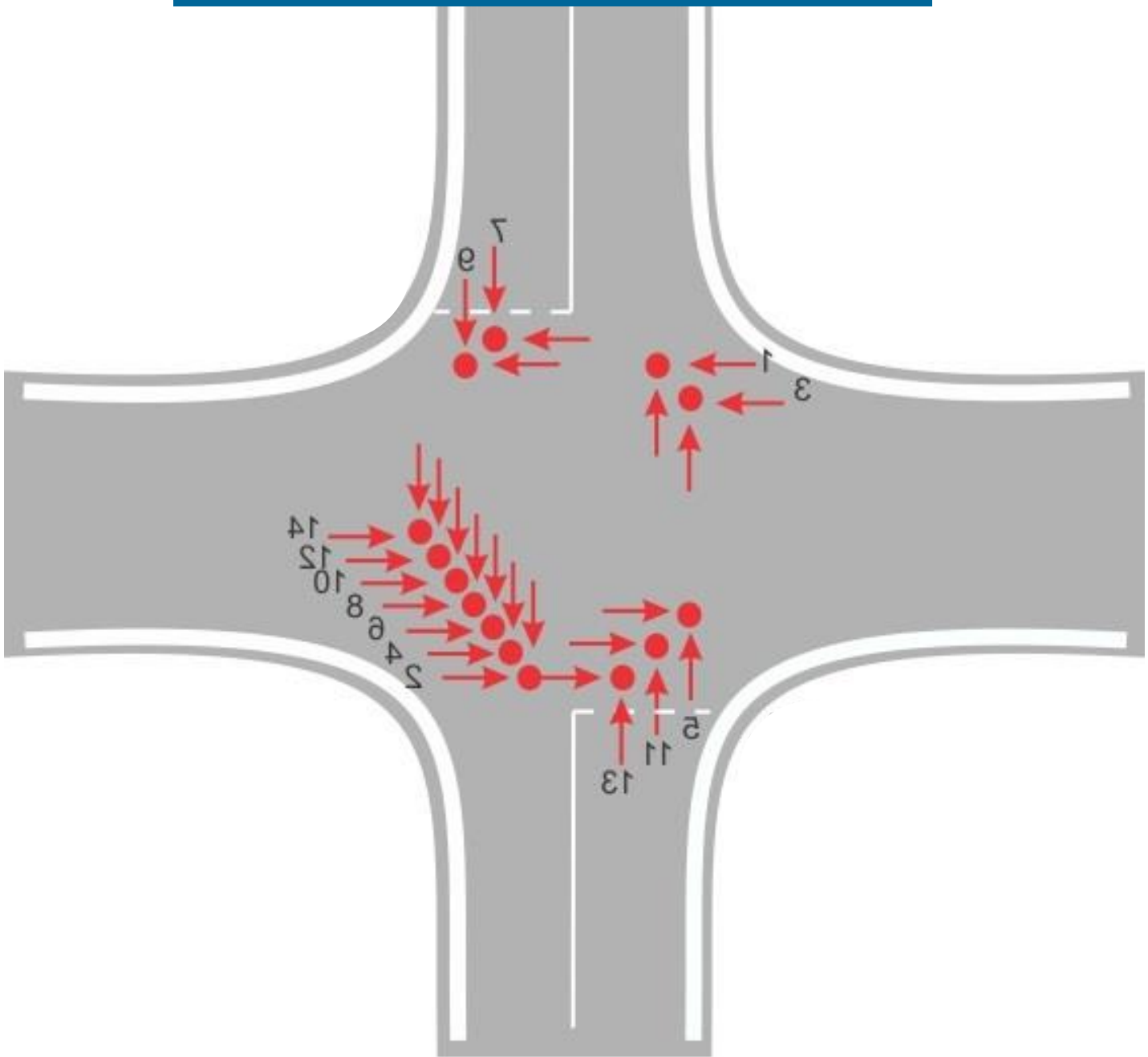
2 Draw a collision diagram

- Make a rough draft first
- For each vehicle – draw an arrow to show its direction
- Show pedestrians, cars, trucks, buses differently
- Show the point of impact accurately

Draw Collision Diagram & Crash Factor Grid



Draw Collision Diagram & Crash Factor Grid



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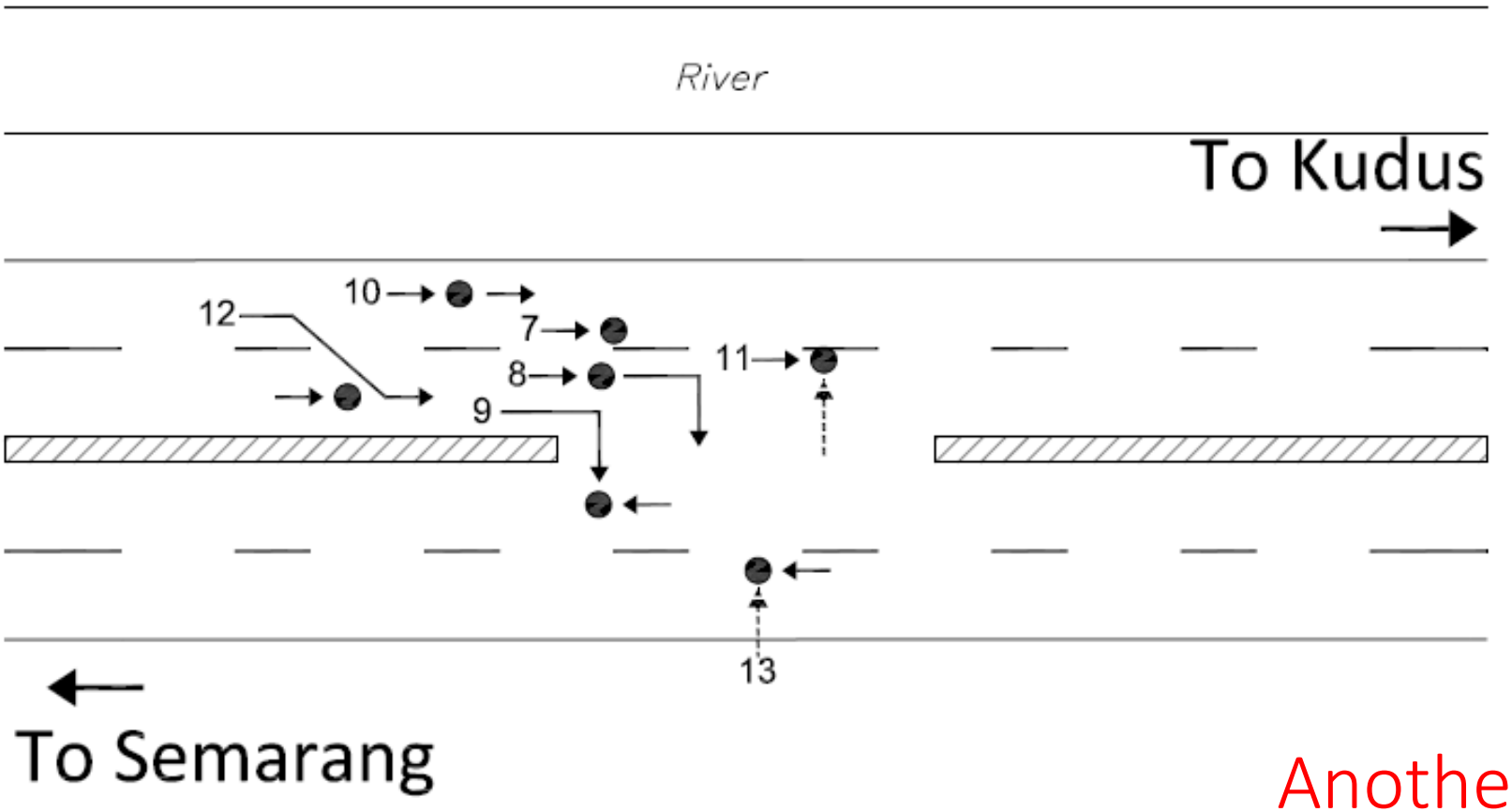


Another Collision Diagram

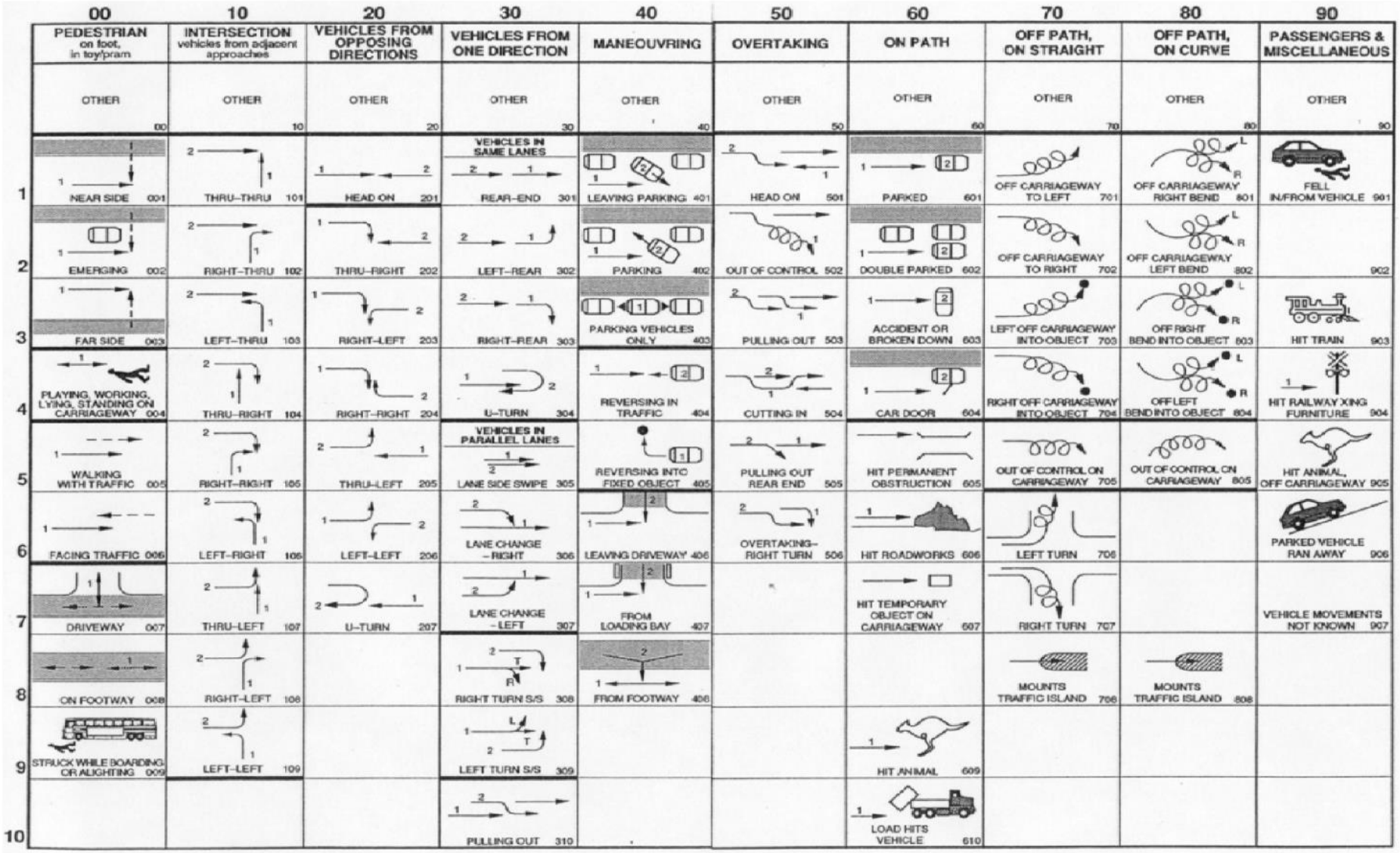
2 Draw a crash factor grid (Matrix)

- Microsoft Excel or similar.
- Pen and paper is also OK.
- For each crash – summarise the details in one column.
- Add rows if extra information is known from the Police reports.

An example of a Crash Factor Matrix

Accident Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Date: day: month	1307	0409	1912	0806	0307	0711	3012	2702	0305	2407	1804	2105	1406	2008
Date: year	15	15	15	16	16	16	16	17	17	17	17	17	17	17
Day of week	Sat	Wed	Thu	Sun	Thu	Fri	Tue	Fri	Sun	Fri	Sun	Fri	Mon	Fri
Time of day	1700	1855	1530	1900	1345	2145	1900	1220	1800	2000	1845	1610	1735	1855
Severity	3	3	2	3	2	4	3	3	4	2	3	2	2	3
Light conditions														
Road Conditions	W	W	D	D	D	D	D	D	D	D	D	D	W	D
DCA Code	101	101	101	101	101	101	101	101	101	101	101	101	101	101
Object 1	Car	Car	Car	Car	Car	Car	Car	Car	Car	Car	Car	Car	Van	Car
Object 2	Car	Car	Truck	Car	Car	Car	Car	Truck	Car	Car	Car	Car	Car	Car
Object 3					Car			Car			Car			
Direction 1	N	S	N	S	N	S	S	S	S	S	N	S	N	S
Direction 2 (& 3)	E	W	E	W	W,E	W	E	W,N	E	W	W,E	W	W	W
Other														

Figure 2.1: Standard accident-type codes for definitions for coding accidents (DCAs) in Australia



A code for classifying crashes by type

3 Diagnose the crash problem

- A patient visits a doctor and tells the doctor about his illness.
- The doctor does not just guess about his illness – he does not want to treat the patient for a headache when he has a heart problem.
- You are like a doctor – diagnosing your sick part of road (a blackspot).
- The blackspot cannot speak – you must look, listen and ask locals.
- This takes time, skill, and logic

3 Diagnose the problem

Examine the Collision Diagram and the Crash Factor Matrix

Look for *patterns*?

- Day time vs night time?
- Wet vs dry?
- Type of crash - head on, or run-off-road, pedestrian etc
- Type of road user?
- Direction of travel?

4 Inspect the site – at the time that the pattern of crashes have happened!

If crashes happened at night, inspect at night!

Put yourself in the shoes of those involved.

Ask yourself ….. why did they have their crash?

….. why did they have their crash?

- Inspect the site day and night. Assess likely causes for the patterns.
- You are a doctor – diagnose your patient to prescribe the best medicine!
- You may NOT get it right immediately. Keep trying!

Be logical .....

Recommend only countermeasures that will reduce the crashes

(For example, if crashes happened mainly during daytime, do not install street lighting as a countermeasure. And do not replace the nearby barrier simply because it is old and rusty, unless it was involved in crashes)

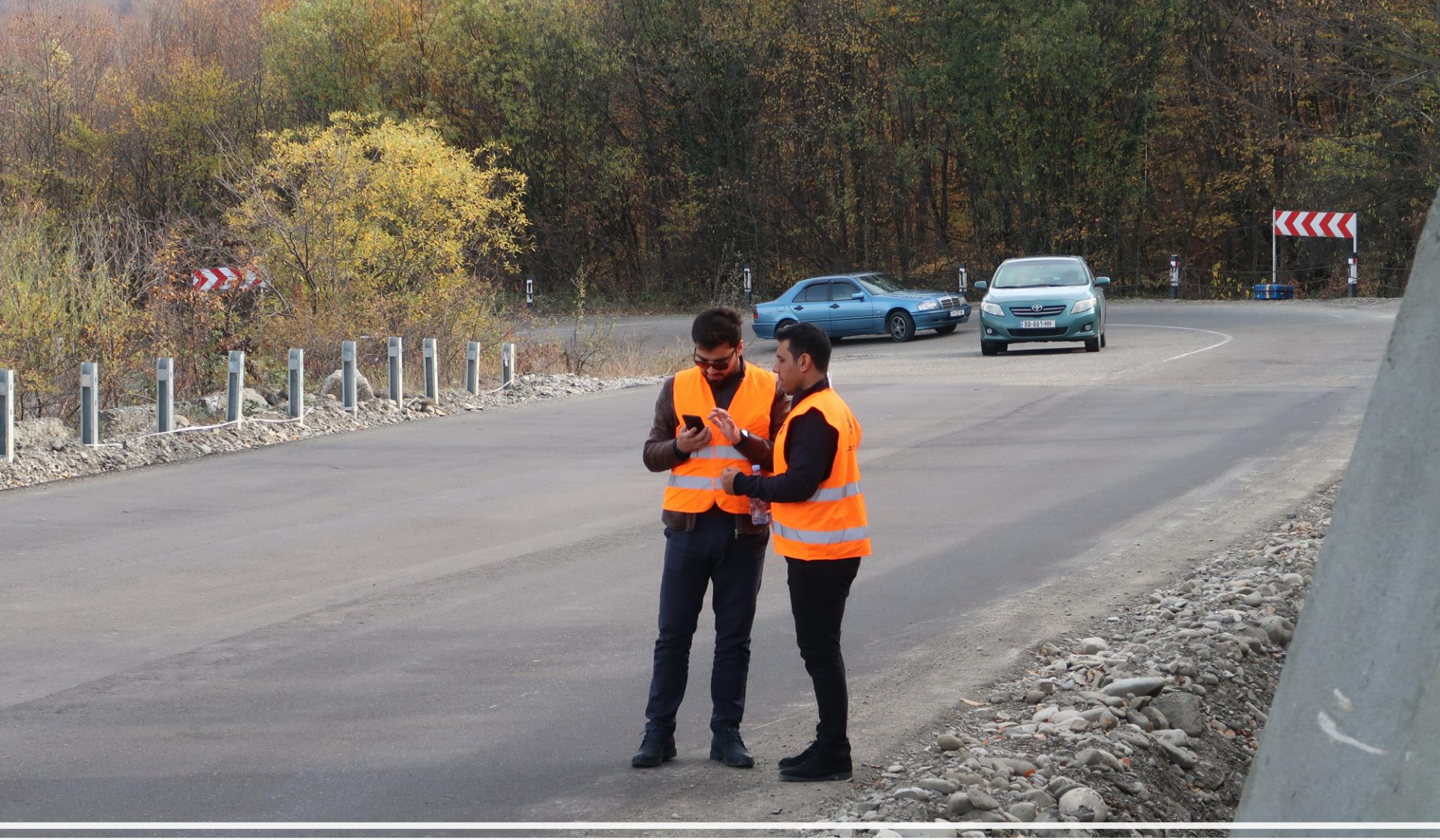
$ are always limited – so look first for low cost options.

When you are on-site……

Get a good “feel” for the location – the topography, the type of traffic, its speed, its volume

Keep asking – why do a few people have crashes here each year, but thousands do not?

What is missing? What is misleading? Be logical!



Inspect the site – at the general time the pattern(s) of crashes happened!

5 Develop countermeasures – discuss them with colleagues

Keep your ideas simple

Use low-cost options wherever possible

Persevere – some sites are difficult but many locations will be open to low cost countermeasures

Your list of low cost countermeasures

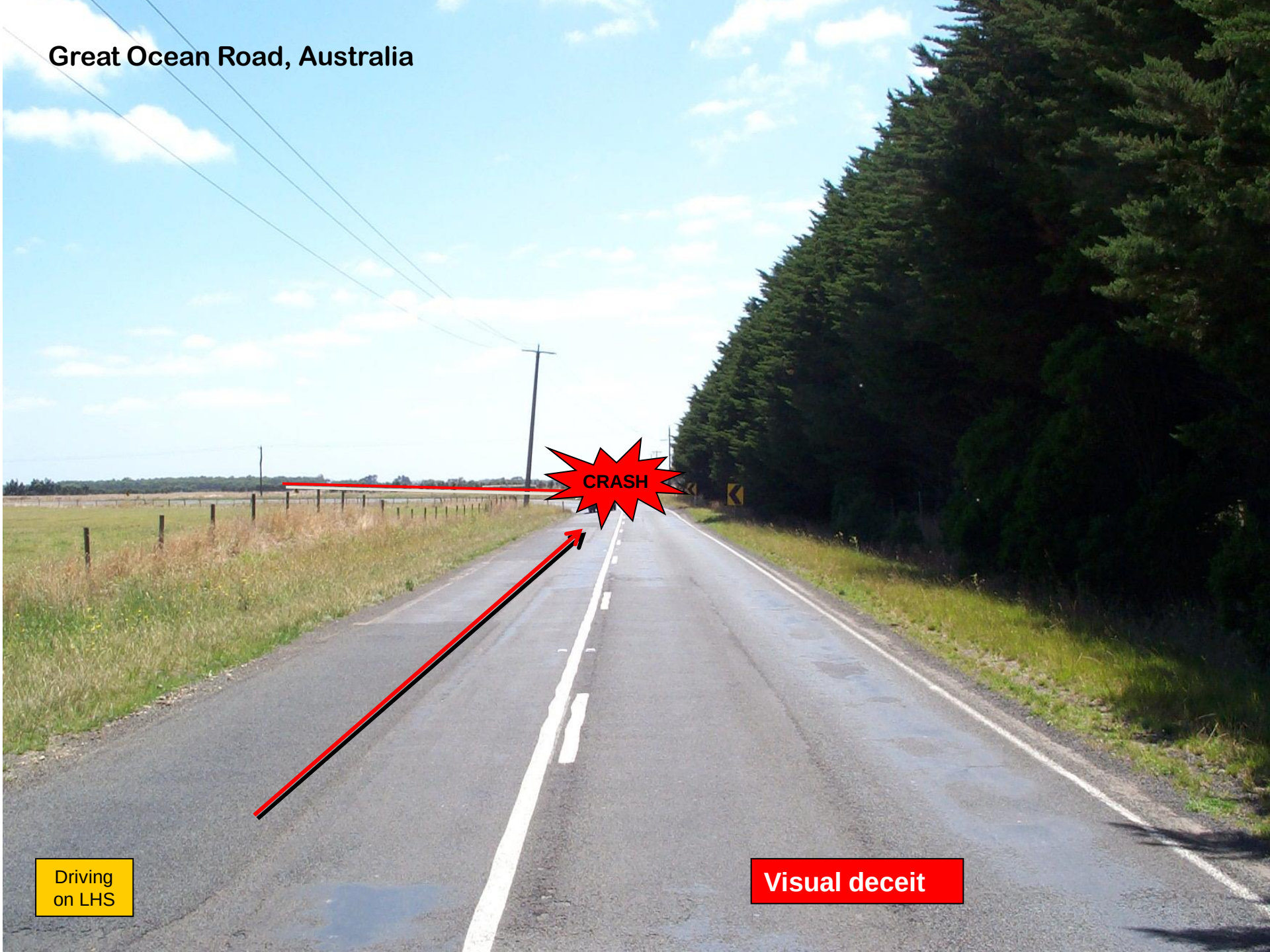
- Signs – warning, regulatory, direction
- Line marking
- Delineation
- Shoulder sealing
- Roadside hazard removal (or shielding)
- Geometric changes
- Opening sight lines (benching, cut vegetation)
- Speed limits
- Traffic signals
- Roundabouts
- Lighting

A few tips for your site inspection (some crashes have nothing to do with the road!!)

Look for "visual deceit"

- Not all drivers/riders see the road the same way.
- You need to try to look at the road as others "might"


Visual deceit


Great Ocean Road, Australia
CRASH
Driving on LHS
Visual deceit

A FEW TIPS FOR YOUR SITE INSPECTION

(SOME CRASHES HAVE NOTHING TO DO WITH THE ROAD!!)

With intersection right angle crashes – you need to decide if the crash is an overshoot or a re-start

Why?

Because your countermeasure(s) may be quite different

The truck failed to give way. But why? Overshoot, or re-start?

Overshoot **– the driver did not know the intersection was there**

- Improve Approach Sight Distance
- Make intersection more conspicuous
- Advance warning signs
- Advance direction signs
- Duplicate GW or Stops
- Lighting (if crashes are at night)
- Roundabout or signals

Re-start – knew intersection was there, slowed, maybe stopped, but selected a “wrong” gap

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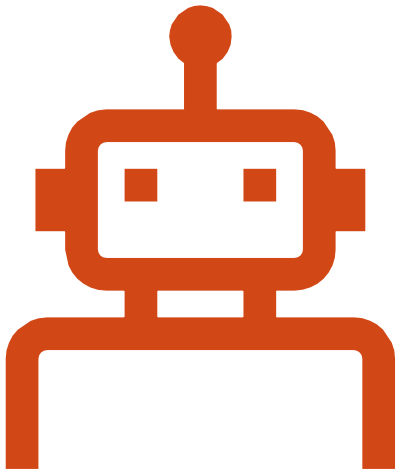
- Improve Safe Intersection Sight Distance
- Maximise sight lines
- Reduce speeds
- Alter the traffic control
- Geometric changes
- Cut trees/grass
- Reduce speed limits
- Roundabouts or signals



WHY?

6 Finalise a preliminary design, and then calculate a benefit/cost ratio for your recommendations

In the future there will be competition for funding within the blackspot program. Then you will have to rank sites so that funds are spent on those sites that will return the “best value” to your country

How will YOU determine benefits and costs?

1. You need to know the benefits to be gained from your countermeasures (in $)
2. You need to know the cost of the countermeasures (in $)
3. You then calculate the benefit/ cost ratio

BCR

To determine benefits and costs

Costs are easy!

But how do we calculate the benefits to be gained (in $)

How many crashes do we expect to save, and how much would each one cost your country?

A TOUGH QUESTION!


Who has heard of crash reduction factors?

Treatments	Crash Reduction Factors	Treatment Life
INTERSECTION		
New roundabout	**85%**	20
Modify roundabout (approach deflection)	**55%**	20
New traffic signals	**45%**	20
Convert intersection signals to roundabout	**30%**	20
Staggered T low volume (<2000 AADT of through road)	**70%**	20
Removal of Y-intersection	**85%**	20
Splitter islands/median, urban	**20%**	20
Splitter islands rural, low volume	**45%**	20
Line marking to improve intersection definition	**10%**	5
Improve sight distance (remove/relocate obstruction)	**50%**	20
Improve signage	**30%**	15
Rumble strips on approaches	**30%**	5
Install Stop signs	**30%**	15
Install signs	**30%**	15
Change to Stop signs	**5%**	15

How will YOU determine benefits and costs?

1. After you have established your countermeasures……
2. Get the Crash Reduction Factor
3. This is the highest CRF of those that apply to your treatments
4. Agree on a crash cost ($) for your country
5. Calculate the benefits of the countermeasures ($)
6. CRF x number of crashes saved x $ value for each crash

How will YOU determine benefits and costs?

7. Calculate the cost of the works ($)
8. Calculate the benefit/ cost ratio
9. Include this BCR in your ABI report
10. Head Office will approve funding to the highest BCR's first – working down the list until the annual budget is committed. Funding is approved on the basis of BCR's – not the cost.

EXAMPLE OF CALCULATING THE BENEFIT COST RATIO

To work out the BCR we need to know the benefits (in $) of the countermeasures, and the cost (in $) of the countermeasures.

- An intersection blackspot with many right angle crashes
- Construct a roundabout – save 85% of crashes for next 20 years
- The roundabout will cost $1,200,000 USD

Benefits – you need a table that shows the Crash Reduction Factor for each countermeasure

What percentage of crashes at the blackspot will be reduced if we construct a roundabout as the treatment for an intersection crash problem?

Treatments	Crash Reduction Factors	Treatment Life
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Change to Stop signs	**5%**	15

Crash reduction factors based on real experience from the Victorian (Australia) blackspot program since 1980

PAVEMENT WORKS	%	YEARS
Road reconstruction	**25%**	20
Duplication short length	**30%**	20
Install raised median	**30%**	20
Add median strip	**20%**	20
Widen pavement	**10%**	20
Construct overtaking lane	**25%**	20
Add lane	**10%**	20
Widen road for Right Turn lane	**50%**	20
Widen road for Left Turn lane	**15%**	20
Lane widening - 0.3m	**5%**	20
Lane widening - 0.6m	**12%**	20
Widen shoulder not seal - 0.3m	**3%**	20
Widen shoulder not seal - 0.6m	**7%**	20
Widen shoulder not seal - 1m	**10%**	20
Widen shoulder and seal - 0.3m	**4%**	20
Widen shoulder and seal - **0.6m**	**8%**	20
Widen shoulder and seal - 1m	**12%**	20

Crash reduction factors based on real experience from the Victorian (Australia) blackspot program since 1980

DELINEATION		
Reflectorised guide posts	**30%**	**20**
Advance Curve Warning signs - static	**20%**	**15**
Advance Curve Warning signs - vehicle activated	**75%**	**15**
Install chevron signs (CAMS) - normal	**35%**	**15**
Install chevron signs (CAMS) - electronic	**50%**	**15**
Painted centrelines	**30%**	**5**
Tactile centrelines	**40%**	**5**
Painted edge lines	**25%**	**5**
Tactile edge lines	**35%**	**5**
Barrier lines	**30%**	**5**
Raised reflectorised pavement markers (RRPM)	**20%**	**5**

ROADSIDE HAZARD MANAGEMENT		
Wire Rope Safety Barrier (WRSB)	**45%**	20
Guardrail	**35%**	20
Median barriers (any type including centreline WRSB)	**20%**	20
Guard rail at culvert	**25%**	20
Guardrail for bridge end post	**20%**	20
Crash Cushions	**15%**	20
PEDESTRIANS & CYCLISTS		
Refuges, Channelisation, Kerb extension	**30%**	20
Pedestrian signals	**25%**	15
Bicycle paths, threshold treatments	**10%**	20
Upgrade pedestrian signals	**20%**	15
Pedestrian overpass	**10%**	20
MOTORCYCLISTS		
New roundabouts	**75%**	20
Intersection signal remodel	**50%**	15
Fully Controlled Right Turn	**55%**	15
Shoulder sealing	**50%**	20
STREET LIGHTING		
Provision of street lighting general	**25%**	15
Improve lighting at intersections	**25%**	15
Improve lighting at roadway segment	**25%**	15
Improve lighting at PEDESTRIAN CROSSING	**40%**	15
Improve lighting at railway crossing	**10%**	15

Benefits – you need a table that shows the Crash Reduction Factor for each countermeasure

- 20 reported crashes in 5 years
- A roundabout will reduce 85% (17) of these crashes
- 20 years = 4 x 17 = 68 fewer crashes
- Each crash in Mongolia = $65,000 USD
- 68 x $65,000 = $4,420,000

Benefit/ Cost Ratio

BCR

- Benefits = $4,420,000USD
- Costs = $1,200,000USD

BCR = almost 3.7

7 & 8 WRITE AN ACCURATE REPORT AND SEND TO H/O SEEKING FUNDS

7 Write your blackspot report – use a template.

8 Send the report to Head Office for approval for funding

9 Once approved this site goes into the Annual Works Program. Ensure to implement the agreed countermeasures(s).

HEAD OFFICE WILL APPORTION FUNDS DOWN THE LIST ACCORDING TO BCR.

THIS IS WHY IT IS VITAL TO AIM FOR LOW COST HIGH BENEFIT COUNTERMEASURES – TO GET A HIGH BCR AND THUS TO MAXIMISE FUNDING POSSIBILITIES

Steps in the blackspot process

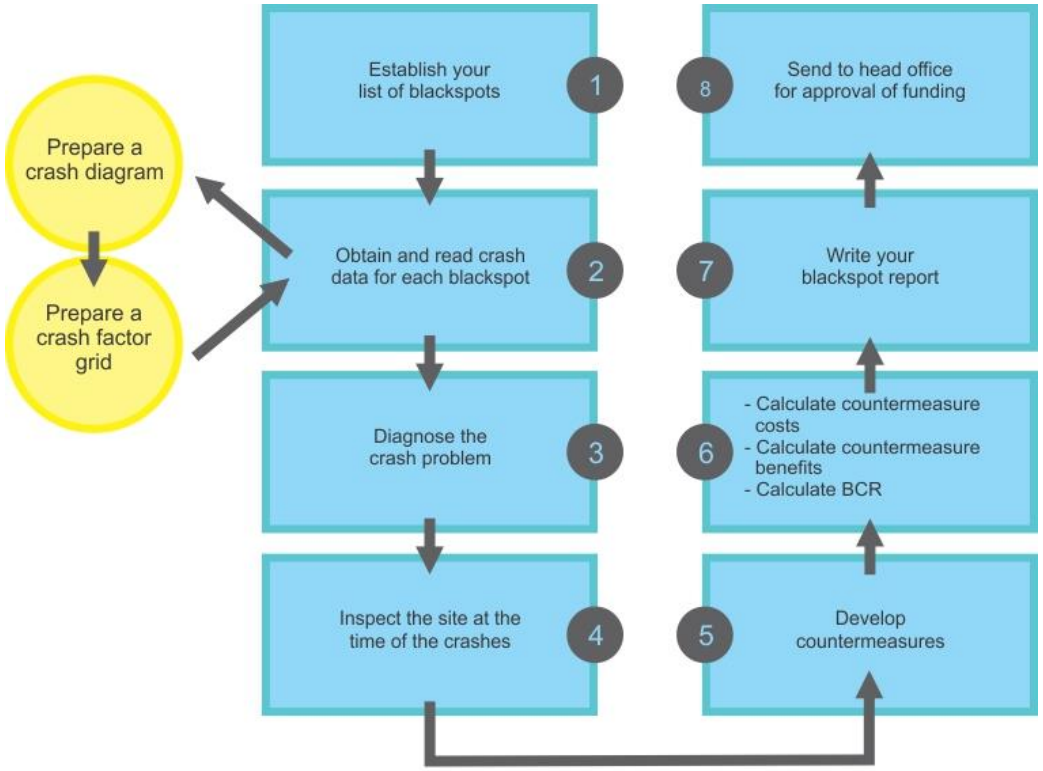


Figure 4.1 Steps in a Blackspot Investigation

Some recent blackspots

1. A village on a newly improved CAREC highway
2. The Airport Road, UB
3. Large roundabout, UB
4. A U-turn on Sonsgolon Road, UB
5. A rural Y junction
6. A suburban cross road intersection (in Melbourne)

1 VILLAGE BLACKSPOT

Six pedestrian fatalities, many other serious casualty crashes in 2 years


Image © 2019 DigitalGlobe
Google Ea


КАДУЧИ
KADUCHI


1732CB01


WHAT ARE YOUR THOUGHTS ABOUT THIS BLACKLENGTH?
WHAT TREATMENTS DO YOU SUPPORT?

Recommendations

- Large gateway signs each end of village
- 40km/h speed limit
- Flat top road humps each 100m, with kerb extensions
- Zebra Crossings only on humps near mosques, schools


80
Garston


40
PAINSWICK
Fairtrade
40
40

Crash reduction factor 30% for 20 years

Crash savings = $2,675,000

The humps, sealing, signs and line marking will cost $225,000

Benefits = $2,675,000
Costs = $225,000

BCR = 11.9

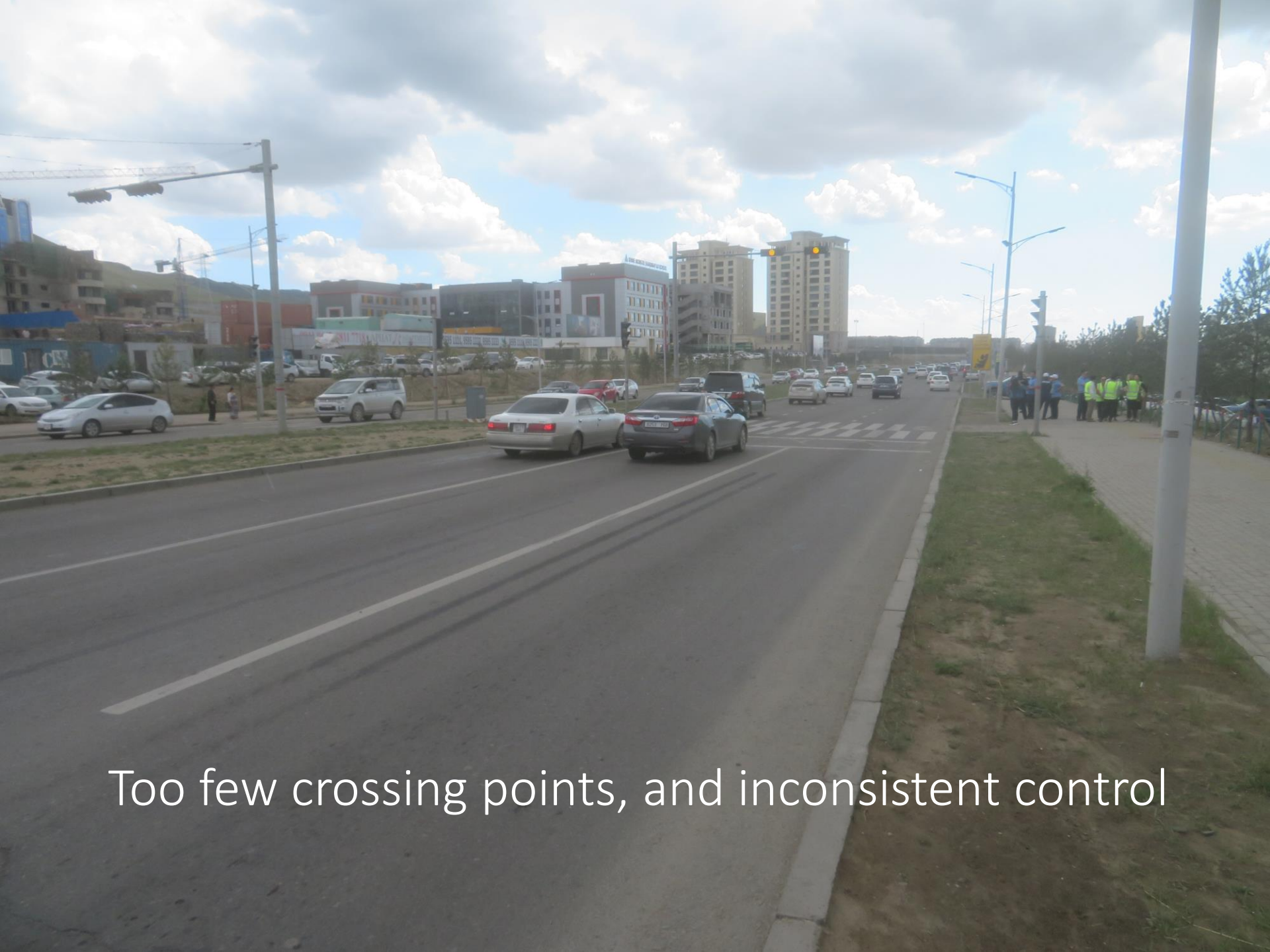
This project will be compared with all other blackspots in the country – those with the highest BCR's will be treated first. The others will wait for next year.....

BCR

2 Airport Road, UB – pedestrian black length

11 pedestrian fatalities in one year. All at night. Many intoxicated

Several signalised crossings and three Zebra crossings


Too few crossing points, and inconsistent control


What can we do – at modest cost?

Think about all of your customers:

- senior citizens - 19% of pedestrian fatalities are over 65 years
- young - 20% of pedestrian fatalities are aged 4-12 years
- intoxicated - 43% of night time pedestrian fatalities ≥ 0.15% BAC
- ……plus the disabled

My recommendations

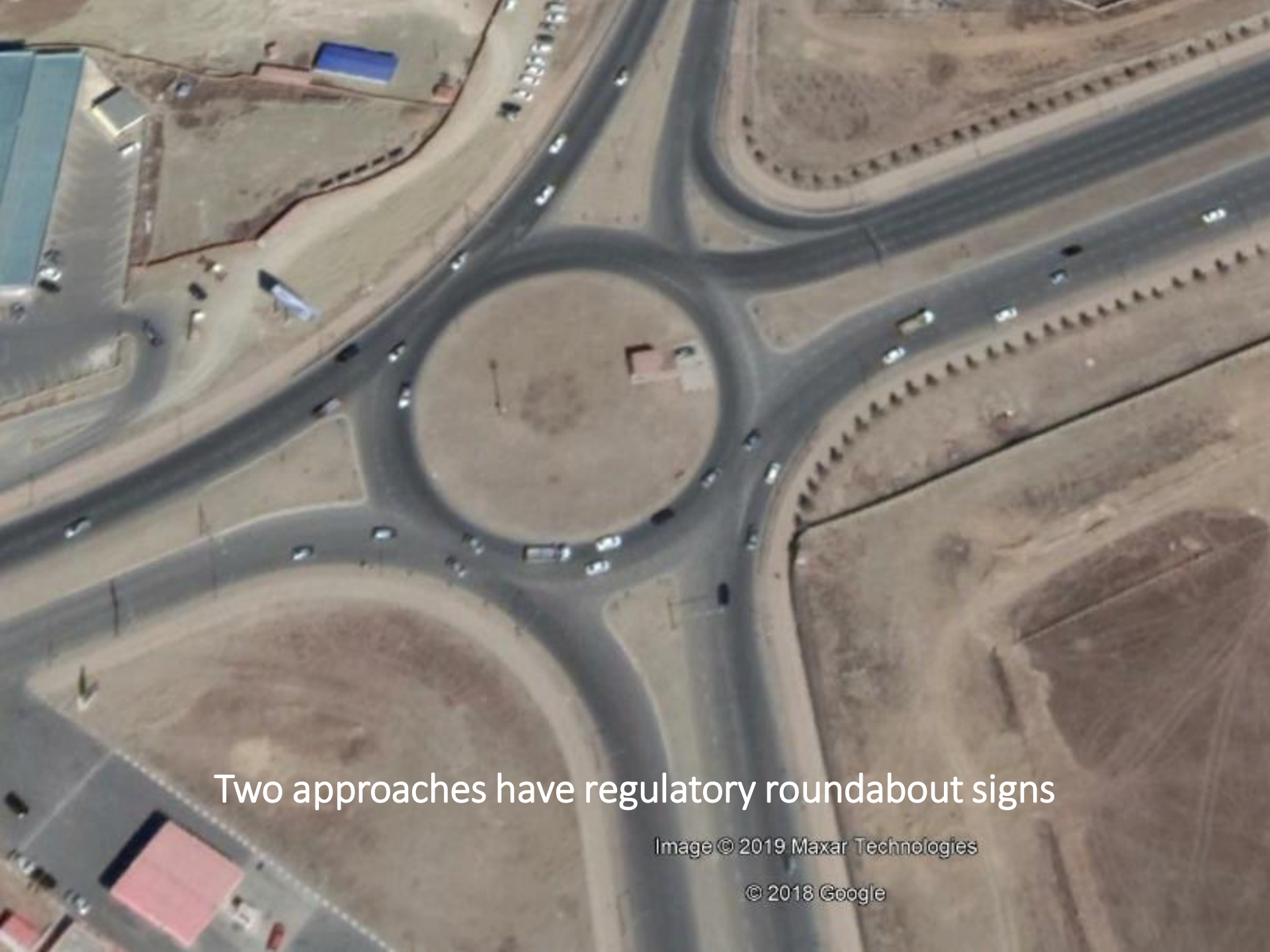
Make all crossings signalised - consistency

Separate phases for each carriageway

Pedestrian push buttons

Increase flood lighting at each

3 Large roundabout on the Airport Road


Two approaches have regulatory roundabout signs
Image © 2019 Maxar Technologies
© 2018 Google


TRAFFIC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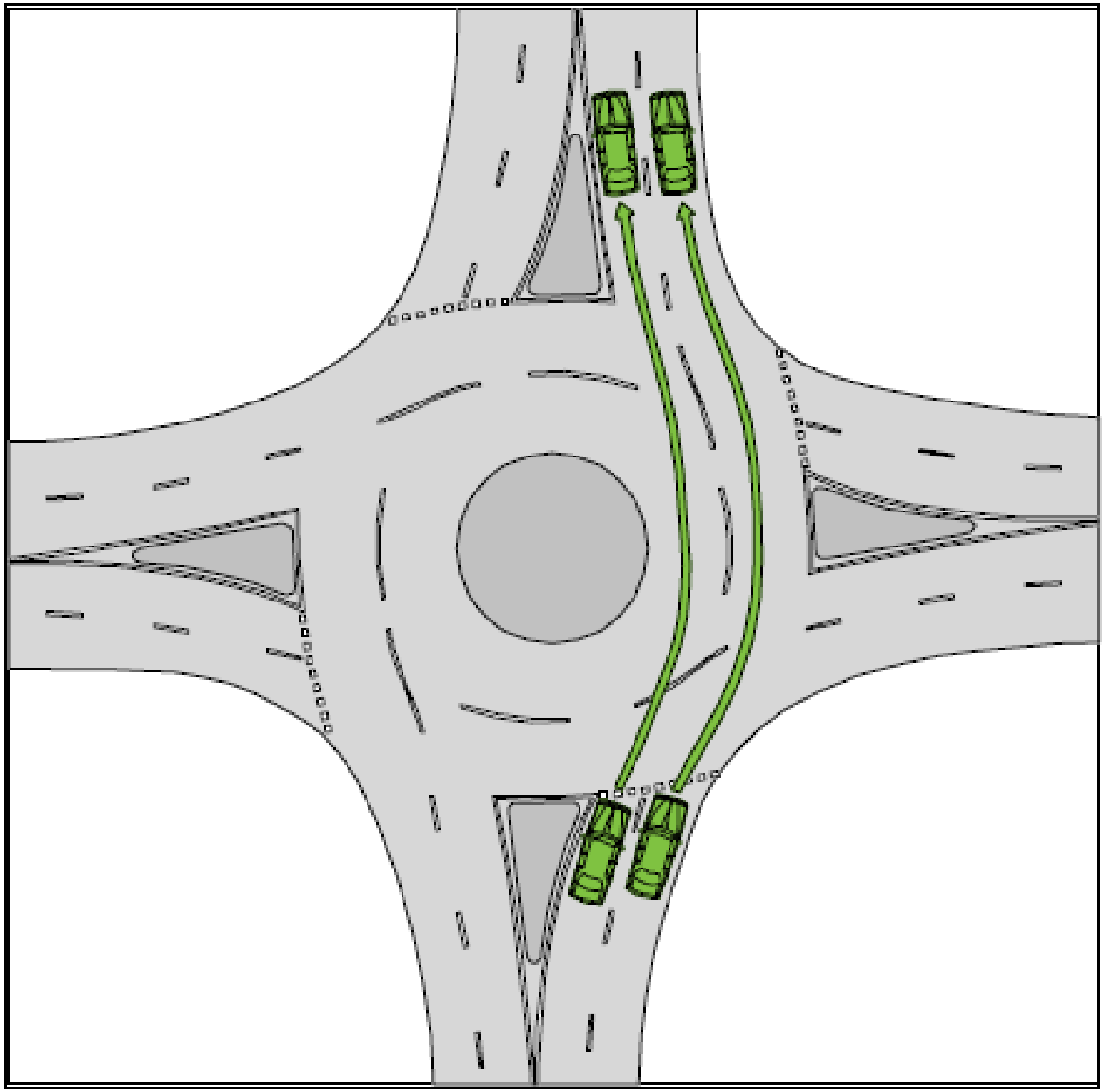
Is this a blackspot?

My suggestion:

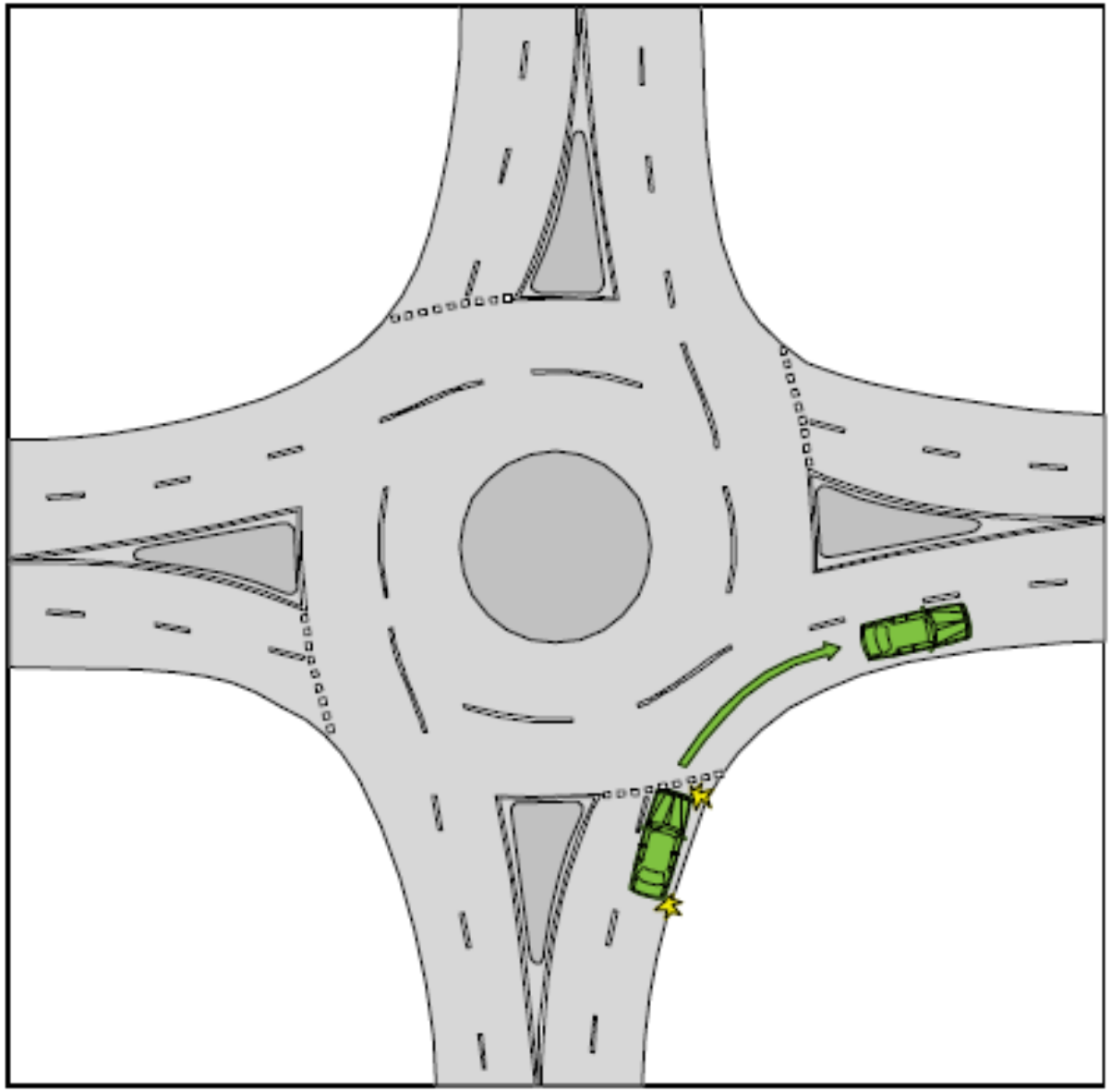
Either make this a correctly compliant roundabout or remove all roundabout signs.

And consider “Exit line marking”

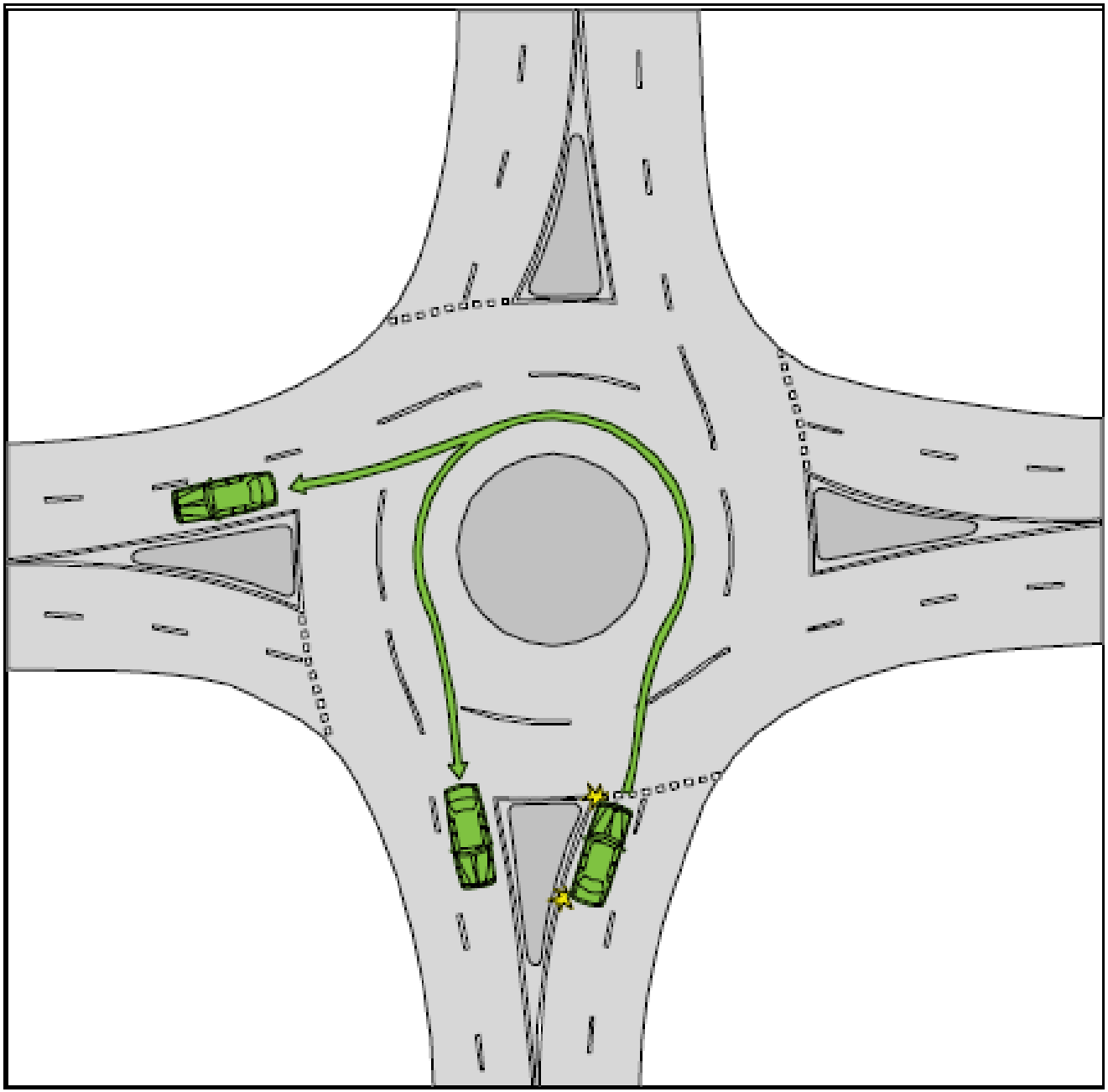
Exit line marking for multi-lane roundabouts



Exit line marking for
multi-lane roundabouts



Exit line marking for multi-lane roundabouts




My recommendation

4 U-turn on Sonsgolon Road, UB

3 fatalities in 2018 – all pedestrians


Line marking worn. Sign knocked over.
Risk of innocent striking of median

This sign ???

But this doesn’t effect pedestrians. What can we do to assist pedestrians?

My recommendations

Improve lighting

Renew line marking

Delineate median

5 Y-JUNCTION BLACKSPOT

Six fatalities, 14 serious casualty crashes in 5 years

COLLISION DIAGRAM

- Six fatalities, 14 serious casualty crashes in 5 years
- Cost $3,500,000 for 5 years


ПАНҶ
PANJ
50
ПАНҶИ ПОЁН
PANJI POYON
24


9123
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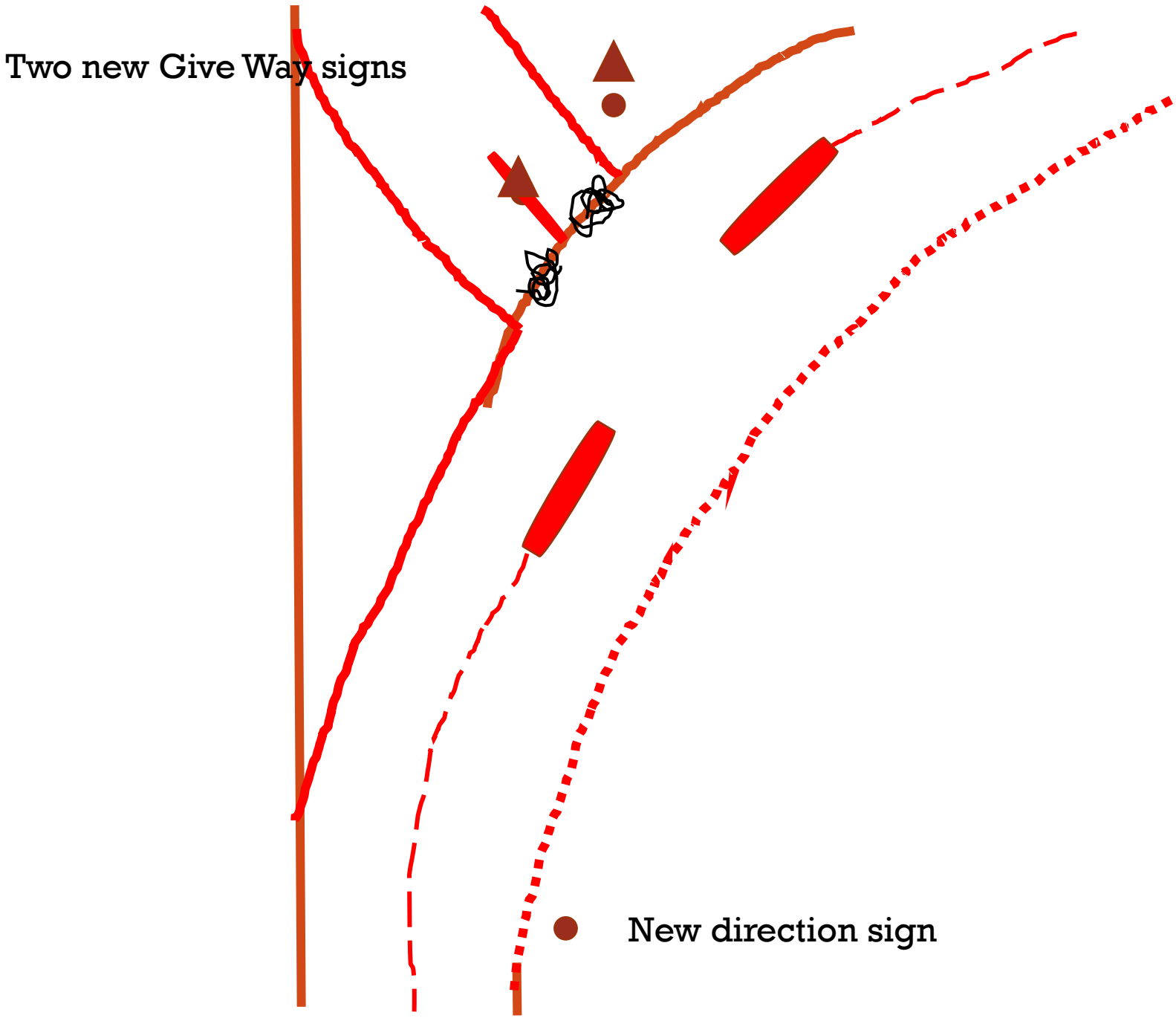
WHAT ARE YOUR THOUGHTS ABOUT THIS BLACKSPOT?
WHAT TREATMENTS DO YOU SUPPORT?

Stage 1

- Install new diagrammatic advance direction signs on all three approaches informing road users of the destinations in each direction.
- Install oversized (900mm) “Intersection” warning signs on both approaches of the NH.
- Install a tactile centre line and edge lines on national highway.
- Install duplicate Give Way signs and line marking facing minor road traffic.
- Install an advance warning sign “Give Way Ahead” on the minor road.
- Pave all shoulders through the intersection at least 1.5m wide for at least 200m each side of the intersection.

Stage 2

- Square up the minor road to intersect with the NH at a T-junction.
- Widen the NH and construct channelisation on it to give physical separation of NH traffic though the junction, including a sheltered left turn lane for traffic turning from the NH to the minor road. (See typical layout).
- Install lighting at the intersection.


Two new Give Way signs
New direction sign

Treatments	Crash Reduction Factors	Treatment Life
INTERSECTION		
New roundabout	**85%**	20
Modify roundabout (approach deflection)	**55%**	20
New traffic signals	**45%**	20
Convert intersection signals to roundabout	**30%**	20
Staggered T low volume (<2000 AADT of through road)	**70%**	20
Removal of Y-intersection	**85%**	20
Splitter islands/median, urban	**20%**	20
Splitter islands rural, low volume	**45%**	20
Linemarking to improve intersection definition	**10%**	5
Improve sight distance (remove/relocate obstruction)	**50%**	20
Improve signage	**30%**	15
Rumble strips on approaches	**30%**	5
Install Stop signs	**30%**	15
Install signs	**30%**	15
Change to Stop signs	**5%**	15

Stage 2
Crash reduction factor 85% for 20 years

Crash savings = $11,900,000

The removal of the Y junction, signs, lines plus lighting will cost $925,000

Benefits = $11,900,000
Costs = $925,000

BCR = 12.9

This project will be compared with all other blackspots in the country – those with the highest BCR's will be treated first. The others will wait for next year.....

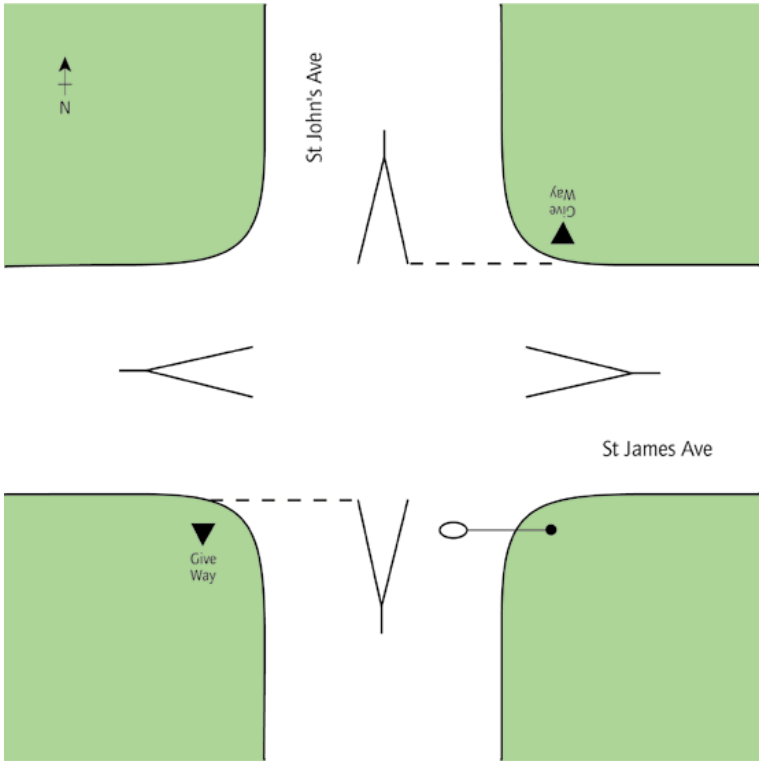
BCR

Melbourne SE suburban blackspot

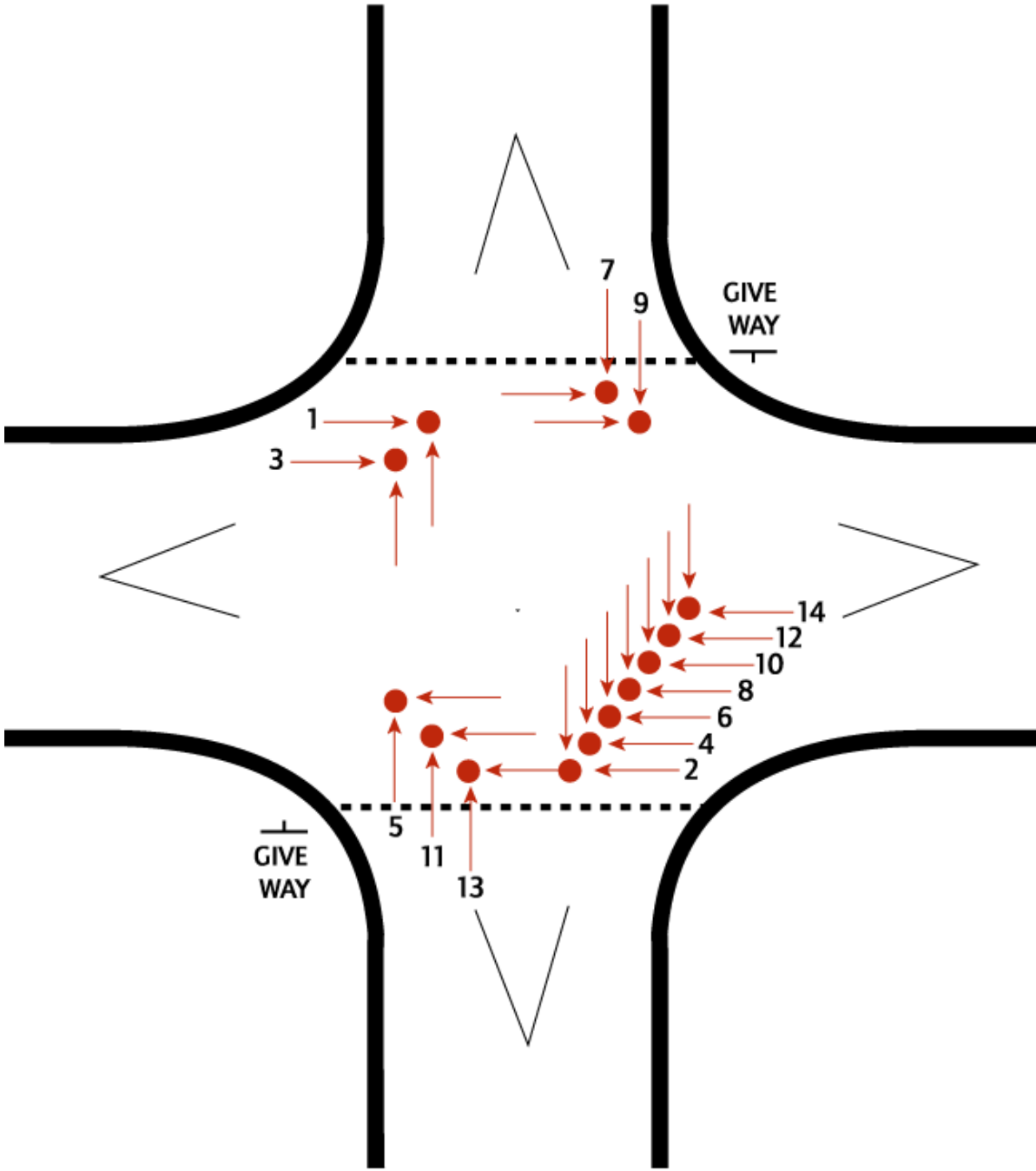
A suburban blackspot

6 St James/St Johns Ave, in suburban Melbourne

- Intersection of local streets
- Give way signs north & south
- 14 reported crashes in 5+years
- 9 of these were from the north (travelling south)
- All were right angle (DCA 110)
- O fatalities, 9 casualty crashes, 5 property only crashes



COLLISION DIAGRAM – ST JAMES/ ST JOHNS



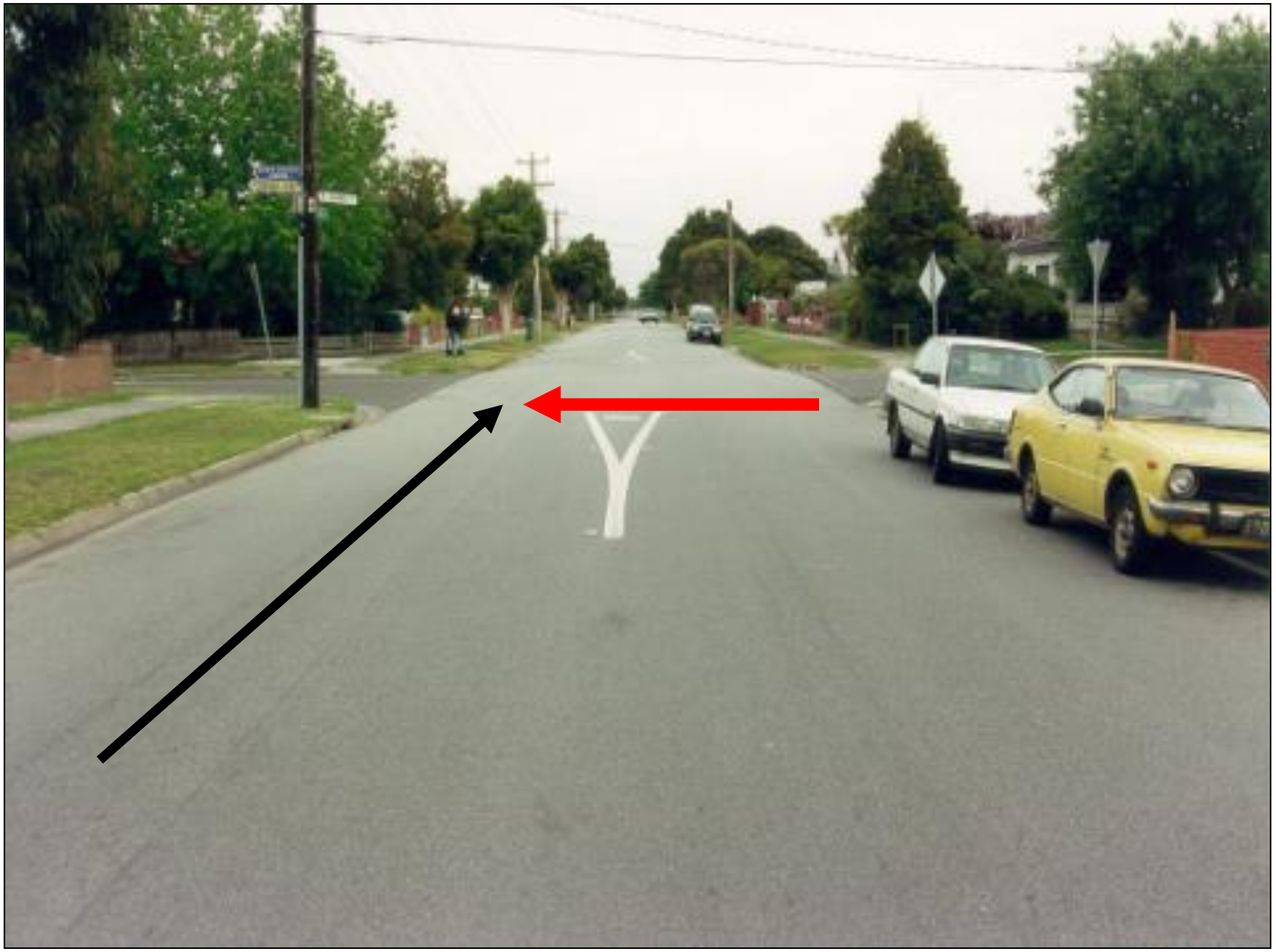
CRASH FACTOR GRID – ST JAMES/ ST JOHNS

Accident Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Date: day: month	1307	0409	1912	0806	0307	0711	3012	2702	0305	2407	1804	2105	1406	2008
Date: year	15	15	15	16	16	16	16	17	17	17	17	17	17	17
Day of week	Sat	Wed	Thu	Sun	Thu	Fri	Tue	Fri	Sun	Fri	Sun	Fri	Mon	Fri
Time of day	1700	1855	1530	1900	1345	2145	1900	1220	1800	2000	1845	1610	1735	1855
Severity	3	3	2	3	2	4	3	3	4	2	3	2	2	3
Light conditions														
Road Conditions	W	W	D	D	D	D	D	D	D	D	D	D	W	D
DCA Code	110	110	110	110	110	110	110	110	110	110	110	110	110	110
Object 1	Car	Car	Car	Car	Car	Car	Car	Car	Car	Car	Car	Car	Van	Car
Object 2	Car	Car	Truck	Car	Car	Car	Car	Truck	Car	Car	Car	Car	Car	Car
Object 3					Car			Car			Car			
Direction 1	N	S	N	S	N	S	S	S	S	S	N	S	N	S
Direction 2 (& 3)	E	W	E	W	W,E	W	E	W,N	E	W	W,E	W	W	W
Other														

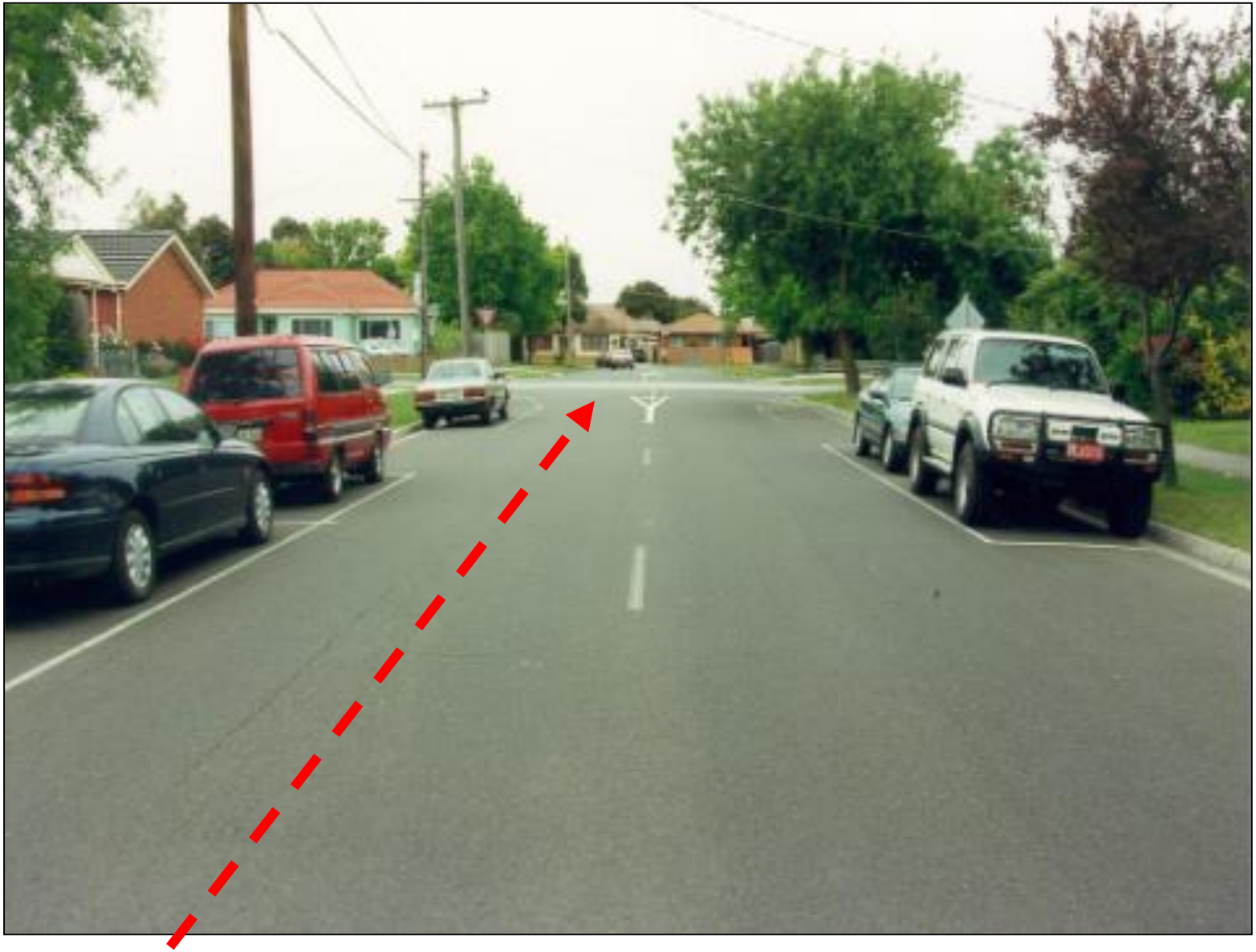
Southern approach in St Johns Ave, Springvale


Southern approach in St Johns Ave, Springvale

Eastern approach in St James Ave, Springvale



Eastern approach in St James Ave, Springvale



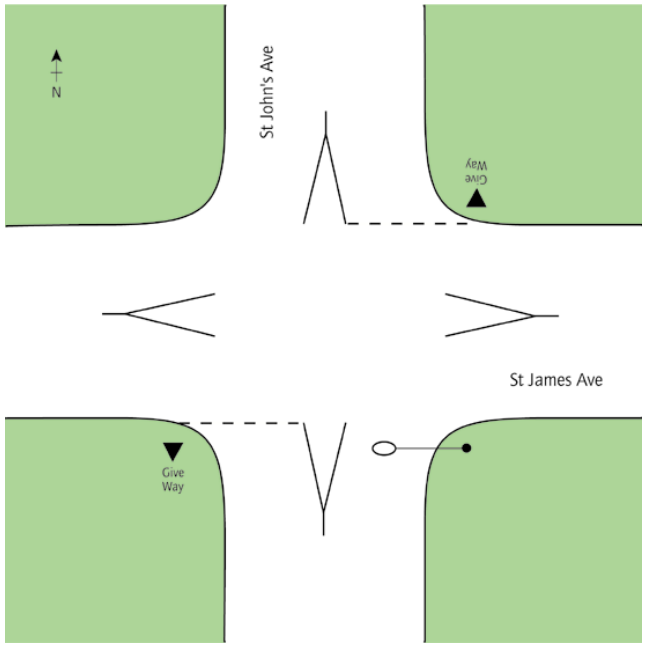
Northern approach in St Johns Ave, Springvale

Northern approach in St Johns Ave, Springvale

Western approach in St James Ave, Springvale

St James/St Johns Ave, Springvale

- What may be causing the crashes?
- What countermeasures do you suggest?
- What will they cost?
- Estimated benefits?
- BCR?



What was the agreed countermeasure for this intersection?

A small diameter roundabout was built

Installation cost $40,000 - life of 20 years

Maintenance ($2000pa. @6%) = $23,000

Cost = $63,000

Benefits

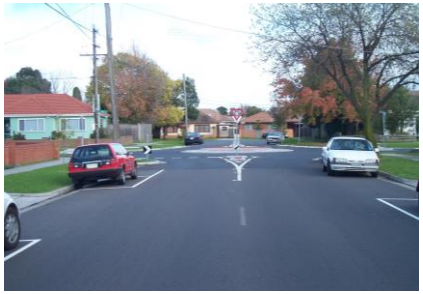
Estimated benefits – an 85% reduction of 14 crashes (from crash reduction factor sheet)

ie 12 crashes in 5 years @ $18,200 per crash

About $218,400 may be saved in 5 years.

That is about $873,600 saved in the 20 year life of the roundabout.

<u>Benefits = $0.87 million</u>



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Central Asia Regional Economic Cooperation Program

$0.87 million (Benefits) divided by $63,000 (Cost) yields the BCR of 13.8 to 1

Road Safety
INTERNATIONAL

AFTER

Northern approach

The roundabout is working well.

There have been no reported crashes.

Summary

- Road safety engineering reduces road trauma
- Perseverance is often needed
- Be a “detective” (or a doctor)
- Your “patient” cannot speak
- Aim for countermeasures with high BCR’s
- Road safety engineering is the last “safety net” when enforcement, education and publicity have failed
- We have a responsibility to investigate thoroughly, to spend funds wisely and to protect all road users

Road Safety INTERNATIONAL

CAREC
Central Asia Regional Economic Cooperation Program

I look forward to your questions