Advanced Planning and Design for Cycling

Module 4 Intersections

Section 1
Introduction

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VIASTRADA

Housekeeping

- Cell phones off, please!
- Toilets
- Evacuation procedure
- 8:45 am start
  - Morning tea 10:30 am
  - Lunch time 12:30 pm
  - Site visit 1:30 pm
  - Afternoon tea 3:30 pm
- Aim for 4:45 pm finish

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2

About the presenters…
Axel Wilke

- ME (Civil)
  - Master of Engineering
- ViaStrada (Director)
- 15 years traffic/transportation experience
- Cycling-related projects/publications
  - Design/audit many cycle facilities
  - Develop Cycling Strategies around NZ
  - Peer reviewer to NZ Supplement
  - Technical advice/articles for CAN
  - Cycling papers at numerous conferences/workshops

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4

About the presenters…
Megan Fowler

- MET
  - Research project in road safety field
- 4 years at ViaStrada
  - Cycle facility design and safety auditing
  - Signal design, intersection modelling
  - Legal implications of SBFs
  - Various research projects and conference presentations
- Enjoys cycling
  - 15 km daily cycle commute
  - A bit of recreational cycling as well

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Attendees – who are you?

- Quick round of introductions
  - Name
  - Organisation
  - Work role
  - *Do you cycle regularly/occasionally?*
  - *Have you attended the Fundamentals course (now "Module 1") or Modules 2/3? If so, when?*

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Course Development

- Course material prepared by ViaStrada & NZTA
- Developed on behalf of NZTA
  - Constantly updated so that it stays current
- If you did the Fundamentals course (Module 1):
  - some material will look familiar
  - is worthy of repetition

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Course prerequisites

- Traffic engineering experience helpful
  - Need further study & practical experience
  - Don't rely only on advice from this course
  - Use sound engineering judgement and seek expert advice as needed
  - Get on your bike too!
- The Advanced Course follows on from Fundamentals of Planning and Design for Cycling (Module 1)

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Overall Course Structure

Module	Level	Duration	Topic
1	Fundamentals	1 day	Planning & Design for Cycling
2	Advanced	½ day	Planning and Funding • Policy and Legislation • Data Collection and Analysis • Evaluation and Funding • Auditing
3		½ day	Mid-block and Path Design • General midblock issues • Protected cycleways • Cycle Lanes and Parking • Cycle Paths and Shared Paths • Neighbourhood greenways & Traffic Mgmt
4		1 day	Intersection Design • Signals • Roundabouts • Priority and grade separated junctions

Course structure

- Course book
  - Handouts of slides for note taking
  - Course handbook with references
    - Austroads Guides – cycling synopsis
- Questions
  - Any time (but may be addressed later)

References are shown like this on slides

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Module 4 outline

Section	Topic
1	Introduction to Module 4
2	Signalised Intersection Layout Exercise 1: ASB placement
3	Traffic Signal Infrastructure and Phasing Exercise 2: Phasing
4	Roundabouts
Lunch	
	Site Visit Exercise 3: Intersection Design
5	Priority and Grade Separated Junctions
6	Summary and Course Evaluation

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14

Advanced Planning and Design for Cycling

Module 4 Intersections

Section 2
Signalised intersection layout

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Section 2 Outline
Signalised Intersection Layout

- Refresher: 6 elements of intersection design
- Providing cycle lanes
- Advanced stop boxes and advanced stop lines
- Hook turns
- Cycle slip lanes
- *Interested but Concerned* cyclists at signalised intersections
  - Dutch intersection design principles

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2

Why still mix cyclists with motor traffic?

- The latest design approach seems to be focused on physical separation
- But designing for the *Interested but Concerned* doesn't mean we should neglect the *Enthused & Confident* altogether!
  - Need a holistic approach in network planning
  - Ensure that directness is provided for strategic routes
- Target Audience concept is a spectrum
  - Some on-road facilities may be suitable for a certain percentage of *Interested but Concerned*
- On-road provision is more than just cycle lanes
  - Intersection treatments are key for all users.

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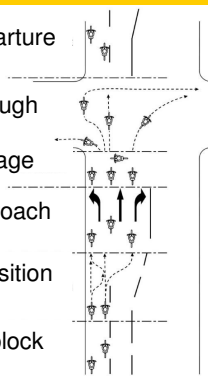
Six Elements of Continuity

6. Departure
5. Through
4. Storage
3. Approach
2. Transition
1. Midblock



Through element not as critical in NZ context as for AUS, where continuity markings are common

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Module 4, Section 2

Cumming *et al. 2000*

4

Usefulness of Six Elements

- Structured approach to intersection design
  - *Can a cyclist get from each leg to every other leg?*
- Enables well-ordered audit of existing intersections
  - Designed for signalised intersections but can also be useful for auditing for other user types

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Cycle Facilities at Intersections

- Reasons for provision:
  - Increase cyclist-motorist intervisibility (safety)
  - Make cyclist behaviour more predictable
  - Enable cyclists to travel in their desired direction

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Cycle Lane Provision Priority

- In Europe, kerbside facilities are most common, even with exclusive motorised vehicle turn lanes
- Different approach in New Zealand

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Module 4, Section 2

7

Cycle Lane Provision Priority

- In NZ, we base provision on movements
- We generally prioritise cycle lanes for through cyclists over those for turning cyclists
  - Based on speed differential between cyclists and motor vehicles – highest differential in through lanes
  - CROW recommends max differential of 10km/h for weaving traffic
  - Safer for cyclists approaching limit line during green phase

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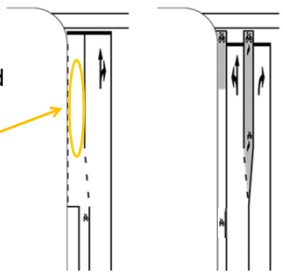
Signalised Intersection Transitions

- Well designed transitions are important for cycle provision at signalised intersections
- Note unmarked LT lanes – discussed later on



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Signalised Intersection Transitions

- Kerbside protected cycleway at intersection

Right turning cyclists often difficult to accommodate

- Hook turn (exposed position / consider target audience)
- Dedicated cycle RT phase vs intersection efficiency

10

Signalised Intersection Transitions

- Kerbside cycle lane transitioning at intersection
  - Could the same principle be applied for a protected cycleway?

11

Signalised Intersection Transitions

12

Signalised Intersection Transitions

- Transition and storage locations depend on placement of departure provision
- Make transitions as cycle friendly as possible:
  - Control vehicle speeds
  - Short transition lengths


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Signalised Intersection Transitions

- Specific provision not always needed if:
  - Providing for *enthused & confident* cyclists
  - Low-speed environment
- Subtle changes can make a big difference

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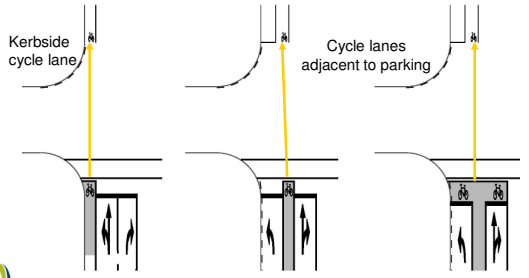
Signalised Intersection Transitions

- Storage location should ideally line up with departure provision



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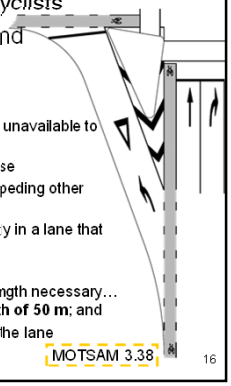
Markings Crossing Traffic Lanes

- Left turners must give way to cyclists
- Enhanced by continuity lines and coloured surfacing
- Road User Rule:
  - 2.3 (3): A driver may drive… in a lane that is unavailable to the driver… if:
    - (a) it is impracticable to proceed otherwise
    - (b) …can be done safely and without impeding other traffic
  - 2.3 (4) A driver may also drive wholly or partly in a lane that is unavailable to the driver… if the driver:
    - (a) drives in the lane to cross it…
    - (b) drives in the lane for the minimum length necessary… and for no more than a **maximum length of 50 m**; and
    - (c) gives way to vehicles entitled to use the lane



MOTSAM 3.38

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Finding Space

- Constraints:
  - Adjacent land uses
  - On street parking in the midblock
  - Providing for all movements at intersections
- Conflicting objectives
  - E.g. increasing road capacity for motor vehicles vs. accommodating cyclists
- *We'll be talking about finding space throughout the day*

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Cyclists Breaking Intersection Rules

- Cyclists may break traffic rules
  - for their own safety
  - out of impatience
- Most illegal behaviours may reduce the risk of common cycling crash types
  - There are reasonable ways of avoiding real risks, but may increase other real risks
- Risks can be controlled by
  - Engineering measures
  - OR by legalising the behaviour

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Rule Broken – Why?

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Advanced Stop Boxes and Stop Lines

- Advanced Stop Box (ASB):
  - Aka "head start storage area" (Austroads)
  - Allow cyclists to queue at intersections
  - Do not require presence of approach or departure cycle lanes (but very desirable!)
- Advanced Stop Line (ASL):
  - Continue a cycle lane further than adjacent traffic lane(s)
  - Should always be provided where ASBs are not feasible or desirable

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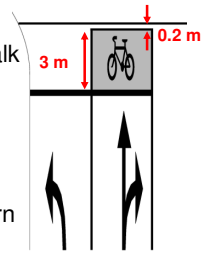
ASB Useful with Mixed-Turn Lanes

ASB Design

- 3 m deep
- As wide as the traffic lane
- 0.2 m from pedestrian crosswalk line
- Cycle symbol
- Coloured surfacing
- Should not have to cross more than one lane to get to right turn ASB
- Provision must be consistent with signal phasing operation

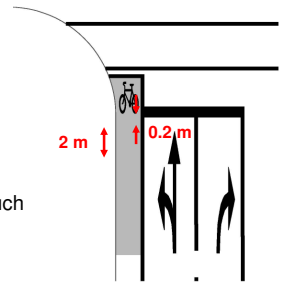


MOTSAM 3.34 (1)

Advanced Stop Line

ASL Design

- 2 m deep
- As wide as the cycle lane
- 0.2 m from pedestrian crosswalk line
- Cycle symbol
- Coloured surfacing
  - Motor vehicle intrusion much less likely with colour



MOTSAM 3.34 (2)

ASB / ASL Pros and Cons

- ASBs do not *require* cycle lanes to be present in the intersection approach and transition
  - But much easier to access with approach cycle lane
- ASLs have fewer 'problems'
  - ASBs difficult if cyclists arrive during green
- Both provide greater profile to queued cyclists
- Both require motorists to be set back further from intersection
  - Increased travel time through intersection
  - Decreased visibility around corners
  - Setback may already be required to accommodate swept paths

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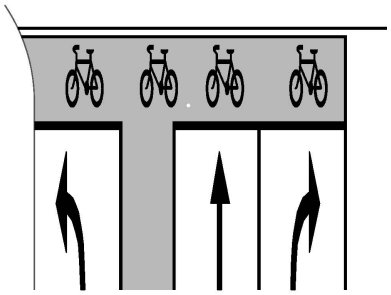
ASB with Approach Cycle Lane



MOTSAM 3.34 (3)

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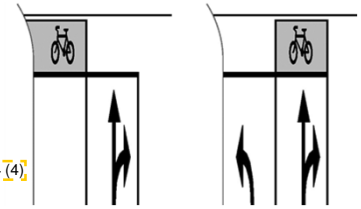
ASB without Approach Cycle Lane

- Road User Rule:
  - 3.2 (5a) While a steady red signal … is displayed…a driver of a vehicle facing the signal or signals must not enter the controlled area, but **a cyclist may enter ahead of a marked vehicle limit line and stop behind a marked cycle limit line**.



MOTSAM 3.34 (4)

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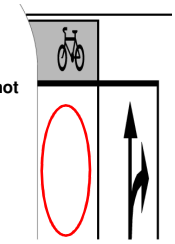
ASB without Approach Cycle Lane

- Road User Rule:
  - 2.4: If road markings or traffic signs designate specific lanes for specific manoeuvres at the approaches to an intersection, **a driver must not use any lane except for the manoeuvre appropriate to its marking or signage**.
- Therefore, existing left turn arrow removed to allow cyclists to legally travel straight from ASB



MOTSAM 3.34 (5)

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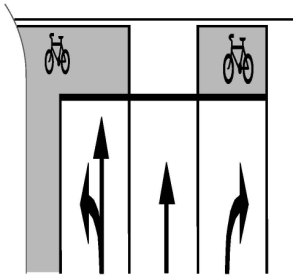
ASB separate from Cycle Lane

- Limit lines in straight line regardless of whether a lane has an ASB in front
- Should not have to cross more than one lane to get to right turn ASB
- ASBs should not extend across more than two adjacent lanes if no approach cycle lane is provided.



MOTSAM 3.34 (6)

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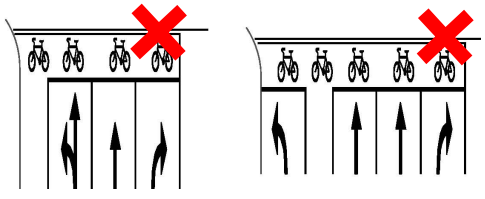
Inappropriate use of ASBs

Error: stop boxes extend across three lanes



MOTSAM 3.34 (7)

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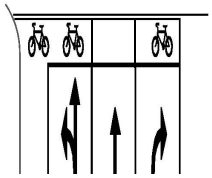
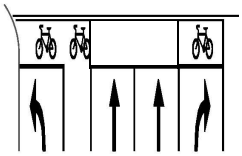
Appropriate use of ASBs



Remedy: use an ASL or ASB kerbside and in front of RT lane



Remedy: use an ASL and / or ASBs in front of turning lanes only

MOTSAM 3.34 (8)

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Non-Signalised Intersections

- Generally ASBs should only be used at signalised intersections
  - At priority controls, traffic waits at limit line for a gap, not a green light
- ASLs can be used at non-signalised intersections
  - Still need to consider compatibility with traffic lanes (lane designations, setback)

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Exercise 1: ASB placement

- Design ASBs for the five scenarios
  - sheet in course book at end of Module 4 Section 2
- Assume no lead left turn phases
- Answers will be given on separate handout

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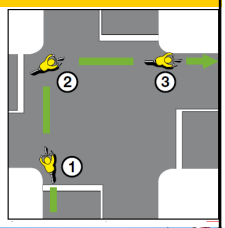
Hook Turns

- Preferred option at multi-lane signals
  - Also mixed through-right lanes
- Cyclists complete a right turn in two stages
- Commonly provided farside / departure (shown)
  - Nearside / approach example shown later



MOTSAM 3.35 (1)

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Hook Turns – Legalities

- Road User Rule amendment (2009):
  - 2.5A (1) A cyclist may enter an intersection by making:
    - (a) A right turn
    - (b) A hook turn in accordance with subclause (2)
  - Subclause 2.5A (2) explains the hook turn manoeuvre
    - Does not require a marked hook turn box
    - Can be performed at unsignalised intersections also
- Endorsed by NZTA
  - Included in MOTSAM
- Manoeuvre taught in schools

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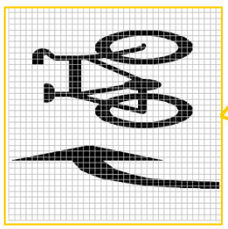
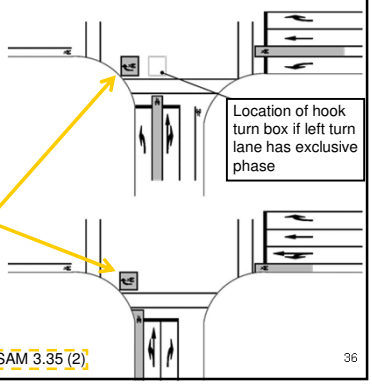
Module 4, Section 2

Hook Turn Design

- Placement depends on lane configuration and signal phasing





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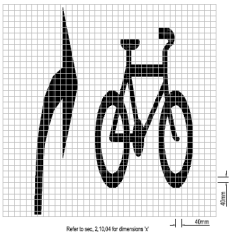
MOTSAM 3.35 (2)

36

Hook Turn Design

- Size depends on number of cyclists to be accommodated
  - Minimum depth of 1.5 m
  - Minimum area of 3 m^2
- Arrow is integral part of marking
- Cycle symbol orientation
- Should be automatic design solution where there are 2 through lanes



Departure

Approach

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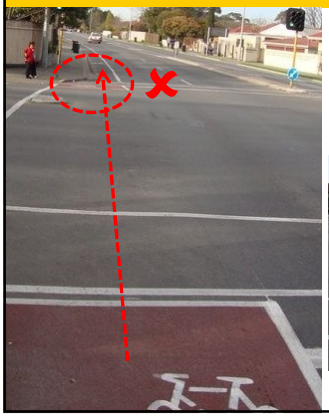
MOTSAM 3.35

37

Hook Turn Box Alignment



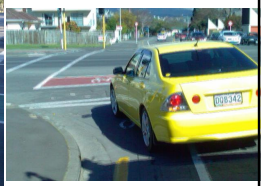
- Should not impede through cyclists!

38

Hook Turns – make use clear

- Approach cycle lane in photo below should be coloured too

- Otherwise, cyclists may be encouraged to proceed to hook turn box
- Also may reduce encroachment



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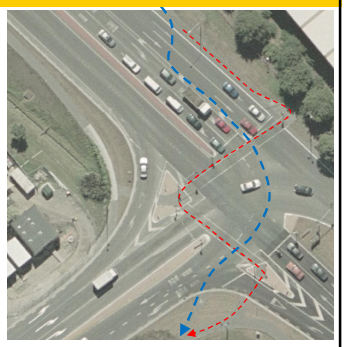
39

Approach Hook Turn

- Off peak or experienced cyclists use blue route
- Novice or peak period cyclists use red route
  - Dedicated cycle facility (no peds)



Wilke, 2007

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40

Hook Turn Pros and Cons

Pros:

- Aids cyclists in turning right without:
  - Negotiating traffic to get into right turn approach lane
  - Negotiating opposing traffic to perform filter turn
- Much more appropriate than ASB in front of right turn lane for *interested but concerned* users
- Can also useful for confident cyclists during peak traffic

Cons:

- Users may feel vulnerable waiting for start of next phase
  - *Interested but concerned* cyclists may still not want to use it
- Increased delay for experienced users (if they are not provided with alternative ASB option)
- Relatively new facility in NZ – may confuse road users

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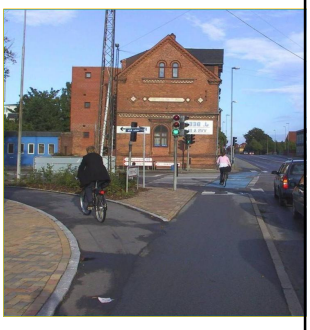
41

Cycle Slip Lanes

- Reduces delay
  - Don't always have to require cyclists to stop at signalised intersections
- Suitable for *Interested but Concerned* cyclists
- Use for left turns or the head of a T intersection
- Must consider potential conflict with pedestrians



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43

Cycle Slip Lanes

- Would be ideal at this location

St Asaph St / Hagley Ave, Christchurch

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44

Cycle Slip Lanes

- Some cyclists will illegally turn left on red after filtering through pedestrians
- Avoids getting pinched
- Good reason to have a slip lane

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45

Cycle Slip Lanes

- Here is an example of how to do it

Moorhouse / Waltham intersection, Christchurch

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Cycle Slip Lanes

- Ensure crossfall enables rain to carry debris off slip lane – monitor maintenance regime
- Squared slip lane for left turning motor traffic
  - slows merge speeds and protects through cyclists on main road

Double slip lanes at Te Awe Awe / Fitzherbert signals
Photo: Glenn Connelly, PNCC

47

Cycle bypass False one-way street

Perth

Module 4, Section 2 48

48

Cycle bypass Restricted access street

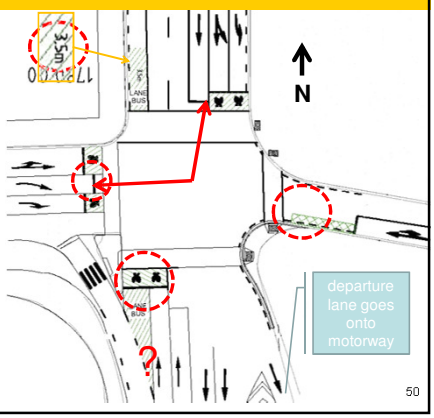
Wellesley St, Auckland

Module 4, Section 2 49

49

Every intersection is different...

- What is wrong with this scheme?
- 2 min to come up with problems



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50

Intersections for *Interested but Concerned*

- *Interested but Concerned* cyclists need to cross intersections too.
- Will they feel comfortable using
  - ASLs?
    - Only if they're physically protected as well.
  - ASBs
    - Probably not – feel vulnerable of wait in front of motor vehicles
  - Hook Turns?
    - Perhaps… depending on the intersection and facility design
  - Slip lanes
    - Yes! ... But what if they want to turn right?
- So, how can we provide for this target audience?

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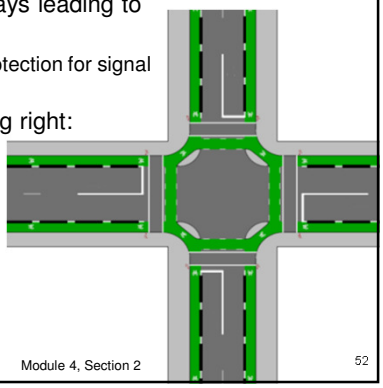
51

Intersection treatment...Dutch style

- Protected cycleways leading to intersection
  - also provides protection for signal hardware
- For cyclists turning right:
  - effectively a hook turn manoeuvre
  - with physical protection



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Module 4, Section 2

52

Intersection treatment...Dutch style

- 4 main elements:
  - Corner refuge island
    - reduces left turning speed
    - protects cyclists
    - protects pedestrians
  - Advanced stop line
  - Setback cycle and pedestrian crossings
    - Provides space and time to see and react to conflicts
  - Cyclist-friendly signal phasing
    - Reduces delay to cyclists

Falbo, 2014

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Intersection treatment...Dutch style

Montreal, Canada:
- Bollards for corner refuge "island"

www.spacing.ca/montreal

Somewhere in Holland

www.bicycleductch.wordpress.com

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Intersections for *Interested but Concerned*

- Other possible provisions for *IC* cyclists:
  - Route planning – choose other, quieter streets where possible
    - Depends on directness with respect to desire lines - *IC* more likely to accept increase in distance, but they have their limits
  - Divert facilities around the corner and provide simpler midblock crossings
  - Provide large pedestrian queuing areas so that cyclists have the opportunity to dismount and cross busy intersections as pedestrians
    - But difficult to ensure they actually dismount and don't conflict with pedestrians
  - Trial Barnes' dances for cyclists and pedestrians at the same time

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Summary

- ASBs
  - With or without approach cycle lane
  - In front of unmarked left turn lane
- ASLs
  - Provide wherever ASB not feasible / desirable
- Hook turns
  - Good for heavy traffic, less confident users
  - Placement based on phasing and lane configuration
- Cycle slip lanes
- Dutch style intersection
  - Corner refuge island
  - Advanced stop line
  - Setback cycle and pedestrian crossings
  - Cyclist-friendly signal phasing

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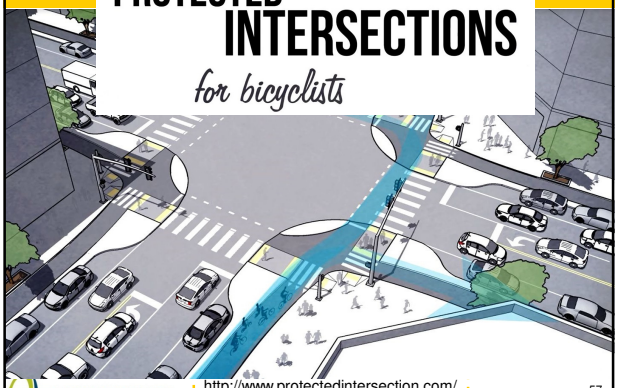
PROTECTED INTERSECTIONS

for bicyclists



http://www.protectedintersection.com/

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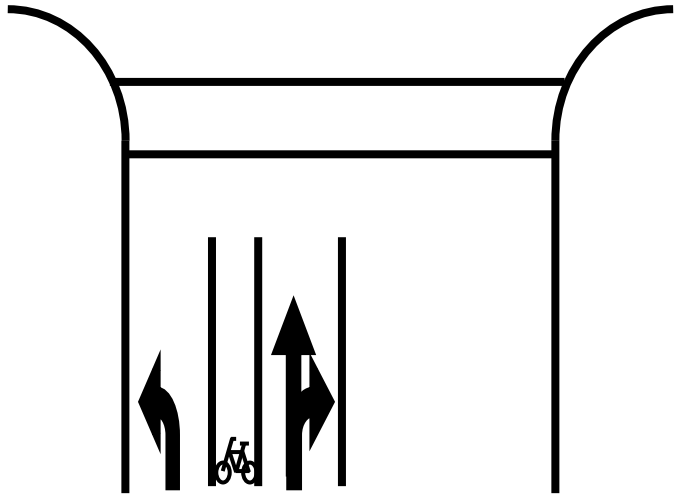
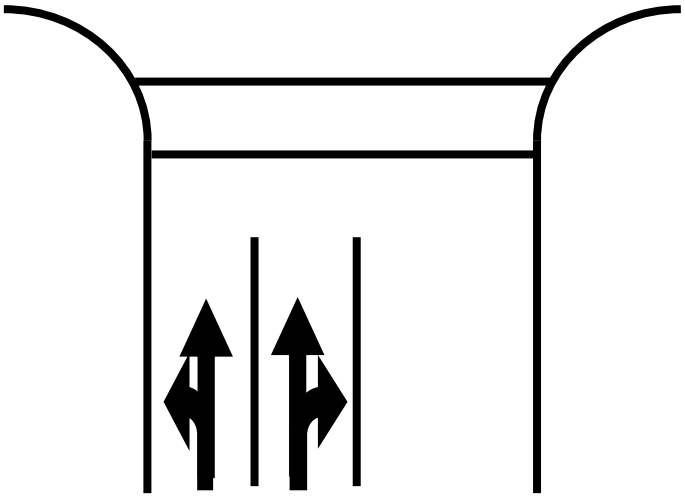
Exercise - ASB Designs

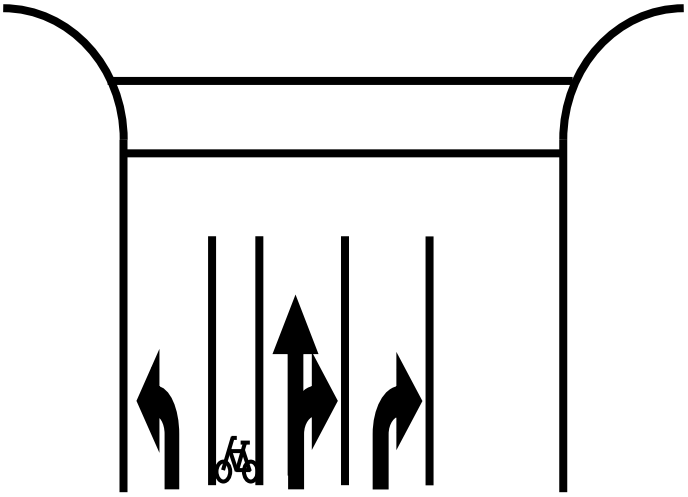
Scenario 1



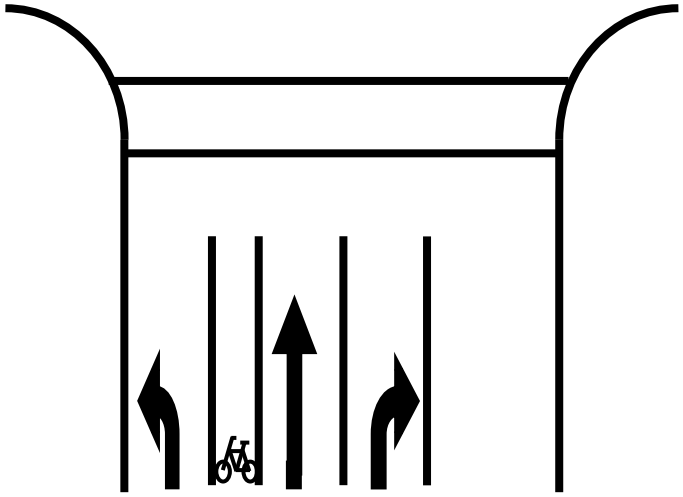
Scenario 2



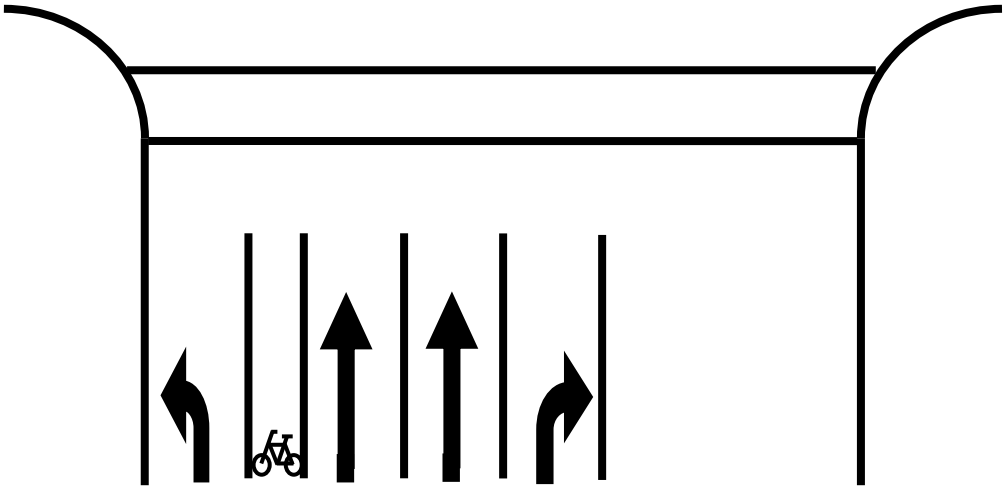
Scenario 3



Scenario 4



Scenario 5



Advanced Planning and Design for Cycling

Module 4 Intersections

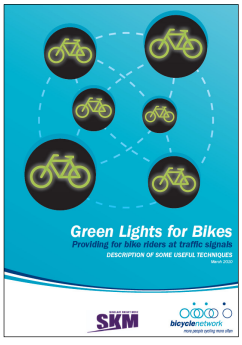
Section 3
Traffic signal infrastructure and phasing

Section outline
Signal infrastructure and phasing

- Cycle detection at signalised intersections
- Signal heads and call buttons
- Phasing
- Phasing exercise
- Case studies from Christchurch
  - Blenheim Road
  - Hospital Corner

Useful guidance

- Detection
- Early starts
- All red
- Dwell on green for cyclists and pedestrians
- Clearance at the end of green
- All red time extension
- Bicycle lanterns
- Riding through top of T



SKM, 2010

Cycle detection

- 2 reasons:
  - Call a phase and / or
  - Extend a phase
- Intersection operation dictates whether detection is required for specific cycle movements
  - If a phase is introduced only when called, detection must include cyclists
  - If a phase is automatically introduced regardless of detection, cyclists need not be detected

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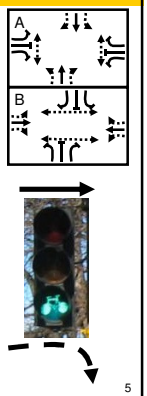
Signal glossary

- Phase
  - is identified by at least one movement gaining right of way at the start of it and at least one movement losing right of way at the end of it
- Movement
  - stream of vehicles that enters from the same approach and departs from the same exit
- Aspect
  - single optical system (circular, arrow, or symbolic) on a signal face capable of being illuminated at a given time
- Filter turn
  - turning movement that must give way to and find safe gaps in conflicting vehicle or pedestrian traffic before proceeding



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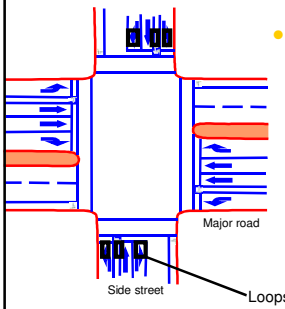
Cycle detection – example



- If signals stay in major phase unless side street phase is called:
  - Major road detection extend
  - Side street detection call and extend
  - Cycle detection required on side street only

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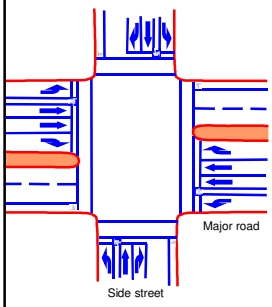
Cycle detection – example



- Alternatively, if signals swap between two phases according to set plan:
  - Major road detection extends
  - Side street detection extends
  - No cycle detection required
- Night time operation might differ from day time

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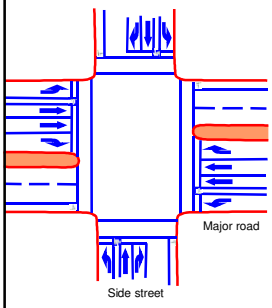
Module 4, Section 3
7

Cycle detection – example



- Therefore, very important for designer to talk to signals engineer
  - Need to understand exactly how intersection operates (day as well as night)
  - Signal plans don't give enough detail
  - Site visits don't cover full daily operation

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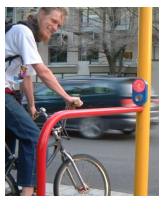
8

Bicycle detection methods

- Inductive loops
  - Standard SCATS loops
    - Edges parallel to cycle direction most effective
    - Try using a bicycle wheel for calibration
  - Special loop arrangements / products specifically for cycles
- Call buttons
  - Similar to pedestrian call buttons
- Other technologies
  - Video - not widely proven
  - Infrared - increasingly used in USA



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9

Inductive loops

- Advance loops
  - Detect moving cyclists
    - In midblock location (including protected cycleways / cycle paths) on the approach to a signalised intersection
- Stop line loops
  - Detect stationary cyclists queuing at signalised intersection
    - Specific loops in cycle facility, OR:
    - Loops in general traffic lanes may also detect cyclists

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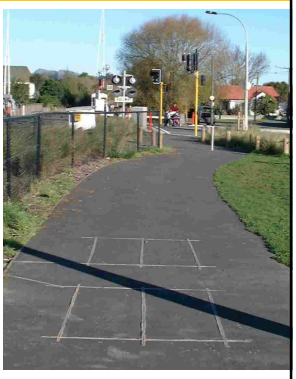
Module 4, Section

Advance detector loop

- Loops used to call cycle crossing before cyclist arrives
- Two loops to distinguish direction
- Easier to calibrate loops in path than road
  - No problems with detecting traffic in adjacent lanes



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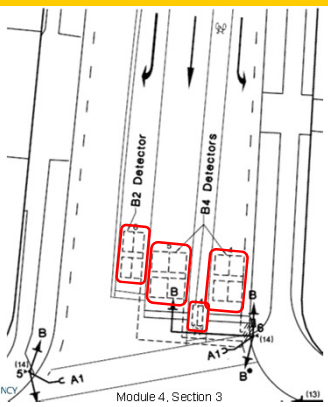
Stop line loops



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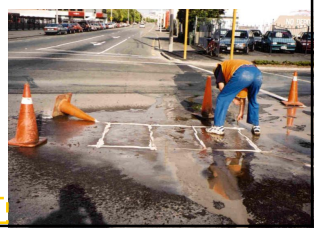
Module 4, Section 3

12

Cyclists at wide intersections

- Loops used to extend phase when cyclists are still travelling through intersection during amber
  - Can help *Interested but Concerned* cyclists, but may not increase their perceived safety
  - e.g. http://viastrada.co.nz/pub/single-loop
    - Loop shape shown in photo has since been modified



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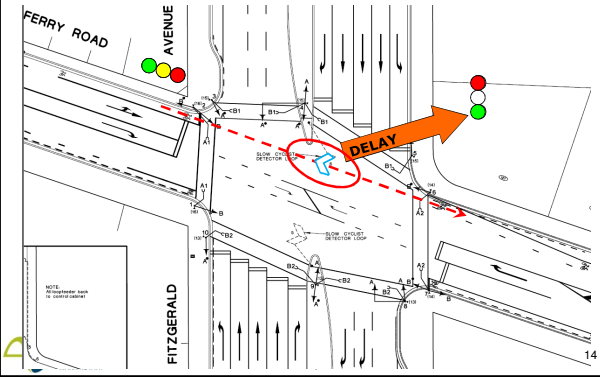
Wilke, 2001

Cyclists at wide intersections



14

Head start

- Buttons can be used to call cycle head-start

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15

Call button hardware

- Modified RTA (Road and Traffic Authority) pedestrian call button
  - Currently only used in Christchurch
- Call accept lights up when cycle detected
  - Commonly only loops used for detection (i.e. call button not connected)
  - Could use call button (instead of loops)
  - **If button not connected, preferable to use blank plate instead**

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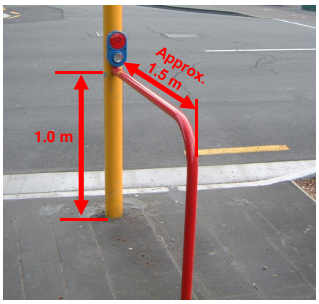
16

Call button positioning

- Call accept light and hold rail adjacent to detector loops
- Can use a "stub" pole (rather than full height signal pole)
  - Make sure it doesn't impede visually impaired pedestrians



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17

Mid-block signalised crosswalks

- Different hardware for cyclists and pedestrians
  - Shorter clearance time for cyclists
  - More efficient if no pedestrians crossing (signals go back to main road faster)

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18

Cyclists on pedestrian crosswalks?

- Road User Rule:
  - 3.2 (b) While a green signal in the form of a disc is displayed, a driver facing the signal, including a driver turning left or right, must… **give way to pedestrians** lawfully crossing or about to cross the roadway **and give way to** motor vehicles and **cycles lawfully proceeding straight ahead**.
- Somewhat ambiguous – does it include cyclists coming from parallel cycle paths?

Cyclists on pedestrian crosswalks?

- Road User Rule:
  - 3.5 (1) When a special signal for pedestrians indicates a **green walking human figure symbol**, **pedestrians, riders of mobility devices and riders of wheeled recreational devices** may, if facing the signal, enter the roadway to cross towards the signal…
  - **Pedestrian** – means **a person on foot** and on a road and includes a person in or on a contrivance equipped with wheels or revolving runners that is not a vehicle.
  - **Cycle** – means **a vehicle** that has at least two wheels and that is designed primarily to be propelled by the muscular energy of the rider and includes a power-assisted cycle.

Cyclists on pedestrian crosswalks?

- Road User Rule:
  - i.e. turning motorists do not legally have to give way to cyclists riding on signalised pedestrian crossings
- Cyclists and pedestrians have different time requirements
- Therefore, provide separate crossings for cyclists and pedestrians
  - Otherwise expose road users to legal ambiguity and risk of crashes
  - Requires separate hardware

Signal displays for cyclists

- Three aspect signal displays (red, yellow and green) for most situations
  - Cycles are vehicles
  - Can't leave out the yellow aspect
- Road User Rule:
  - 3.7 (1) While a green cycle symbol is illuminated, cyclists may proceed straight ahead, or turn left or right
    - (But do they give way while turning?)
- Traffic Control Devices Rule
  - If the signals control only the movement of light-rail vehicles, buses or cycles, a single column of three T, B or cycle symbols may be installed

TCD Rule, Schedule 3 Traffic signals

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22

Signal displays in bus lanes

- As of 2011, not required, but may provide single green cycle signal
  - Green cycle symbol extinguished when following traffic green commences
- Two aspect red and green cycle combination (like for pedestrian crossings) not allowed

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23

Signal provision and location

- Cycles are vehicles, therefore TCD Rule applies:
  - 6.2(1)(c) …a road controlling authority must install… at least one supplementary steady traffic signal in a position that is visible to road users stopped.
  - Also rules for signs, markings, aspect displays etc…
- Austroads Part 7 also applies to cycle signals
  - Type of movement (maj / min, left / straight / right) determines:
    - Number of signals required (absolute minimum of two)
    - Location (primary / secondary / tertiary) of signals

TCD Rule, section 6; Austroads Part 7, chapter 7

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24

Use of detectors for counting

- SCATS can record number of times loops detect a cyclist (usually only on pathways)
  - Less accurate than specialised cycle counting equipment but still useful data
  - Problems with groups of cyclists
- SCATS intersection diagnostic monitor (IDM) can be used to record every cycle where a cycle crossing is demanded
  - Doesn't equate to actual cycle volumes
  - Useful for modelling (more important to know average delays etc per cycle)

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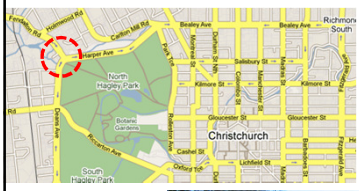
Phasing example 1



- Deans / Harper / Fendalton, Chch
- High cycle volumes through Hagley Park to / from CBD

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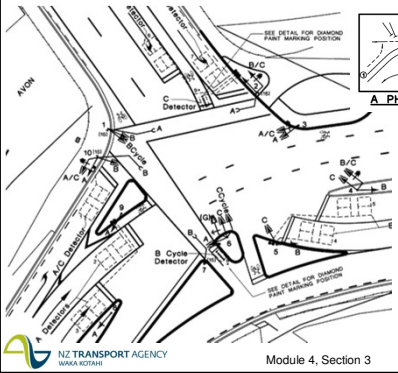
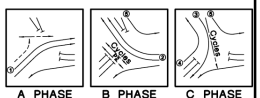
Phasing example 1





- No changes to vehicle movements in phases with introduction of cycle movements
- Minimal changes to timing

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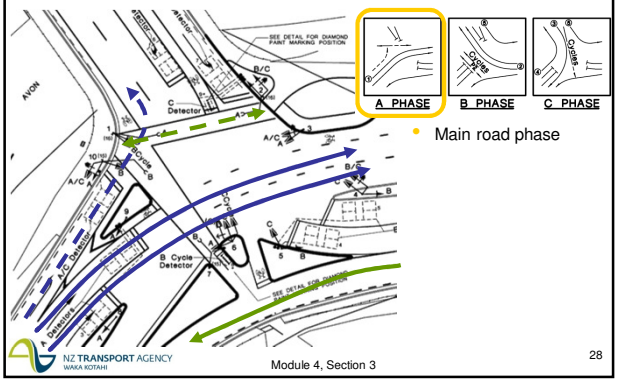
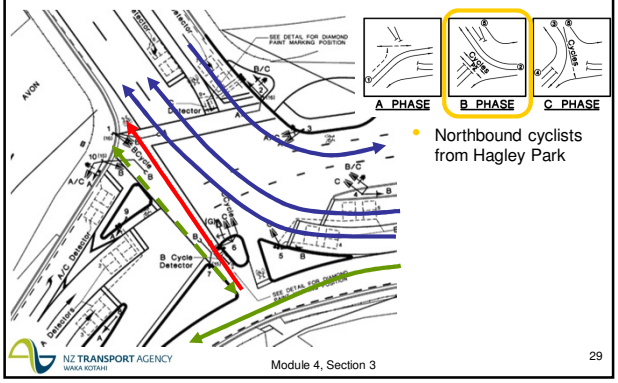
Phasing example 1



- Main road phase

Module 4, Section 3 28

Phasing example 1



- Northbound cyclists from Hagley Park

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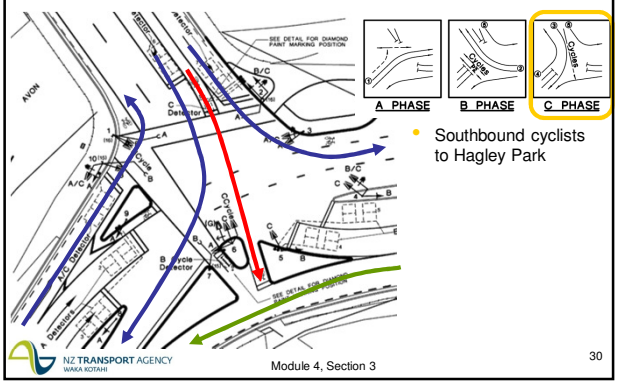
Phasing example 1



- Southbound cyclists to Hagley Park

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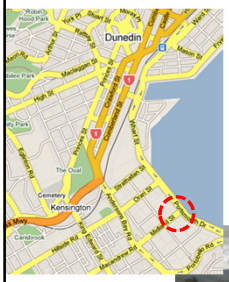
Phasing example 2



- Portsmouth / Midland, Dunedin
- Cycle crossings to / from scenic shared path

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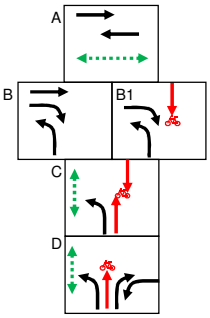
Phasing example 2



Aerial photo courtesy of Dunedin City Council

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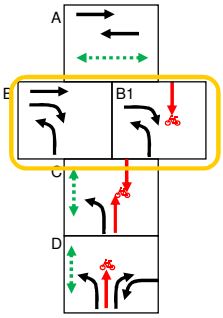
Phasing example 2



- Main road through movement given less green time when cycle crossing from north called.

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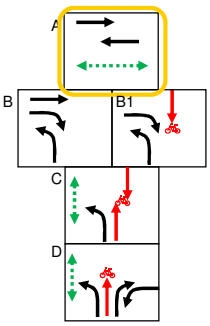
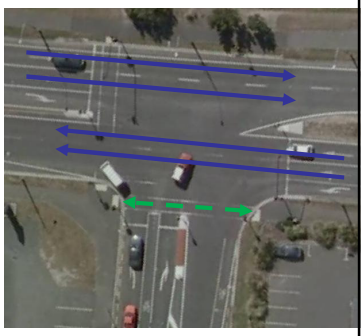
Phasing example 2





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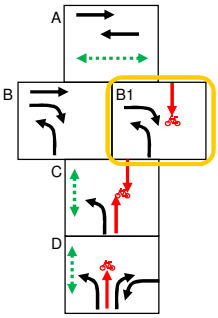
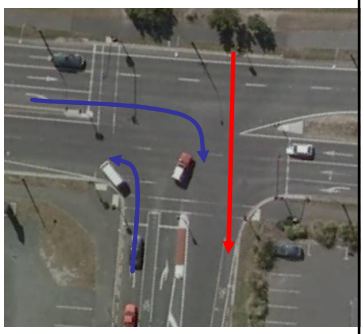
Module 4, Section 3

34

Phasing example 2





Aerial photo courtesy of Dunedin City Council

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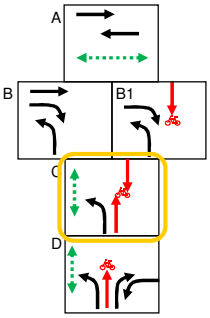
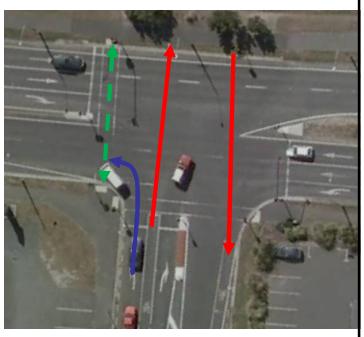
35

Phasing example 2





Aerial photo courtesy of Dunedin City Council

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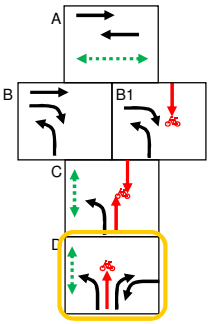
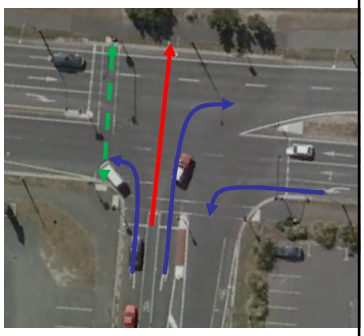
36

Phasing example 2





Aerial photo courtesy of Dunedin City Council

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37

Exercise: phasing

- Exercise sheet in course book at end of section
- Solutions given in separate presentation and handouts
- Problem stated on next three slides

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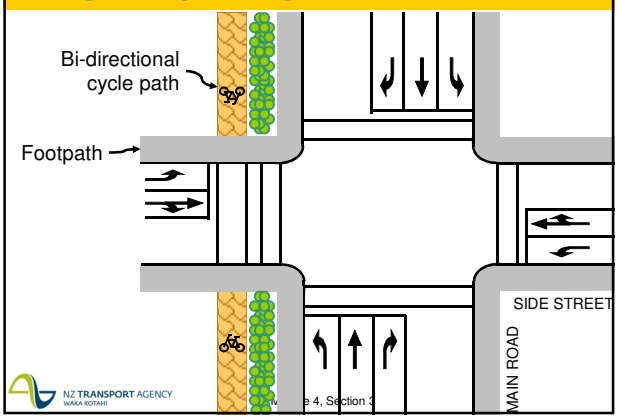
38

Design the phasing for this intersection:



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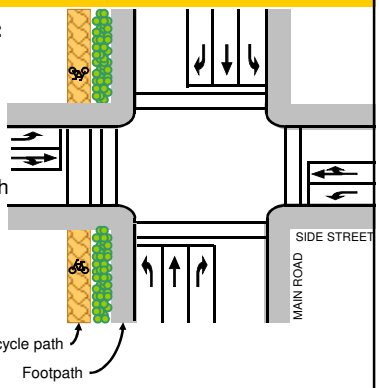
Design the phasing for this intersection:

Additional information:

- Filtering (with respect to other motor vehicles) allowed for Main Rd and Side St
- Side St volumes low enough to operate with a single phase
- No special pedestrian protection measures considered necessary



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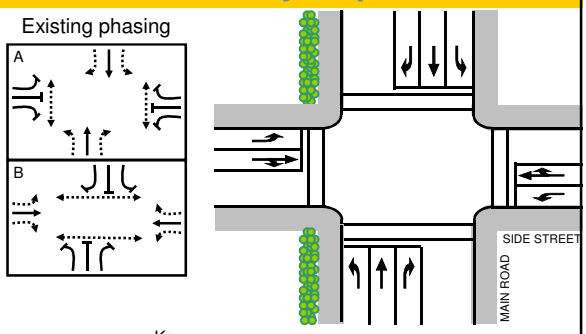
Module 4, Section 3

Without cycle path

Existing phasing



Key:

CYC Cycle phase	Pedestrian movement	Filter turn	Full green	Red light / red arrow

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Discussion: Layout and phasing

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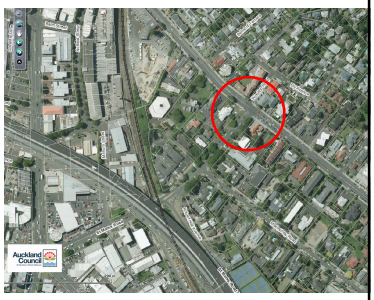
42

Module 4, Section 3

Discussion: Layout and phasing

Intersection 2060 – overview

- Two main roads
  - Remuera Road
  - St Marks Road
- One cul-de-sac
  - Wootton Road
- ASB in front of shared through/left
  - Heavy left turn



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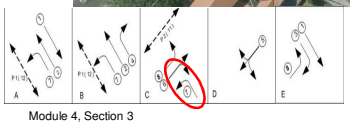
Module 4, Section 3

Intersection 2060 – detail

- ASB in front of shared thru/left
  - Exclusive left turn during C phase
  - Straight ahead cyclists along Remuera Rd block left turn
  - toot!



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Module 4, Section 3

Left turn overlap phasing & cycling

- Left turn overlaps – discuss application for different scenarios:
  - Kerbside through/left lane
  - Kerbside cycle lane
- Potential measures to mitigate issues?
- Where is a safe and comfortable waiting position on a bike?
  - Discuss appropriate ASB position to suit both left turning traffic and waiting cyclist

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Module 4, Section 3

Summary

- Cycle detection at signalised intersections
  - Important to understand intersection operation
  - Advance vs stop-line loops
- Cycle vs pedestrian crossings
  - Practical and legal implications
    - Need separate facilities
- Signal heads and call buttons
  - Signal displays and locations
  - Call-accept hardware
- Phasing
  - Important aspect in providing for target audience at intersections

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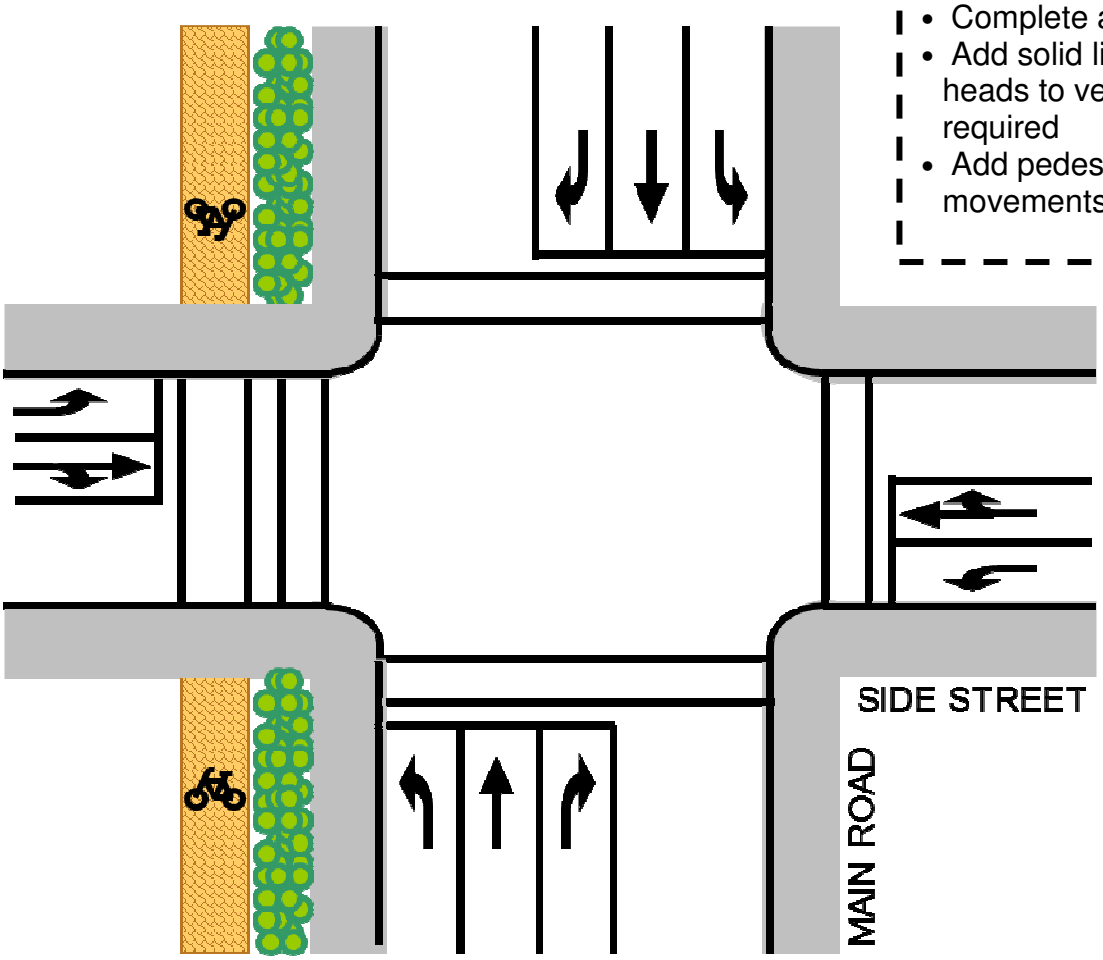
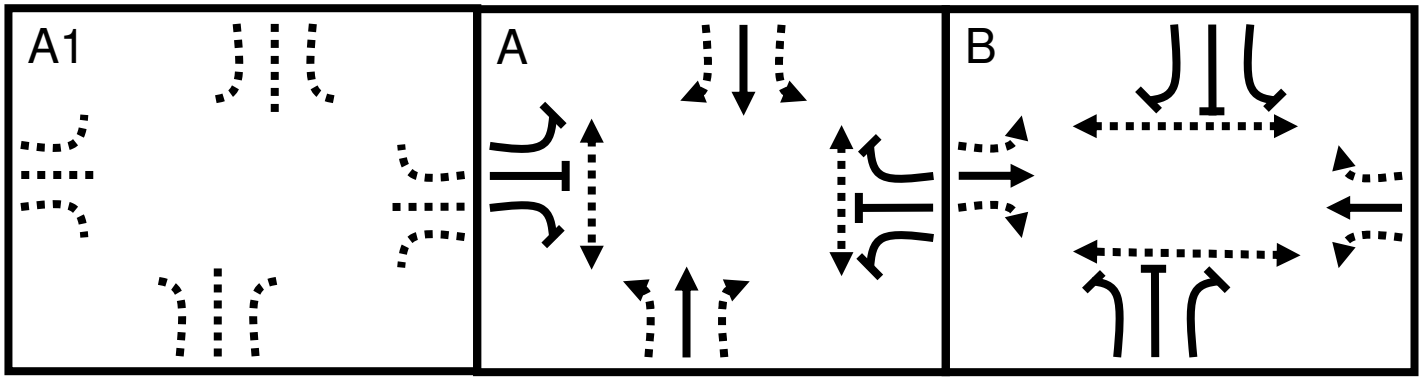
Module 4, Section 3 61

Exercise - Phasing Design

Instructions
- Complete additional phase (A1)
- Add solid lines and arrow heads to vehicle movements as required
- Add pedestrian and cycle movements as required

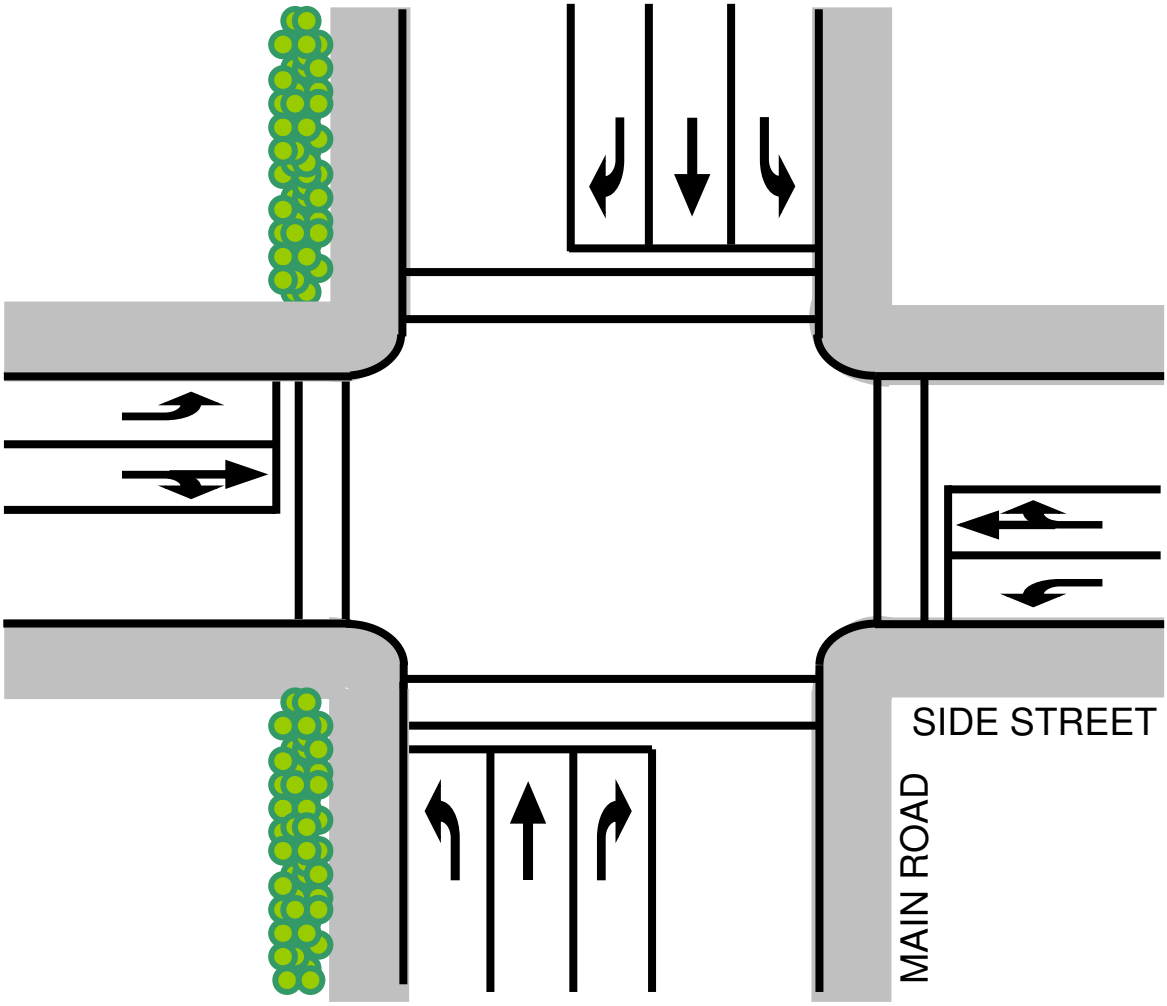


Phase diagram:

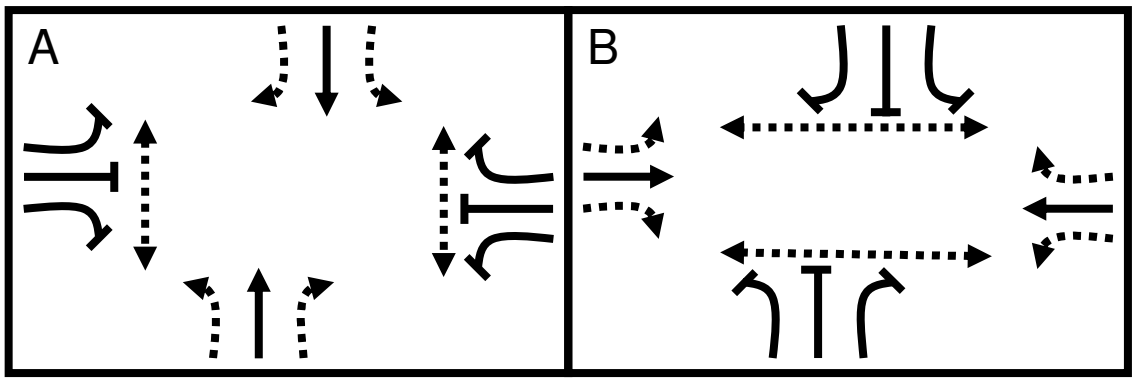


Additional Information:
- One extra phase required compared with situation without cycle path (see overleaf)
- Filtering (with respect to other motor vehicles) allowed for Main Rd and Side St
- Side St volumes low enough to operate with a single phase
- No special pedestrian protection measures considered necessary

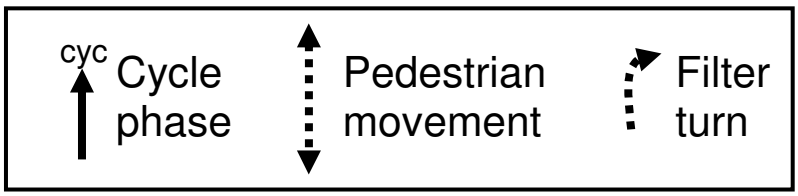
Phasing example - intersection without adjacent cycle path:



Phase diagram:



Key:



Advanced Planning and Design for Cycling

Module 4 Intersections

Section 4 Roundabouts

NZ TRANSPORT AGENCY WAKA KOTAHI

VIASTRADA

Section outline

- Introduction
- Crash types and factors
  - Four main types
  - Road user factors
  - Road environment factors
  - Correct way to cycle in a roundabout
- Roundabout design for safer interaction
  - Geometry and visibility
  - Cycle lanes
  - Multi-lane solutions
  - Off-street solutions

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Introduction

- Critical distinction
  - **novice** versus
  - **experienced** cyclists
- Roundabouts need to be
  - Safe
  - Comfortable
  - Direct and accessible to different cyclist types

NZTA (2005)

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Introduction Typical cyclist approach

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Introduction Not for all Cyclist Types!

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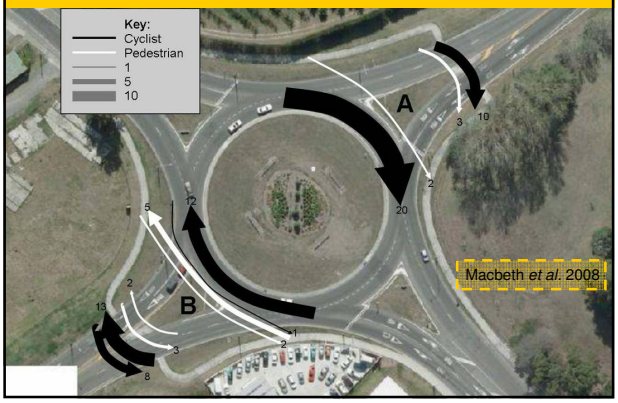
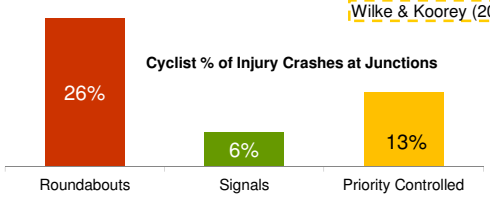
Introduction Route choices



Roundabout safety

- 26% of roundabout injury crashes are cyclists
  - Are roundabouts less safe for cyclists, or
  - Are roundabouts safer for motorists?

Wilke & Koorey (2001)



- Multi-lane roundabouts are 2.6 times more hazardous than single lane roundabouts VTI (2000)

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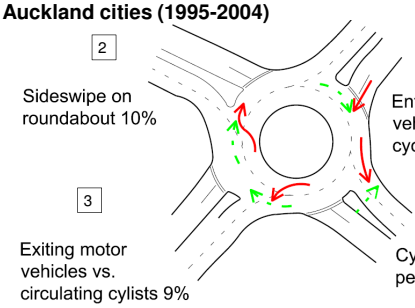
Cyclist crash types

Cyclist crash data at multi-lane roundabouts in the four Auckland cities (1995-2004)

Campbell (2005)



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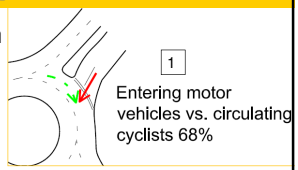
Crash types – 1

- Crash risk increased when
  - cyclist does not "defend the lane" (vehicular cycling) and is therefore less obvious
  - excessive inter-visibility leads to motorist looking for faster cars further out on previous leg
  - excessive inter-visibility leads to motorist failure to recheck gaps near limit line



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Crash types – example

- Screening by larger vehicles
- Sometimes drivers can't see past car in adjacent approach lane

Entering motor vehicles vs. circulating cyclists 68%

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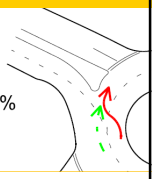
10

Crash types – 2

- Crash risk increased when
  - cyclist does not defend the lane (vehicular cycling) especially on multi-lane roundabouts
  - speed differential is high

2

Sideswipe on roundabout 10%



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Module 4, Section 4

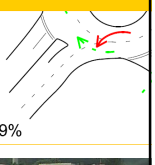
11

Crash types – 3

- Crash risk increased when
  - improper lane position
  - failure to indicate
- RUR change (Nov '09)
  - Cyclists no longer required to signal in roundabouts if it's not practicable
  - eases cyclist workload
  - may not improve safety

3

Exiting motor vehicles vs. circulating cylists 9%



Note: MOTSAM states cycle lanes should NOT be marked in roundabouts

Hutt roundabout

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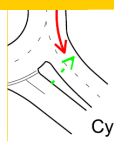
Module 4, Section 4

12

Crash types – 4

- Cyclist intimidated by riding in roundabout
- Motorist looking right
  - on approach side



Cyclist crossing as pedestrian 8%

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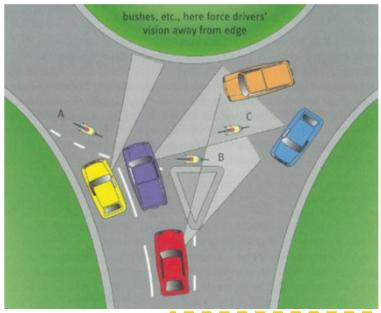
Module 4, Section 4 13

Factors – looked but failed to see

- LBFS less likely in position C
- LBFS exacerbated by:
  - Lane positioning
  - Entry speed
  - Visibility



Lund (2008); Franklin (2007)

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Module 4, Section 4

Crash factors – summary

- Improper lane positioning
  - Often results from fear of "holding up traffic"
  - Screened by other vehicles
  - Position alongside kerb is outside core field of vision of motorists
- Failure to signal intentions
  - overtaken in roundabout
  - exacerbated by improper lane position

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Module 4, Section 4 15

Crash factor commonality

Why are

- Motorists failing to see or attempting to overtake cyclists
- Cyclists using improper lane positioning or pedestrian facilities

?

Many factors are correlated. The key factor is...

Speeds are too high

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"Correct" way

- Speed differentials make this difficult

Anglesea/Bridge St, Hamilton

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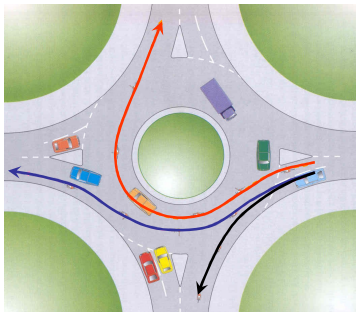
"Correct" way

- Exposed position
- Cyclist should ride fast
  (30 km/h or more)
- Difficult and dangerous



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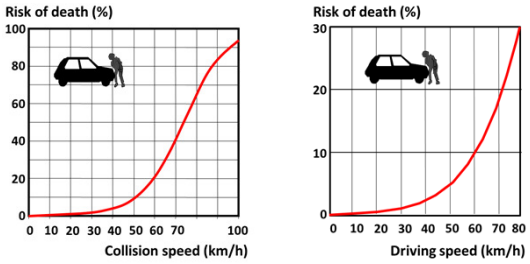
Speed and safety

- Austroads GTEP 4.2.6 maximum design speed (50 km/h)
- Risk of death in car vs pedestrian collisions



Rosén & Sander (2009)

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Speed reduction benefits

- ↓ numbers and severity of **all** crashes
- Improves driver recognition of cyclists
  - gap selection becomes less strenuous task
- Assists cyclists
  - to establish proper lane position
- May increase capacity
  - smaller gaps and headways required

Campbell (2005)

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Speed reduction

- Benefit-cost analysis
  - Accident cost savings more than offset by travel time increases
    - Continental European approach is to maximise safety
    - NZ approach is to maximise BC, which results in higher speeds and severity of crashes
  - Capacity may improve as smaller gaps are acceptable
- Improved cyclist access
- All roundabout elements should have same design speed (balanced)

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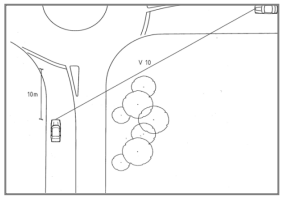
Solutions

We will address each of these in turn:

1. Visibility
2. Constrain the geometry
3. Vertical deflection
4. Cycle lanes
5. Signalisation
6. Bypasses and slip lanes
7. Off street paths

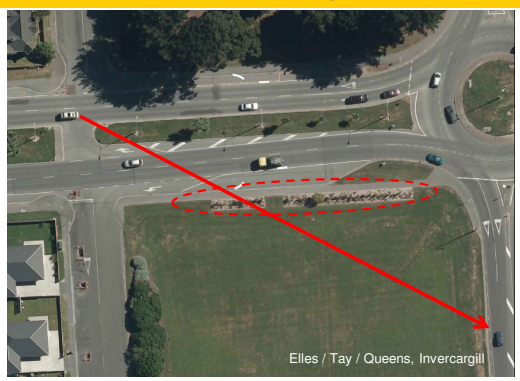
1. Visibility

- High visibility contributes to motorist failure to recheck at limit line
- Motorist is looking further upstream on the previous leg based on assumption of entering vehicle speed
  - not equal to cyclist speed
- Reductions best applied with constrained geometry



DFT (2007); Turner et al (2009)

1. Visibility

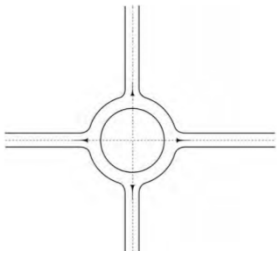


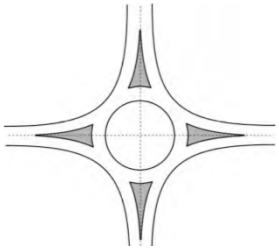
1. Visibility

- Use sightline screening
  - Especially at higher speed multi-lane roundabouts
  - Provide enough visibility for gap selection
  - But not *too* much!

DFT (2007)

2. Geometry



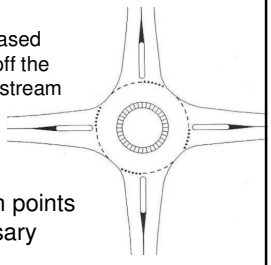


- Radial
  - Deflection reduces speeds
  - Assists cyclists to "take the lane"
  - Typical continental Europe practice
- Tangential
  - Flared entries
  - Typical UK / Aus / NZ practice

Fig 3.1 in Herland and Helmers (2002)

2. Geometry

- Deflection reduces speed
  - Safety benefits outweigh increased incidence of motorists "falling off the roundabout" and striking downstream objects (e.g. power poles)
- Take care not to create pinch points for cyclists through unnecessary deflection
  - e.g. head of T junctions



Dutch example

Schnüll *et al.* (1992); Spacek (2004); Baier *et al.* (2006); ITE (2008); Daniels *et al.* (2009)

2. Geometry – single-lane

- Inscribed dia. 25 – 30 m
- Inner dia. 15 m
- Core dia. 12 m
- Circulating road width 4 – 6 m
- Entry and exit widths 4 – 5 m

Ford / Hawford in Christchurch

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2. Geometry – multi-lane

To provide for cyclists, if:

- More than one circulating lane
- Outside diameter larger than about 30 m
  - High motor vehicle through-speeds
- A (cycle) crash history
- Then you need to consider the following…

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2. Geometry – multi-lane

- Increase deflection
  - However, beware of the “fastest path” problem: during light traffic, motorists may use all available lanes to travel through roundabout without slowing
- Reduce number of lanes on one or more legs
- C-Roundabout *(coming up)*
- Or consider alternatives such as
  - signalisation *(refer Sections 2 & 3)*
  - grade separation *(refer Section 5)*
  - another route...but remember the 5 Main Requirements (**directness**, **coherence**, safety, attractiveness, comfort)

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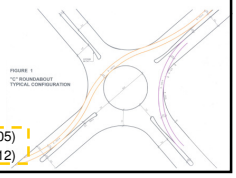
2. Geometry – C-Roundabout

- Trial C-Roundabout (Campbell 2005)
  - 58 multi lane roundabouts in Auckland in 2004
  - 35 m inscribed diameter multi-lane
  - Large vehicles use two lanes
  - Improves gap acceptance and capacity
  - Increases geometric delay, lowers speed
- NZTA research report 476 (Campbell et al 2012) Recommends:
  - "Roundabouts First" policy
  - Dutch turbo roundabouts
  - C-Roundabouts
  - Part time signals



Campbell *et al.* (2005)
Campbell *et al.* (2012)

NZ TRANSPORT AGENCY WAKA KOTAHI

2. Geometry – C-Roundabout

- Narrow (2.7 m) approach lanes aid cyclists in taking the lane

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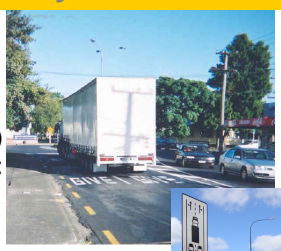
Module 4, Section 4 32

2. Geometry – C-Roundabout

- HCVs straddle both lanes
- Proposed (not yet authorised) approach sign:

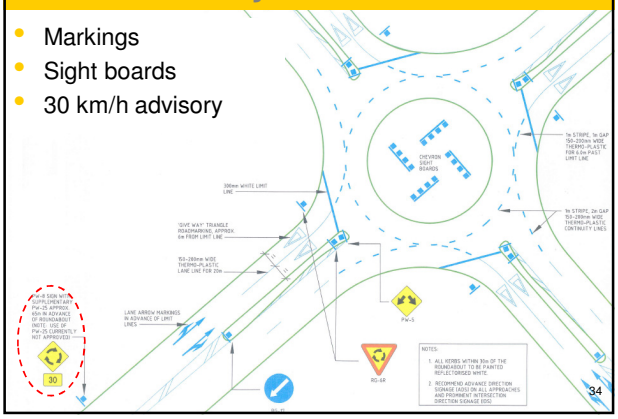


NZ TRANSPORT AGENCY WAKA KOTAHI

Module 4, Section 4

2. Geometry – C-Roundabout

- Markings
- Sight boards
- 30 km/h advisory



34

3. Vertical deflection

- May also be suitable on higher hierarchy streets
- May negatively affect Public Transport
- This profile relatively comfortable for cyclists

– *Note also...there is room for a cycle bypass at head of Tee (left side of photo)*

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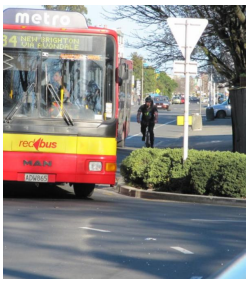
4. Cycle lanes introduction

- NZ's tangential roundabouts have higher speeds compared to radial design
- Cycle lanes or shared lane markings at roundabouts have been implemented in an effort to address cyclist safety

NZ TRANSPORT AGENCY WAKA KOTAHI Module 4, Section 4 Hutt City

4. Cycle lanes – approach

- Cycle lane may guide riders into dangerous positions
  - onto footpath or to stop
  - difficulty in "taking the lane"



NZ TRANSPORT AGENCY WAKA KOTAHI Riccarton / Deans, Christchurch 37

4. Cycle lanes – approach

- Advice from MOTSAM:

Coloured surfacing is not to be used on the cycle lane approaches...as cycle lanes are to be terminated prior...cyclists may need to take a general lane for their desired manoeuvre

MOTSAM 3.18.06

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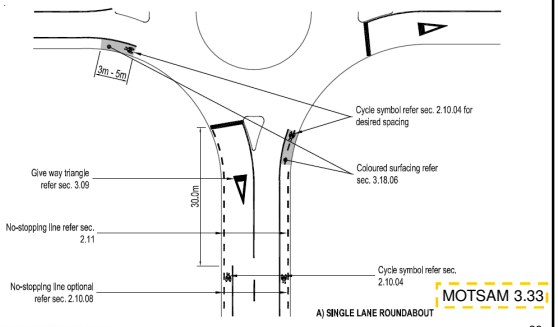
4. Cycle lanes – approach (single)

- Cycle lane ends 30 m from limit line, no colour

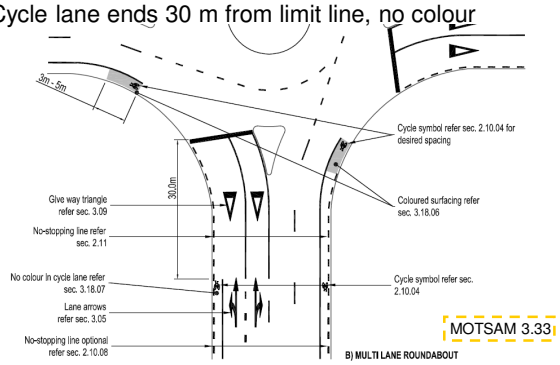


MOTSAM 3.33

NZ TRANSPORT AGENCY WAKA KOTAHI Module 4, Section 4 39

4. Cycle lanes – approach (multi)

- Cycle lane ends 30 m from limit line, no colour

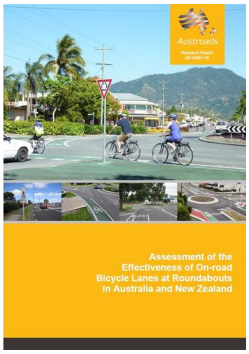


MOTSAM 3.33

4. Cycle lanes – approach

- Is there a better way?
- Area of ongoing research and location-specific trial treatments

Austroads 2014: AP-R461-14



4. Cycle lanes – approach

- Left – cycle slip lane
- Straight – lead in cycle lane
- Right – no cycles?

York, UK

4. Cycle lanes – approach

- Major cyclist flow is straight ahead
- "Not to standard"

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Cook & College Street, Palmerston North

43

4. Cycle lanes – approach

- Major cyclist flow is left
- Two major schools nearby
- "Not to standard" trial marking, note advisory

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Featherston/Freyburg Street, Palmerston North

44

4. Cycle markings – circulatory

NZ trial; not currently sanctioned in NZ

4. Cycle markings – circulatory

Australian example; not currently sanctioned in NZ

McRae Rd, Perth

4. Cycle lanes – circulatory

- Feature of some European roundabouts
  - Are highlighted with texture, colour in an attempt to increase prominence of cyclists in circular nearside lanes
  - Not permissible in Germany

Copenhagen (images reversed)

4. Cycle lanes – circulatory

- "Magic Roundabout" York, UK (2000)
- Replaced a circulating lane with a cycle lane
- Reduced cycle injuries
  - was it the markings or high cyclist volumes?
- Specific layout – Y shape intersection

York, UK

Basis of Austroads suggestion (next slide)

4. Cycle lanes – circulatory

- GTEP suggestion based on VicRoads Cycle Note 15
- Alberta-equivalent exit lane markings
- Not supported by NZTA – <u>not applicable in NZ</u>

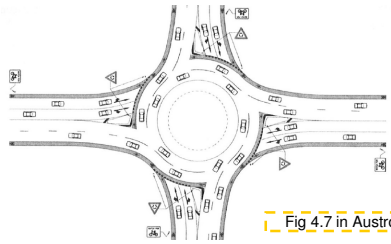

Fig 4.7 in Austroads (2007)

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4. Cycle lanes – circulatory

- Conclusions (at this time) – don't use cycle lanes in roundabouts:
  - SAFETY: Circulating cyclists less obvious to entering motorists looking at centre of lanes (LBFS)
  - Disapproval of motorists when cyclist not using lane
  - Circulating cyclists may turn right from Alberta-style cycle lanes (dangerous & illegal to do so)
- Issues with large, high speed roundabouts remain
- Check out Austroads research report

MOTSAM 3.18.07 (2008)

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5. Signalised roundabouts

- ramp meter the flows (doesn't help cyclists)
- signalise the approach leg at the limit line
  - slow start up and longer gap requirement at entry is no longer a major issue
  - assists cyclists in vehicular cycling (defending the lane) while negotiating entry to roundabout

Dryland & Chong (2007)

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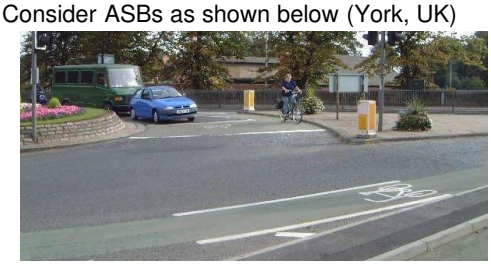
5. Signalised roundabouts

- Useful for unbalanced flows
  - major / minor road junctions
- May be on one or more single or multi-lane arm
- Consider ASBs as shown below (York, UK)

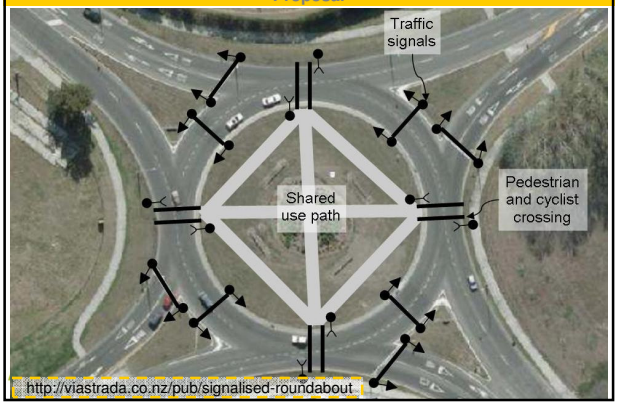


5. Signalised roundabout

Central island path

5. Signalised roundabout

Proposal



6. Slip lanes and bypasses

- Cyclists don't have to give way
- Similar to bypass for straight through cyclists at signalised Ts
- Improves cycle travel time, safety & LOS – unless turning right

Southampton, UK

7. Off street options

- Circular paths (generally shared use)
- Grade separation
  - *Covered in Section 5*

7. Circular cycle path

Approach caters for *Interested but Concerned*

- Approach traffic island for peds & cyclists crossing
- Traffic speed and capacity still need controls
  - Can you cross multi-lane approaches?
- Where it fits, a raised median aids 2 lane crossing

Harewood Road, Chch

7. Circular cycle path

- Indirect
- Consider pedestrian flows
- Safety implications of "wrong way" cycling as noted earlier
- Intervisibility at exits

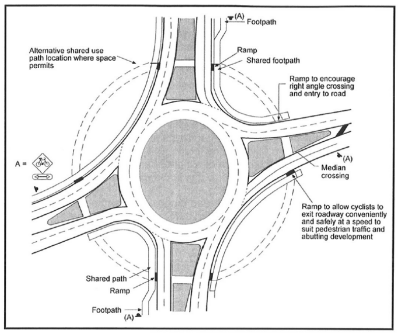
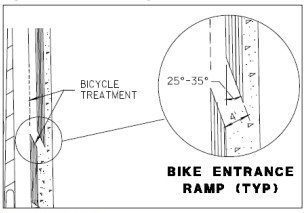


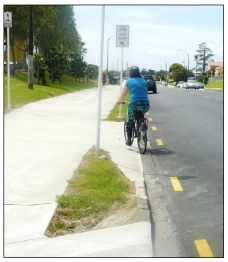
Figure 4.6: Paths for cyclists at roundabouts

Fig 4.6 in Austroads (2007)

7. Circular cycle path Transitions

- Comfortable – smooth without lip
- Smooth gradient <1:12
- Utilise pavement markings, kerbs to shield re-entry to carriageway
- Angle 25-35 degrees





7. Circular cycle path Transitions

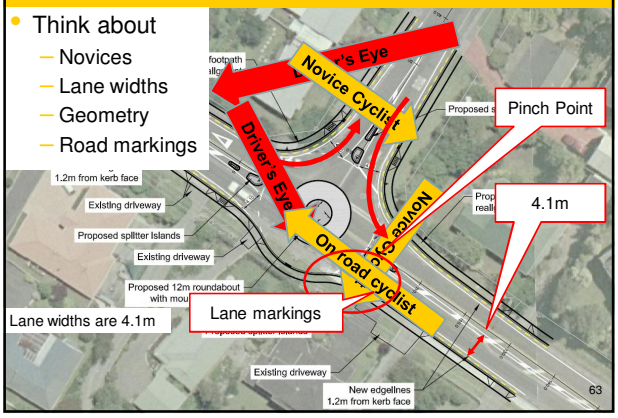
- Protect re-entry with kerb alignment

Mini exercise

- Can you identify some issues?

Mini exercise

- Think about
  - Novices
  - Lane widths
  - Geometry
  - Road markings



Section 4 summary

- Single lane roundabouts are reasonably safe if design speed is kept low 30–35 km/h

<u>avoid</u>

- Large, multi-lane, fast flowing (like below)
- Too much visibility (like below)
- Circulating cycle lanes

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65

Advanced Planning and Design for Cycling

Module 4 Intersections

Intersection design exercise briefing

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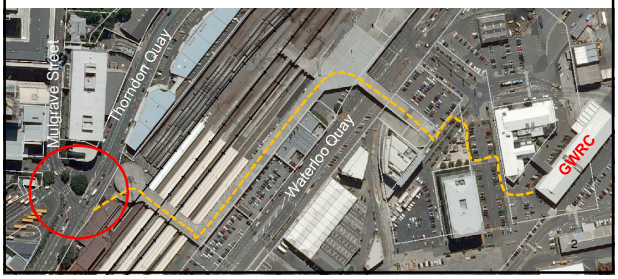
VIASTRADA

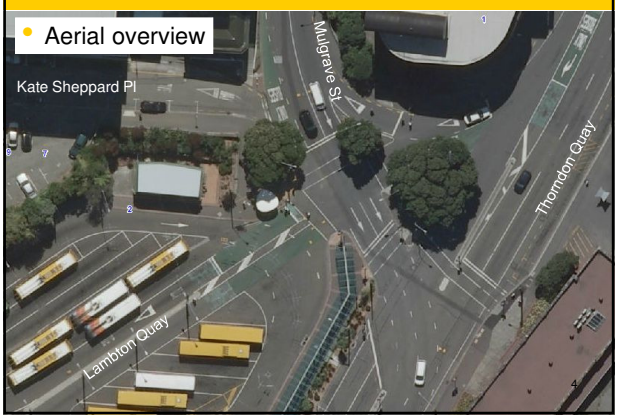
Mulgrave Street / Thorndon Quay

- Location
  - 850 m from workshop venue
  - 10 min walk (Bike if you'd like to)
  - Meet there at 1:30pm

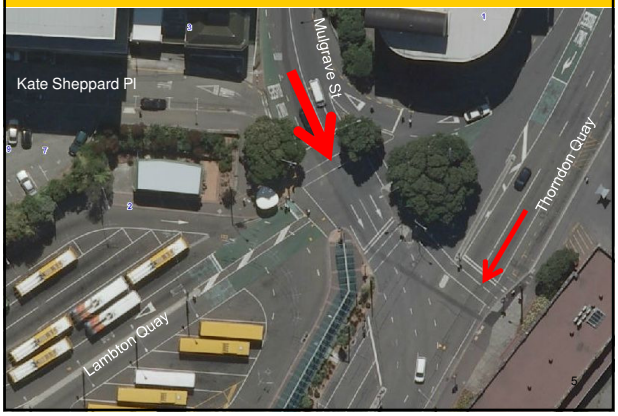


Mulgrave Street / Thorndon Quay

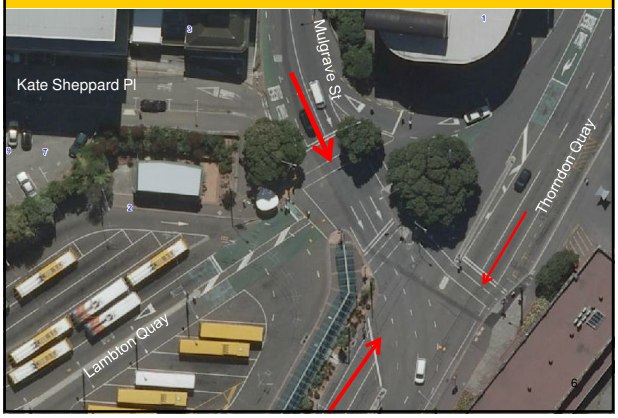
- Aerial overview



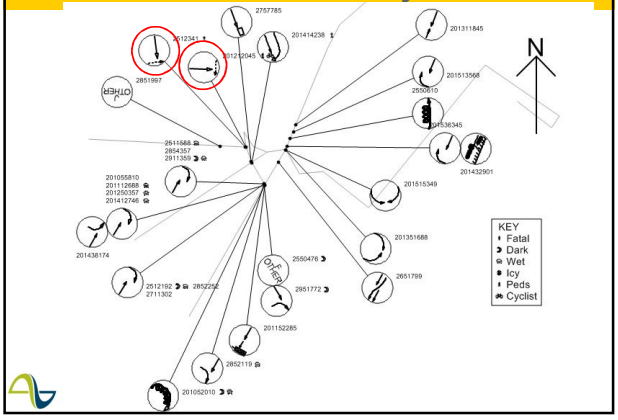
Key movements – AM peak



Key movements – PM peak



Crash history



Site visit purposes

- To experience firsthand the challenges faced by cyclists (and pedestrians) at a busy intersection
- To apply the principles taught in today's course and improve a real life example
- **How can we better provide for cyclists here?**

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WAKA KOTAHI

Notes for site visit

Advanced Planning and Design for Cycling

Module 4 Intersections

Section 5
Priority controlled and grade separated junctions

Section outline

Providing for cyclists to cross the road...

- Give way junctions
  - Road User Rule 4.2
  - Path gives way to the carriageway
  - Above, plus refuge for 2 stage crossing
  - Carriageway gives way to path
- Signals *(covered in previous sections)*
- Grade separation

Unsignalised intersections

- The previous sections of this course have dealt with signalised intersections
- Need to remember to consider cyclists at unsignalised intersections as well
  - Give way and stop ("priority controlled")
  - Grade separation
  - Also roundabouts (covered in section 4)
- Also crossing points
- However, these intersections require different treatment types and considerations

Road User Rule 4.2

4.2 Giving way where vehicles are controlled by same type of sign or in absence of signs

(2) A driver changing lanes or about to change lanes, or turning or about to turn, must give way to any vehicle not changing lanes, or not making a turn.

But we also have common law:

- Anybody entering a roadway gives way to traffic already on a roadway

Hence cyclists on pathways have to give way, even when RUR appears to suggest otherwise:

- When crossing side streets, to traffic coming out of it, and
- To traffic turning off the main road

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Module 4, Section 5 4

Road User Rule 4.4

4.4 Giving way when entering or exiting driveway

A driver entering or exiting a driveway must give way to a road user on a footpath.

Hence cyclists on pathways have right of way at driveways

Tennyson Street, Christchurch

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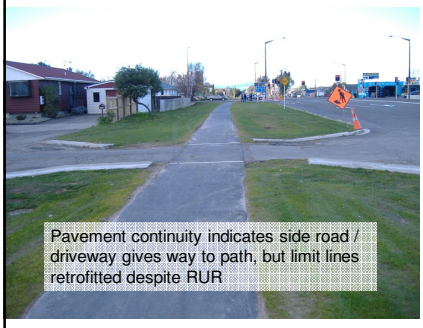
Path vs side road – ambiguity



Pavement continuity indicates side road / driveway gives way to path, but limit lines retrofitted despite RUR

- Side road or driveway?
- Path : Side vols. 1000 : 160
- RCA may erect give way signs on side road

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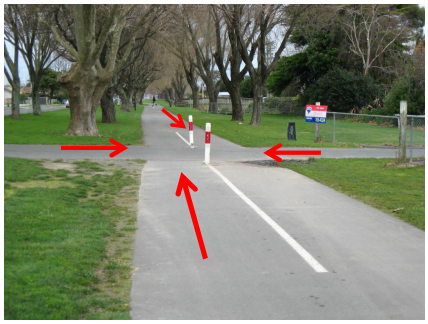
Module 4, Section 5 6

Path vs side road – ambiguity

- Who has right of way?



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Module 4, Section 5
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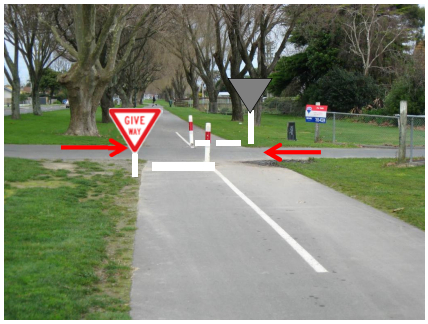
Path vs side road – ambiguity

- Give road users priority?



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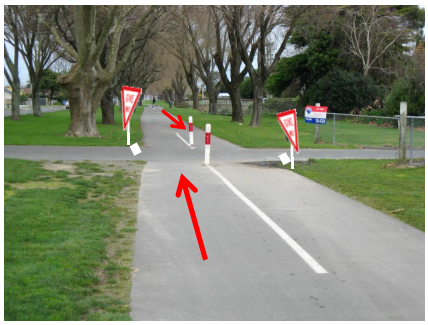
Module 4, Section 5
8

Path vs side road – ambiguity

- Give path users priority?



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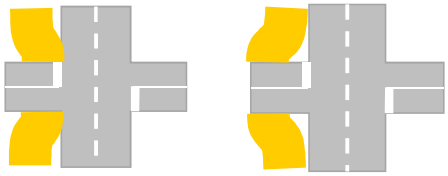
Path at intersection

- The separation between a path and parallel road may not be the best distance for a crossing near an intersection
  - Intervisibility issues
  - High cognitive demands
- Bend path towards or away from adjacent road?



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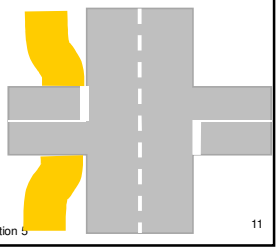
Path at intersection

- Path bends in:
  - Improves intervisibility between path users and turning vehicles
  - Conflict points closer



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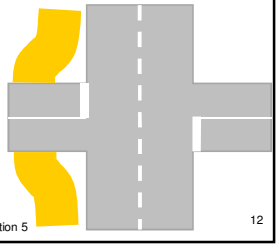
Path at intersection

- Path bends out:
  - Separates conflict points
    - Motorists have negotiated intersection and can then concentrate on checking for path users
  - Problem with trucks – may have increased speed and not be ready to brake for path users



NZ TRANSPORT AGENCY WAKA KOTAHI Module 4, Section 5 12

Separated path at intersection

Path vs side road – cycle merge

Note lack of use of kerb protecting start of cycle lane

Pioneer Highway path, Palmerston North

- Video clip

NZ TRANSPORT AGENCY WAKA KOTAHI Module 4, Section 5 14

Carriageway gives way to path

(midblock)

Urban area application limits:

- TCDs required
- Raised platform
- Narrow carriageway

Nelson Railway Cycleway

If: V_{max} ≥ 50 km/h &
veh/h peak flow > 500

- Then use in combination with traffic signals

CROW (2007)

NZ TRANSPORT AGENCY WAKA KOTAHI Module 4, Section 5 15

Carriageway gives way to path
(midblock)

- High NMU / MV ratio
- Road ahead signage
- Traffic control devices
- Hold rails
- Bollards & markings

Nelson Railway Cycleway

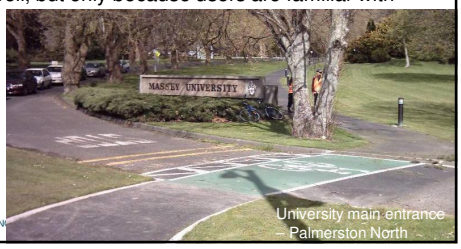
Carriageway gives way to path
(side road)

German example

- Rare in NZ
- Legal implications (previously discussed)
- Limit line placement such that queuing vehicles don't block cyclists
- Better to rejoin road in advance with a cycle merge

Carriageway gives way to path
(intersection)

- Slip lane has stop control
  - Sign missing
- Intervisibility compromised
  - But tree and sign are sacrosanct
  - Works well, but only because users are familiar with facility?



University main entrance – Palmerston North

Carriageway gives way to path
(intersection)

- Cross intersection with 4-way stop on roads
- No control against pathway
  - All movements give way to pathway traffic
  - Pathway was supposed to be built on raised platform, but not constructed like designed

Harakeke / Matai, Christchurch

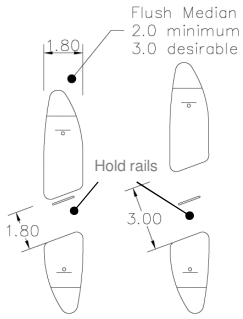
Cyclists on zebra crossings?

- Zebra crossings do not include cyclists
  - Therefore they are required to dismount and walk across if they want right of way over motor traffic
- Could provide a separate cycle crossing next to a zebra crossing
  - May be ambiguous – cyclists may think they have right of way
  - Courtesy crossing style perhaps a better option

NZ TRANSPORT AGENCY WAKA KOTAHI Module 4, Section 5

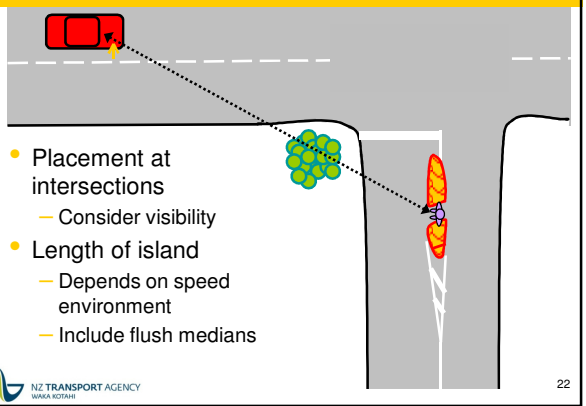
Crossing island design Dimensions

- Enables 2 stage crossing
- 3.0 m depth desirable to cater for trailers and tandems
- Width depends on volume or depth
  - enables trailers or tandems to pull in diagonally



NZ TRANSPORT AGENCY WAKA KOTAHI Module 4, Section 5 CCC Standard 21

Crossing island design Layout



- Placement at intersections
  - Consider visibility
- Length of island
  - Depends on speed environment
  - Include flush medians

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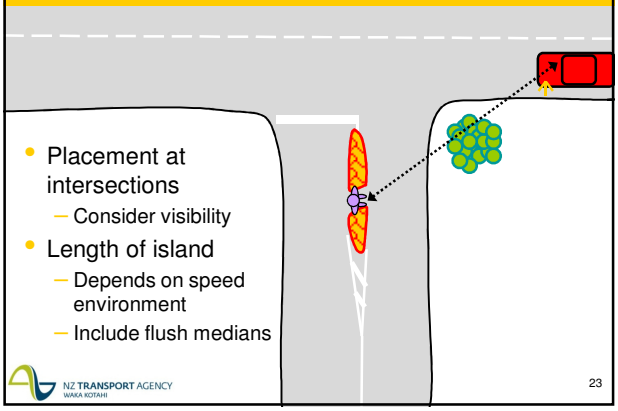
22

Crossing island design Layout



- Placement at intersections
  - Consider visibility
- Length of island
  - Depends on speed environment
  - Include flush medians

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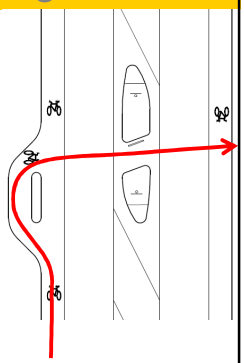
23

Accessing a crossing island

- Where it is difficult to turn right because of high:
  - Flows
  - Speed differentials
  - Novice cyclist numbers
- Use a “jug handle”



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Module 4, Section 5

25

Crossing island design

- Road crossing much simpler when dealing with traffic from one direction only
- Provide enough storage room in island
  - Dangerous is bicycles overhang into traffic lanes
- Maintain safe kerb to kerb dimensions for cyclists on carriageway
- Hold rails give crossing conspicuity

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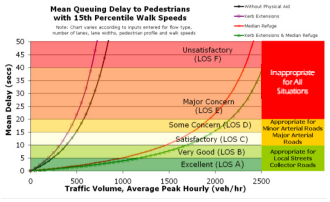
Module 4, Section 5

26

Choice of crossing provision

- Can use ped crossing design spreadsheet
  - Simply change ped speeds to cycle speeds
- Four options:
  - Without physical aid
  - with kerb extension
  - with median island
  - With kerb extension plus median island
- Outputs:
  - Indication of LOS
  - Economic analysis



NZTA 2007

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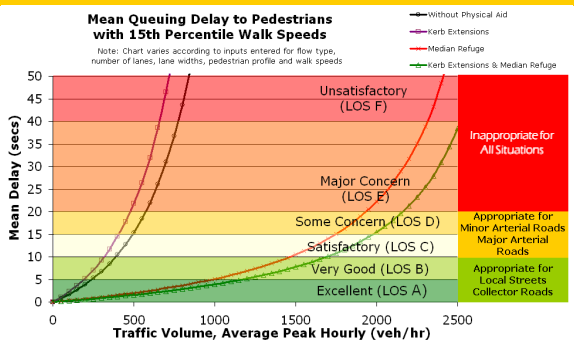
Module 4, Section 5

27

Choice of crossing provision



NZTA 2007

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Module 4, Section 5

28

Grade separation Underpass

- Complete separation from motor traffic
  - Great for *Interested but Concerned…*
  - *As long as their perceived safety isn't compromised by other factors…*
- Consider Crime Prevention Through Environmental Design (CPTED)
- Check against 5 main requirements:

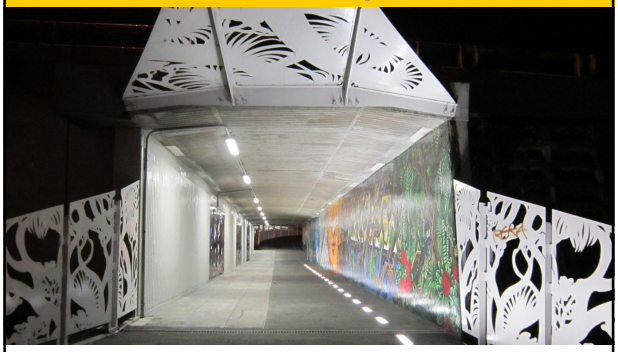
coherence, directness, attractiveness, safety, comfort

New Plymouth

Grade separation Underpass CPTED

Former Mangere Bridge Underpass, Auckland

Grade separation Underpass CPTED

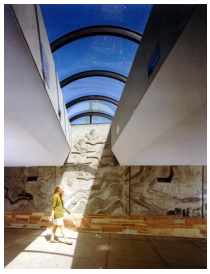


New Mangere Bridge Underpass, Auckland

Grade separation Underpass

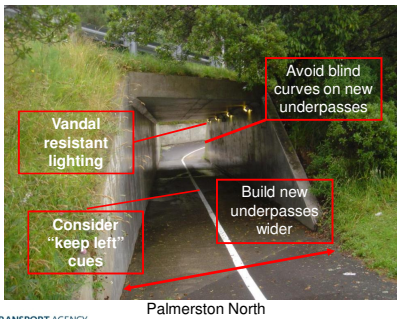
- Width aids pedestrian and cyclist sharing
- Natural light and art

UC, Boulder



Grade separation Underpass

- Where visibility and/or width are constrained, reduce head-on crash risk via centreline



Palmerston North

Grade separation Underpasses

- Large, new roundabouts, highways
- $$$

Nelson

Visibility extends to other end (but… lighting would be useful too)

Christchurch CSM

Visibility improved with a light well

Grade separation Elevated roundabout

- Elevated junction
- Extensive cycle path network underneath
- High LOS, $$$

Berenkuil Roundabout, Eindhoven, The Netherlands

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Module 4, Section 5 35

Grade separation Elevated roundabout

- Wide and well lit underpasses are at-grade
- Motor vehicle carriageways are elevated
- Legal graffiti “art”

Berenkuil, Eindhoven

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Module 4, Section 5 36

Grade separation Connectivity

- Accessible shallow gradient versus directness
- Counts show that most users cross at grade or ride “wrong way” on what was intended as 1-way network

Manawatu River Bridge, Palmerston North

NZ TRANSPORT AGENCY WAKA KOTAHI

Module 4, Section 5 37

Grade separation Clip-ons

- $6-10K / m versus replacement
- Maintain shared path width
- One or two way issues

Motueka

Grade separation Clip-ons

- Low traffic noise
- Weather protected
- User separation
- CPTED, low usage typical of AKL mode share
- No approach signage

- Kerbing and geometry control speed at junctions on either end but increase effort and travel time

Former Mangere Bridge, Auckland

Section 5 summary

- Some ambiguity in road user rule and general user understanding of intersections between paths and roads
  - Need to make it clear who has right of way
- Where paths intersect with roads, consider applying the give way to lower flow approach
- Highest LOS obtained through grade separation
  - but remember 5 main requirements!
- CPTED

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Module 4, Section 5

41

Advanced Planning and Design for Cycling

Module 4 Intersections

Section 6
Wrap-up

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VIASTRADA

Section 6 outline

In Module 4 Intersections, we covered four intersection types, breaking signals into two sections...

Section	Topic
1	Introduction to Module 4
2	Signalised Intersection Layout
3	Traffic Signal Phasing and Infrastructure
4	Roundabouts
5	Priority and Grade Separated Junctions
6	Wrap Up (this section)

In Section 6, we'll quickly recap these and then show how it's done elsewhere ☺

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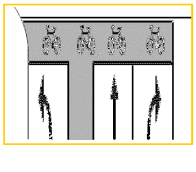
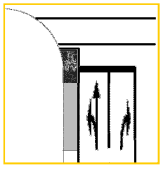
2

Section 2 SUMMARY
Signalised intersection layout

- Cycle intersection storage
  - ASBs
  - ASLs
  - Hook turns





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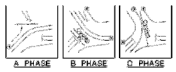
3

Section 3 summary
Signal phasing and infrastructure

- Hardware
  - Loops
  - Call buttons
  - Accept lights
  - Aspects (displays)
- Pedestrians and cyclists
  - Separate infrastructure required due to RUR
- Phasing examples
- Case studies showing layout + hardware + phasing put together





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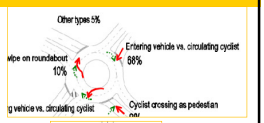
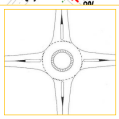
4

Section 4 summary
Roundabouts

- Cycle issues at roundabouts
  - Crash types and causes
  - Speed differentials
  - Inter visibility
  - Geometric design
  - Cycle lanes
  - Off street (path) provisions



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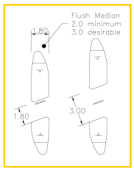
5

Section 5 summary
Priority and grade separated intersections

- *Getting across the road*
  - Give way controls appropriate to flows
  - Consider RUR 4.2
  - Cycle merges
  - Refuge design
- Grade separation
  - Critical to consider 5 main requirements
  - Devil is in the details – poor design = low use

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6

A Barnes Dance for cycles?

- Cyclists are hybrids – part pedestrian and part vehicle (basis of shared paths)
- Slower speeds + lower consequences of errors = negotiation between pedestrians and cyclists
- Groningen, The Netherlands example (2008)

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7

The end

- We hope you found this course useful
  - And enjoyed it!
- Course evaluations, please…

Module	Level	Duration	Topic
1	Fundamentals	1 day	Planning and Design for Cycling
2		½ day	Planning and Funding • Policy and Legislation lection and Analysis n and Funding
3	Advanced		ath Design • General midblock issues • Protected cycleways, cycle paths cycle lanes, bus lanes • Neighbourhood greenways & traffic management
4 ✓		**1 day**	**Intersection Design**

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8