

1. INTRODUCTION

Auckland has a number of arterial roads that experience heavy congestion on a daily basis during specific peak periods of the day. The roads often have spare capacity within the width of the road corridor that is under-utilised during these times, which would be better used to accommodate the peak traffic direction of travel.

There is also a drive from the New Zealand Transport Agency (NZTA) and Auckland Transport (AT) boards to employ innovative travel demand solutions to make better use of the existing road space, accommodate peak period movement and reduce the need to widen roads and build new roads at significant cost.

The Dynamic Lane concept, similar to the tidal flow lanes concept, is one such initiative that is currently being explored to use the existing network more efficiently for the movement of people and goods. There are existing similar arrangements currently in operation in Auckland including Panmure Bridge and Auckland Harbour Bridge. Both of these locations benefit from a reasonably straight-forward road layout.



Figure 1: (Top) Panmure Bridge, (Bottom) Auckland Harbour Bridge.

2. Selection Criteria

Six criteria have been developed to select appropriate locations for Dynamic Lanes for further study, covering the assessment of the existing operational performance, the level of infrastructure provision, and the potential land use and route functionality of a corridor. Three locations were identified as possible trial sites, Redoubt Road (Manukau), Blockhouse Bay Road (Avondale) and Whangaparaoa Road (Red Beach). Blockhouse Bay Road was found to be unsuitable to accommodate a trial as there width restrictions down-stream, therefore Redoubt Road and Whangaparaoa Road were the two preferred roads taken forward for further study and a potential trial.

Selection Criteria

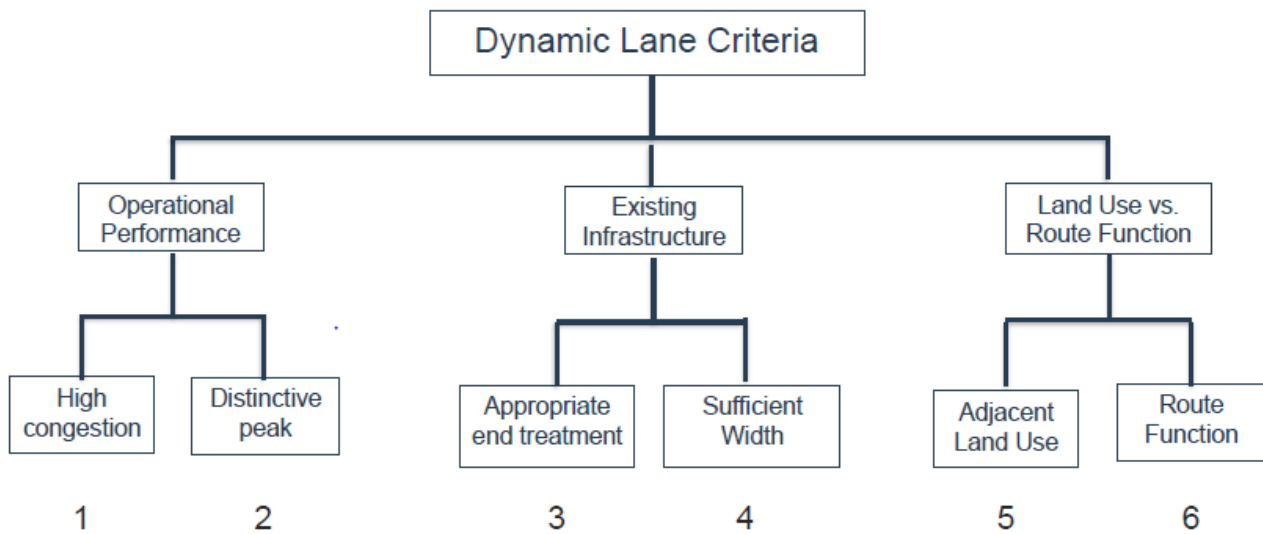


Figure 2: Selection Criteria Flow Chart

3. Trial Locations

Using the selection criteria above, the preferred location for a trial of a Dynamic Lane was Redoubt Road. This road already has a three lane arrangement, with two lanes that are motorway (westward) bound at all times and is approximately 450m in length. There is an opportunity to reverse the direction of the middle lane in the evening peak hours and improve the efficiency of the corridor. However, there is currently a significant project underway reviewing the Mill Road corridor, which extends in to Redoubt Road that proposes to widen the road in the medium-term. Redoubt Road is still a possible option for a trial but will require programming in line with the Mill Road project to avoid any abortive work.

Whangaparaoa Road has been taken forward as the preferred trial site for further development of Dynamic Lanes. This meets a majority of the selection criteria including high levels of congestion and it has a tidal flow with a distinctive morning peak flow in the westbound direction, towards the State Highway 1 and an afternoon peak flow away from the State Highway 1. The traffic volumes below show current vehicle flow and direction:

- Westbound / Eastbound
- 1,800/400 (am peak hour) – 80% / 20%
- 700/1300 (pm peak hour) – 35% / 65%
- 20 to 30km/h (am) 30 to 35km/h (pm)

Whangaparaoa Road has sufficient width to introduce three lanes and relatively low density adjacent land use minimising disruption to residents. The route also requires few alterations along its length to accommodate a third lane as there is only one traffic island and pedestrian facilities are not provided. However, the Hibiscus Coast Highway intersection is restricted by the left-turn slip lane and other alignment issues, limiting the exit capacity in the westbound direction to one lane. A compromise has been allowed, for the morning peak capacity improvements will be minimal. However the evening peak will have a significant capacity increase in the eastbound direction. If the trial is found to be successful, investment is recommended to increase the Hibiscus Coast Highway intersection capacity to accommodate the additional vehicle volume.

4. Traffic Control Devices

The Traffic Control Devices (TCD) committee was presented with a paper highlighting the possible Dynamic Lane arrangements for direction and guidance for the project to meet legal requirements.

The information provided to the TCD included background information on the selection criteria etc. along with details about how the dynamic lanes would potentially operate. This included the information as shown in Figures 3 to 7:

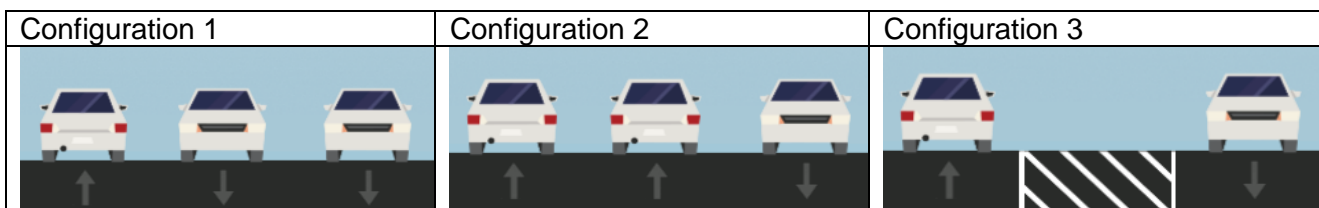


Figure 3: Lane Configuration on a Dynamic road

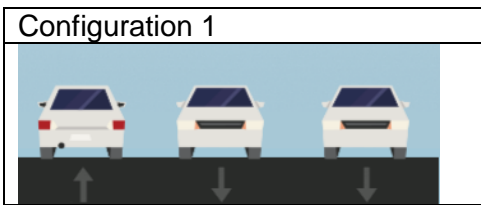
- Whangaparaoa Road is an Arterial Road with side access roads, private driveway access and pedestrian access on the north side, all requiring regular and clear information about the arrangement of the road;
- At peak times the central lane will operate as a tidal lane in the peak direction. Outside peak periods the central lane will operate as a flush median to help turning movements for local residents and businesses.

The proposed solutions to clarify the Dynamic Lane arrangement include:

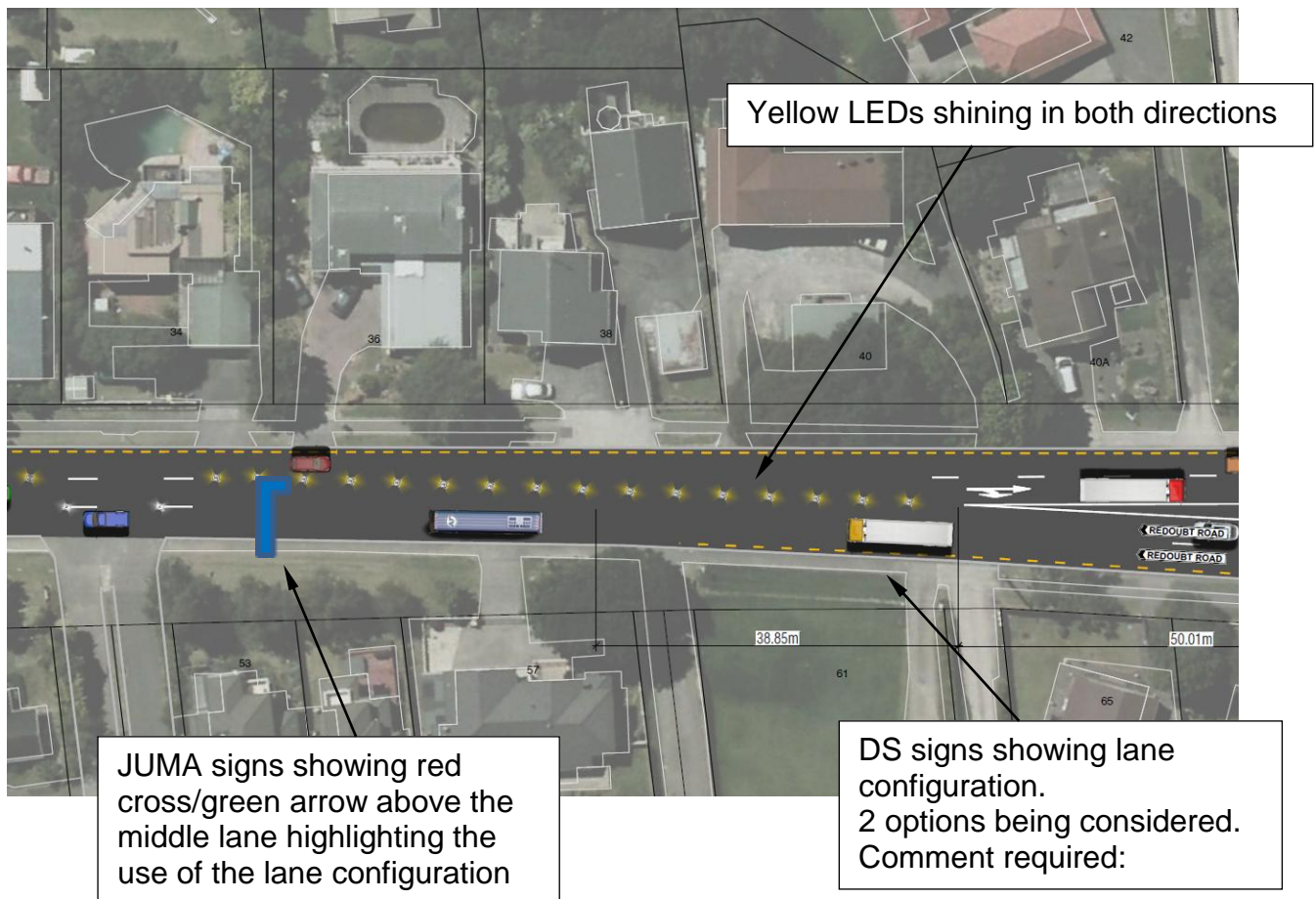
- LEDs shining in both directions to help all users confirm the use of the middle lane throughout the length of the road;
- Type DS signs showing the lane arrangement in advance of the lane changes on approach to dynamic sections of the road;
- Joint Use Mast Arm (JUMA) with a red cross/green arrow above the middle lane highlighting the use of the lane

Details were also provided to the TCD regarding the transition area between the existing road arrangement at Red Beach Road intersection and Hibiscus Coast Highway intersection. Options were provided for all the proposed solutions to clarify dynamic lanes including the Type DS signs, LED and line marking arrangements with JUMAs.

Figure 4: Transition area Configuration 1 - Westbound priority (morning peak hours)



No line-marking to be provided during the transition area



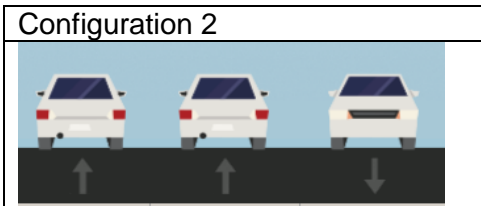
Option 1



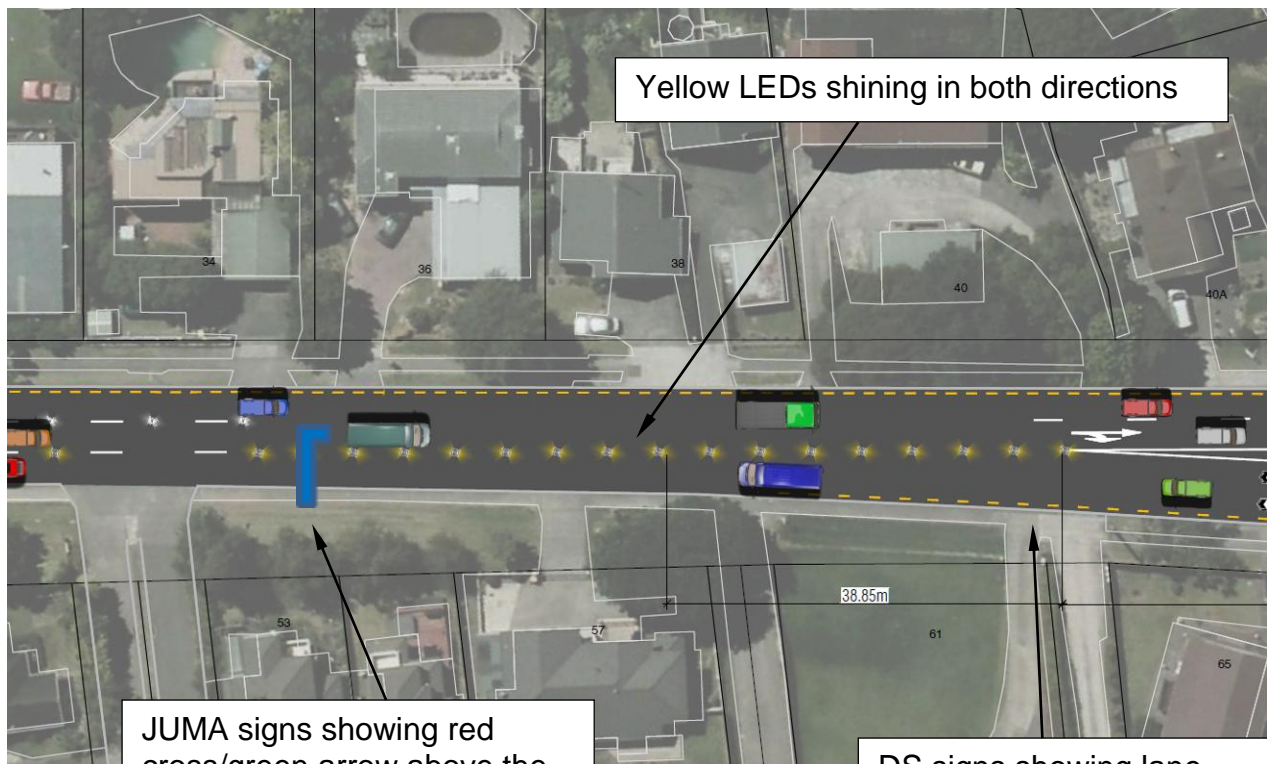
Option 2



Figure 5: Transition area Configuration 2 - Eastbound priority (afternoon peak hours)



No line-marking to be provided during transition area



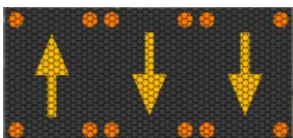
Yellow LEDs shining in both directions

JUMA signs showing red cross/green arrow above the middle lane highlighting the use of the lane configuration

DS signs showing lane configuration. 2 options being considered. Comment required:



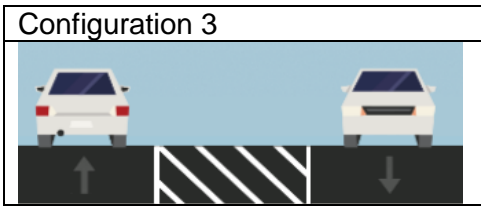
Option 1



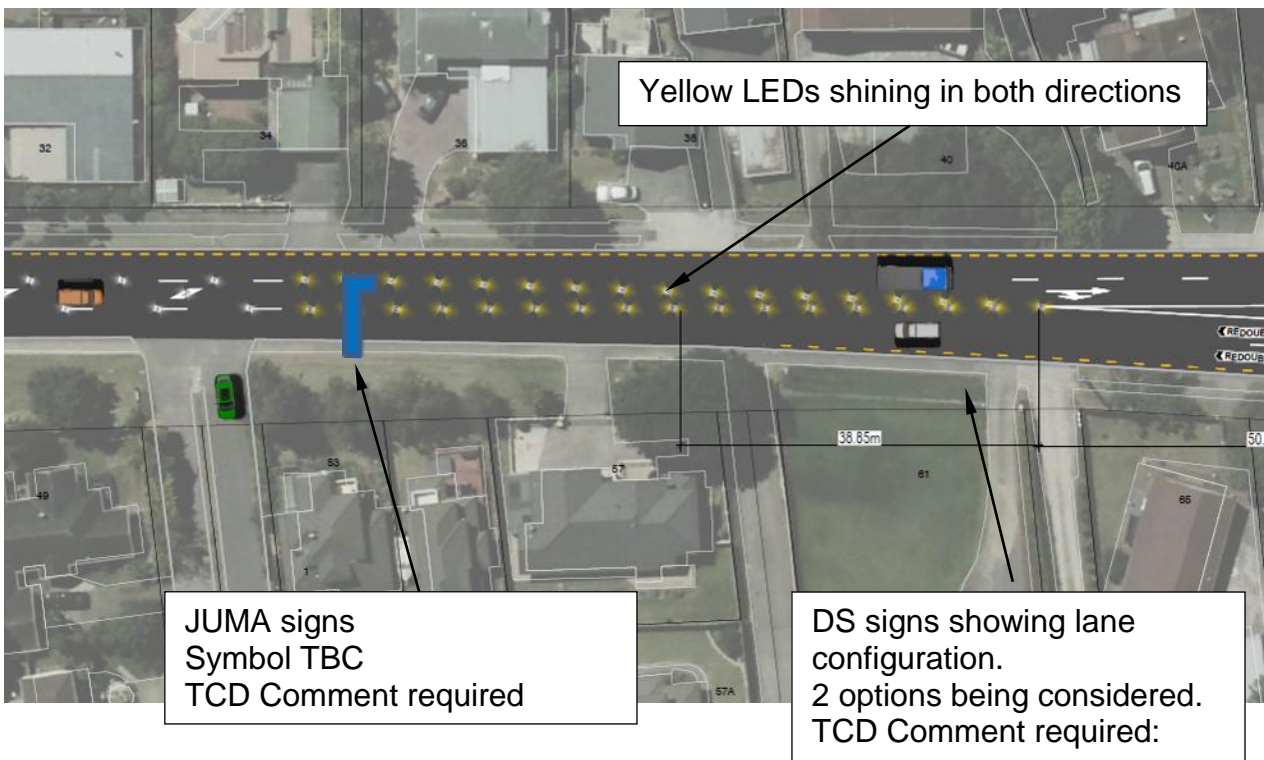
Option 2



Figure 6: Transition area Configuration 3 – Flush Median Arrangement (off-peak)



No line-marking to be provided during transition area



Option 1



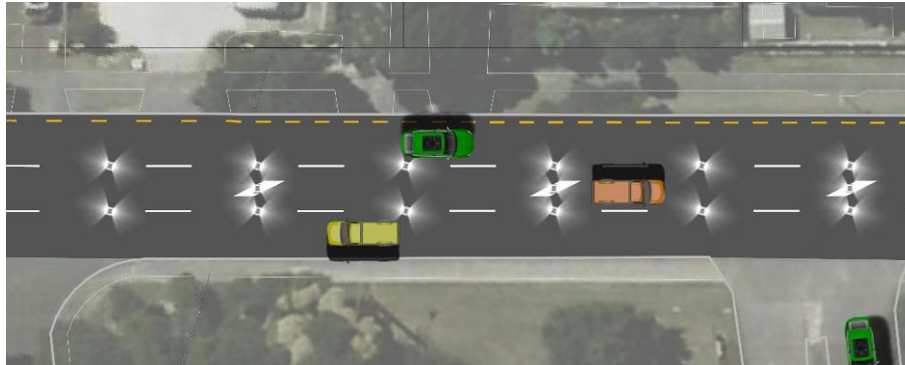
Option 2



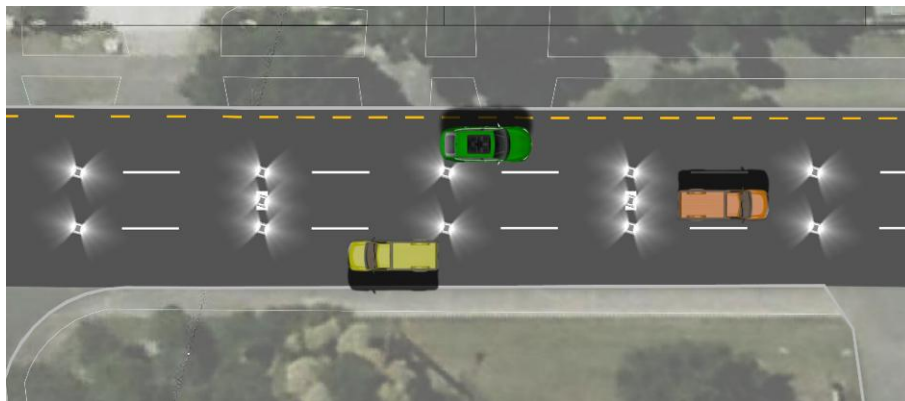
Various options were provided showing possible signage and LED lighting to give drivers' sufficient warning of the approaching lane arrangement. The preferred guidance for drivers, based on current understanding of driver behaviour is a JUMA with a red-cross and/or green arrow, similar to the Panmure Bridge arrangement, along with Variable Message Signs (VMS) on the approach and

white/yellow LED lighting in the road showing the lane marking. Several options of lighting arrangement were also provided for discussion, to show the potential option for the use of the middle lane as a flush median, in off-peak hours. It was suggested that additional line marking be introduced for the possible scenario of a power failure shown below.

Diagonal Marking (1/3rd the length of a standard flush line marking)



Perpendicular line marking (1/3rd of the available width)



Central line marking

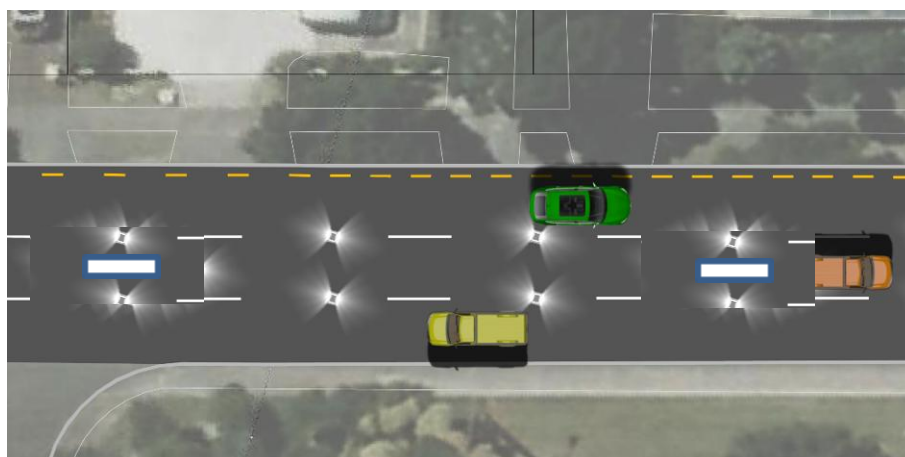


Figure 7: Potential central lane arrangements

The feedback from the TCD was that the LED only option is preferred for the transition area, with JUMAs as shown and Option 1 for the VMS signs. They also advised that the central lane arrangement should also be LEDs only, along with the lane line marking.

5. PROJECT DEVELOPMENT

Auckland Transport is now working with The University of Waikato to gather data on driver behaviour when faced with the new potential dynamic lane road layout, also known as a Psychological driver behaviour assessment. This involves developing a video with all existing road signs and line marking 'edited out', and the new proposed dynamic lane arrangement 'edited in'. This will then be run on the University of Waikato simulator where a Toyota Prius is placed in front of video screens. The video runs at a certain speed which can be altered by the accelerator and breaks. There are also screens in the mirrors showing the reverse direction to give drivers as real an experience as possible, without the possible dangers of a live road. A number of drivers are shown the edited videos where the driver behaviour is monitored and recorded to get as real and unbiased data set as possible. This will provide the project with a clearer understanding of how drivers will react when introduced to the new arrangement. Other projects the University have been involved with of a similar nature include:

- Driving while conversing (cell phone distraction);
- Drinking and Driving (the effects of moderate alcohol consumption);
- Self-explaining roads, and more.

Subject to the outcome of this study, the project will introduce the new dynamic lane arrangement in 2016 where the road capacity for vehicles will double in the peak direction.

Whangaparaoa Road will benefit from the trial mainly in the eastbound direction due to the capacity constraints at the intersection with Hibiscus Coast Highway in the westbound direction. However, relatively minor changes at this intersection will allow for higher vehicle flow through the intersection and improve the level of service for road users.

6. POTENTIAL APPLICATIONS

There are potential applications that the dynamic lane concept can be adapted for. Provision of an additional lane on the corridor also opens the possibility to introduce other capacity improvements for people and goods movement, including:

- Bus Lanes;
- Transit Lanes;
- Freight Lanes;
- Parking;
- Cycle Lanes;
- Segregated Cycle Lanes.



Figure 8: International examples of Dynamic Lanes and LED use

This potential will be available for many existing arterial roads around Auckland, with some necessary alterations to pedestrian facilities, but it will also open additional options for roads that have already been widened. Some corridors have two lanes in both directions, but are unable to accommodate cycling infrastructure or other demands effectively. The dynamic lane could allow for the removal of a lane which could be allocated to a bi-directional cycle lane, cycle lanes on both sides, or maintain parking through urban centres. It could even be used to add an additional lane in the peak direction.

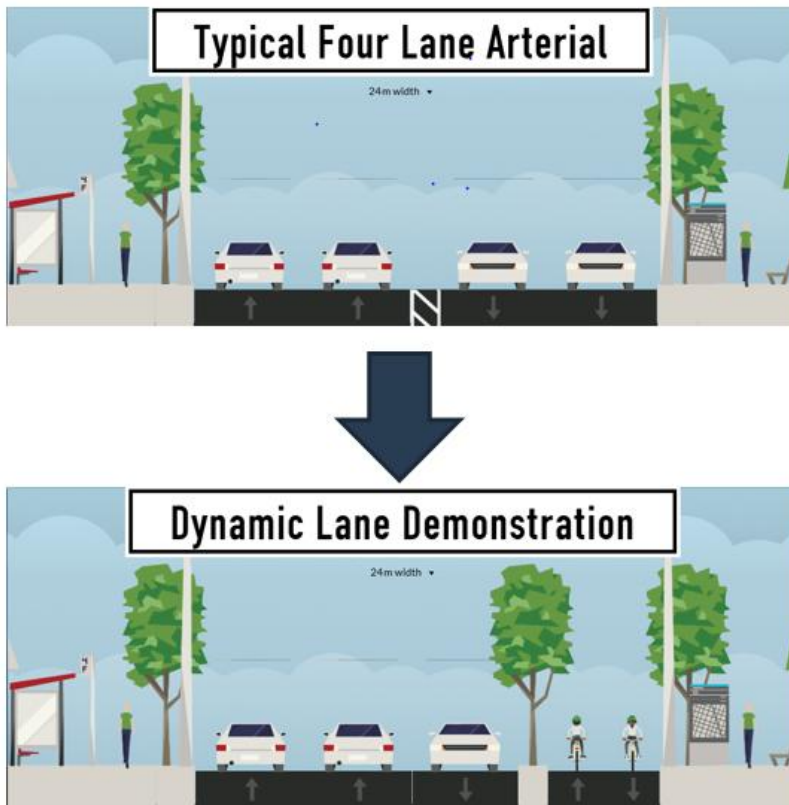


Figure 9: Potential central lane arrangements

7. SUMMARY

The Dynamic Lane project concept is still in development and has a number of likely hurdles and challenges to overcome before one can be introduced to the road network. Other versions have been introduced around the world, generally on main highways, bridges and tunnels where turning movements are minimised.

However, the majority of Auckland's roads have property access requirements and a slightly different approach is required. If the trial is proven a success, it is highly likely this will be introduced to a number of roads throughout the region, improving traffic flow and accommodating Auckland growth for some time ahead.