

Welcome to the CAREC “Road Safety Engineering” Workshop

- for professionals in
Turkmenistan

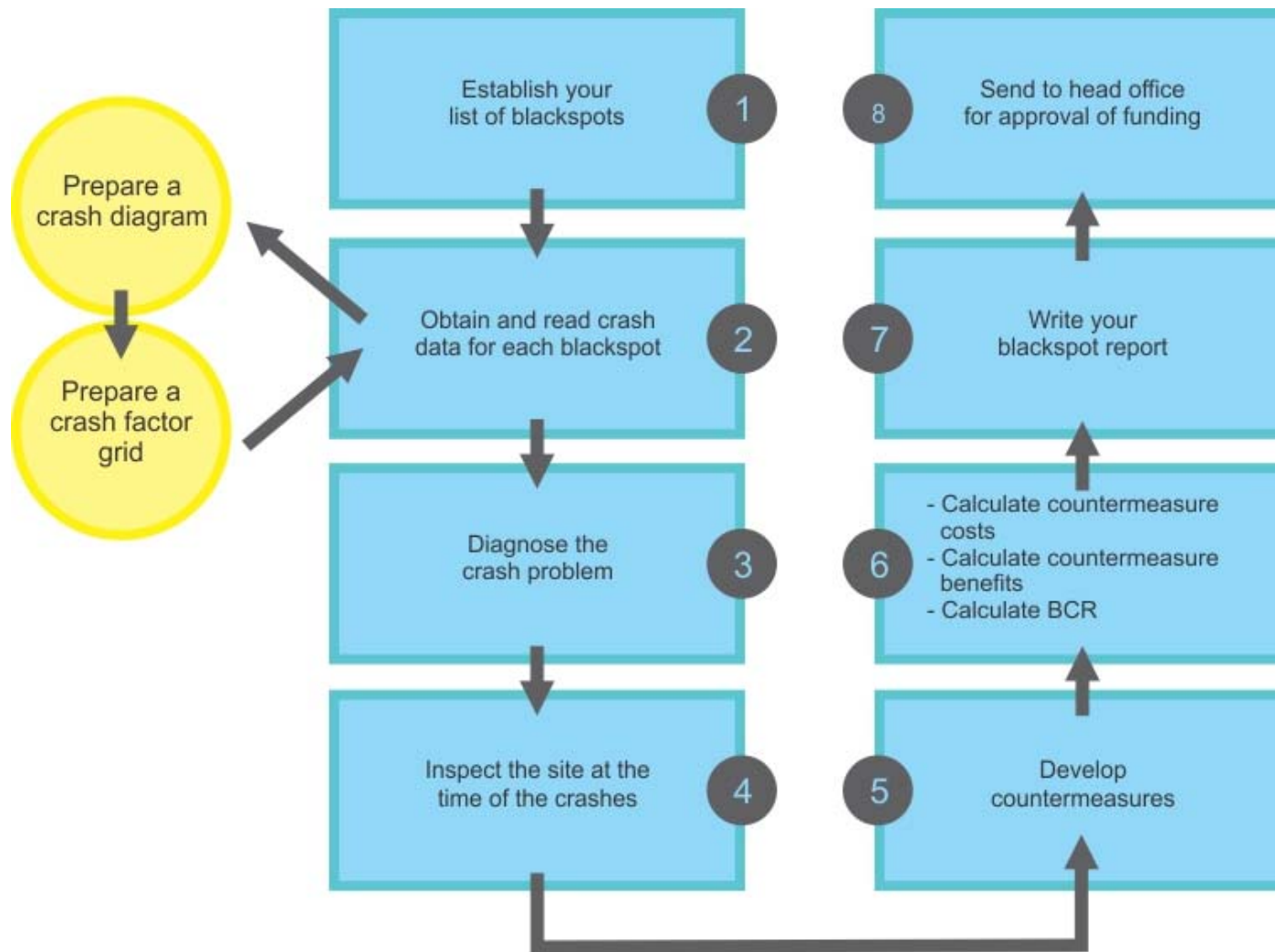
Module 5
– ROAD SAFETY AUDIT –
HOW, WHAT, WHEN, WHERE

Tuesday 26th April 2022



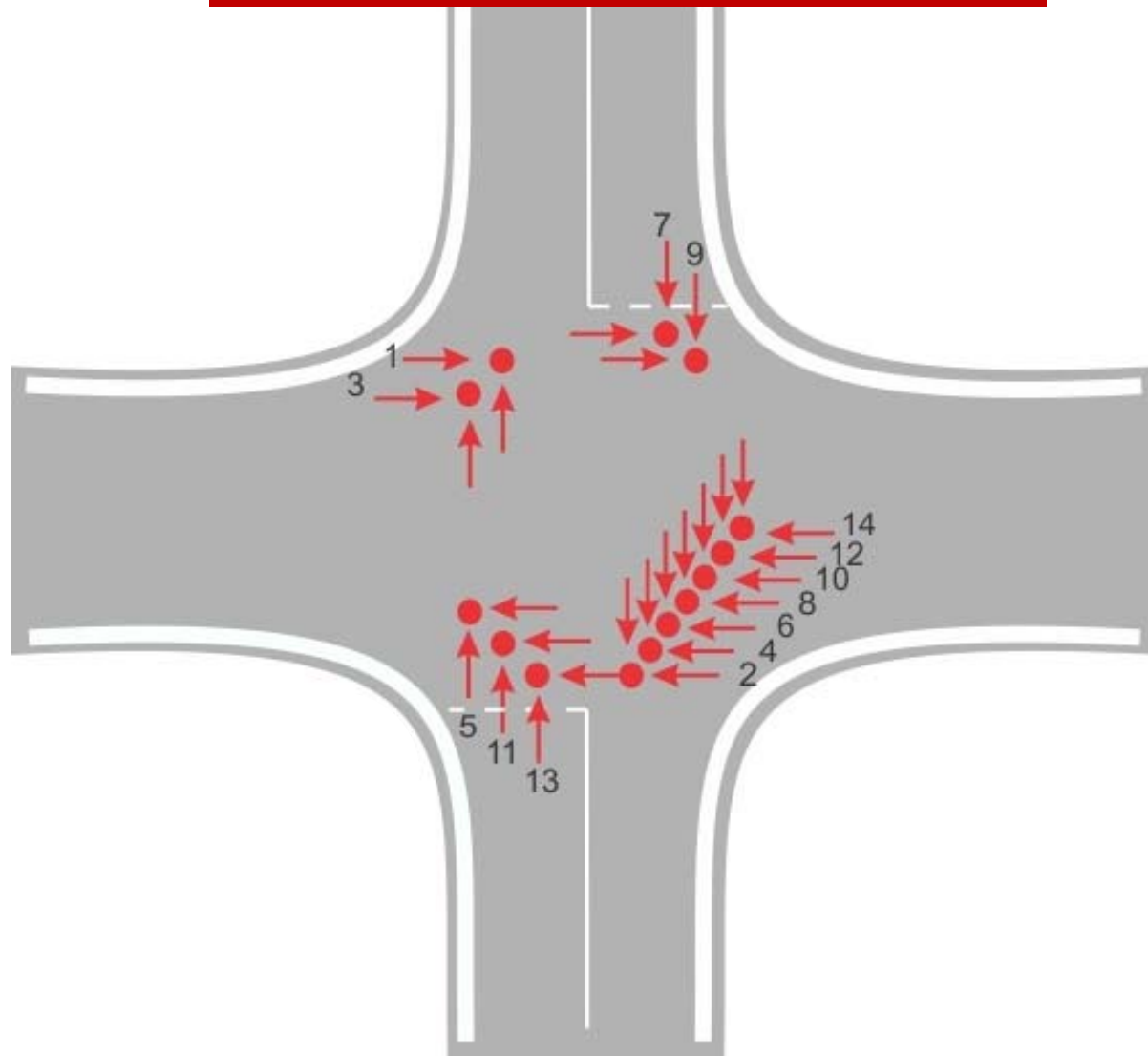
Hi . Welcome back. I
wonder who will count
correctly today?





Steps in the blackspot process

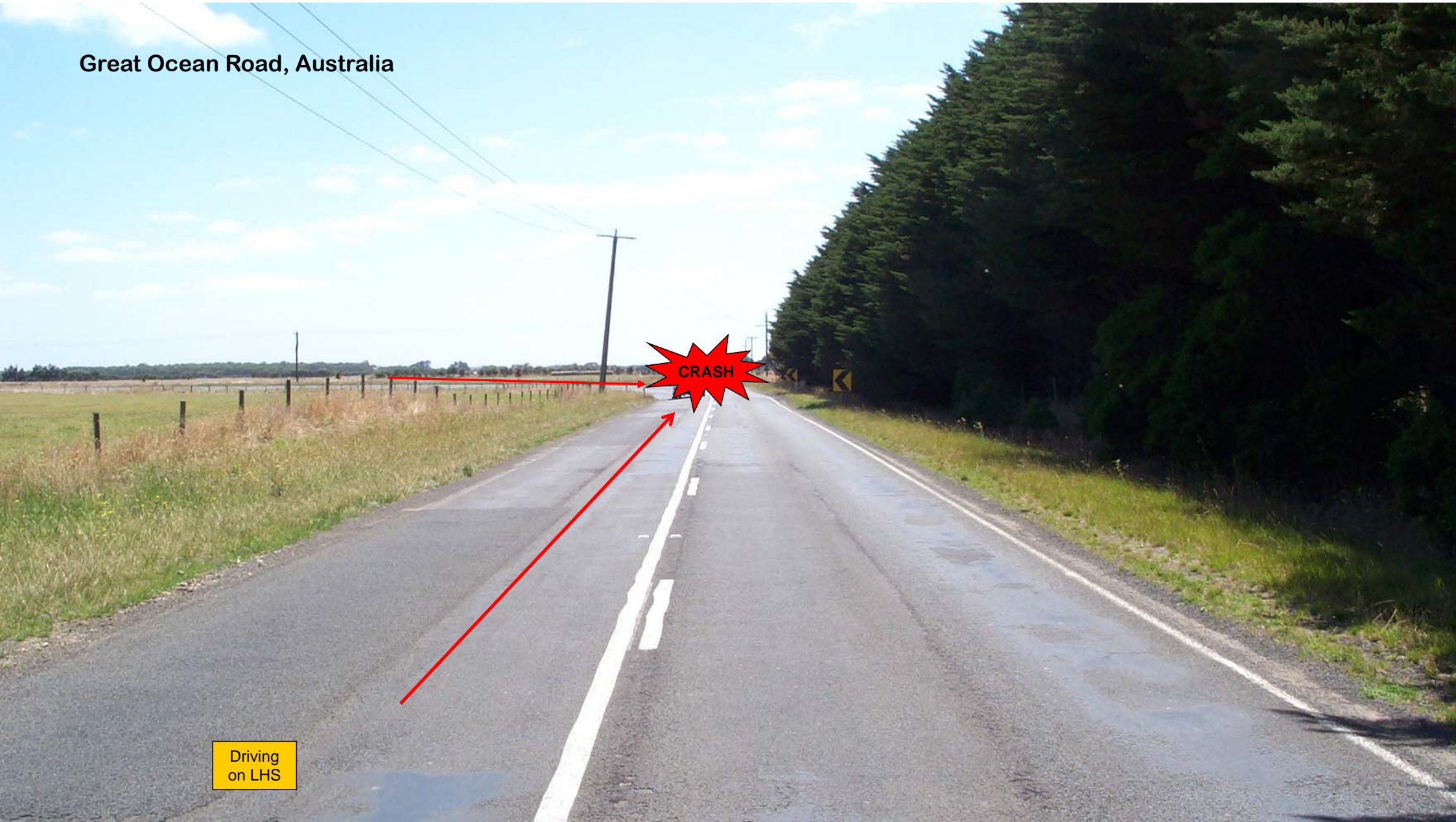
Draw a Collision Diagram (& Crash Factor Grid)



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	17	17	17	18	18	18	18	19	19	19	19	19	19	19
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														

Great Ocean Road, Australia



Driving
on LHS

CRF for All Casualty crashes %

CRF for Specific Crash Type %

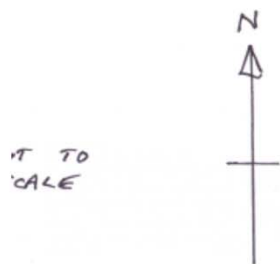
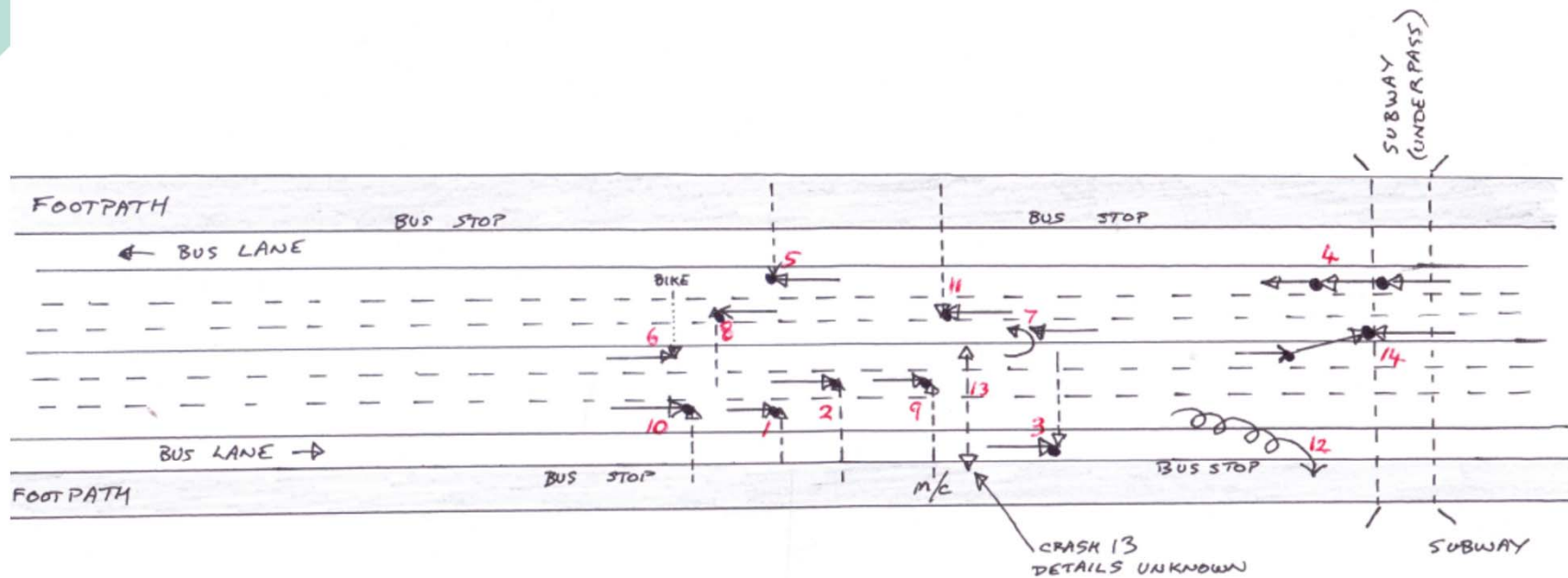
	INTERSECTION		
1	Roundabout (one circulating lane) - Urban environment	70	
	Rural environment	80	
2	Roundabout (2 circulating lanes) - Urban environment	60	
	Rural environment	70	
3	Roundabout (3 circulating lanes) - Urban environment	50	
	Rural environment	60	
4	Turbo roundabouts (2 lanes) - Urban environment	70	
	Rural environment	80	
5	Modify roundabout (speed reduction measures)		55 only crashes impacted by treatments
6	Convert signals to roundabout - urban environment	43	
	(one and two circulating lanes) - rural environment	66	
7	Staggered T	40	
8	Removal of Y-intersection by squaring the layout	85	
9	Splitter islands urban	40	
10	Splitter islands rural	35	
11	Improve intersection definition by linemarking	10	
12	New traffic signals	45	60 serious casualty crashes



Homework Option 1

Urban arterial pedestrian collision problem. 14 crashes in past 3 years. Mainly at night.

CRASH NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14
DATE	12/3	5/5	11/10	29/11	20/1	28/3	1/4	5/9	8/12	31/12	2/2	10/3	5/6	7/9
DAY OF WEEK	SUN	FRI	WED	WED	SAT	WED	SUN	WED	SAT	MON	MON	SUN	WED	SAT
TIME OF DAY	01.15	22.30	19.20	17.50	11.10	20.55	18.30	23.00	14.40	04.00	06.45	23.30	?	20.30
SEVERITY	1	2	2	3	3	3	2	1	3	1	3	1	2	2
LIGHT CONDITION													?	
ROAD CONDITION	WET	DRY	DRY	DRY	DRY	DRY	WET	DRY	WET	DRY	DRY	DRY	?	DRY
CRASH TYPE	003	003	001	303	001	102	207	002	102	004	001	502	?	301
VEHICLE 1	CAR	CAR	BUS	BUS	CAR	CAR	M/C	CAR	CAR	CAR	M/C	M/C	PED	CAR
VEHICLE 2	PED	PED	PED	TRUCK	PED	BIKE	CAR	PED	M/C	PED	PED		?	CAR
VEHICLE 3				CAR										CAR
DIRECTION VEH. 1	E	E	E	W	W	E	W	W	E	E	W	E	?	E
DIRECTION VEH.2	N	N	N	W	S	S	W	N	S	N	S	N	?	?
DIRECTION VEH.3				E										W
OBSERVATIONS	ALC	ALC	SPEED					ALC & SPEED				SPEED		U TURN



COLLISION DIAGRAM FOR PEDESTRIAN BLACKSPOT

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

	00	10	20	30	40	50	60	70	80	90
	PEDESTRIAN on foot, in toy/pram	INTERSECTION vehicles from adjacent approaches	VEHICLES FROM OPPOSING DIRECTIONS	VEHICLES FROM ONE DIRECTION	MANOEUVRING	OVERTAKING	ON PATH	OFF PATH, ON STRAIGHT	OFF PATH, ON CURVE	PASSENGERS & MISCELLANEOUS
	OTHER	OTHER	OTHER	OTHER	OTHER	OTHER	OTHER	OTHER	OTHER	OTHER
	00	10	20	30	40	50	60	70	80	90
1	NEAR SIDE 001	THRU-THRU 101	HEAD ON 201	REAR-END 301	LEAVING PARKING 401	HEAD ON 501	PARKED 601	OFF CARRIAGEWAY TO LEFT 701	OFF CARRIAGEWAY RIGHT BEND 801	FELL IN/FROM VEHICLE 901
2	EMERGING 002	RIGHT-THRU 102	THRU-RIGHT 202	LEFT-REAR 302	PARKING 402	OUT OF CONTROL 502	DOUBLE PARKED 602	OFF CARRIAGEWAY TO RIGHT 702	OFF CARRIAGEWAY LEFT BEND 802	
3	FAR SIDE 003	LEFT-THRU 103	RIGHT-LEFT 203	RIGHT-REAR 303	PARKING VEHICLES ONLY 403	PULLING OUT 503	ACCIDENT OR BROKEN DOWN 603	LEFT OFF CARRIAGEWAY INTO OBJECT 703	OFF RIGHT BEND INTO OBJECT 803	HIT TRAIN 903
4	PLAYING, WORKING, LYING, STANDING ON CARRIAGEWAY 004	THRU-RIGHT 104	RIGHT-RIGHT 204	U-TURN 304	REVERSING IN TRAFFIC 404	CUTTING IN 504	CAR DOOR 604	RIGHT OFF CARRIAGEWAY INTO OBJECT 704	OFF LEFT BEND INTO OBJECT 804	HIT RAILWAY XING FURNITURE 904
5	WALKING WITH TRAFFIC 005	RIGHT-RIGHT 105	THRU-LEFT 205	VEHICLES IN PARALLEL LANES LANE SIDE SWIPE 305	REVERSING INTO FIXED OBJECT 405	PULLING OUT REAR END 505	HIT PERMANENT OBSTRUCTION 605	OUT OF CONTROL ON CARRIAGEWAY 705	OUT OF CONTROL ON CARRIAGEWAY 805	HIT ANIMAL, OFF CARRIAGEWAY 905
6	FACING TRAFFIC 006	LEFT-RIGHT 106	LEFT-LEFT 206	LANE CHANGE - RIGHT 306	LEAVING DRIVEWAY 406	OVERTAKING- RIGHT TURN 506	HIT ROADWORKS 606	LEFT TURN 706		PARKED VEHICLE RAN AWAY 906
7	DRIVEWAY 007	THRU-LEFT 107	U-TURN 207	LANE CHANGE - LEFT 307	FROM LOADING BAY 407		HIT TEMPORARY OBJECT ON CARRIAGEWAY 607	RIGHT TURN 707		VEHICLE MOVEMENTS NOT KNOWN 907
8	ON FOOTWAY 008	RIGHT-LEFT 108		RIGHT TURN S/S 308	FROM FOOTWAY 408			MOUNTS TRAFFIC ISLAND 708	MOUNTS TRAFFIC ISLAND 808	
9	STRUCK WHILE BOARDING, OR ALIGHTING 009	LEFT-LEFT 109		LEFT TURN S/S 309			HIT ANIMAL 609			
10				PULLING OUT 310			LOAD HITS VEHICLE 610			

MANY CRASHES!

**SEVERE
OUTCOMES!**

TIME TO ACT

- A mid-block blackspot/blacklength with many pedestrian crashes (DCA 001, 002, 003)
- Mostly at night
- I believe speeding, poor lighting, and wide road with no crossing facilities are major contributors.
- Alcohol too.
- Engineers cannot do much to stop/prevent this
- BUT – we can help the intoxicated get home safely!

Common suggestions from participants:

- ❖ Improve the underpass – ramps, lighting, shops
- ❖ Install fencing to block pedestrian access to the road
- ❖ Street lighting (7 of 8 ped crashes were at night)
- ❖ Pedestrian refuge
- ❖ New signals (PUFFIN)

Your work was well done – with some small errors:

- Selecting a treatment that gives a high CRF instead of the most logical and best treatment.
- Maybe focussing on the simple, restrictive treatments (fencing, speed limits, subway improvements – not considering enough “time separation”).
- But – it is difficult to recommend treatments for a site you have not visited/inspected.
- You need to inspect the site day and night. In Dushanbe!

I would recommend a two-stage approach; Stage 1 will commence as soon as approvals and funding will permit. Stage 2 in one year

Stage One:

- Improve the underpass by constructing ramps (for the disabled) and by improving the lighting (outside and inside the underpass).
- Construct a long central refuge where pedestrians cross the road between the bus stops. A 2m wide refuge is achievable by reducing each traffic lane to a uniform width of 3.5m. A 20m long refuge will be able to store 500+ pedestrians per hour.
- Install twelve new streetlights to enhance the area after dark.
- Begin regular Police enforcement of speeding.
- Monitor closely after these works to assess if Stage Two is needed.
- CRF = 45% of pedestrian crashes (for the pedestrian refuge)

Stage Two:

- A PUFFIN crossing will be designed and installed in Year 2 (when more funds are available) to give pedestrians the time separation from motor vehicles they need on this wide arterial road.
- No additional CRF – as the whole package is calculated as one and costs are split over 2 years

Stage 1 and 2 BCR = Benefits 45% of ped crashes (67% of fatal ped crashes)

Use 45% of 8 crashes = 3.6 crashes in 3 years, so about $8 \times 4 = 32$ crashes “saved” in 25-year life of the refuge.

One casualty crash in this country = \$150,000

Benefits = $32 \times \$150,000 = \$4,800,000$

Costs estimated \$300,000

$BCR = 4,800,000/300,000 = 16$



HOMework OPTION 2
Y-JUNCTION BLACKSPOT

12 casualty crashes in 3 years

CRASH NUMBER	1	2	3	4	5	6	7	8	9	10	11	12
DATE	12/3	14/5	11/7	29/1	28/3	1/4	5/9	8/2	31/4	26/6	10/8	7/9
DAY OF WEEK	SUN	FRI	WED	WED	WED	SUN	WED	SAT	MON	TUES	SUN	SAT
TIME OF DAY	13.00	23.30	20.30	16.50	23.00	18.30	22.00	17.40	04.00	04.00	23.30	20.30
SEVERITY	1	2	2	3	1	2	2	1	1	2	1	3
LIGHT CONDITION												
ROAD CONDITION	WET	DRY	DRY	DRY	DRY	WET	DRY	WET	DRY	WET	DRY	DRY
CRASH TYPE	202	202	202	301	202	202	001	202	301	802	202	102
VEHICLE 1	CAR	CAR	BUS	BUS	CAR	M/C	CAR	CAR	CAR	TRUCK	M/C	CAR
VEHICLE 2	BUS	TRUCK	TRUCK	CAR	M/C	BUS	PED	CAR	M/C	?	TRUCK	CAR
VEHICLE 3										?		
DIRECTION VEH.1	E	E	S	S	S	S	S	E	N	NW	E	E
DIRECTION VEH.2	N	N	NW	S	NW	NW	E	S	N	?	S	W
DIRECTION VEH.3												
OBSERVATIONS			SPEED	SPEED						MAY HAVE BEEN ANOTHER VEH INVOLVED	SPEED	

MANY CRASHES!

SEVERE
OUTCOMES!

TIME TO ACT

- An intersection blackspot with many “head-on” crashes (DCA 202)
- Mostly at night
- I believe an “overshoot” problem – drivers unaware of the conflict areas.
- Two stage treatment – short term (signs, line marking)
- Longer term (geometric changes).
- For this, check traffic movements to decide on a T-junction or a roundabout
- I determine a T junction is the best because of traffic movements
- It will cost \$1,200,000 USD (prelim. cost)

	Treatments	Crash Reduction Factors	Treatment Life
	INTERSECTION		
	New roundabout	80%	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



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

DELINEATION	%	YEARS
Reflectorised guideposts	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

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

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

Each casualty crash in Turkmenistan = \$400,000 USD (approx.)

What percentage of crashes at the blackspot will be reduced if we construct a T-junction?

Benefits – look at a table that shows the Crash Reduction Factor for each countermeasure

12 crashes in 3 years

Each casualty crash in TRK costs \$400,000

\$4,800,000 in 3 years = \$1,600,000 pa

Removing Y-junction has a CRF of 85% of crashes for the next 20 years

85% reduction will save \$1,360,000 pa

20-year life of treatment = \$27,200,000 crash savings

Benefit/ Cost Ratio BCR

- Benefits of T-junction = \$27,200,000 _{USD}
- Cost of the T-junction = \$1,200,000 _{USD}

$$\text{BCR} = 22.66$$

(This is an excellent BCR and almost certainly will receive funding approval in most countries)

An introduction to road safety audit

How, what, when, where
and why?



Road Safety Audit

My objectives are to:

- outline the road safety audit process,
- encourage the introduction of the audit process in your road authority,
- encourage you to undertake audits especially during the design stages of new road projects, and
- answer your questions about the audit process

What is road safety audit?

Why do we
need audit?

How do we do an audit?

Where?

When?

—

Road Safety Audit

Prevention is
better than cure



Road Safety Audit guidelines





A road safety audit is.....
“a formal, systematic and detailed examination of a road project by an independent and qualified team of auditors that leads to a report listing the potential safety concerns in the project.”

(CAREC 2018)



A road safety audit is.....
“a **formal**, systematic and detailed examination of a road project by an **independent and qualified team of auditors** that leads to a report listing the potential safety concerns in the project.”

(CAREC 2018)





An audit is:

- A formal process – not an informal check
- Carried out by people who are independent of the design
- Undertaken by people who have appropriate experience and training
- Restricted to road safety issues





Road Safety Audit
is NOT:

- another name for a blackspot investigation
- a substitute for a blackspot investigation
- an opportunity to redesign a scheme
- a design standards check, or a compliance check



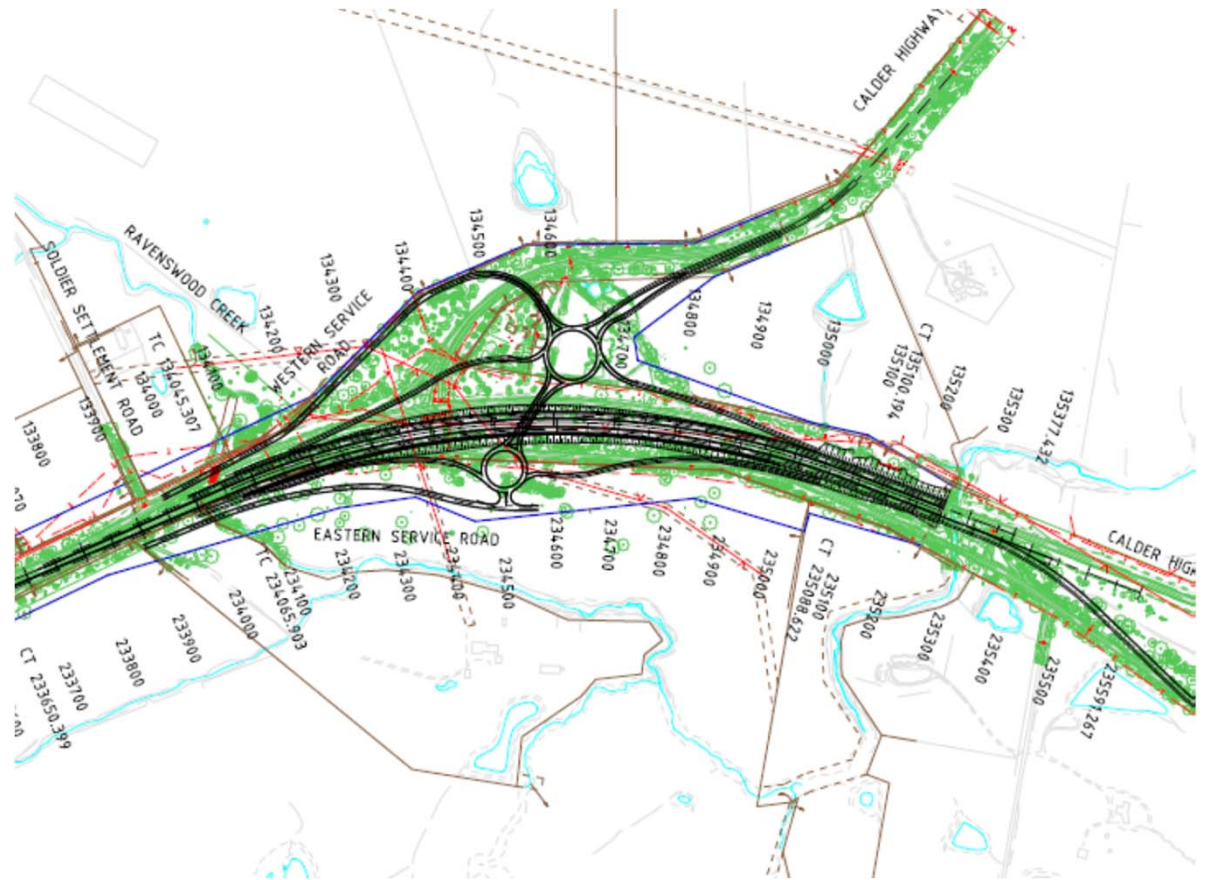
Road Safety Audit

Prevention is better than cure



A road safety audit....

- requires professional judgment
- helps to inject safety into projects



Prevention is better than cure

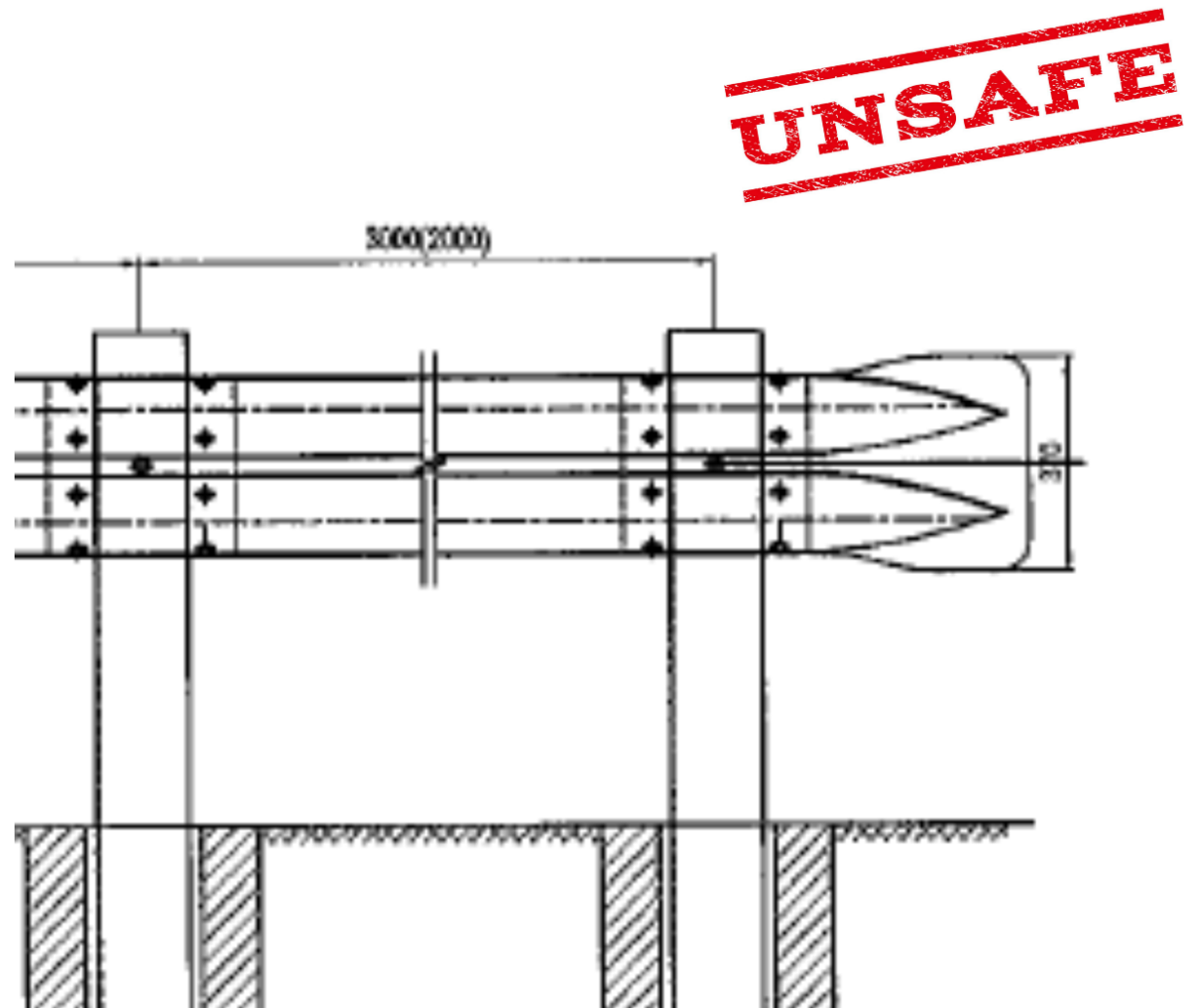


Remember that a road safety audit does not take over the responsibility for the project.

That remains with the Project Manager.

Road safety audit
applies practical safety
experience at the
design stages of a
project to ensure ...

.....unsafe features are not
introduced





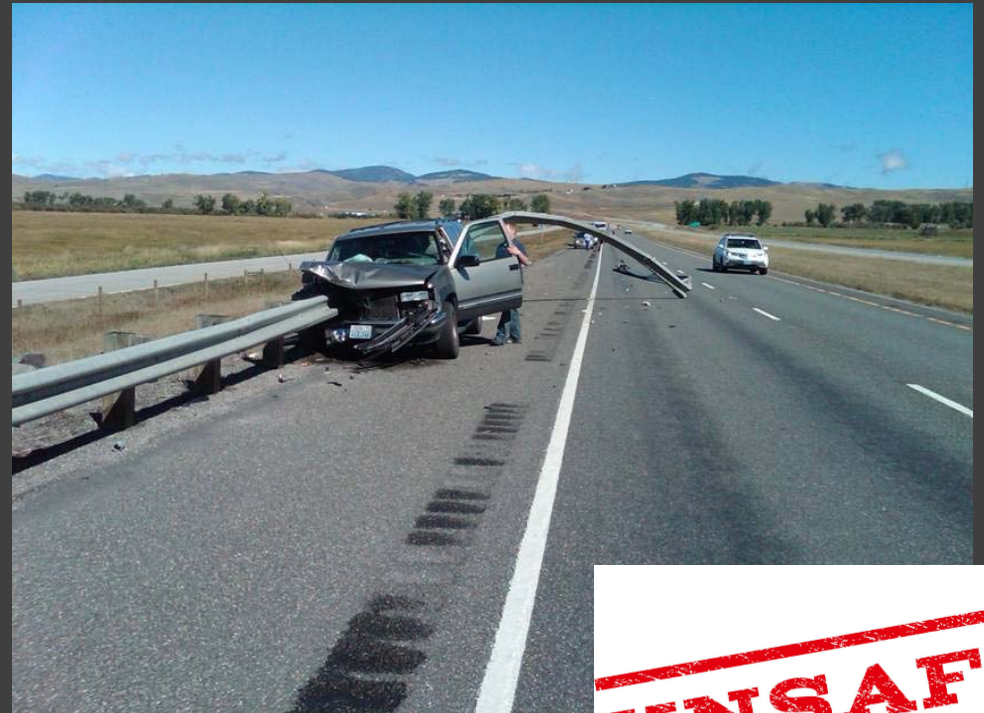
UNSAFE

Maybe “standard” –
but very UNSAFE



Road safety audit applies practical safety experience at the design stages of a project to ensure ...

...unsafe features are not introduced



UNSAFE



Road safety audit applies practical safety experience at the design stages of a project to ensure ...

..... safe features are introduced



Prevention is better than cure - by Phillip Jordan

Engineers are problem solvers

Auditors need to be problem finders!



Objectives of road safety audit

To minimise the risk of crashes occurring on a new road project, and to minimise the severity of the crashes that do occur;

To minimise the risk of crashes occurring on adjacent roads (that is, to avoid the possibility that the project creates crashes elsewhere on the network;

To recognise the importance of safety in road design (so that the needs and perceptions of all road users are met, and to achieve a balance where they may be in conflict);

To reduce the long-term costs of a new road project, bearing in mind that unsafe designs may be expensive (or even impossible) to correct at a later stage;

To improve the awareness of road safe engineering principles by all involved in the process of planning, design, construction and maintenance of roads.



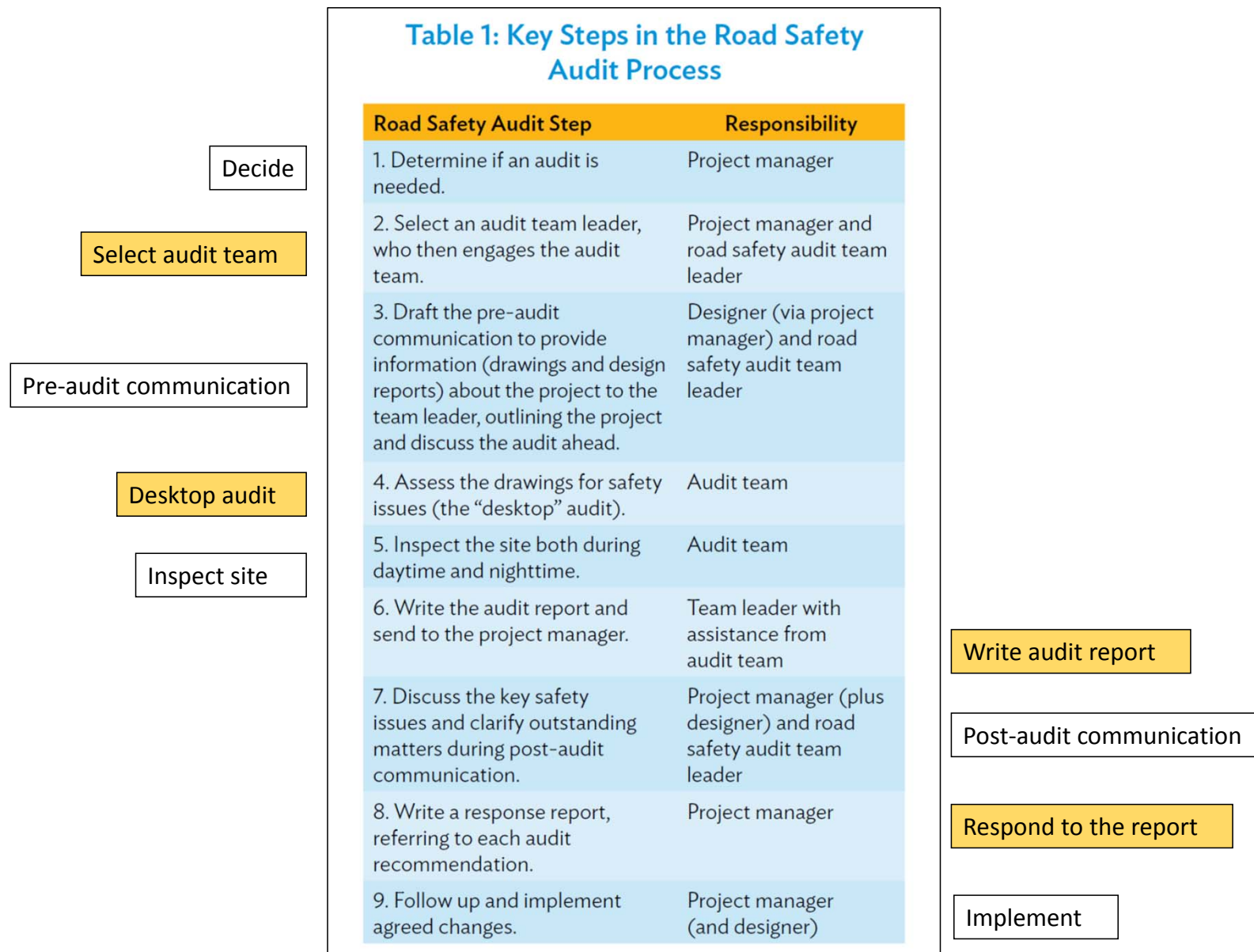
Road safety audit
helps a project

Road safety audit is
“safety insurance”
for a new road



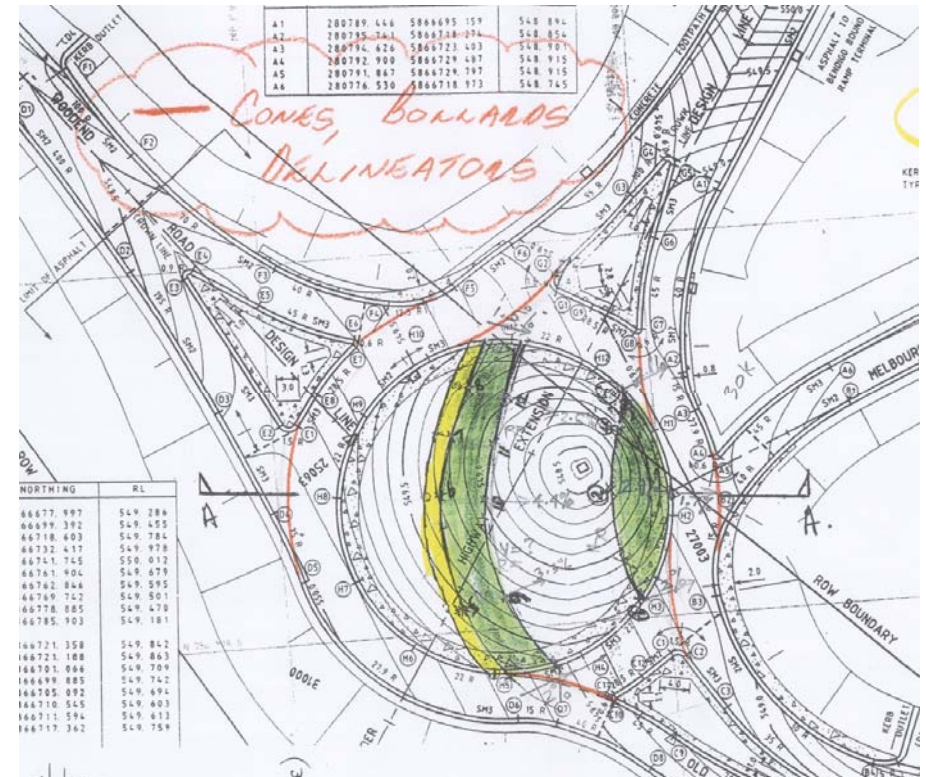
How do we do a road safety audit?





Key audit steps....

Closely review drawings



Use checklists

GUIDE TO ROAD SAFETY PART 6: ROAD SAFETY AUDIT **CHECKLIST 4: PRE-OPENING STAGE AUDIT**

Issue	Yes	No	Comment
4.1 General topics			
4.1.1 Changes since previous audit; translation of design into practice			
General check: have any matters that have changed since a previous audit been executed safely?			
Has the translation of the design into practice been executed safely?			
4.1.2 Drainage			
Is the drainage of the road and surrounds adequate?			
4.1.3 Climatic conditions			
Are any facilities put in place to counter climatic problems effective?			
4.1.4 Landscaping			
Is the planting and species selection appropriate from a safety point of view?			
Is vegetation/landscaping 'frangible' in locations where vehicles may run off the road?			
Is visibility maintained past or over vegetation/landscaping (particularly for pedestrian safety)? Will this continue to be so once plants grow and mature?			
4.1.5 Services			
Are all boxes, pillars, posts and lighting columns in safe positions?			
Are they of appropriate materials and design?			
4.1.6 Access to property and developments			
Are all accesses safe for their use?			
Are all accesses adequate in location and visibility?			
4.1.7 Emergency vehicles			
Are the provisions for emergency stopping safe?			
4.1.8 Better treatment			
Will the better treatment prevent or limit conflict?			

GUIDE TO ROAD SAFETY PART 6: ROAD SAFETY AUDIT **CHECKLIST 2: PRELIMINARY DESIGN STAGE AUDIT**

Issue	Yes	No	Comment
2.1 General topics			
2.1.1 Changes since previous audit			
Do the conditions for which the scheme was originally designed still apply? (for example, no changes to the surrounding network, area activities or traffic mix)			
Has the general form of the project design remained unchanged since previous audit (if any)?			
2.1.2 Drainage			
Will the scheme drain adequately?			
Has the possibility of surface flooding been adequately addressed, including overflow from surrounding or intersecting drains and water courses?			
2.1.3 Climatic conditions			
Has consideration been given to weather records or local experience that may indicate a particular problem? (for example, snow, ice, wind, fog)			
2.1.4 Landscaping			
If any landscaping proposals are available, are they compatible with safety requirements? (for example, sight lines and hazards in clear zones)			
2.1.5 Services			
Does the design adequately deal with buried and overhead services? (especially in regard to overhead clearances, etc)			
Has the location of fixed objects or furniture associated with services been checked, including the position of poles?			
2.1.6 Access to property and developments			
Can all accesses be used safely? (entry and exit/merging)			
Is the design free of any downstream or upstream effects from points of access, particularly near intersections?			
Have rest areas and truck parking accesses been checked for adequate sight distance, etc?			
2.1.7 Adjacent developments			
Does the design handle accesses to major adjacent generators of traffic and developments safely?			

Most RSA manuals have checklists to remind and guide you in your audits

Key audit steps....

- inspect the site, day and night
- use checklists to prompt....



Key audit steps....

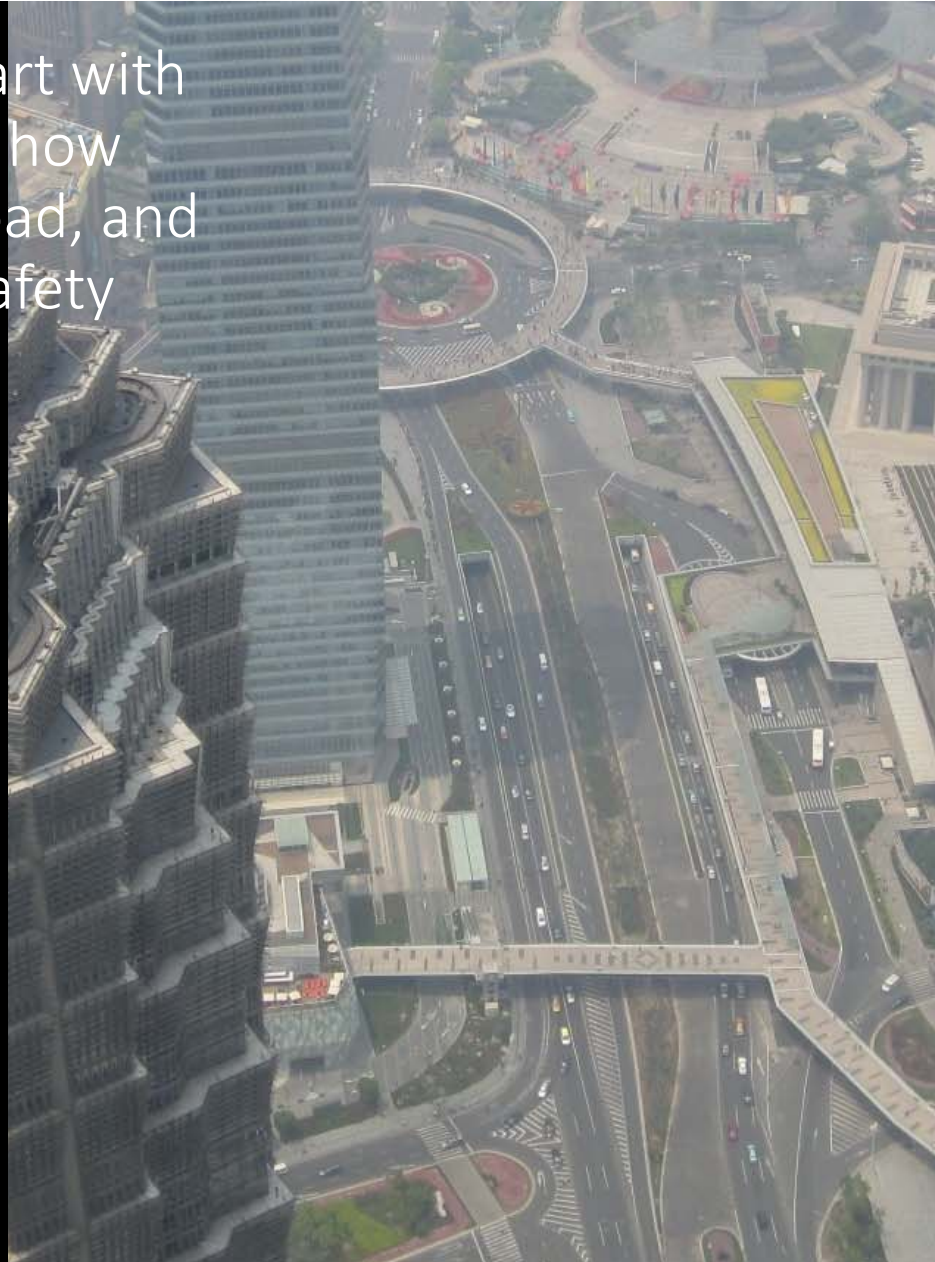
Respond to the audit report



Road safety audit reports on safety issues - only!



Road safety audit combines art with science - the art of assessing how the road users will use the road, and the science of proven road safety engineering principles.



What projects
should be road
safety audited?

All road projects – big and small



What projects
should we
audit?



Big road projects

Small road projects

Urban projects

Rural projects

Traffic management schemes

Pedestrian projects

Roadworks

Any work that interacts with the road

Road safety audit is
for big projects



Audits are for big projects



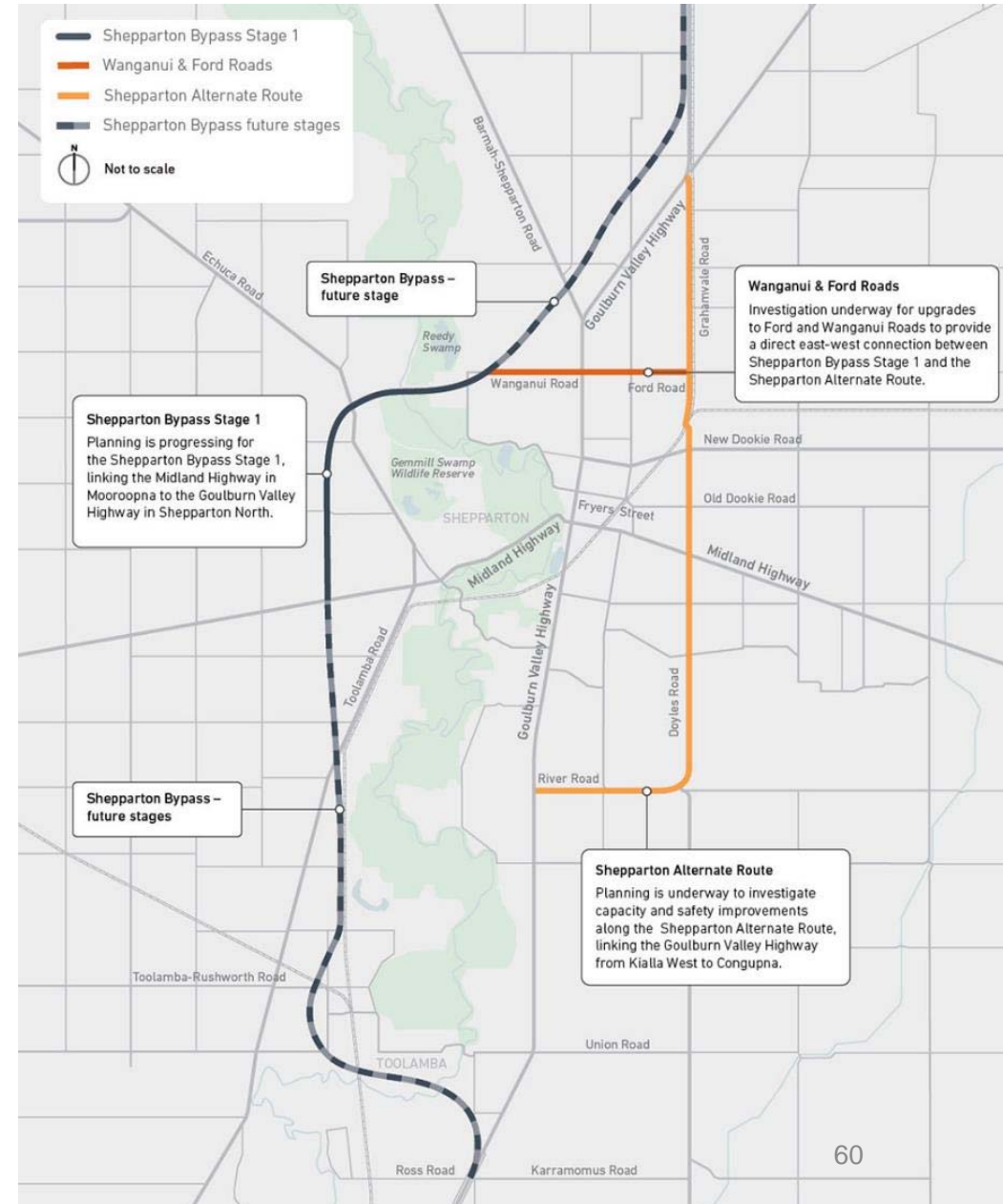
Presentation title here

Road safety audit is for small projects



Road Safety Audit

Road safety audit is for rural road projects – such as this proposed town by-pass





Road safety audit is for urban projects

Prevention is better than cure - by Phillip Jordan

Road Safety Audit

Road safety audit is for small projects, such as parklets and local street closures (during the COVID pandemic)





Road safety audits are for intersection improvements

Road Safety Audit

Road safety audit is for pedestrian projects





Road safety audit
is for road works

Road Safety Audit

Road safety audit is for road works



Road safety audit is for
bicycle projects





Road Safety Audit

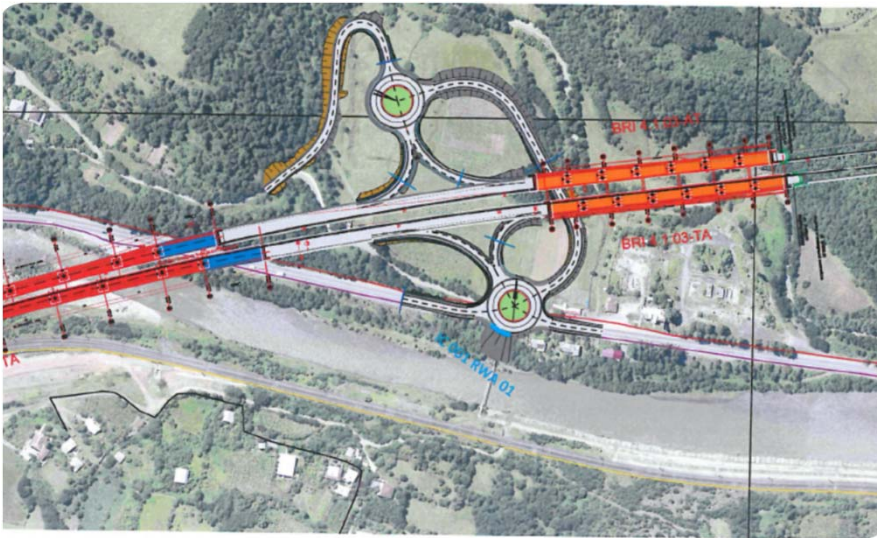
Prevention is better than cure



When do we do road safety audits?

There are six agreed stages

The 6 international stages of road safety audit



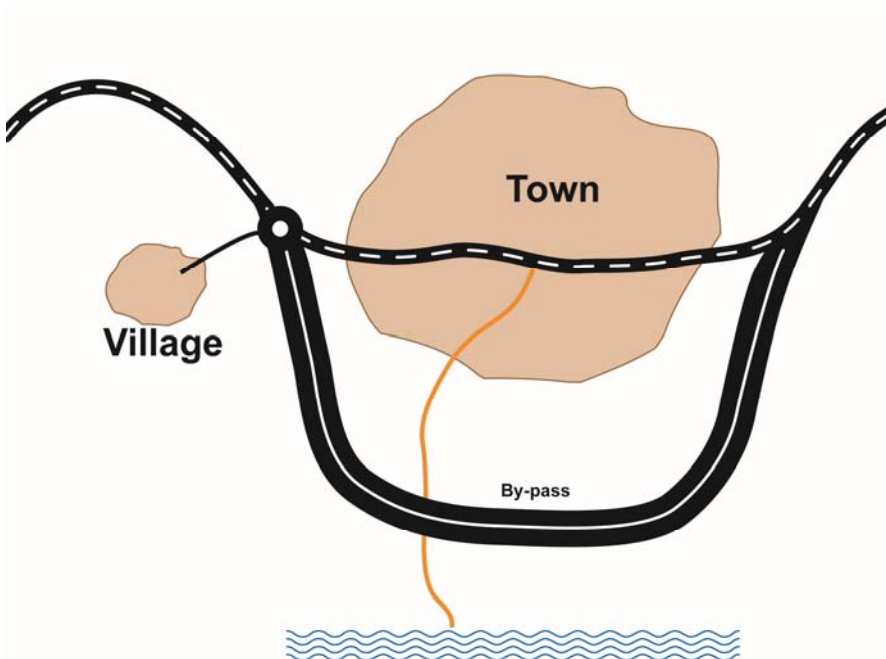
- Planning
- Preliminary design
- Detailed design
- Traffic management
- Pre-opening
- Existing road (called road safety inspections)

Existing road audits are called “inspections” – their overuse is not recommended as they...

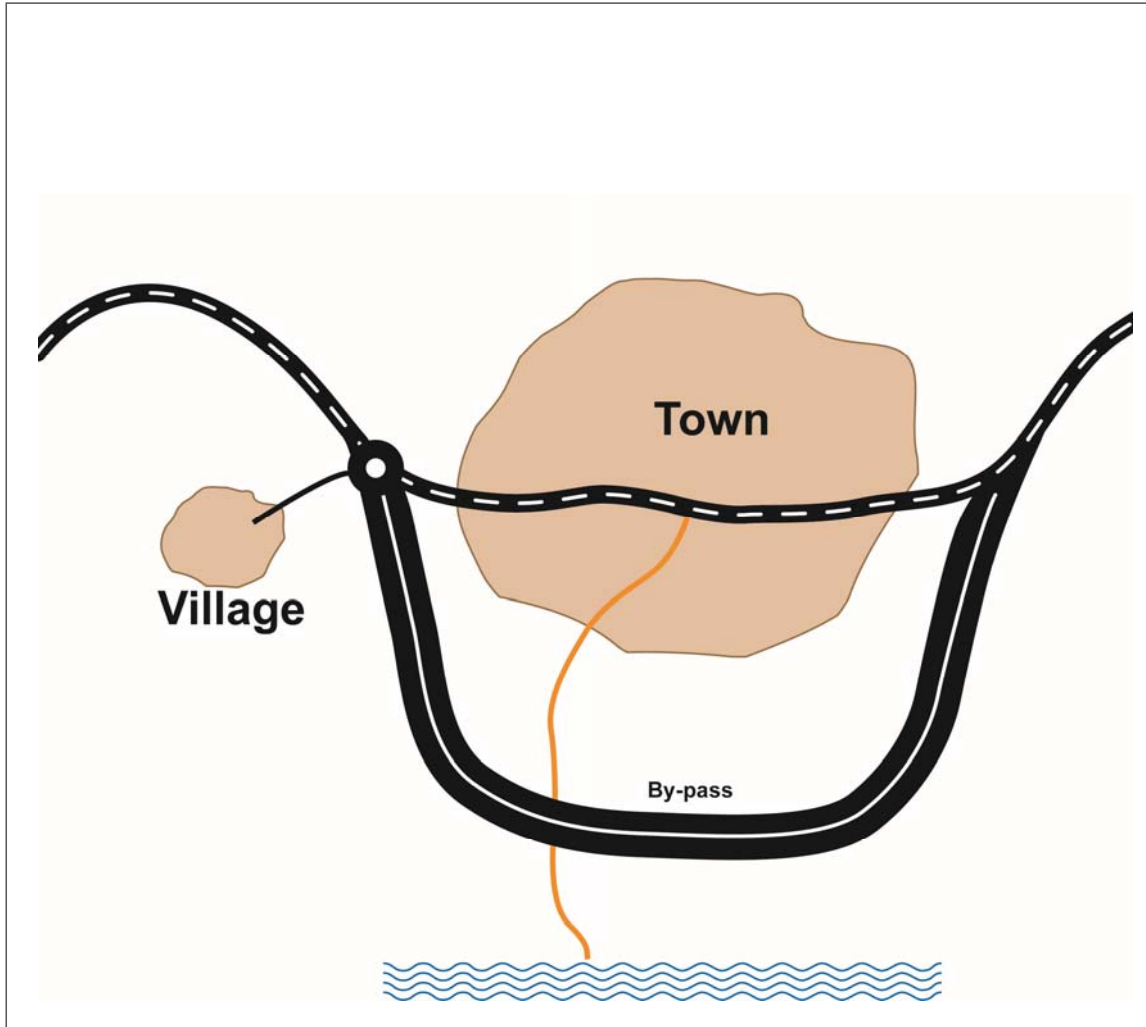
- Lead to unfulfilled expectations if remedial work is not undertaken
- May cause misunderstandings with the benefits of design stage audits
- May cause confusion with crash investigations (blackspots)
- Should already be part of a good maintenance regime.



Planning stage audits consider.....

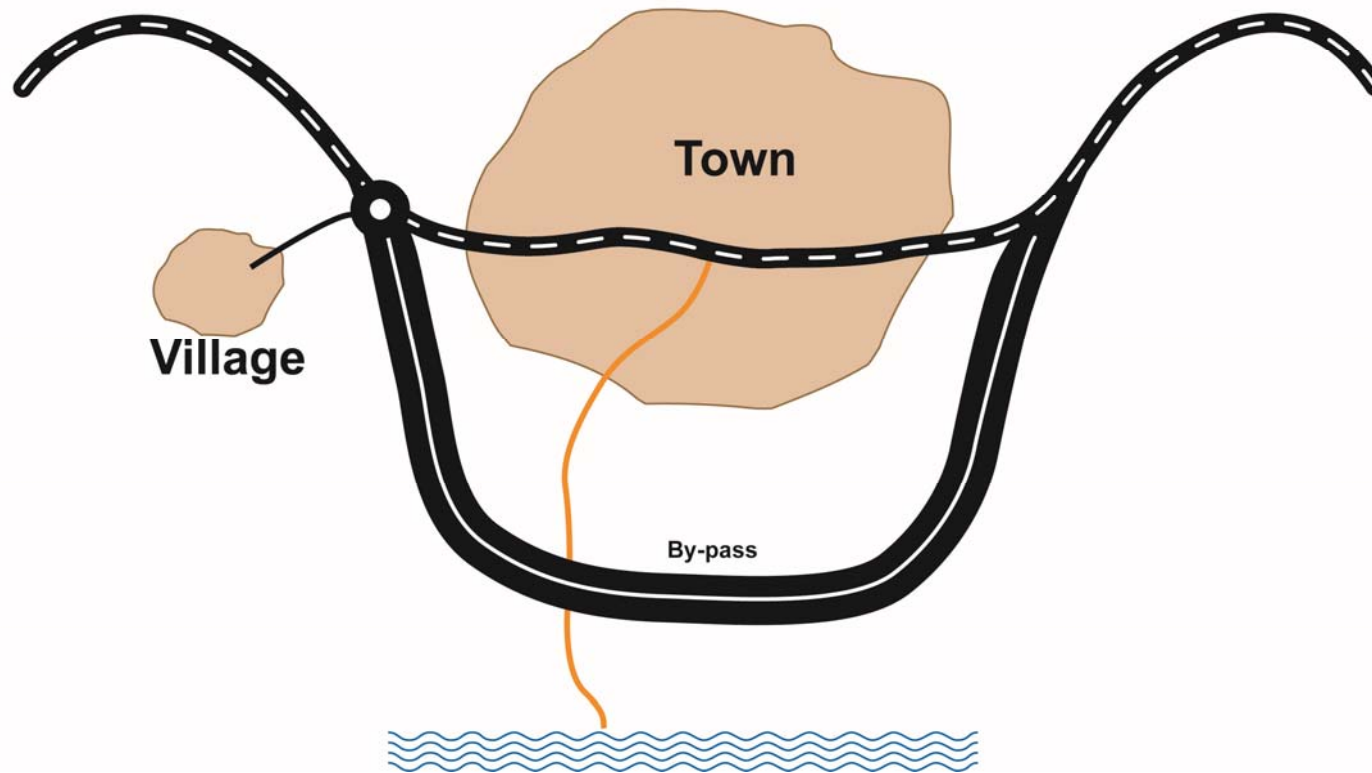


- route choice
- design standards
- impacts on the adjacent road network
- intersection types
-and much more

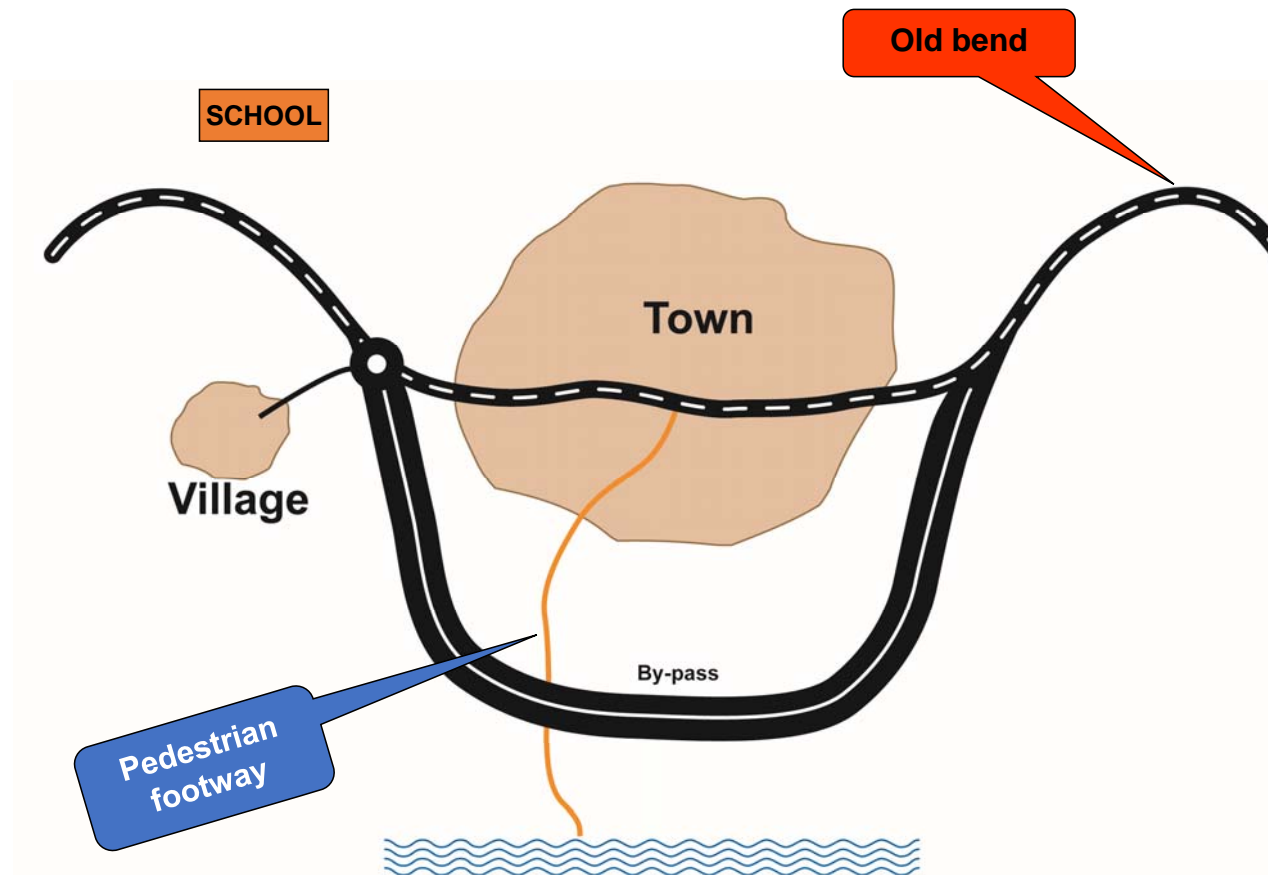


A town in the western part of the country has problems because of a busy highway. A By-Pass is proposed.....

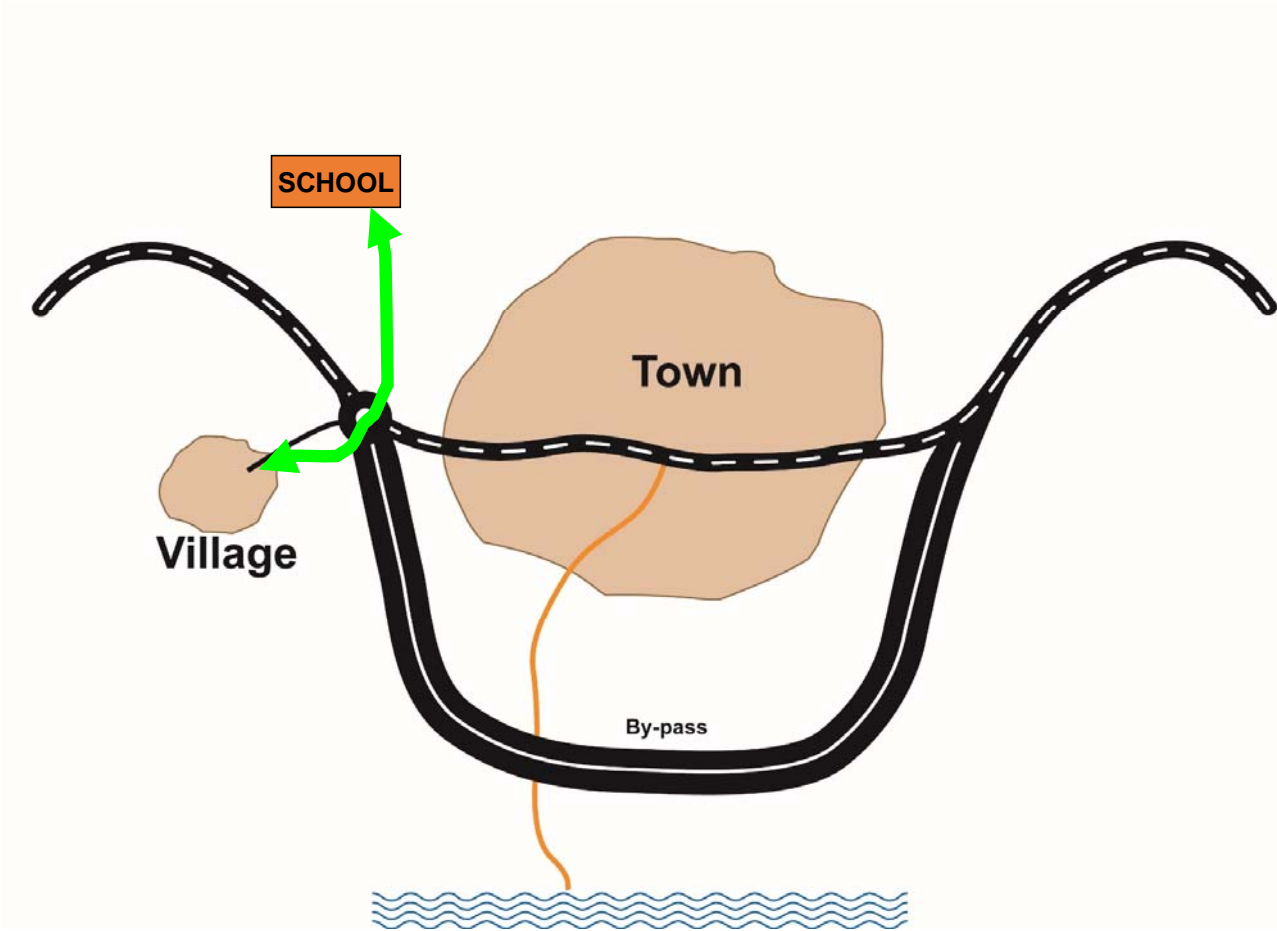
The By-Pass will take through traffic away from the highway and the development. Of course, it will be safer. Does it need to be audited?



An audit team looks at, and beyond, the proposed scheme



The audit team finds:



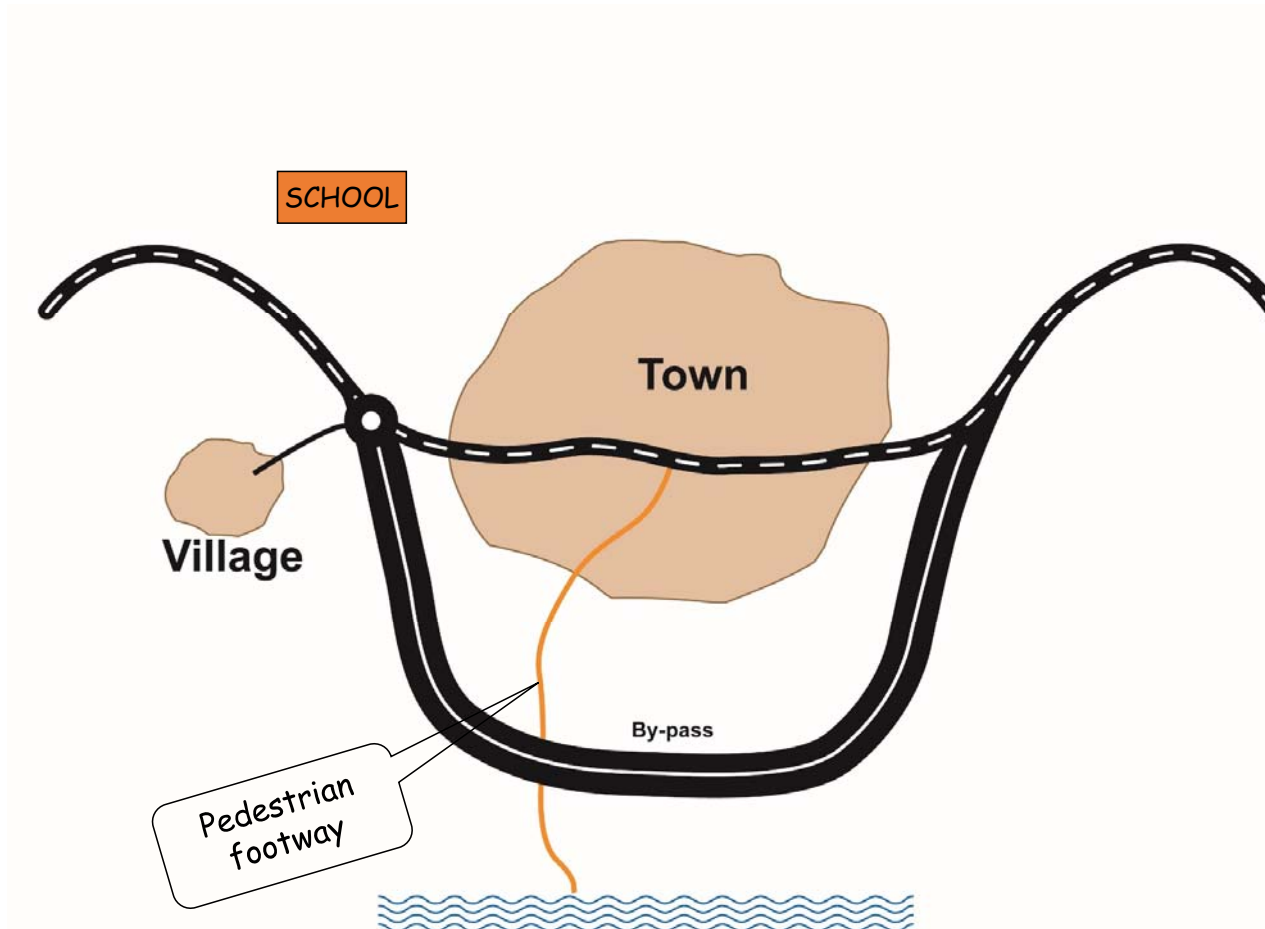
Prevention is better than cure



Prevention is better than cure

A similar roundabout exists nearby, in the same area – the proposed roundabout will look like this.

The audit team finds:

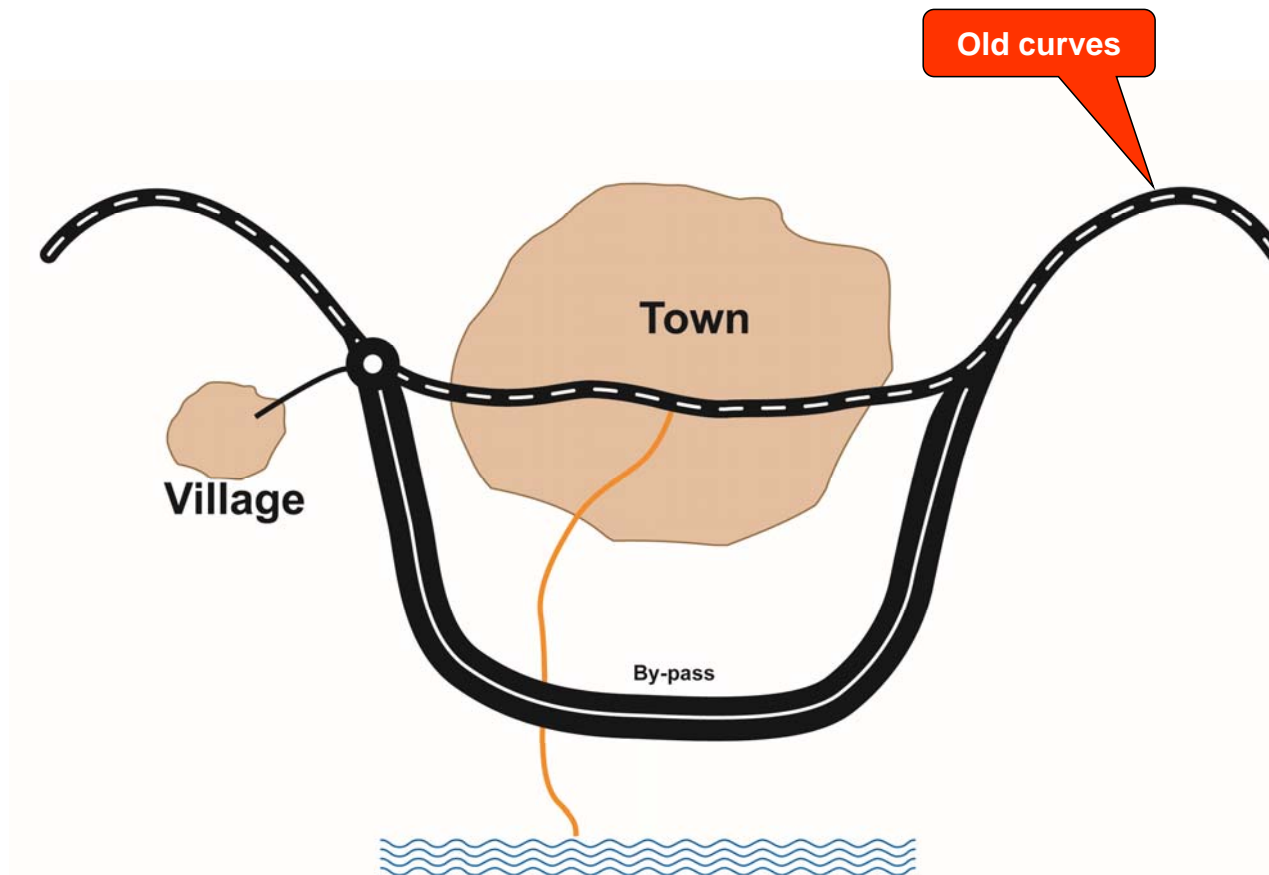


Prevention is better than cure



Prevention is better than cure

The audit team finds:

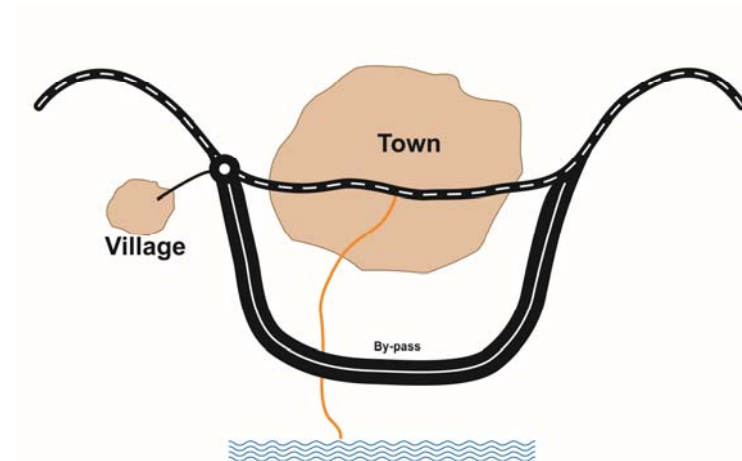




Old curves, just outside
the project

The audit team reports on the possible safety concerns of.....

- Young pedestrians & cyclists at large roundabouts
- Pedestrians attempting to cross the new By-Pass
- Higher speeds entering the old curves



The Project Manager is now required to respond to these safety concerns and to follow up with necessary improvements.

The Project Manager decides:

Children at proposed roundabout

- Difficult issues
- Don't give up on a roundabout if possible
- Give options to the design team
- A Stop/Give Way crossroad? But these have higher risk than roundabouts for other users.
- The designers are responsible for deciding and submitting new drawings to the Project Manager



The Project

Manager decides: Pedestrians crossing high speed road

- Difficult
- Offer options to the design team
- Overpass/underpass?
- Traffic signals?
- Break in median?
- Nothing!
- Not a zebra crossing!!!



Prevention is better than cure



The Project
Manager decides:

Higher speeds entering the old bends – pave the shoulders and install chevron alignment markers

Some people think road safety audit is a compliance check with standards.....

What standards are involved in this example?

There are none!

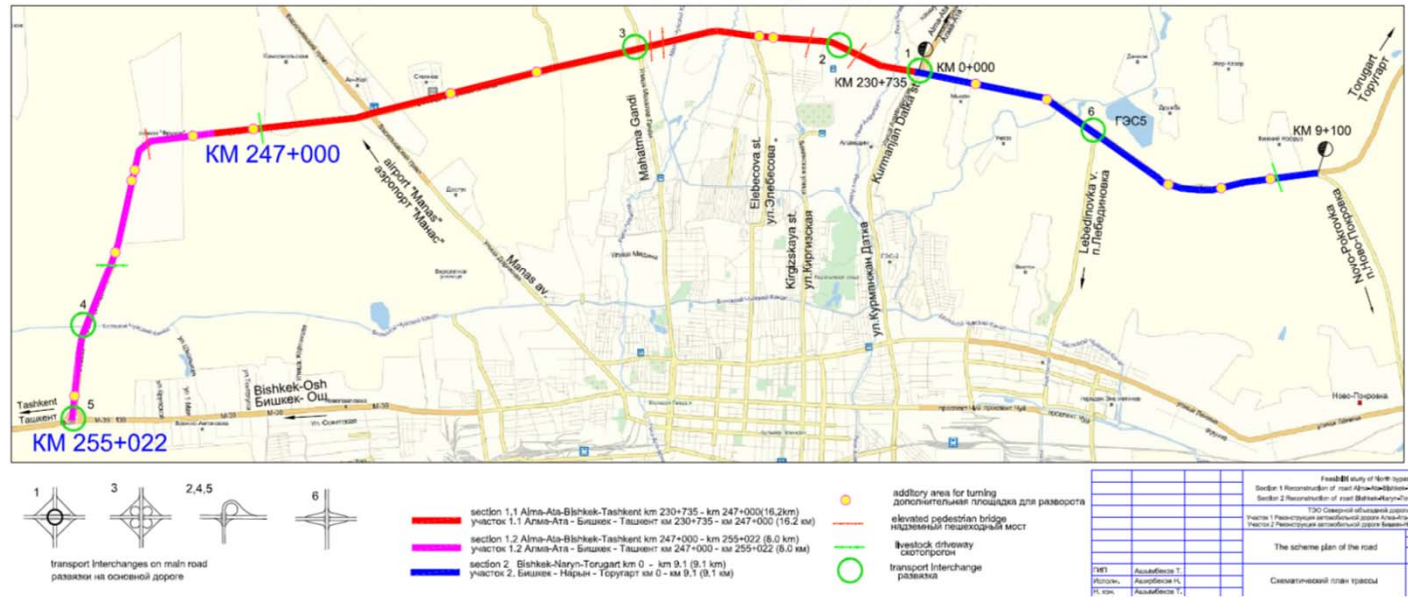
Road safety audit is not a compliance check against standards

Preliminary design stage audits consider...

- geometrics
- alignments
- intersection layouts
- cross sections
- vulnerable road users
-and more



The scheme plan of the bypass road of Bishkek city
Схематический план трассы объездной дороги г.Бишкек



Northern Bishkek By-Pass – preliminary design stage audit

This preliminary design stage audit found safety issues with...

- Cross sections
- U-turn
- Interchange layouts
- Vulnerable road users
- .. and more



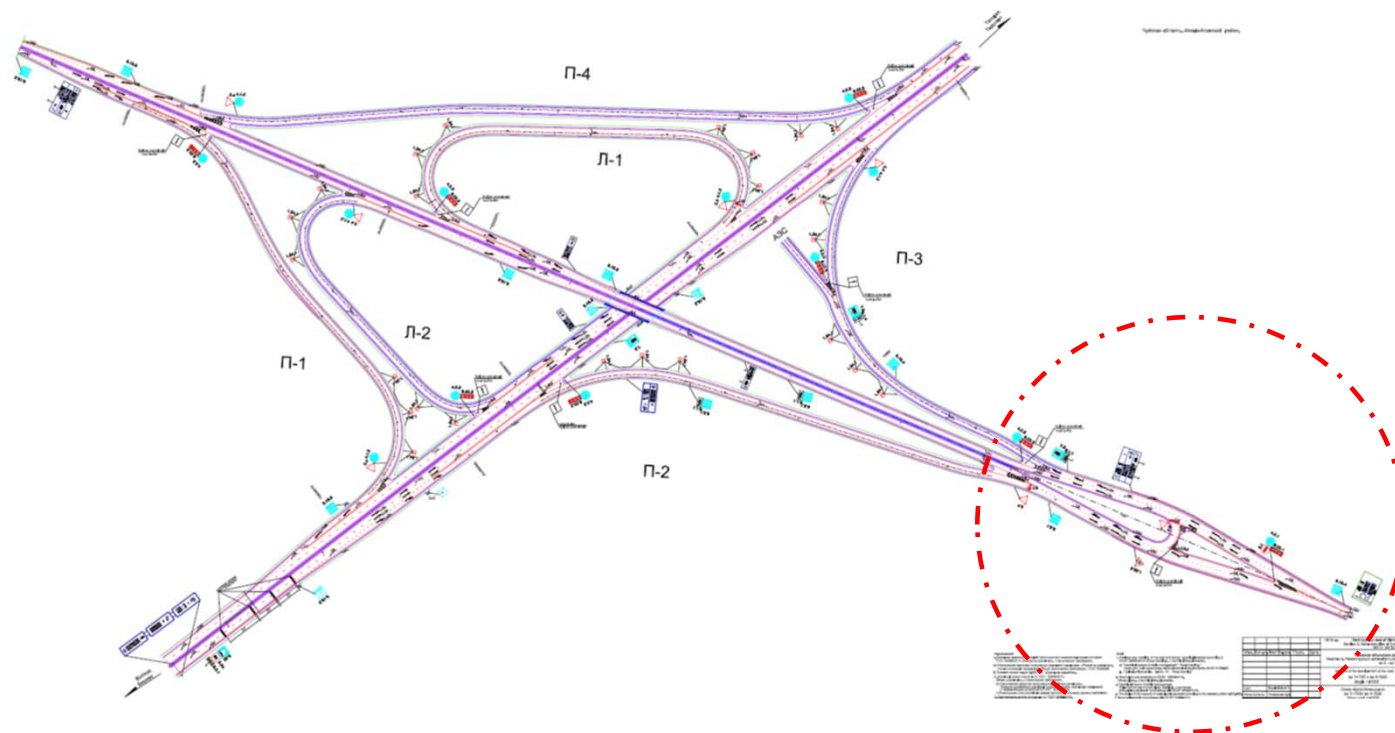
During the inspection, look to see who
your customers are, and will be.



Existing 2-lane roundabout



Northern Bishkek By-Pass – preliminary design stage audit







Low volumes
on N approach

Proposed
U-turn

© 2020 Google
Image © 2020 Maxar Technologies

Google Earth

Safety concerns.....

A thick yellow horizontal bar spans the width of the slide, with a vertical yellow bar extending downwards from its right end.

The preliminary design for the proposed interchange has several safety concerns:

- Wrong-way movements in the ramp could occur as vehicles leave the small road serving the service station.
- The proposed one-direction U-turn on the southern approach to this interchange will be located near an entry ramp where 2 lanes of traffic will be merging just as the U-turn opens; but the U-turn does not have a sheltered turn lane. On the other carriageway, U-turners will enter the road just before an exit ramp

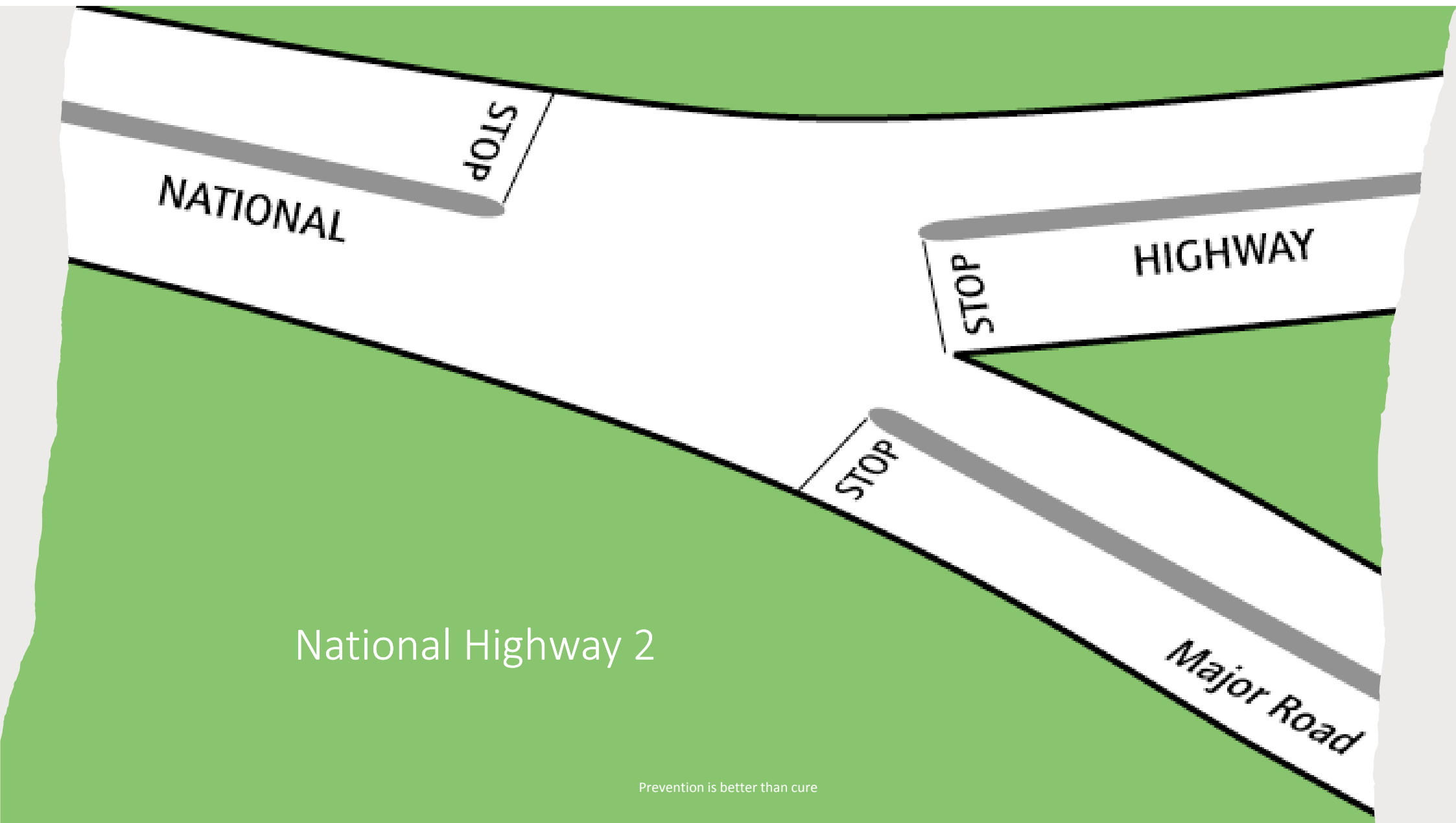
Medium risk

Recommendations.....


- Review the decision to construct this interchange.
- Consider improving and retaining the 2-lane roundabout. (It will not need a U-turn).
- If an interchange is built, consider adopting a conventional closed diamond interchange (serving all approaches – even the approach with low traffic volumes).
- Provide for all approaches to have access to/from the By-pass though the interchange.
- Then, remove the proposed U-turn from the design.

Detailed design
stage audits
consider...

- clear zone issues
- signs/line marking
- crash protection
- traffic control
- geometric design
- lighting.....and more



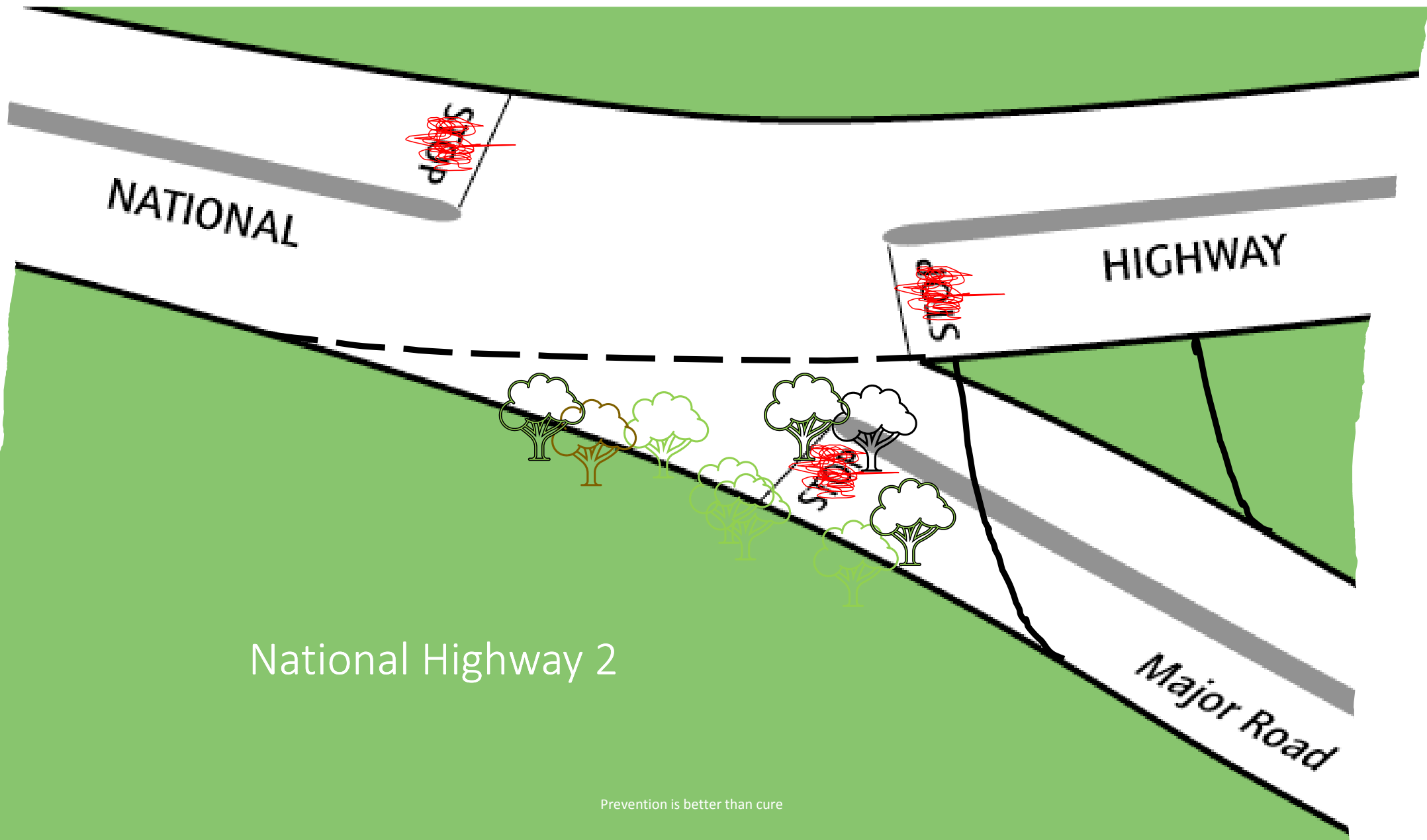
Prevention is better than cure

A photograph of National Highway 2 in India. The road is paved and curves to the left. A person is riding a bicycle on the right side of the road. There are trees and bushes on both sides. Several billboards are visible, including one for Colgate and one for 'विकास चौराहा' (Vikas Chauraha). The sky is blue with some clouds.

National Highway 2

Prevention is better than cure



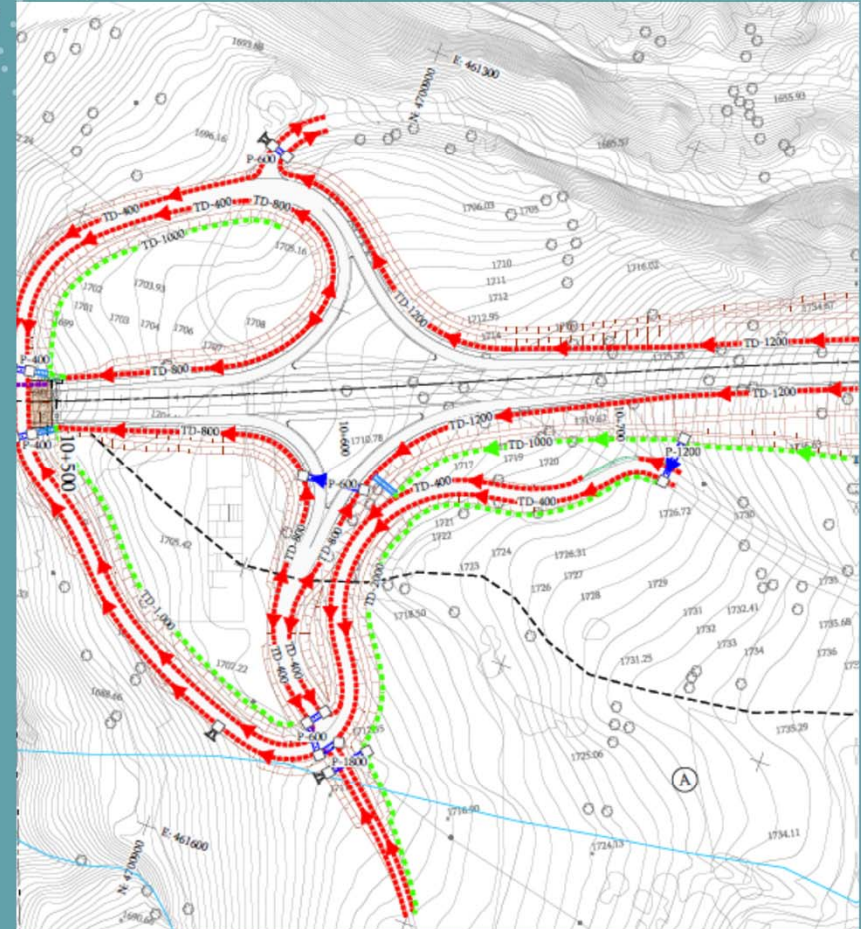


National Highway 2

Prevention is better than cure

DETAILED DESIGN STAGE AUDITS CONSIDER...

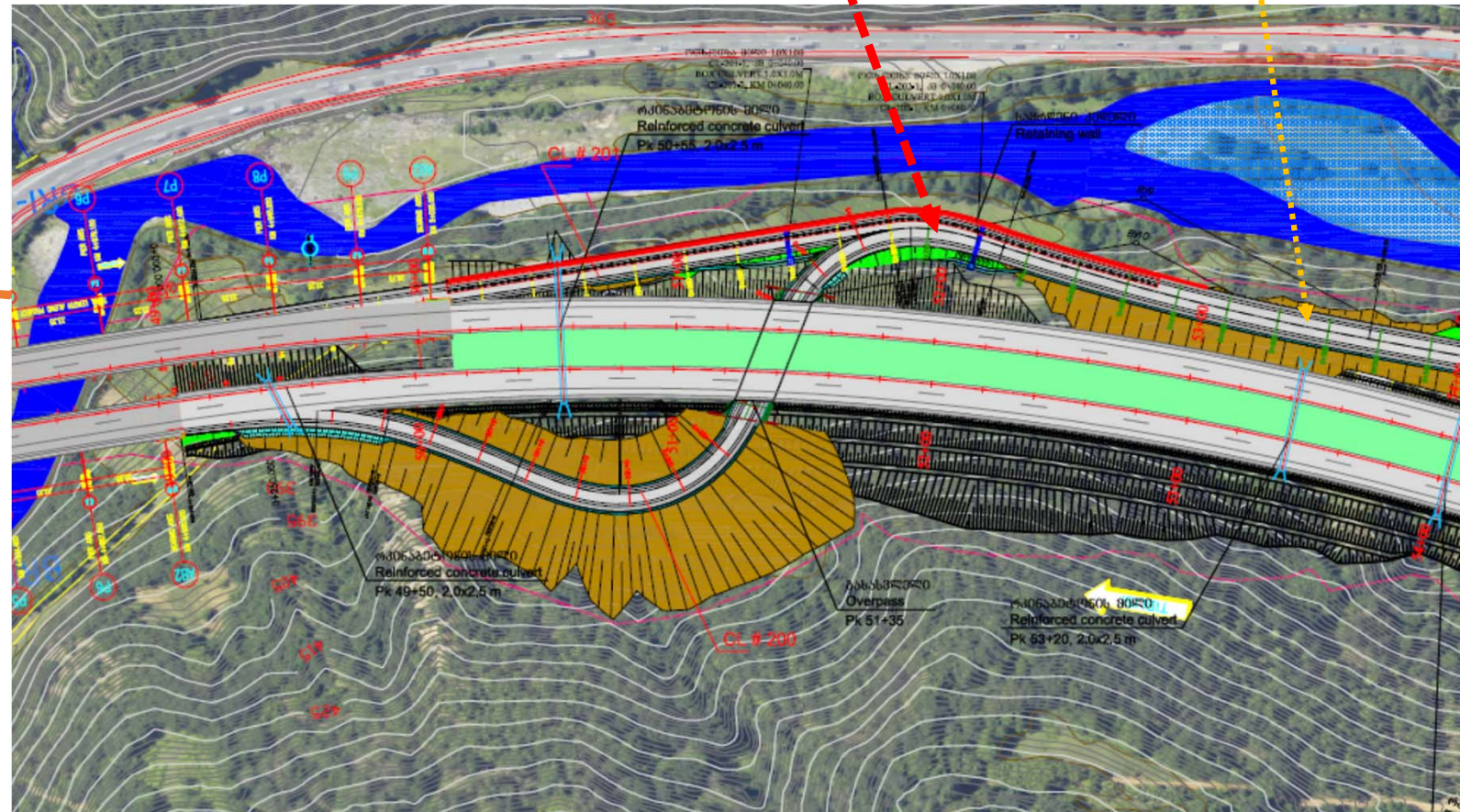
- roadside safety issues
- signs/line marking
- geometric issues
- traffic control
- pedestrian/bicycle issues
- lighting.....and more



A detailed design stage audit in Georgia – a new expressway

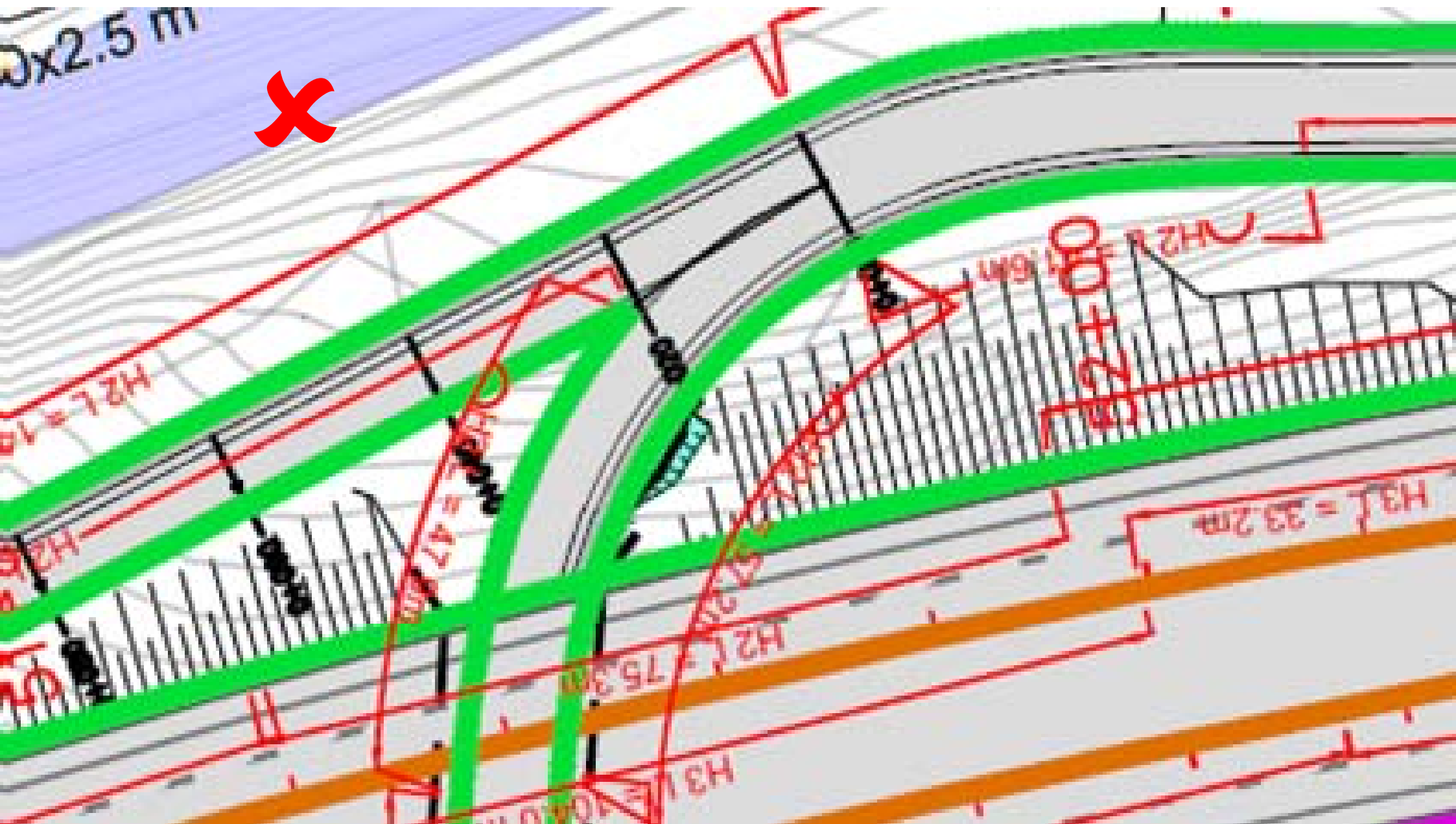


An aerial photograph showing a road intersection. A red dashed line is drawn across the image, indicating a lane change or a specific path. The road is labeled 'PATTON ROAD' and 'BROADWAY'. The surrounding area includes green fields and some buildings.



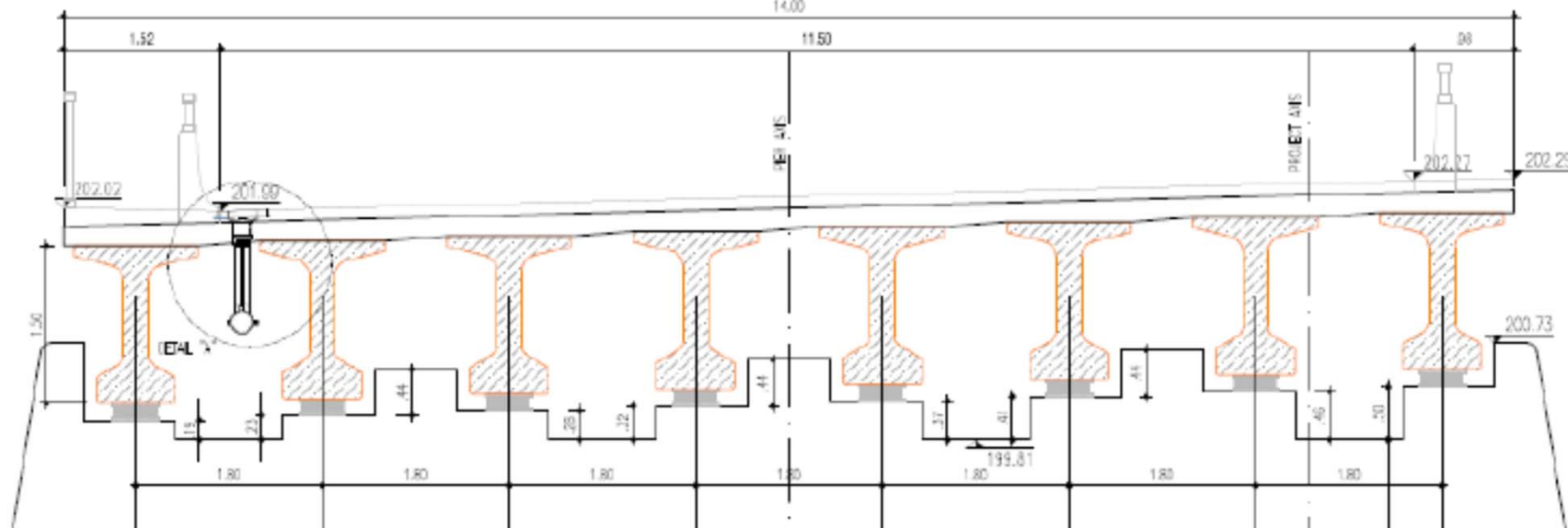
0x2.5 m

x





TRANSVERSAL SECTION PIER 1
Km 9+087.48
(SCALE 1 : 50)



“Standard” but very unsafe



X

"Standard" but very unsafe

Audits of traffic management of road works consider....

Crash protection at the work site

Delineation

Traffic control

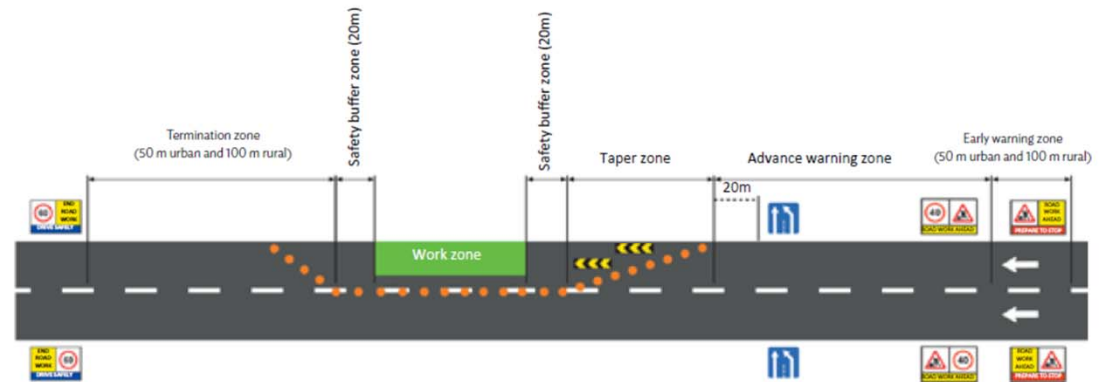
Traffic management

Safety of workers

Signs, lightingand more

Begin by auditing the Traffic Management Plan (TMP)

Figure 17: Closure of the Right-Hand Lane of a Multilane Carriageway



m = meter.

Note: The traffic management plan is for one direction of travel only.

Source: Asian Development Bank.

Not enough
advanced warning!





Think of this work site at night!



Traffic approaches at 130km/h.
Consider trucks at night!



Prevention is better than cure

Pre-opening audits consider...

Previous audit issues – have they been adequately addressed

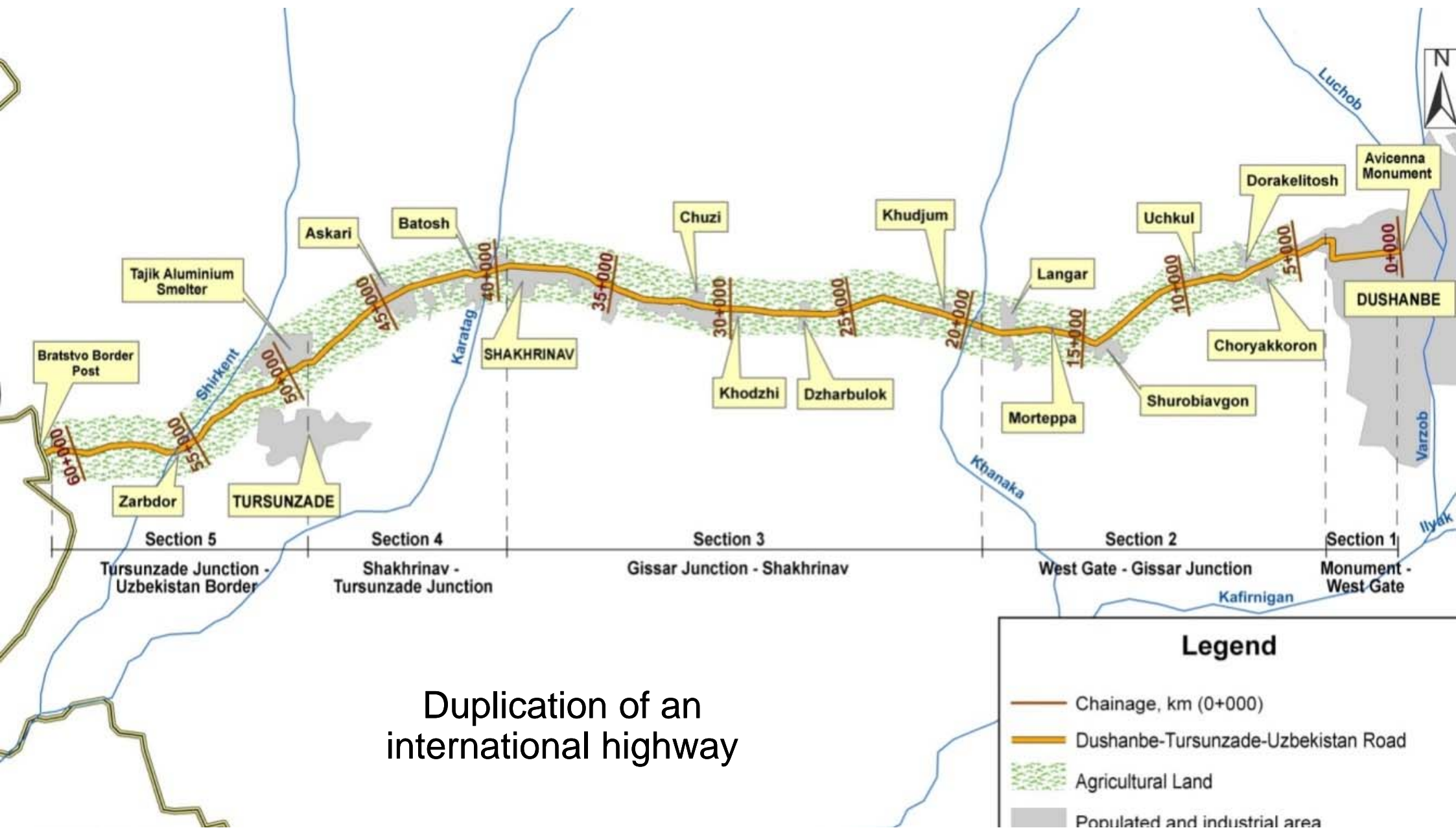
Roadside hazards, including how these have been treated

The correctness of signs and markings

Facilities for pedestrians, bicyclists, and other specific groups

Signal timings, phasing

The road users' viewand more



Duplication of an international highway

Pre/post- opening audit

57 km of newly duplicated highway.
Opened to traffic December 2015.

8 fatalities in first 6 months of 2016.
6 of these were pedestrians!



- High traffic speeds through villages (high risks for pedestrians).
- Geometric and traffic control issues (intersections and U-turns).
- Variations in cross sectional (particularly the width of paved shoulders).
- Roadside hazards (including barriers, concrete barricades, lighting columns, bridges, drains and culverts).

Pre/post-opening stage audit



Pre/post-opening stage audit

???

Google earth

Image © 2016 DigitalGlobe

Pre/post-opening stage audit



Pre/post-opening stage audit





Pre/post-opening stage audit

Pre/post-opening stage audit



Pre/post-opening stage audit





Pre/post-opening stage audit



Audits of existing roads (road safety inspections) consider all issues relevant to the crash potential of the road...







Prevention is better than cure

If an existing road audit identifies a *potential* safety issue, how can the road manager justify spending money to rectify it, while there are “black spots” (with proven crash records) waiting for funds ?



Prevention is better than cure - by Phillip Jordan



But audits of existing roads (road safety inspections) can....

... be useful in countries that do not have complete and accurate crash data

... guide engineers to high-risk locations

But remember, too
many road safety
inspections may...

- lead to unfulfilled expectations
- cause a misunderstanding of the benefits of design stage audits
- cause confusion with crash investigations

Road safety audit -
the earlier, better -
safer, cheaper





Road safety audit...may be the
only time that road safety is
explicitly considered in a project

The costs and the benefits of road safety audit

Road safety audits are a small part of the design cost...

- 1-2% of total design costs
- A fraction of 1% of total project costs (the bigger the project, the lower this percentage)

The costs and the benefits of road safety audit

UK Highways Agency

- TRL examined 22 audited sites on trunk roads
- The costs of implementing the audit recommendations were compared with the costs of rectifying the sites after the project was constructed
- Average saving per site of £11,373

Surrey County Council

- 19 audited sites were compared with 19 non-audited sites
- 2+ years of crash data were compared
- Audited sites had a casualty saving of 1.25 pa
- Non-audited sites had a casualty saving of just 0.25

The costs and
the benefits of
road safety
audit



The costs and the benefits of road safety audit

Jordan

- 9 sites that had been constructed in the past decade (not audited) and had become safety problem sites
- It was assumed that, if the sites had been audited, they would not have required improvements later
- First year rate of return of 120%

The costs and the benefits of road safety audit

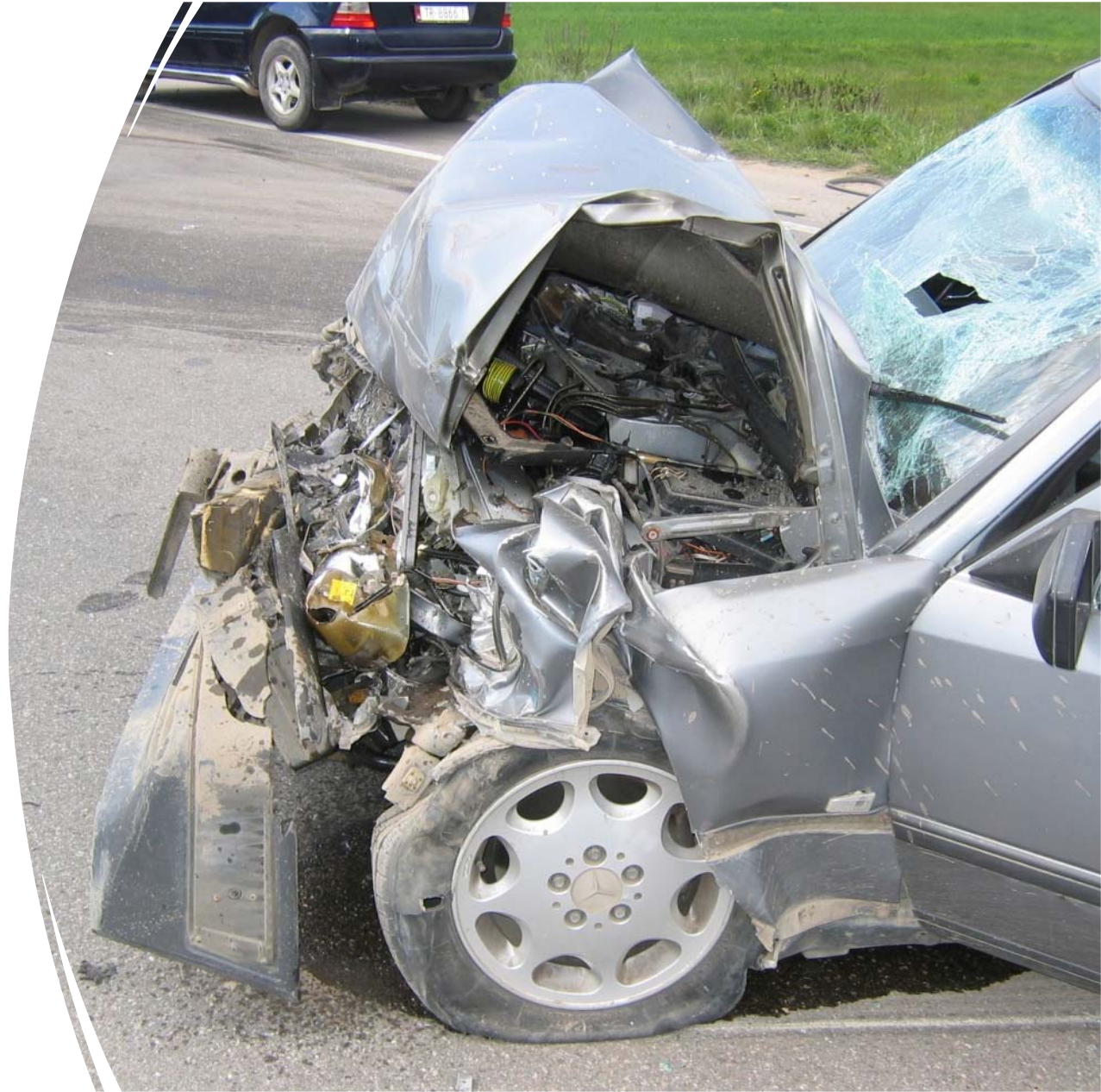
Denmark

- Assessed 13 schemes that had been audited during the design phase
- An evaluation panel conducted cost benefit analyses of these safety audits
- A general crash prediction method was used
- First year rate of return of 146%

The costs and the benefits of road safety audit

- AUSTROADS
 - Design audits had benefit cost ratios ranging from 3:1 to 242:1
 - Existing road audits had benefit cost ratios ranging from 2:1 to 84:1

One road crash
fatality in your
country costs?





The costs and benefits of road safety audit

- ✓ Audits are low cost
- ✓ Audits are high benefits



Road safety audit is a positive
process



CONCLUSION

Road safety will benefit from road safety audit for several reasons.....

experience elsewhere has shown that the optimum road safety outcome is not achieved solely by compliance with standards

road safety audit provides some “protection” against total reliance on standards

road safety audit is a low-cost process, with demonstrated high benefits

CONCLUSION

It is a “transparent” process
– open for all to see and ask
questions about

It demonstrates professional
responsibility in road safety
engineering

It is attractive -
bureaucratically as well as
politically

CONCLUSION

There are growing concerns about road safety now

These will increase & grow

“Get it right the first time”

No one wants to build a blackspot!

What projects are to be audited in your country?

SUGGESTED RSA POLICY

“All road projects will be road safety audited at the following stages according to the class of road, in accordance with the procedures contained in the CAREC Road Safety Audit manual”

What road projects should be audited in your country? (A draft RSA policy!)

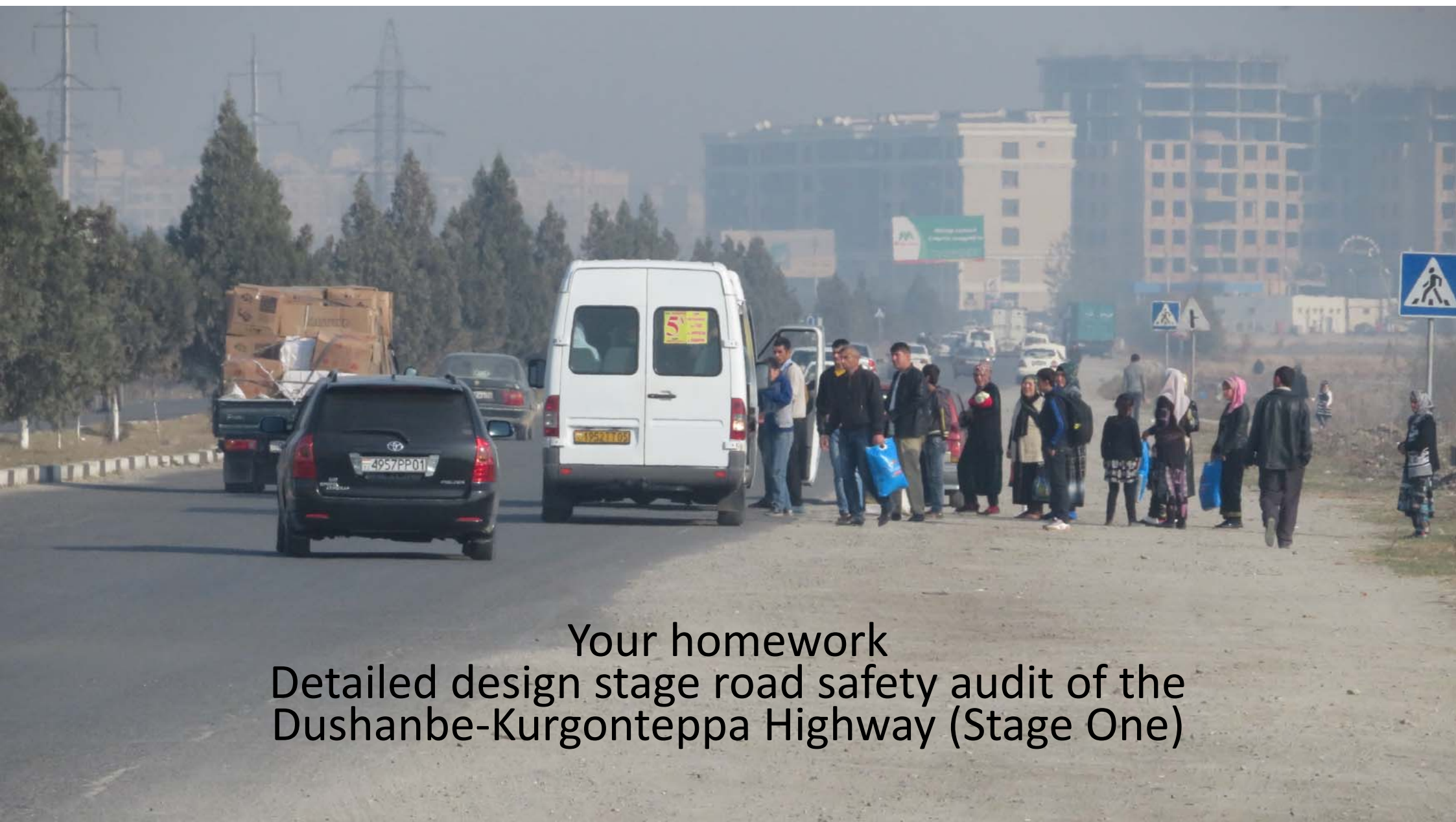
AUDIT	EXPRESSWAYS & INTERNATIONAL HIGHWAYS	NATIONAL HIGHWAYS	MAJOR ROADS (URBAN/RURAL)	LOCAL STREETS & VILLAGE ROADS
FEASIBILITY	√	Optional	Optional	N/A
PRELIMINARY DESIGN	√	Optional	Optional	N/A
DETAILED DESIGN	√	√	√	√
ROAD WORKS	√	Optional	Optional	Optional
PRE-OPENING	√	√	√	√
SAFETY REVIEWS OF EXISTING ROADS				
ACCORDING TO LOCAL POLICY AND RESOURCES				
NO. OF AUDITS	5	Minimum 2	Minimum 2	Minimum 2

Prevention is better than cure

I wish you well for this
important road safety process,
and I look forward to your
questions



Prevention is better than cure



Your homework
Detailed design stage road safety audit of the
Dushanbe-Kurgonteppa Highway (Stage One)



Dushanbe – Kurgonteppa Highway Stage 1



Dushanbe – Kurgonteppa Highway Stage 1



Image © 2021 Maxar Technologies

Dushanbe – Kurgonteppa Highway Stage 1



Image © 2021 Maxar Technologies

A set of drawings for a large road duplication/ rehabilitation project is to be safety audited.

The main reason for doing a “real life” case study audit is for participants to learn more about the audit process.

Some may gain an appreciation of the time an audit takes.

Some may begin to appreciate the skills needed in doing an audit, and some may appreciate the benefits of having an audit team.

Learning about the audit process is the most important reason for doing this homework!

It is a detailed design stage audit. Please remember this.

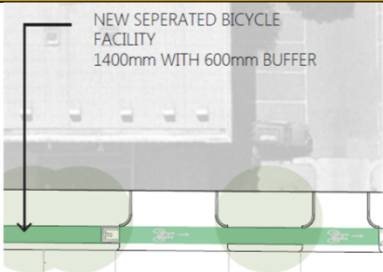


Your Homework 2

- Please **examine the drawings** – or some of them as this is a large project and your time is limited
- Use any **audit checklists** (from your own national RSA manual or another manual) to assist and prompt you.
- Then prepare **an audit report** (with your recommendations).

This should be a clear, accurate 2-page road safety audit report with a clear recommendation(s) for each safety concern you find. (See next slide!)

- All participants are invited to upload their audit report (in English) to the Drive by tomorrow night
- Feedback will be given at the beginning of Module 6 on Thursday

A matrix of audit findings – you may wish to use such a table in your report

SHEET	SAFETY CONCERN	DRAWING/PHOTO	RISK	RECOMMENDATION	CLIENT RESPONSE
SAFETY CONCERNS WITH THE PROPOSED STREETScape IMPROVEMENTS, PAISLEY STREET, FOOTSCRAY, CITY OF MARIBYRNONG					
General	The proposed bicycle lanes are shown in the drawings to be 1.4m wide. This is 400mm less than the AUSTROADS recommended minimum width. While this is likely to be adequate for a single line of cyclists travelling at a similar speed, it is likely to be too narrow to safely support passing manoeuvres (e.g, a faster rider overtaking a slower rider). This could lead to some “side swipe incidents”		MED	<ul style="list-style-type: none"> - As per Austroads Guide to Road Design Part 3, the minimum width for protected bicycle lanes is 1.8 m. Wider lanes of 2.0 m or greater will enable cyclists to pass one another. Physical separation from motor traffic should be provided by a raised traffic island or a safety strip that is desirably 1.0 m or greater wide (0.6 m minimum). - Consider providing a wider protected lane. 	
General	The proposed 600mm buffer shown in the drawings is the minimum acceptable buffer width stated in VicRoads guidelines, but most car doors exceed this dimension. Passengers exiting a vehicle may open their door into the path of an approaching rider. Dooring is a serious bicyclist issue and providing a wider buffer is very desirable.		MED	<ul style="list-style-type: none"> - Increase the buffer (separator) to 1000mm wide. - If this is not possible, try to achieve a minimum 800mm width. 	
General	During the evening site inspection, it was evident that several street lights were not working. This created some dark spots and has a direct impact on personal safety and could also increase the likelihood of tripping hazards. Although a lighting plan was not provided to the auditors (this is a Concept Stage audit and lighting plans would not be expected until a later stage) it is desirable to consider lighting and maintenance of lighting as early as possible.		LOW	<ul style="list-style-type: none"> - Ensure that a lighting review/upgrade is included as part of the project. - Ask Councils maintenance group to inspect and repair any street lights that are not working. 	



Your Homework 2

- These photographs are a substitute for your site inspection. They show the topography and development along the route, and the type of road users.
- Please DO NOT make comments about the safety issues you will see in these photographs. Why – because we are auditing the drawings for the new road project.
- The road will be very different when the work is completed.
- Your job is to undertake a detailed design stage audit of the detailed design stage drawings - ONLY.
- Please examine the drawings and audit them – or at least a few of them. Your time is limited.

HERE IS YOUR SITE VISIT!

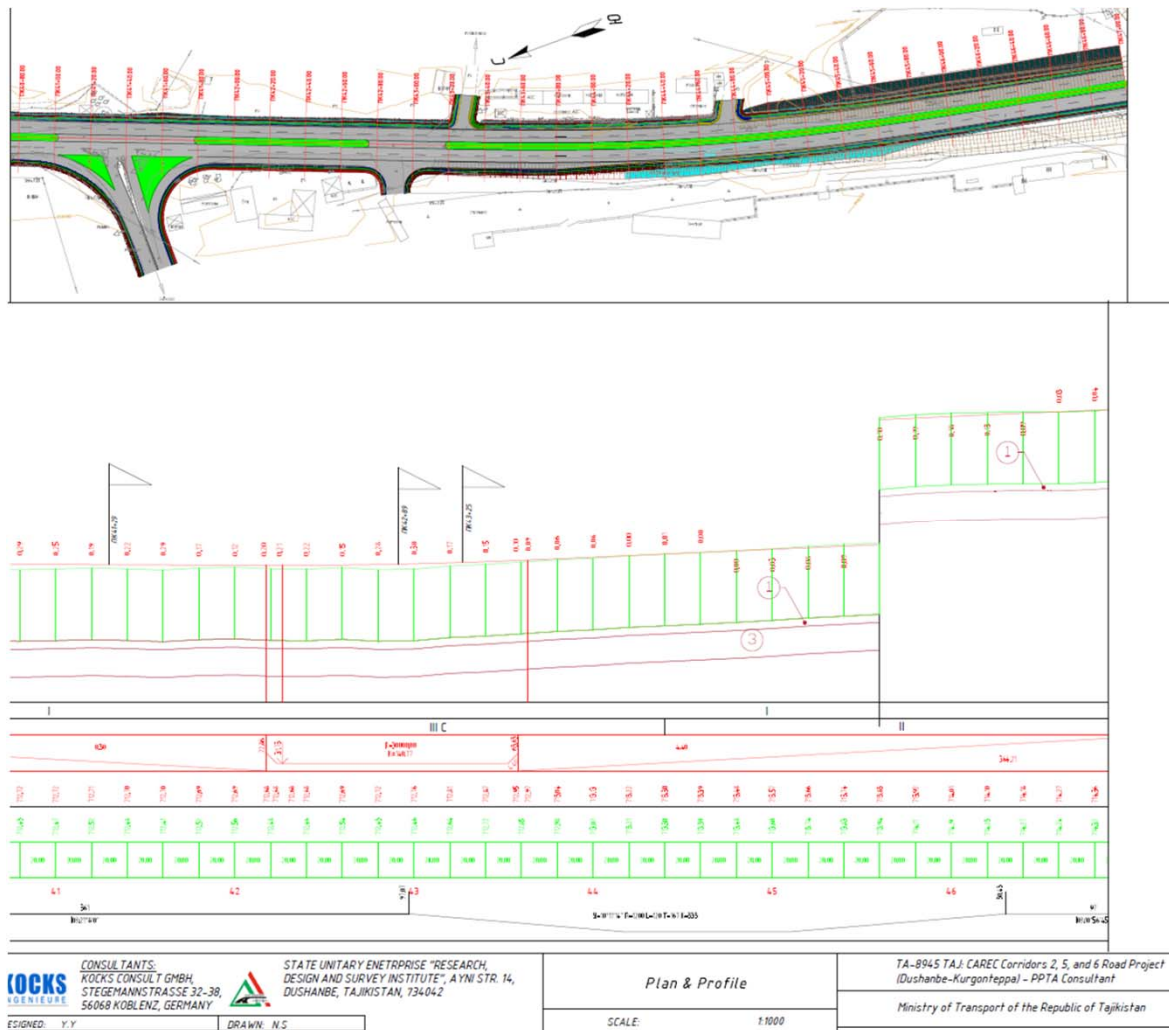
Your audit homework 2 – a learning experience

- ADB-funded project. Approval has been given to use it as a learning experience.
- This “real life” case study audit is for you to learn more about the audit process.
- Download the 2 sets of drawings for a major CAREC highway duplication project from the link.
- Audits take time. Audits require skills and judgement.
- Audits should be done by audit teams.
- Learning about the audit process is the reason for doing this homework.

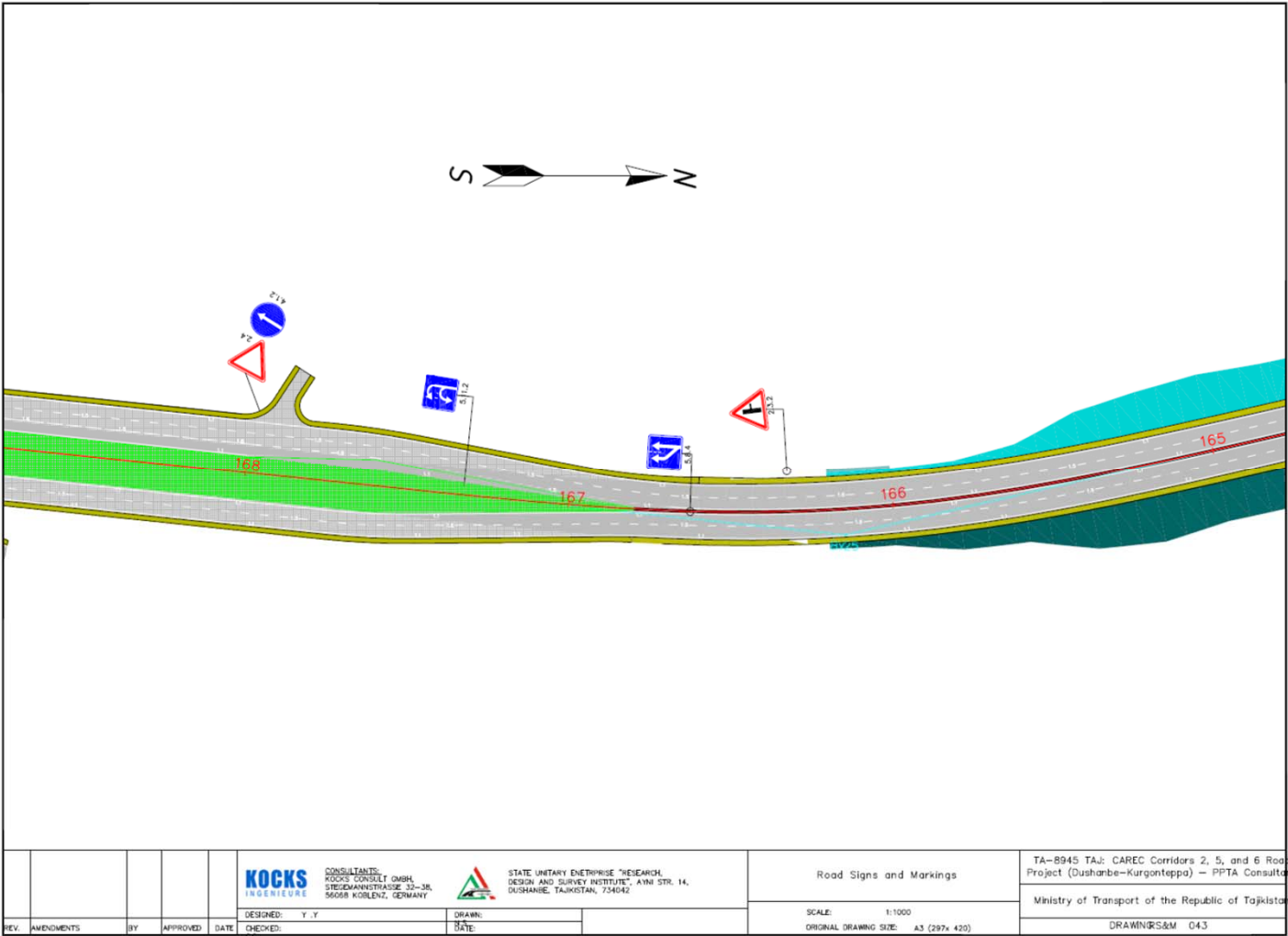
Your Homework 2

- Please **examine the set of drawings** – or a few of each (this is a large project, and your time is limited)
- Use the **audit checklists** (from the CAREC RSA manual, or another manual) to assist and prompt you.
- Then prepare an **audit report** (with your recommendations) and upload it by tomorrow night! Maybe 1-2 pages.
- Quality, not quantity!
- Feedback will be given at the beginning of Module 6 on Thursday

Типовой план и
чертеж профиля.
Для вашего аудита



Типовой план и
чертеж профиля.
Для вашего аудита



Your Homework 2

- We cannot do a site inspection!
- The following photographs are your “substitute” site inspection.
- Please **DO NOT** make comments about the safety issues in the existing highway (*you will see many in these photographs*). The photos show the road users, the topography and why the highway is soon to be duplicated.
- This is a detailed design stage audit. The highway is going to change greatly.
- Your job is to audit the detailed design stage drawings - ONLY.
- Your time is limited.

HERE IS YOUR SITE VISIT!



This is the existing road. Do NOT comment on these photos – audit only the drawings

Generally moving along the chainage from near 0+00 towards 33+00

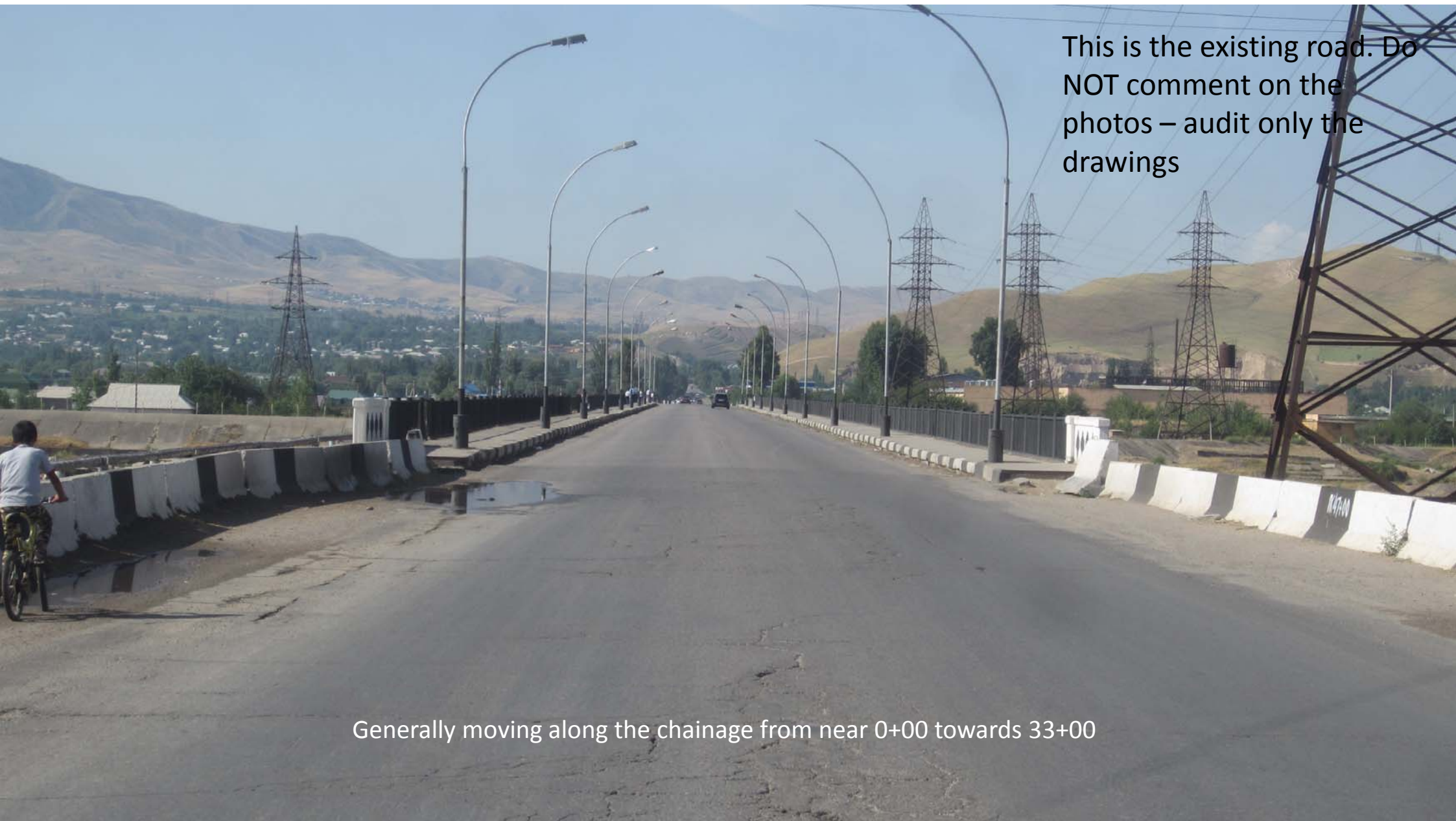
This is the existing road. Do NOT comment on these photos – audit only the drawings

Generally moving along the chainage from near 0+00 towards 33+00

This is the existing road. Do NOT comment on the photos – audit only the drawings



Generally moving along the chainage from near 0+00 towards 33+00



This is the existing road. Do NOT comment on the photos – audit only the drawings


Generally moving along the chainage from near 0+00 towards 33+00

This is the existing road. Do NOT comment on the photos – audit only the drawings



Village of Ovi Shivu

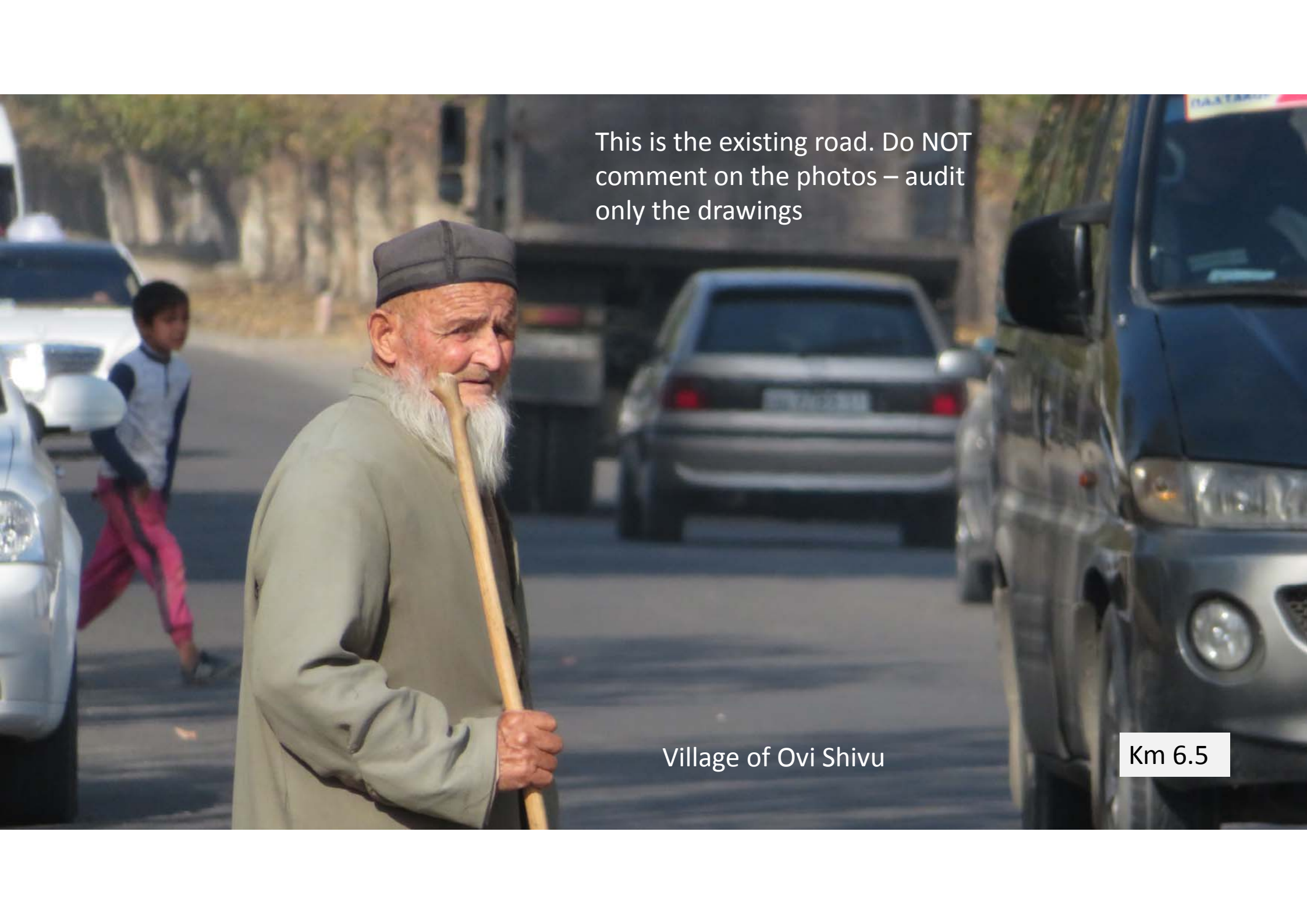
Km 6.5



This is the existing road. Do
NOT comment on the
photos – audit only the
drawings

Village of Ovi Shivu

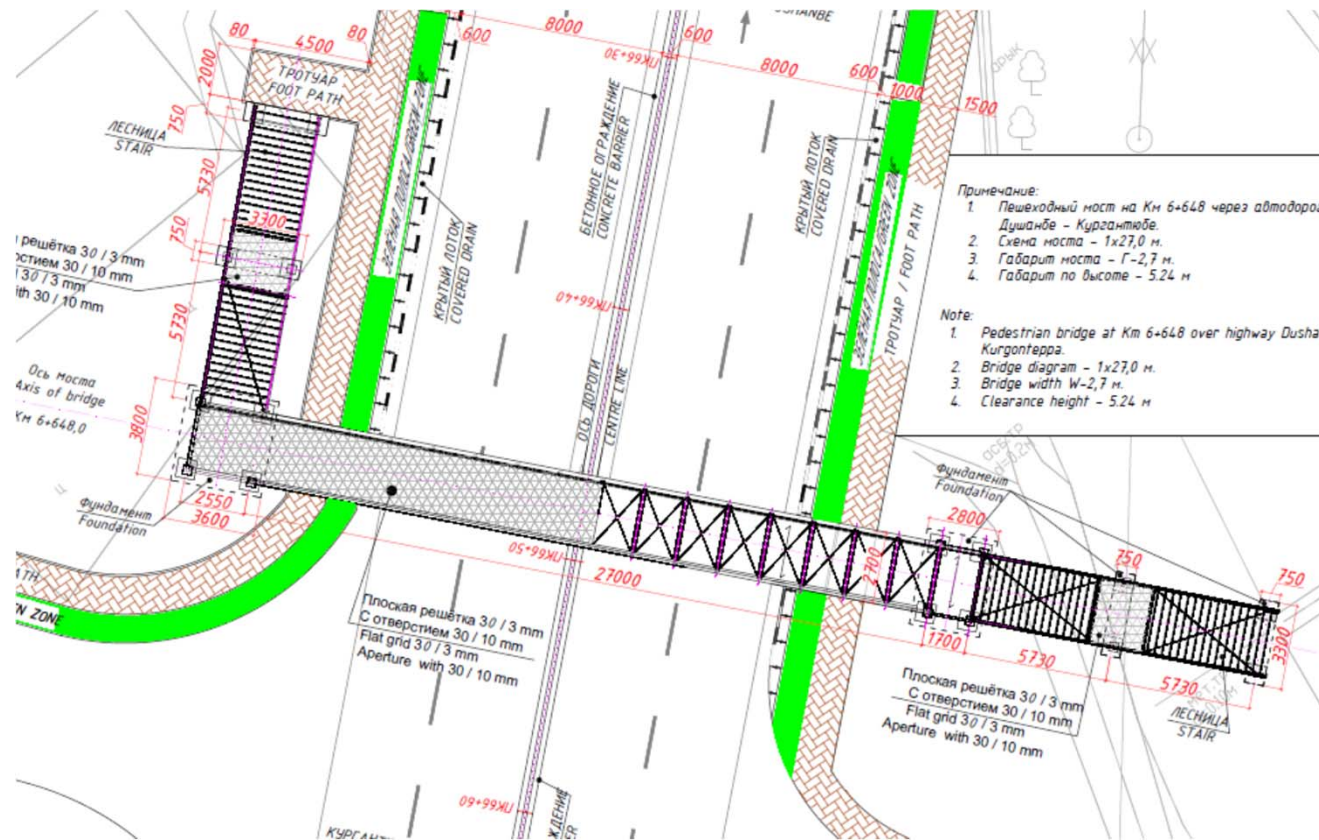
Km 6.5



This is the existing road. Do NOT
comment on the photos – audit
only the drawings

Village of Ovi Shivu

Km 6.5



There is a proposed pedestrian overpass in Ovi Shivu. Auditors need to ask if will it offer service to the pedestrians of the village.
It is located to serve school children. It will have 32 steps up and 32 steps down.
Think of the disabled, or those pedestrians with loads!

Km 6.5

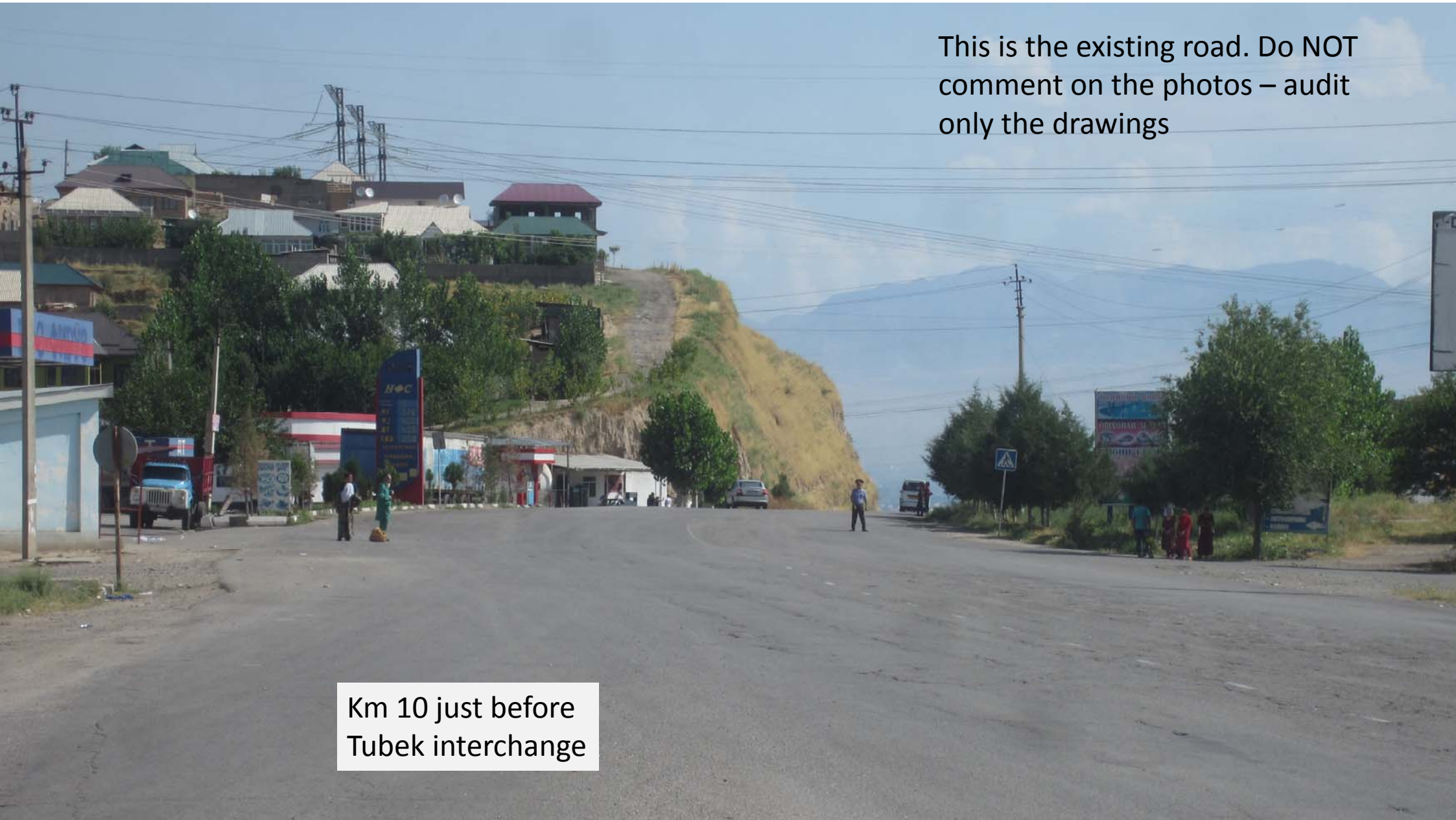
This is the existing road. Do NOT
comment on the photos – audit
only the drawings



Km 9 – 1500m before
Tubek interchange

This is the existing road. Do NOT
comment on the photos – audit
only the drawings


Km 10 just before
Tubek interchange





This is the existing road. Do NOT comment on the photos – audit only the drawings

Tubek interchange



This is the existing road. Do
NOT comment on the photos –
audit only the drawings

Tubek interchange

This is the existing road. Do NOT comment on the photos – audit only the drawings




Tubek interchange

This is the existing road. Do
NOT comment on the photos
– audit only the drawings

Near Km 18-19






This is the existing road. Do
NOT comment on the photos
– audit only the drawings

Near Km 23

This is the existing road. Do NOT comment on the photos – audit only the drawings

Bridge at southern end of Stage 1 (Km 33+475)

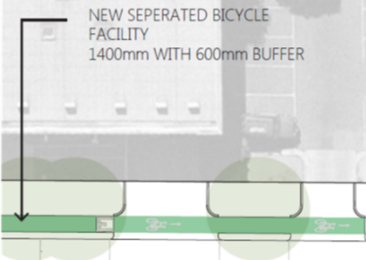




A photograph of a man standing on a paved road in a mountainous area. The man is wearing a brown jacket and dark pants. The road is paved and has white dashed lines. To the right of the road is a white and black striped guardrail. The background shows steep, rocky mountains under a hazy sky. The lighting suggests it might be late afternoon or early morning.

This is the existing road. Do
NOT comment on the photos
– audit only the drawings

Beyond Stage 1 – outside the
scheme near Km 36

Your Homework 2 – a possible template

SHEET	SAFETY CONCERN	DRAWING/PHOTO	RISK	RECOMMENDATION	CLIENT RESPONSE
SAFETY CONCERNS WITH THE PROPOSED STREETScape IMPROVEMENTS, PAISLEY STREET, FOOTSCRAY, CITY OF MARIBYRNONG					
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General	The proposed 600mm buffer shown in the drawings is the minimum acceptable buffer width stated in VicRoads guidelines, but most car doors exceed this dimension. Passengers exiting a vehicle may open their door into the path of an approaching rider. Doorings is a serious bicyclist issue and providing a wider buffer is very desirable.		MED	<ul style="list-style-type: none"> - Increase the buffer (separator) to 1000mm wide. - If this is not possible, try to achieve a minimum 800mm width. 	
General	During the evening site inspection, it was evident that several street lights were not working. This created some dark spots and has a direct impact on personal safety and could also increase the likelihood of tripping hazards. Although a lighting plan was not provided to the auditors (this is a Concept Stage audit and lighting plans would not be expected until a later stage) it is desirable to consider lighting and maintenance of lighting as early as possible.		LOW	<ul style="list-style-type: none"> - Ensure that a lighting review/upgrade is included as part of the project. - Ask Councils maintenance group to inspect and repair any street lights that are not working. 	

Your Homework 2 - RSA

- **DO NOT** comment about the safety issues you see in the photographs. That is the existing highway. Only look at the topography, and the types of road users. Its your site inspection.
- Your job is to audit the detailed design stage drawings for the proposed highway duplication - **ONLY**.



Hi - how many signs
today?





YOUR ROAD SAFETY AUDIT HOMEWORK

- Examine a few drawings (time is short).
- Look for safety concerns in them.
- Prepare a one/two-page RSA report.
- Write the safety concerns clearly and accurately.
- Give a risk for each.
- Give a recommendation for each.
- Upload your report (in English) by tomorrow night.
- Feedback at the start of Module 6 on Thursday.
- Questions?
- Good luck!