

Code of Practice for Traffic Control at Work Zone

July 2019 Edition

The Code of Practice (COP) for Traffic Control at Work Zone was published by Land Transport Authority (LTA), Singapore, to provide those involved in construction activities within the public street a comprehensive guide to temporary traffic control. The COP explains the fundamental principles for the provision of good traffic control and also gives a detailed guide on planning and designing the traffic control plan for the safety of road users.

This July 2019 Edition comes into effect on 1 July 2019 and supersedes all previous editions.

Clarifications on any aspect of this COP may be made with the Road Asset Regulation & Licensing Division of LTA, Singapore.

Origin and Development of Code of Practice for Traffic Control at Work Zone

Conflicts between traffic and works on or next to the road are inevitable. It is important to reduce such conflicts to optimise work efficiency and traffic safety, and to minimise traffic congestion, delay and inconvenience to road users.

The first COP for **Temporary Traffic Control** was published in June 1998 and dealt with the specific work area in the carriageway and its corresponding traffic control arrangement. This proved to be useful in providing contractors with typical temporary traffic control arrangement but inadequate when major temporary traffic schemes are involved. In June 2001, the COP for **Traffic Control at Work Zone** was published to provide those involved in all forms of construction activities within the road reserve with a comprehensive guide to temporary traffic control. In June 2006, general improvements were made to COP for **Traffic Control at Work Zone** to enhance its user-friendliness. Following that, periodically updates were also made to reflect any change in requirements such as new traffic control devices that have been introduced into the industry.

Given the increase in construction activities within the road reserve due to rapid developments and more demands for bigger capacity utility services in recent years, a comprehensive review of the COP was necessary to ensure that it continues to remain user-friendly and relevant from the planning to operations of temporary traffic control in a work zone.

Under this July 2019 Edition, the content had been condensed from 5 Chapters into 4 Chapters with more pictorials for users to better appreciate the requirements of temporary traffic control at work zone to enhance overall safety of working on public streets. Other revisions include a flowchart to guide users on the necessary checks to be carried out and physical improvements to ensure safe deployment of Truck Mounted Attenuator (TMA) at work zones.

Although the COP does not cover every possible situation, the emphasis is nevertheless on *safety first* under any situation. The safety philosophy for carrying out works on public streets is aptly epitomised by the maxim: "It is the works that should adapt to the traffic conditions whenever and wherever possible and not for the traffic to adapt to the convenience of the works!"

It has been assumed that the execution of the provisions in this Code is entrusted to suitably qualified and experienced people, for whose guidance it was prepared. Always consult a qualified person about the provision of temporary traffic control. In situations where the qualified person needs clarifications, he shall seek advice from the Authority.

Compliance with this COP does not of itself confer immunity from legal obligations.

This Code of Practice on Traffic Control at Work Zone is issued by the Land Transport Authority under Regulation 12 of the Street Works (Works On Public Streets) Regulations 1995. It deals with the standards, procedures and other requirements pertaining in particular to paragraph 2(a) of Regulation 12 for carrying out works on public streets.

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Chapter 1 Introduction

1-1 Scope

- 1-1.1 This COP sets out the standards and procedures for **Temporary Traffic Control** when carrying out works on public streets. It gives practical guidance to users of the code when implementing temporary traffic control needed to conduct works on public streets and road related facilities. Work activities include but are not limited to bore-hole exploration, excavation, construction, maintenance, utility works and stationing associated construction vehicles and equipment.
- 1-1.2 This code is **not** intended to prohibit the use of new methods or devices. New methods or devices could be considered provided sufficient technical data is submitted to the Authority to demonstrate that the new method or device is equivalent in quality, effectiveness, durability, and safety to that specified in this code.

1-2 Objectives

- 1-2.1 The **primary objective** of temporary traffic control is to manage the traffic as efficiently and safely as possible under all work conditions.
- 1-2.2 Traffic control aims to give adequate warning and clear information to motorists about the nature of works on site. This will translate into correct actions required in order to pass the work site safely. Traffic control shall also include measures to safeguard pedestrians, cyclists and personal mobility device (PMD) users when necessary. Proper traffic controls also protect those who are directly involved in carrying out the works.
- 1-2.3 The provision of proper traffic control shall comply with the prevailing Street Works Act and Street Works (Works on Public Streets) Regulations and other relevant legislative requirements of other authorities, such as the Workplace Safety and Health Act, Workplace Safety and Health (Construction) Regulations, Road Traffic Act, Road Traffic (Traffic Signs) Rules and etc.

1-3 Application

- 1-3.1 This COP applies to all utilities agencies/departments, contractors, other services providers and etc., who are involved in work on public roads and road related facilities.
- 1-3.2 Works on public streets within the Mass Rapid Transit (MRT) Railway Protection and Railway Safety Zones shall not be carried out without clearance from Development & Building Control Division of the Authority.
- 1-3.3 It is obligatory to apply for approval to work in the Central Expressway (CTE), Kallang Paya-Lebar Expressway (KPE) and Marina Coastal Expressway (MCE), Fort Canning and Woodsville tunnels or on roads or expressways installed with the Expressway Monitoring and Advisory Systems (EMAS), TrafficScan, Junction Eyes or Green Link Determining (GLIDE) System. Application forms are available from Intelligent Transport Systems Operations Division (ITS Operations).
- 1-3.4 Approval shall be obtained from the various divisions in LTA for carrying out road opening works on public streets. All applications shall be submitted via LTA.PROMPT, URL https://prompt.lta.gov.sg, to the Road Asset Regulation & Licensing Division.
- 1-3.5 Besides this Code, anyone who carries out works on public streets shall also be aware of and comply with the relevant requirements stipulated in other rules, regulations and codes of practice of the Authority.

1-4 Improvement Process

1-4.1 The standard of traffic control and road safety shall be improved continually to meet the rising expectations of road users. The process involves a continuous cycle of activities shown in the following diagram and further explained below:



Improvement process- a continuous cycle

- 1) Set New Standards: Set standards against international practices by drawing from the experiences of developed countries.
- 2) Education: Ensure that all personnel involved in traffic control and road safety has knowledge that is equal to their responsibility. Educate road users on traffic control and road safety measures.
- 3) **Implementation**: Making the Code contractually binding by developer/contractor's client would ensure successful implementation.
- 4) Auditing: Appoint an independent and qualified person to review the design and execution of the traffic control scheme. This is to ensure correct and consistent practice at different sites.
- 5) **Evaluation and Review**: Evaluate and review current practices continually to correct mistakes and improve standards.

1-5 Definitions

For the purposes of this COP, the following definitions apply unless the context otherwise requires:

"Authority" means the Land Transport Authority of Singapore established under the Land Transport Authority of Singapore Act 1995.

"carriageway" means the running surface which includes all traffic lanes and shoulders constructed for use by vehicular traffic.

"Peak hours" means the traffic peak hours specified by the Authority under Clause 6.10.1 of COP for Works on Public Streets, which include the hours from Monday to Saturday, 6.00am to 9.30am and from 5.00pm to 8.00pm. A listing of roads with different traffic peak hours is available on LTA.PROMPT system via URL – https://prompt.lta.gov.sg and will be updated from time to time.

"Professional Engineer" means a person who is a registered as a civil or structural engineer under the Professional Engineers Act and possesses a valid practicing certificate issued under that Act.

"qualified supervisor" means a full-time site personnel who possesses at least a Certificate in Pavement Construction and Maintenance issued by the Building and Construction Authority, or equivalent.

"competent person" means a person who has, through a combination of training, qualification and experience, acquired knowledge and skills enabling that person to correctly perform a specified task. To be conversant with the latest LTA's Civil Design Criteria, Standard Details of Road Elements, Road Safety Guidebook and Code of Practice for Traffic Control at Work Zone.

"road" means public street as defined in the Street Works Act 1995 or any part thereof as implied by the context.

"traffic control" means the process required to regulate, warn and guide road users and advise them to traverse a section of a road in the proper manner.

"traffic control devices" means the signs, cones, barriers, flashing lamps or other devices placed temporarily on or adjacent to a road to regulate, warn, or guide road users.

"work zone" means the entire section of the road over which temporary traffic control related to the work activity is exercised.

"work area" means the area occupied physically by the works, which includes the space required for workers, equipment and materials.

"Work duration" refers to characteristic of work. The three categories of work duration are defined below:

- 1) Long term means stationary works which occupy lane(s) for extended period continuously.
- 2) Short term means stationary works which occupy lane(s) temporarily and can be removed quickly.
- 3) Mobile means continuously moving works with intermittent stops.

"detour" means traffic is directed to another road to bypass the closed area.

"diversion" means traffic is directed to a temporary road or lane placed in or next to the carriageway.

"road related facility" includes any traffic sign, directional sign, street name sign, traffic light, bus shelter, railing, lighting apparatus and any optical, electronic, communication, monitoring or computerised equipment necessary for the control and management of traffic, and any other road related structure and facility maintained by the Authority.

Chapter 2 Fundamental Principles of Traffic Control

2-1 General

2-1.1 This Chapter elaborates on the fundamental principles in ensuring that a good and proper traffic control system is provided in a work zone. It is not possible to provide standards and applications to cover all conditions. Therefore a good understanding of the 10 fundamental principles stated in sections 2-2 to 2-11 is essential. Complying with the fundamental principles shall take precedence over standard details and typical applications.

2-2 Safe Road Environment

- 2-2.1 Safe passages should be provided for both motorists, pedestrians and personal mobility device (PMD) users going through the work zone. This can be achieved by:
 - 1) Warning road users in advance of changing road environment;
 - 2) Informing road users of the condition to be encountered;
 - 3) Guiding road users through unusual sections of road;
 - 4) *Controlling* road users at conflict point; and
 - 5) Forgiving road users' mistakes when accidents happen.

2-3 Minimum Risk

2-3.1 Roadside hazard management measures can be considered to reduce the risk to as low as reasonably practicable in providing a forgiving roadside environment. The fundamental principles of roadside hazard management are as follows (in descending order of priority):



- 1) **Removing** the hazard whenever possible or by providing clear zone to enable vehicles veering off the carriageway to recover by themselves;
- 2) **Relocate** the hazard to an alternative location where the risk of a vehicle impact is relatively lower if the roadside feature cannot be removed;
- 3) **Redesigning** the roadside feature that has a relatively lower risk if the roadside feature cannot be removed or relocated;
- 4) Shield the roadside obstacle with an appropriate safety barrier if the roadside feature cannot be removed, relocated or redesigned;
- 5) **Delineate** the carriageway by using signs, lane markings, delineator poles, pavement markers etc. to guide the motorists to keep within the travelled way and minimise the risk of vehicles losing control and veering off the carriageway and impacting roadside obstacles.
- 2-3.2 Risks for road users going through the work zone can be mitigated by ensuring:
 - 1) No surprises;
 - 2) No hidden traps;
 - 3) Free of unforgiving hazards;
 - 4) Controlled release of information;
 - 5) Consistent messages and repeats if necessary to reinforce; and
 - 6) Good visibility under all road conditions.

2-4 Planning Ahead

- 2-4.1 Traffic control requirements at work zones shall be planned in advance in the following phases:
 - 1) *Planning and Design Phase* To identify and incorporate traffic control requirements into contract specification.
 - 2) Start of Construction Phase To integrate traffic control into the construction planning processes.
 - 3) *Start of Every Major Phase* To re-examine and adjust traffic control scheme to suit prevailing site condition.

2-5 Good Traffic Control Plan

- 2-5.1 Traffic Control Plan (TCP) can be designed effectively by:
 - 1) *Designing traffic control plan in advance* To develop the TCP in detail at the beginning of each of the phases stated in **2-4**.
 - 2) *Complying with basic design principles of permanent roads* The road provided in the work zone should be similar to that of a normal road.
 - 3) *Exercising sound engineering judgement* To take into consideration the unique characteristics of each work site.

2-6 Effective Traffic Control Devices

- 2-6.1 Traffic Control Devices (TCD) should be designed, placed, operated and maintained effectively to meet the basic requirements of:
 - 1) Warning, informing and guiding road users;
 - 2) Commanding the attention of road users to the devices;
 - 3) Conveying a clear and simple message;
 - 4) Commanding the respect of road users so that they will obey instructions; and
 - 5) Allowing adequate time for road users to respond in an orderly and predictable manner.

2-7 Trained Personnel

- 2-7.1 By ensuring that only competent persons are involved in traffic control.
 - (1) Appointment of a person with authority to control the progress and to be overall in-charge;
 - (2) Training of site supervisors who are already conversant with safe methods of work in traffic control. Site supervisors should be appointed to supervise the selection, placement, operation, maintenance and removal of the traffic control devices; and
 - (3) Training of workers to be fully conversant with safe methods of placing, operating, maintaining and removing devices on the road.

2-8 Workers Safety

- 2-8.1 Workers are to be protected from the hazards of working in the work zone. This can be achieved by:
 - (1) Training all workers on the basics of road safety;
 - (2) Informing motorists of the workers' presence through traffic signs;
 - (3) Placing continuous barricades along workspace to separate workers from traffic. This will also prevent workers from straying into traffic space during work;
 - (4) Providing appropriate means for workers access when entering or leaving the work zone especially along high-speed roads;
 - (5) Placing temporary safety barriers to protect workers from vehicular traffic;
 - (6) Reducing vehicular speed if necessary for the safety of workers and road users;
 - (7) Providing proper lighting for night work so that the work site is visible at night for the safety of workers and road users. However, the lights used shall not be blinding to motorists;
 - (8) Providing a lead vehicle to warn oncoming traffic and to shield workers. To shield workers and divert traffic with a shadow vehicle; and
 - (9) Providing workers with high visibility clothing so as to be more conspicuous and visible during both day and night.

2-9 Safety of Pedestrian Cyclist and Personal Mobility Device (PMD) Users

- 2-9.1 The following provisions shall be made to separate the pedestrians, cyclists and PMD users from worksite activities and adjacent traffic:
 - (1) Advance information signs to direct pedestrians, cyclists and PMD users to a safe road crossing;
 - (2) In the event that existing footpath/cycling/shared path is affected by the works, an alternative smooth and clearly delineated path with temporary signs shall be provided accordingly. Examples for temporary signs for cycling path are provided in **Appendix I**.
 - (3) In the event that the existing covered walkway is affected by the works, an alternative well-lit covered walkway shall be provided for to protect pedestrians, cyclists and PMD users, especially during long term work;
 - (4) Continuous barricades to keep pedestrians, cyclists and PMD users from interference with the work activity/traffic, thereby preventing accidents; and
 - (5) Watchmen, temporary traffic control devices and/or audible warning devices to control the movement of works vehicles and equipment across pedestrians, cyclists and PMD users' way.
 - (6) Provision of barrier-free access along a footpath/walkway/cycling path/shared path affected by the works. The contractor shall ensure that the same provisions are made along the temporary footpath/walkway/cycling path/shared path affected. The footpath/walkway should never be less than 1m wide, and whenever possible should be at least 1.5m. The cycling path should never be less than 1.8m wide, and whenever possible should be at least 2.0m. The shared path should be at least 2.0m wide, and whenever possible at least 2.5m.

2-10 Vehicles and Equipment Safety

- 2-10.1 All vehicle and equipment used on site shall not be a safety hazard to both road users and workers. Safety can be enhanced by:
 - (1) Controlling work traffic for shared right of way by providing portable traffic signals;
 - (2) Controlling parking by providing safe designated parking space for work vehicles, plants and equipment within work site to prevent them from causing obstruction to others;
 - (3) Improving conspicuous of the vehicles/equipment and to alert road users by displaying revolving amber lights whenever vehicles or equipment are in operation;
 - (4) Inspecting TCDs regularly by using a Safety Inspection Vehicle loaded with additional devices to replace damaged devices;
 - (5) Fitting all protective vehicles with Truck Mounted Attenuators (TMA) and large arrow panel with amber lights;
 - (6) Providing recovery/service vehicle to remove stalled vehicles immediately; and
 - (7) Installing independent surveillance cameras where necessary to monitor traffic conditions effectively and provide real-time information on the effects of roadwork on traffic.

2-11 Road Surface Condition

- 2-11.1 As part of a traffic control layout, there will be occasions when areas of carriageway are brought into operation that would not normally be used. The adequacy of these temporary surfaces should be considered before use. In particular, the effect on traffic of the following should be borne in mind:
 - (1) Cross falls on chevron areas;
 - (2) Drain covers in hard shoulders and in central medium at crossovers;
 - (3) Clearances if traffic runs on edge strengthening;
 - (4) The need to sweep the surface of steel decking or road to remove any construction debris and maintain a skid resistance of not less than 65BPN and 55BPN respectively at all time.
- 2-11.2 The effect on carriageways of carrying unexpected traffic loads also needs to be considered (e.g. drain covers on the hard shoulder may need to be strengthened). There is also a need to provide a regular maintenance regime to reduce incidents during wet weather periods.

Chapter 3 Planning, Design and Implementation of Traffic Control Plan

3-1 General

- 3-1.1 Traffic control at work zone starts from the first advance warning sign and ends at the last traffic device where traffic returns to normal. This Section provides guidelines to plan and design the Traffic Control Plan (TCP).
- 3-1.2 TCP ranges from being very detailed and customised, to a mere reference to a typical drawing(s) in this Code or specified drawings contained in contract documents. Examples of Traffic Control Plan (TCP) for typical situations are given in **Appendix II** of the Code to guide the designer.
- 3-1.3 Traffic control requires forethought and provision shall be included in the contract specification for the contractor to develop the TCP.

3-2 Phases of Traffic Control

- 3-2.1 There are five phases of traffic control for works on road.
 - (1) **PLANNING PHASE** To identify and include traffic control requirements in the contract specification, works program & method of construction.
 - (2) **DESIGN PHASE** To design the TCP in detail. For planned continuous lane closure submission to LTA's approval is required.
 - (3) **IMPLEMENTATION PHASE** To install the temporary traffic control devices safely in accordance with the designed and/or approved TCP and make adjustment if necessary according to site conditions and/or when required by the Authority.
 - (4) **OPERATION AND MAINTENANCE PHASE** To inspect the implemented traffic scheme and devices regularly by day and night to ensure that they are effective and absolutely safe.
 - (5) **CLOSE OUT PHASE** To remove all the traffic control devices safely and reinstate the permanent traffic scheme.

3-3 Planning for Traffic Control

3-3.1 Planning generally involves a detailed understanding of the scope of works and identifying appropriate traffic control scheme for the work zone. The planning phase of traffic control are depicted in an action **Flowchart 3.1**.

Flowchart 3.1 Planning Flowchart



3-4 Design Considerations

- 3-4.1 Design shall start after preferred temporary traffic control scheme has been selected for each stage of the work. Important design consideration shall include the following:
 - (1) Work Duration
 - (2) Road Speed
 - (3) Road Type
 - (4) Road Location
 - (5) Work Location
 - (6) Traffic Condition
 - (7) Type of Work
 - (8) Mode of Operation

Refer to Summary of Design Considerations on page 20 for more details.

3-5 Design Traffic Control Plan

- 3-5.1 Work Zone is typically subdivided into four zones as shown below: -
 - (1) ACTIVITY ZONE
 - (2) TRANSITION ZONE
 - (3) ADVANCE WARNING ZONE
 - (4) TERMINATION ZONE

3-5.2 **Designing the Activity Zone**

The Activity Zone comprises the following components (shown in Figure **3.1**):

- (1) Work Area Area occupied physically by the works, which includes the space required for workers equipment and material.
- (2) **Traffic Space** Area where traffic is routed through the activity area. Traffic space must be properly delineated and channelled to guide traffic through safely. Road capacity and traffic demand will determine the width of the traffic space.
- (3) **Safety Buffer** Space separating traffic space from workspace. No storage of equipment and material, parking of vehicles, or presence of worker (except maintenance activity) is allowed for the safety of the workers and road users. It allows an errant vehicle to stop in time before hitting the workspace. The two types of safety buffers are the longitudinal safety buffer and the lateral safety buffer.
 - (a) Longitudinal safety buffer is a space upstream of a work area. The recommended dimensions are as shown in the Table 3-1.
 - (b) Lateral safety buffer is to separate work area from traffic space. The recommended dimensions are as shown in Table 3-2.

Table 3-1: Longitudinal Safety Buffer				
Speed (km/h)	Length (m)			
=> 80	6	50		
70	3	60		
60	2	20		
50	1	0		
40	10			
Table 3- 2	Table 3- 2 : Lateral Safety Buffer			
Speed (km/h)	Minimum Width (m)			
	Desirable	Absolute		
=> 80	1.2	0.6		
70	0.9	0.6		
60	0.5	0.3		
50	0.5	0.3		
40	0.5	0.3		



Figure 3.1 Component of an Activity Zone

3-5.3 **Designing the Transition Zone**

A transition would be required when traffic is redirected from a normal path to a new path. A suitable taper length and geometry should be provided to meet the requirements of the design speed. The recommended lengths of various types of taper are shown in the **Table 3-3**.

- 3-5.4 The definitions of the tapers (shown in Figure 3.2) referred to in the below paragraph are:
 - (1) A Merging Taper used where two lanes merge into one lane. It needs a longer distance for the drivers to adjust their speed to merge with an adjacent lane before the end of transition.
 - (2) A Shifting Taper used when a lateral shift is needed without merging.
 - (3) A Shoulder Taper used on an expressway when work is in progress on a shoulder lane.
- 3-5.5 The following factors shall be considered when designing a taper. They are:
 - (1) The start of the taper should be located such that its full length is visible at 60m to 100m ahead. The start of the taper should be located at the upstream of a bend so that it is clearly visible on the approach.
 - (2) Transition area is also a safety zone. Nothing other than traffic control devices are allowed in the transition zone.
 - (3) Devices should be spaced such that the taper would appear uniform and continuous to approaching motorists, and traffic cannot weave around them easily.

Table 3- 3 : Recommended Length for Taper (m)						
Speed	90	80	70	60	50	40
(km/h)						
Merging	200	150	120	80	40	20
Shifting	100	80	60	40	20	10
Shoulder	20	20	NA	NA	NA	NA





3-5.6 **Designing the Advance Warning Zone**

The function of the advance warning zone is to give advance warning to the approaching traffic of the activity area and transition area ahead. Drivers shall be able to see the warning signs, understand the conditions ahead and know what is expected of them.

3-5.7 Typically, two temporary advanced warning signs shall be provided for at every approach to work site along expressway and major road as shown in **Table 3- 4**. Signs warning motorists of the nature of road restriction ahead will follow this. Examples of such signs are given in **Table 3- 5**.

	Table 3-4 : Compulsory	Advanced Warning Signs
1st sign	To alert and command road user's attention. A caution sign is normally used to alert and command driver's attention to the work zone. Typical visibility of 1st sign = Minimum Stopping Sight distance.	CAUTION
2nd sign	To notify road users of the general nature of the work ahead. Logo identifies the organisation carrying out the work.	Agency Logo Works Ahead

	Table 3- 5 : Example of Temporary Signs showing lane changes					
3rd sign	To guide road users of the action to be taken e.g. merge to middle lane, slow, do not over-take, workmen present.etc.					

- 3-5.8 Posting of temporary advance warning signs shall comply with the following requirements:
 - (1) Provide temporary warning signs at every approach to work zone along the expressway and major road.
 - (2) The placing of the advanced warning signs shall be in compliance with Table 3-6.
 - (3) The number of signs and spacing shall be adjusted to suit the site condition e.g. poor geometry, adverse sight distance and obstruction etc.
 - (4) Temporary warning signs shall only be duplicated on the right side of the carriageway if signs on the left-hand side are likely to be obscured or overlooked. The typical distances of temporary warning signs upstream of the taper are as shown in the **Table 3-6**.

	Table 3- 6 : Minimum Distances of Temporary Signs						
Distance from taper starts	90/80 km/h	70 km/h	60 km/h	50 km/h	40 km/h and below		
3rd sign	240 m	200 m	160 m	120 m	60 m		
2nd sign	360 m	300 m	240 m	180 m	90 m		
1st sign	480 m	400 m	320 m	240 m	120 m		

3-5.9 **Designing the Termination Zone**

The termination zone is used to channel traffic back to its normal traffic path and also to inform motorists that they have passed the work zone.

- 3-5.10 The design considerations for termination zones are:
 - (1) A taper of 1:10 or at least 30m shall be provided to ease traffic back to its normal path for expressway, major arterial, distributor, and 1:1 for other roads.
 - (2) End of Work Zone Sign shall be used at the end of the work zone of long term work to inform and thank road users for their understanding and co-operation. (Table 3-7)

Table 3- 7 : End of Taper Sign				
End Taper	Expressway, major arterial and distributor – 1:10 or minimum 30m.			
	Other road – 1:1 or minimum 2 traffic cones at 1.2m centre to			
	centre (c/c).			
End of Work Zone sign at		Land Transport Q Authority		
30m after the End Taper		Land Handbort X Handbort		
(applicable for long term		End of Work Zone		
works)		Ellu of Work Lone		
		Thank You		
		For Your		
		Co-operation		

3-6 Drawings

3-6.1 The following information as provided in **Table 3-8** shall be submitted to the Authority for prior approval.

Table 3-8 : Drawing Information Table				
Title	Scales	Use		
Location plan	1:20,000/10,000/5,000	To locate the work zone within the general vicinity		
Survey plan on current site condition	1:1,000/500/100	To show all existing feature, topography and boundaries		
Setting out plan	1:1,000/500/100	To show detail lines, dimension, position, orientation and direction of the components		
Layout plan/Site plan	1:1,000/500/100	To show the spacing, types, layout and position of the devices used in each component		
Traffic plan	1:1,000/500/100	To show the traffic scheme proposed for the temporary traffic control		
Longitudinal section	1:1,000/500/100	To comply with permanent road design drawings' detail		
Cross section	1:20/10	To show the position, dimensions and details of the components' cross section		
Detail plan	As required	To amplify in detail all important information of traffic control and road safety		

	Planning Process of Traffic Control			
Star	Description	Deteil		
	Assemble Data	Detail		
1	Assemble Data	• Scope of works, Method of construction, Road data, Traffic data, ata, should be required		
2	Study roadway	Duration of the works		
2	occupancy	Duration of the works Comission of the work		
	occupancy	 Carriageway space occupied by the work Boad accupied at any one time or day 		
		 Road occupied at any one time of day The hours by which the road will be affected each day 		
3	Identify feasible	Ine nours by which the road will be affected each day Lone constriction		
5	alternatives	Lane construction		
	unternatives	Lanc closure Shored right of year		
		Median arossovar		
		Detour		
		Detour Tomporous by poss/diversion		
		Intermittant alogura		
		Intermittent closure Use of read shoulder or median		
4	A polyce volume/conscity	Use of foad shoulder of median Treffic impost study		
4	relation & traffic impact	Ability to some with the twoffie domand		
5	A palyse other	Ability to cope with the frame demand		
5	improvement techniques	On-peak works Night works		
	improvement teeninques	Remove parking		
		Remove parking Deschedule works		
		Weekend works		
		Reversible lane		
		Reversion faile		
		Modify signal time		
6	Evaluate traffic control	Vehicle delays and stops		
0	schemes	 Safety and accidents 		
	senemes	 Project and traffic controls' costs 		
		Air pollution and husiness losses		
		Ftc		
7	Modify procedure	Review designs		
		Work procedure		
		Alternative construction methods		
		Other procedure		
8	Select preferred traffic	• Identify preferred traffic control scheme for each stage of the		
-	control scheme	works		

S/No	Туре	Differentiation		Characteristic
1.	Work	Long Term	٠	Long term means stationary works which occupy
	Duration			lane(s) for extended period continuously
			•	Require to change the alignment of the road and/or
				maintain the same number of the existing lane
			•	Require use of portable and elaborate devices e.g.
				use of high containment road safety barrier for the
			•	Require relocation of traffic signals and/or traffic
				furniture
			•	Detailed TCP/traffic diversion plan and comply
				with the LTA Civil Design criteria, Road Safety
				Guidebook and approved by LTA
			•	Examples include but are not limited to:
				Tunnel shaft construction
				Deep excavation
				Rigid Pavement Construction
				Road Widening
2.		Short term	•	Short term means stationary works which occupy
				lane(s) temporarily and can be removed quickly
			•	Examples include but are not limited to:
			•	Connection works for utility supply
				Trial trench
				 Trenching for utility laying
				 Manhole maintenance
3.		Mobile	•	Continuously moving works with intermittent stops
			•	Portable device
			•	Examples include but are not limited to:
				Signs washing
	D 1			Road marking
4.	Road	besign speed for diversion	•	Horizontal alignment
	speed	than 10 km/h of the existing	•	Vertical profile
		permanent gazette speed	•	Cross-section Sight distance
		limit		Taper length
		Road Geometry for		Safety huffer
		diversion shall comply with	•	Sign spacing
	D 1	LTA Civil Design Criteria		
5.	Koad Tura	Expressway	•	Legal speed
	rype	Primary Access	•	Access control
		Local Access		Junction type
		2.5.001 1100005		Shoulder Stopping/waiting
				Stopping/waiting Parking/driveway
6	Road	Rural area	•	Local traffic
0.	Location	Urban area		Pedestrian
		Public housing	•	Local business
		Private housing	•	Bus stop
		CBD	•	Parking
		Industrial area	•	Driveway

Summary of Design Considerations

S/No	Туре	Differentiation	Characteristic	
		School Zone	Stopping	
7.	Work Location	Outside/near carriageway Shoulder lane Slow/left lane Intermediate lane Fast lane Multi lanes Median Junction/interchange	 Road encroachment Work access Work traffic Speed gradient Fast/right lane is hazardous Special attention on fast lane 	
8.	Traffic Condition	CONDITION I: Demand always< road capacity CONDITION II: Demand at peak> road capacity	 Long term lane closure may be allowed for condition I Lane closure will not be allowed on peak hours. Temporary widening or traffic diversion required for long term work 	
9.	Type of Work	TYPE I: Can be removed quickly. TYPE II: Cannot be removed easily.	 Simple planning would suffice for Type I Detailed planning needed for Type II for unforeseen delays 	
10.	Mode of Operation	MODE I: Workmen are always in attendance. MODE II: Work left unattended.	 Use simple and portable devices for Mode I Use robust devices and keep clear of passing vehicles. 	



3-7 Implementation, Operation & Maintenance and Close-out

*Where there is any modification to approved temporary traffic diversion plan, LTA's approval is required prior to implementation.

Figure 5.1

3-8 Implementation Procedure

3-8.1 A full-time qualified supervisor shall be appointed to implement TCPs before works start. Implementation includes preparation and execution. The supervisor shall perform the following check:

(1) **Preparation Phase**

- (a) Determine and prepare all devices to ensure that they are available and in good working condition.
- (b) Ensure that the personnel assigned to place the devices are aware of their duties.
- (c) Set out the components of the work zone by marking the positions on the ground.
- (d) Verify that the setting-out is suitable and feedback to the competent person if modification is required.
- (e) For long term works,
 - (i) Seek LTA's approval to alter the approved temporary traffic diversion plan if required.
 - (ii) Inform the relevant authorities in advance of the day of implementation.

(2) Execution Stage

- (a) Place the devices following a safe system.
- (b) Ensure clear visibility of temporary traffic signs.
- (c) For long term works,
 - (i) Cover the temporary traffic signs and devices with suitable material before they are required and remove the covers upon implementation of temporary diversion plan.
 - (ii) Cover up or remove permanent signs that have become inapplicable or misleading.
- (d) Check for adequacy and clarity of the traffic control layout before work starts.

3-9 Operation Procedure

- 3-9.1 The same supervisor should supervise the operation. He should perform the following daily routine tasks: -
 - (a) Inspect and record devices that have been displaced or damaged during the night or the day before.
 - (b) Deploy a protective (shadow) vehicle where needed.
 - (c) Make adjustment to the devices for the day's work.
 - (d) Check the safety and effectiveness of the devices through a drive.

(1) When working

- During the course of work, the qualified supervisor shall: -
- (a) Ensure at all times that the signing represents the prevailing conditions accurately.
- (b) Ensure that workers do not stray into adjacent live traffic lanes and safety zone.
- (c) Ensure that nothing e.g. equipment, machinery, material, vehicles, men etc is within the safety zone.
- (d) Check that the floodlight does not dazzle drivers.
- (e) Re-position devices that have been displaced by traffic.

(2) End of workday

With the exception of long term works, the qualified supervisor shall ensure: -

- (a) All temporary traffic signs are removed from site in a safe manner; and
- (b) The affected traffic lane is reinstated and reopened for use at the end of each workday.

(3) Long term works

Where temporary traffic diversion is involved, the qualified supervisor shall carry out periodic inspection of all the traffic devices to ensure that they are properly maintained at all times.

(4) After the workday (inclusive of weekends and holidays)

- (a) Assign personnel to inspect and maintain the devices.
- (b) Provide after-hours contact for replacing damaged and displaced devices.
- (c) Record all damaged or displaced devices.

3-10 Closing out Procedure

- 3-10.1 The following routine shall be followed when carrying out permanent reinstatement works: -
 - (a) Reinstate all markings and make good all defects on road.
 - (b) Restore all permanent signs that were covered or removed.
 - (c) Clean up the site.
 - (d) Remove the temporary devices by following a safe procedure.
 - (e) Rectify all permanent devices before installation.
 - (f) Ensure that the permanent devices are in order of original positions before leaving the site.

3-11 Safe Operation Procedure for Truck Mounted Attenuator (TMA)

3-11.1 Only trained driver/operator is allowed to operate the TMA. The operator shall carry out daily routine checks on all items contained in the inspection checklist provided by the manufacturer and maintain the TMA in tip-top condition. The guidelines for use of TMA for road works is detailed in **Appendix III**.

Chapter 4 Design and Application of Traffic Control Devices

4-1 General

- 4-1.1 Traffic control devices are used to ensure orderly and predictable movement of traffic, as well as to warn and guide road users safely through the work zone. Temporary traffic control devices include: -
 - (1) Temporary advanced warning signs
 - (2) Channelling and delineation devices
 - (3) Road safety barriers
 - (4) Barricades
 - (5) Truck mounted attenuators
 - (6) Visibility enhancing devices
 - (7) Traffic portable system
 - (8) Half-height hoarding

Refer to Appendix IV for examples of good and poor temporary traffic control at work sites.

4-2 Temporary Advance Warning Signs

4-2.1 Design – Temporary advance warning signs shall be diamond-shape with a black legend on *Fluorescent Orange Wide Angle Microprismatic Retro-reflective Sheeting*. Sheeting specifications shall be in accordance to Type IX and above sheeting classification specified in the prevailing version of *ASTM D4956 Standard Specification for Retro-reflective Sheeting for Traffic Control*. The size of the sign shall be as follows: —

Road Type	Size
Expressways	1200mm x 1200mm (min)
Other Roads	900mm x 900mm (min)

4-2.2 Application - Warning signs call for attention to potential hazardous conditions on or adjacent to a road temporary traffic warning signs are placed in advance of the site to alert road users of the obstructions or conditions caused by the works ahead. The complete temporary warning sign applications are given in the **Appendix V**.

4-3 Information Signs

4-3.1 Design – Unless otherwise directed, all temporary information signs shall be rectangular-shape with a black legend on a *Fluorescent Orange Retro-Reflective Sheeting*. Sheeting specifications shall be in accordance to Type IV and above sheeting classification specified in the prevailing version of *ASTM D4956 Standard Specification for Retro-reflective Sheeting for Traffic Control*.

The design of the legend should comply with the guidelines as specified in the LTA Standard Details of Road Elements issued by the Authority and is available via URL – <u>https://www.lta.gov.sg/content/ltaweb/en/industry-matters/development-and-building-and-construction-and-utility-works/street-proposals.html.</u>

4-3.2 Application – Information signs are mainly used to give road users simple and direct information of the works or direction. Example of information sign applications are given in **Appendix V**.

4-4 Lateral Shift Markers (LSM)

4-4.1 Design – LSM shall be provided to show a lateral change of direction of the carriageway through a work zone or to indicate a sharp bend on a diversion or detour road. It shall be 600mm wide by 750mm high with a black legend on *Fluorescent Orange Wide Angle Microprismatic Retro-Reflective Sheeting*. Sheeting specifications shall be in accordance to Type IX and above sheeting classification specified

in the prevailing version of ASTM D4956 Standard Specification for Retro-reflective Sheeting for Traffic Control.

4-4.2 Application – They shall be used as supplements to other delineators e.g. at the approach taper together with traffic cones. They shall be placed, on the outside of a turn or curve, in line with and at approximately a right angle to the approaching traffic. Spacing of the LSM should be such that the road user always has at least two in view, until the change in alignment eliminates the need for the signs.



4-5 Pavement (road) Marking

- 4-5.1 Design Pavement markings used in the work zone shall be the same as for permanent roads. The markings must comply with the standard application and designs as prescribed in the Road Traffic (Traffic Signs) Rules. Approval of the Authority shall be required if existing pavement marking is to be altered as part of a temporary diversion plan.
- 4-5.2 Application
 - 1) Black paint shall not be used over existing road lines as it may confuse motorists under certain lighting conditions.
 - 2) Water-blasting road marking removal system shall be used to remove existing road markings. Alternative method of removal may be used, on case-by-case basis.
 - 3) Water based road marking paint, which complies with SS624, or thermoplastic paint may be used for temporary markings as long as the markings are properly maintained at all times and removed completely when changes in road lines pattern are anticipated. There shall not be any "ghost" marks that will confuse road users.

4-6 Sign Mounting & Covering

- 4-6.1 Signs should normally be placed:
 - 1) At right angle to the line of sight facing the traffic.
 - 2) Do not obstruct existing traffic signs.
- 4-6.2 Type of supports

Signs shall always be placed in front of any physical obstruction. Signs shall never be placed directly behind a tree, lamp pole or other obstructions such that they obscure the full message on the sign face.

Post-mounted fix-in-place signs cast in concrete footing are generally used for long term works. The support details shall be constructed in accordance to LTA Standard Details of Road Elements. Typical clearances for post-mounted signs are as follows:

	Minimum Clearance
Vertical	2.4 m above ground level
Lateral	0.6m from edge of traffic lane



Example of support for post-mounted sign

Portable sign supports are generally used for short-term works. These portable supports can be designed to be collapsible or folded for ease in carrying, quick assembly at site and storage e.g. Aframe. The sign should be at least 300mm above the ground.



Example of portable sign support



Example of a plastic sign support mounted with the lateral shift marker

Types	Warning	Information		
		Land Transport Q Authority (Type of Works) Completing (Approximate Date) The Office: 28288888		
Background Fluorescent Orange colour		Fluorescent Orange		
Legend Black Pictograms/ Words		Black Pictograms/ Words		
Shape	Diamond	Rectangle		
Reflectivity	Wide Angle Microprismatic conforming to the requirements stated in the prevailing version of ASTM D4956 Type IX and above sheeting classification.	High Intensity Grade conforming to the requirements stated in the prevailing version o ASTM D4956 Type IV and above sheeting classification		

Summary

Types	Warning	Information	
Size (mm)	Enlargement Factor		
Expressway Other Roads	Refer to LTA Standard Details of Road Elements issued by the Authority and is available via URL –https://www.lta.gov.sg/content/ltaweb/en/industry- matters/development-and-building-and-construction-and-utility-works/street- proposals.html		
Sign posting	In advance	Well in advance	
Sign facing	Approximate at right angle to line of sight or turned away slightly		
Lateral Min : 0.6m clearance		Min : 0.6m	
Others	Signs shall not be obstructed by lamp posts or trees		

4-7 Delineation and Channelling Devices

- 4-7.1 Delineation and channelling devices shall be used in conjunction with other devices to:
 - (1) Separate traffic from the workspace, pavement drop-offs, pedestrian paths, or opposing traffic.
 - (2) Guide road users safely by indicating clearly the edge of the route and the path they should take.
 - (3) Guide and direct the approaching vehicles smoothly and gradually into the designated lane/s to pass the work zone safely.

4-8 Traffic Cones

- 4-8.1 **Design** Traffic cones shall be fluorescent red for good daytime visibility. It shall be fitted with retro-reflective band(s) for good night visibility and 2 numbers of agency logo shall be placed diametrically opposite each other on the band(s). The retro-reflective bands shall conform to the prevailing version of *ASTM D4956 Type IV* and above sheeting classification. The design of the cone should comply with the *prevailing version of BS EN 13422*.
- 4-8.2 Traffic cones shall be minimum 700mm tall, stable and not easily blown over or displaced by moving traffic.



Example of traffic cone with band(s), logo and dimensions

- 4-8.3 **Application** The portability of traffic cone is of particular advantage in emergencies for quick delineation, or in works that need regular changes of delineation.
 - (1) Traffic cones are mainly used for short duration delineation.
 - (2) They shall be removed after completion of works.



4-8.4 Only one type of traffic cone shall be allowed on site. The traffic cones shall be clean to ensure that they are clearly visible at all times. Using different types on one site would appear haphazard to drivers.

4-9 Temporary Kerbs

4-9.1 **Design** — Temporary kerbs shall be Type D1 kerb as shown in the Standard Details of Road Elements.



Example of temporary D1 kerbs used in road widening

4-9.2 **Application** — The use of D1 kerbs are similar to the permanent K2 kerbs. It could be used to delineate the edge of the temporary carriageway and temporary traffic island for long-duration road works along all roads except expressway.



4-9.3 Delineation for long-term work shall be augmented with 200mm thick pavement edge marking. Temporary kerbs cannot prevent vehicle or pedestrian intrusions onto a work site effectively. They should not be a substitute for safety barriers when these are clearly needed.

4-10 Water-Filled Barricades

4-10.1 Design — Water-filled barricades are modular water filled plastic containers of various sizes and shapes. They shall be minimum 1m tall for major roads and expressway and 0.8m tall for other roads. Each unit shall come with interlocking devices for use on tangent straight and horizontal curves with mounting devices for lighting.



Water-filled barricades used to delineate the carriageway

- 4-10.2 Application Water-filled barricades shall be interlocked and arranged in alternate red and white colours. It shall be used as traffic delineator to separate work area from traffic or to separate traffic from pedestrians, cyclists and PMD users when walkway is temporarily diverted next to a carriageway.
- 4-10.3 Water-filled barricades are not temporary safety barriers as they would not be able to contain a vehicle during an accident. It shall not be used as a replacement for permanent barriers, such as vehicular impact guardrails, that has to be temporarily removed because of the works. When VIGs or such permanent barriers are removed and need to be replaced temporarily, water filled safety barriers (WFSB) as those shown in Section 4-13.1 shall be used instead. It shall be placed at least 0.5m from the edge of the carriageway for expressway and 0.3m for other roads. Only one type shall be allowed on site. Using different types on one site would appear haphazard to drivers.



4-11 Traffic Cylinders/Vertical Panels

- 4-11.1 Design These devices shall comply with the prevailing version of BS EN 13422. The colour shall be fluorescent red that offers good day visibility. High Intensity Grade (the prevailing version of ASTM D4956 Type III) retro-reflective bands shall be fitted for night visibility. It shall be at least 750mm tall when fixed onto the ground, and at least 50mm wide.
- 4-11.2 Application Traffic cylinders are similar to traffic cones. However they shall be used only when space restriction does not permit the use of larger devices. They shall be easily fixed on the road or paved surface and not be easily displaced.



Delineation & Channelling Devices					
Туре	Traffic Cone	Temporary D1 Kerb	Water filled Barricade	Traffic Cylinder	
Colour	Fluorescent Red	Alternate Black and White	Alternate Red and White	Fluorescent Red	
Reflective Collars/Bands	White, Wide Angle Microprismatic conforming to the requirements stated in the prevailing version of ASTM D4956 Type IV and above sheeting classification	NA	Mounted with Fluorescent Orange Retro- reflective Disc	White, Wide Angle Microprismatic conforming to the requirements stated in the prevailing version of <i>ASTM</i> <i>D4956 Type IV</i> and above sheeting classification	
	700	Road Standard	*1000	Height : 750	
Min height (mm)			**1000	Width : 50	
		Detail	***600		
Min lateral clearance (mm)	300	100	*500 **300	300	
	*12			*17	
Activity Zone	**6			**6	
spacing (m)	***6	Continuous	Continuous	***6	
	*6		Continuous	*6	
Taper length	**3	Continuous		**3	
spacing (m)	***3			***3	
Others	Design: BS EN 13422	Do not use on expressway	With label: "WARNING – THIS IS NOT A SAFETY BARRIER"	Design: BS EN 13422	

Summary

*Expressways, **Major Roads, ***Other Roads

Delineation & Channelling Devices (Cont.)			
Туре	Lateral Shift Marker	Plastic Mesh Fencing	Plastic Barricades
Colour	Fluorescent Orange	Red Orange	Alternate Orange and White Board
Reflective Collars/Bands	White, Wide Angle Microprismatic conforming to the requirements stated in the prevailing version of <i>ASTM D4956 Type IX</i> and above sheeting classification	NA	Orange and White High Intensity Grade retro- reflective strip stated in the prevailing version of <i>ASTM</i> <i>D4956 Type III</i> and above sheeting classification
Min height (mm)	-	1	1
Lateral clearance (mm)	Min: 0.6m Absolute: 0.3m	Not applicable on carriageway	Not applicable on carriageway
		*12	*12
Activity Zone	_	**6	**6
spacing (m)	-	***6	***6
	-	*6	*6
Taper length		**3	**3
spacing (iii)		***3	***3
Others	Black Pictograms/ Words	Minimum 0.5m from deep excavation. Not allowed if heavy pedestrian movement is expected.	Minimum 0.5m from deep excavation. Not allowed at deep excavation and at heavy pedestrian areas.

*Expressways, **Major Roads, ***Other Roads

4-12 Road Safety Barriers

4-12.1 A safety barrier is a device that is used to shield errant vehicles from impacting roadside features by containing the impact and redirecting the vehicle back onto the carriageway. In a work zone, they are used to shield temporary works to ensure the safety of all road users including pedestrians and the work site personnel.



Use of safety barriers for temporary road works

- 4-12.2 Warrants for a road safety barrier –A risk assessment has to be conducted to determine the need to use a safety barrier. The following are some examples of high risk locations where the use of safety barriers has to be considered:
 - (1) Next to embankment where the slope is 1 vertical to 3 horizontal or steeper
 - (2) Next to vertical drop
 - (3) Next to existing rigid obstruction
 - (4) Next to deep drains or uncovered drain within the clear zone of the road
 - (5) Next to deep excavations
 - (6) At sharp bends where the desirable minimum radius of the carriageway is used
 - (7) Adverse opposing traffic conditions
 - (8) Along expressways
- 4-12.3 Based on the principles of roadside hazard management, road safety barriers should only be considered if the roadside hazards cannot be removed, relocated or retrofitted. Considerations should always be given to provide as much clear zone as possible based on the road environment to enable the errant vehicles to recover by themselves without impacting on any rigid roadside hazards.
- 4-12.4 If the use of safety barriers is required, the design of the work zone and temporary traffic scheme has to consider the need to provide adequate space to install the safety barriers properly so that it will be able to function as intended.
- 4-12.5 Requirements for a road safety barrier –Due to the dynamic nature of a vehicle impact, the crash worthiness of a road safety barrier can only be assessed by subjecting it to a full crash-test and evaluated according to the requirements of the National Cooperative Highway Research Program (NCHRP) Report 350, BSEN 1317 or MASH. Safety barriers that meet these requirements are termed as type-approved.
- 4-12.6 The contractor has to demonstrate that the intended road safety barrier system has been certified to meet with the requirements of NCHRP Report 350, BSEN 1317 or MASH. The certification authorities include the U.S. Federal Highway Administration (FHWA) or the U.K. Highway Agency.
- 4-12.7 **Types of road safety barriers** Road safety barriers can be generally categorised as either a non-rigid safety barrier or a rigid safety barrier. A non-rigid road safety barrier will dynamically deflect to contain and redirect an errant vehicle. Hence, there should be sufficient clear zone behind the safety barrier for it to fully deflect when impacted.

- 4-12.8 In comparison, for rigid safety barriers, the containment and redirection of an errant vehicle are achieved by the surface profile of the barrier itself. The energy of the impacting vehicle is dissipated as the vehicle glides along the traffic face of the rigid safety barrier.
- 4-12.9 Generally road safety barriers are classified either as:
 - (1) Non-proprietary; or
 - (2) Proprietary

Non-proprietary barriers are safety barriers whose design specifications can be found in international highway agencies websites or design manuals and available for users to refer to. For proprietary barriers, these have to be designed and installed according to the system manufacturer specifications.

4-12.10 Examples of type-approved road safety barriers – Examples of non-proprietary safety barriers includes the following:

Non-rigid safety barriers (1) w-beam VIG. (2) Thrie-beam VIG.

Rigid safety barriers

(1) Cast-in-situ concrete barrier.

(2) Pre-cast concrete barrier. (Pre-cast concrete barriers have to be anchored to the ground if there is no room for the barriers to deflect when impacted. The barriers may be painted in yellow and black bands shaped in an arrow similar to lateral shift markers.)

(3) Bridge parapet (e.g. P1-2).



TYPE F Precast Concrete Barrier (Oregon Department of Transportation) Dimension: 3.8m (L) x 0.81m (H) x 0.61m (W) Installation Length: 16 units x 3.8m (Crash Test Installation) Minimum Radius : 235m



TYPE F Precast Concrete Barrier (Alberta Department of Transportation) Dimension: 3.0m (L) x 0.81m (H) x 0.57m (W) Installation Length: 45m Minimum Radius : 45m



Dimensions of yellow and black arrow on vertical flat surface of concrete barriers

- 4-12.11 In addition to the above, there are also type-approved proprietary safety barriers that can be used for temporary road works, such as:
 - (1) Water-filled safety barricade
 - (2) Steel safety barriers



Example of water-filled safety barricade



Example of steel safety barriers

- 4-12.12 Selection of road safety barriers Only type-approved safety barriers shall be used. Non-rigid safety barriers are used where there is sufficient clear zone behind the barrier for it to deflect when impacted. Typically for a standard w-beam VIG, a clear zone of 1.0m is required. There should not be any rigid objects such as lamp poles, sign posts, open drains etc. within the clear zone. If the clear zone is not available on site, rigid safety barrier should be considered.
- 4-12.13 For work zone application, the selection of the safety barriers would also depend on the type of road works to be carried out. If the carriageway of the diversion scheme needs to be realigned over several stages, moveable safety barriers or water-filled safety barricades would be more suitable.
- 4-12.14 The selected safety barrier has to be used as a complete system and non type-approved modifications are not permitted.



Clear zone provided behind the w-beam VIG

- 4-12.15 **Design considerations** The safety barriers have to be properly installed on site to ensure that they will be able to perform as intended and that the barriers themselves do not create a hazard to motorists. Some of the design considerations are as listed below:
 - (1) <u>Protection of leading terminal</u> A type-approved end treatment has to be provided to shield the leading terminal of the safety barrier to reduce the severity of impact of a head-on collision.
 - (2) <u>Ground anchorage (Intermediate and Terminal Restraint)</u> Temporary safety barriers have to be properly restrained by anchoring the barrier segments onto ground if the site condition is inadequate to enable the safety barrier to be used as an unrestrained system. Ground anchorage is required based on the design specification or manufacturer's recommendation for the specific type of safety barrier





Example of anchored temporary precast concrete safety barrier:

Type F precast concrete safety barrier as specified in the design drawing from Alberta Department of Transportation using anchor bolts for the ground anchorage.

Example of anchored temporary precast concrete safety barrier:

Type F precast concrete safety barrier as specified in the design drawing from Oregon Department of Transportation using droppins for the ground anchorage.

(3) <u>Flare rate</u> – The flare rate of the safety barrier has to be designed based on the operating speed limit of the carriageway. This is to reduce the severity of the impact



Recommended flare rate for various design speed (Source: AASHTO Roadside Design Guide, 2002)

(4) <u>Transition section</u> – Where a non-rigid safety barrier will be joined to a rigid safety barrier, a proper transition section has to be provided to ensure that there is a gradual transition in the relative stiffness of the different types of safety barriers.



Example of transition from w-beam guardrail to rigid or precast concrete safety barrier using thrie-beam section
- (5) <u>Site terrain and features</u> The site terrain and features have to be designed as necessary to ensure that the safety barriers can function properly. Site terrain and features such as sloping ground conditions and road kerbs could have adverse effects on the function of the safety barriers.
- (6) <u>Curved installation</u> It is necessary to ensure that the selected type of safety barrier is suitable to be used for the particular location taking into account the installation radius which must satisfy the minimum requirement as specified in the design reference or manufacturer's recommendation.



Example of steel barriers connected with corner-sections to maintain continuous section of safety barrier along tight sections.



As an alternative to temporary safety barriers, non-rigid safety barriers such as w-beam or thrie beam guardrail can also be used along road bends as the beam sections can be shopbend to achieve small radius.

4-12.16 Similar to the main section of the safety barriers, other components of the safety barrier such as the end treatment, terminal anchorage and transition section must also be certified to comply with the requirements of NCHRP Report 350, or BSEN 1317 or MASH.

4-13 Water-filled Safety Barriers

4-13.1 Design — Water-filled safety barriers are modular plastic containers of various sizes and shapes. Each unit shall come with interlocking devices for application on tangent straight and horizontal curves, and mounting devices for lighting.



Example of safety barrier that meets NCHRP Report 350 Test Level 2 Crash Test

- 4-13.2 Application Temporary safety barriers are used to prevent vehicles from penetrating work area and minimising injuries to people in the errant vehicles. Protective requirements of a work zone govern the use of temporary safety barriers.
 - (1) Used between traffic and severe hazards such as bridge piers or deep excavations or to separate opposing traffic and to protect workers on major roads and expressways.

- (2) When erected parallel to the traffic flow, the effect of hitting the ends of the barrier shall be mitigated by flaring the ends away from the traffic or by the use of impact attenuators.
- (3) Placed at a minimum of 0.3m away from the delineation in alternate white and orange to provide superior day and night visibility.
- (4) Other requirements for application shall comply with the manufacturer's recommendation.
- (5) The device used on roads with speed limit not higher than 70km/h shall meet NCHRP (National Cooperative Highway Research Program) Report 350 or MASH Level 2 Crash Tests, and if speed limit is higher than 70 km/h, it shall meet NCHRP 350 or MASH Level 3 Crash Tests.

4-14 Barricades

- 4-14.1 Barricades are used to:
 - (1) Deny road users access to the work site.
 - (2) Prevent accidental encroachment of the work or workers onto the non-work areas in the activity zone.
 - (3) Control traffic by closing, restricting or delineating all or a portion of the right-of-way.

4-15 Plastic Mesh Fencing

4-15.1 **Design** — The fence is a 1m high flexible plastic mesh made of UV-stabilised high-density polyethylene in red-orange colour. The vertical fence post shall be constructed and spaced at a maximum of 2.5m. The mesh is to be tied to the posts with plastic cable ties, which shall not distort when taut.



Example of plastic mesh fence, fence post and ties.

- 4-15.2 **Application** It is used mainly to delineate and guide pedestrians, cyclists and PMD users away from a work zone safely and for the containment of personnel. It shall be kept at least 500mm from the edge of excavation. It shall not be used on carriageway and/or if heavy pedestrian movement is expected.
- 4-15.3 Similar to the main section of the safety barriers, other components of the safety barrier such as the end treatment, terminal anchorage and transition section must also be certified to comply with the requirements of NCHRP Report 350, BSEN 1317 or MASH.

4-16 Plastic Barricades

4-16.1 Design — Barricades are portable devices having two sign boards with alternating orange and white High Intensity Grade retro-reflective strips. Sheeting specifications shall be in accordance to Type III sheeting classification specified in the prevailing version of ASTM D4956 Standard Specification for Retro-reflective Sheeting for Traffic Control. The barricade shall be minimum 1m tall, be stable and not easily blown over, or displaced by pedestrians. Where there is an existing cycling path, 1m high barricade is to be used.



Example of plastic barricade posts and double boards

4-16.2 Application — It shall be erected without gaps along pedestrian paths throughout the activity work zone for the control of pedestrian movement. Plastic barricades shall not be used on carriageway and/or if heavy pedestrian movement is expected.

They shall not be used next to deep excavations or steep falls and shall be placed such that a minimum distance of 500mm separates the plastic barricade and the excavated pit.

4-17 **Impact Attenuator (Stationary & Truck Mounted)**

- 4-17.1 Design Impact attenuator is an energy-absorbing device. This product shall pass acceptable performance test (NCHRP 350 or the AASHTO Manual for Assessing Safety Hardware (MASH) standards TL-3) and be designed for each application to ensure performance.
- 4-17.2 Application Stationary attenuators or crash cushions shall be used only if other suitable end treatments are not appropriate as the leading terminal of a safety barrier for works along expressways and other roads where the operating speed limit is \geq 70km/h. For other road environments, a crash cushion is also warranted at high risk locations such as at a road bifurcation. As crash cushions are proprietary products, they shall be designed and installed by the Manufacturer Certified Installer.



stationary Example of а attenuator system

Use of crash cushion to shield the Use of crash cushion to shield the leading terminal of the w-beam VIG

leading terminal of the concrete safety barrier

4-17.3 Truck mounted attenuators attached to the rear of protective vehicle shall be used during short duration and mobile works to absorb the impact of the errant vehicle.



4-18 Visibility Enhancing Devices

4-18.1 They are mounted on supports, barricades, barriers or other channelling and delineation devices to warn road users/ worker/ motorists by enhancing the visibility of the temporary traffic control devices, and hazards within the work zone particularly at night.

4-19 Retro-reflective Disc

4-19.1 Design — It is a 200mm round disc fitted with Fluorescent Orange Wide Angle Microprismatic Retroreflective sheeting on an aluminium plate or any other suitable mounting substrate. Sheeting specifications shall be in accordance to Type IX and above sheeting classification specified in the prevailing version of ASTM D4956 Standard Specification for Retro-reflective Sheeting for Traffic Control.



Example of retro-reflective disc

4-19.2 Application — Retro-reflective discs are to be spaced at regular intervals to provide a continuous line of sight. The interval shall be 6m c/c and 10m c/c for minor roads and expressways/ major roads respectively. It is an economical and effective visual enhancing device. It shall be mounted facing the direction of the traffic, at about 1m above the ground on the delineation devices. It shall not be used for pedestrian footpath and off-road areas.

4-20 Flashing Beacons

- 4-20.1 **Design** It is a portable, lens-directed, and enclosed amber light device (200mm diameter). It shall be able to operate in STEADY mode or FLASHING mode comply with the prevailing version of *BS EN* 12352.
- 4-20.2 Application Beacons should space at regular intervals to provide a continuous line of sight:
 - (a) Minor road 6m c/c
 - (b) Major road 10m c/c
 - (c) Expressway -10 m c/c

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Example of flashing beacon

4-21 **Portable Amber Rotating Lamps**

4-21.1 Design - It is a battery-operated device emitting rotating amber light intermittently complying with the prevailing version of United Nations Economic Commission for Europe (UNECE) Regulation 65 on Special Warning Lamps.



Example of a portable amber rotating light

- 4-21.2 Application These are powerful attention-seeking devices and the uses are as follows:
 - 1) Mounted on vehicles, plant and equipment during operation to warn road users of their presence.
 - 2) Placed behind channelling or delineation devices.

4-22 High Visibility Warning Cloth

- 4-22.1 **Design** The design shall be lightweight and cool, and of 100 percent polyester knit fabric or woven mesh. The vest shall be fluorescent lime yellow embossed with organisation identification /logo. The retro-reflectivity of the double vertical and horizontal bands shall comply with the prevailing version of *BS EN ISO 20471*.
- 4-22.2 Application All personnel working on or near the road shall put on the vest to make them more conspicuous and to warn road users of their presence. Only fluorescent lime yellow shall be used on a work zone for ease of identification.



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	Visi	bility Enhancing dev	vices	
Туре	Retro-reflective Disc	Flashing Beacon	Portable Amber Rotating Lamp	High Visibility Warning Cloth
		0		M
Size	200mm diameter	Proprietary	Proprietary	Per requirement
Colour	Fluorescent orange	Amber	Amber	Fluorescent lime yellow
Reflectivity	Type IX and above sheeting classification specified in the prevailing version of ASTM D4956	NA	NA	BS EN ISO 20471
Mounting height (min)	1m	1m	1m	NA
Delineation spacing	*10m c/c **10m c/c ***6m c/c	*10m c/c **10m c/c ***6m c/c	NA	NA
Material	Plastic or Aluminium plate	Plastic housing	Plastic housing	100% polyester mesh
Standard	NA	BS EN 12352 or approved equivalent	UNECE R65 or approved equivalent	BS EN ISO 20471

Summary

*Expressways, **Major Roads, ***Other Roads

4-23 Use of Other Devices

4-23.1 The Authority may direct, when the situation and condition require, such devices and/or any other necessary devices to be used to enhance and complement the devices used in the road construction work zone.

4-24 Portable Traffic Light System

4-24.1 **Design** — To refer to the guidelines for portable traffic light under **Appendix VI**.



4-24.2 Application — Portable traffic light to regulate traffic for shared right of way shall be used when traffic control is required.

4-25 Flashing Arrow

4-25.1 Design - Flashing arrows are lamps flashing sequentially to create a chevron pattern, indicating a move to the left or right. It is usually mounted on truck.



Example of a variable message sign (VMS) displaying flashing arrows

4-25.2 Application - They are used to warn motorists about lane closures ahead, the side where work is carried out and channel traffic to its intended traffic path. They shall be placed behind channelling or delineation devices.

4-26 Variable Message Sign

- 4-26.1 Design This is a traffic sign which is capable of displaying real-time information and is generally mounted on vehicle or placed independently on the road side.
- 4-26.2 Application It is displayed in advance to supplement other devices to provide additional advance information to the road user.
- 4-26.3 The sign can be used during one of the following scenarios:
 - Construction or maintenance work zone.
 - Incident management
 - Advance notice of traffic scheme implementation.
 - Notification of future construction or event.
- 4-26.4 The sign can provide a unique message that alerts the motorist and support signing for:

- Speed reduction.
- Advance notice of lane closures and shifts.
- Diversion to a different route.
- Advance notice of ramp closures.
- Changes in alignment or surface conditions.

4-27 Half-Height Hoarding

- 4-27.1 The hoarding for work sites is generally joined at right angle at all corners. For work site near road intersection, this often affects the line of sight of road users if the hoarding is not properly set back. To mitigate the situation, half-height hoarding shall be erected and extended minimally 35m within the areas of traffic junctions/side roads/slip roads to allow clear visibility of road users at road intersection.
- 4-27.2 The design shall take into consideration several factors such as traffic speed, road geometry, temporary lighting provision and movement of pedestrians and PMD users and to be adjusted accordingly onsite to ensure the line of sight of road users to traffic lights, pedestrian crossings, etc. is not impeded.
- 4-27.3 The recommended maximum height of opaque hoarding is 800mm from road level. The section catered for unobstructed visibility shall be free of material storage and stationary machinery within the required visibility zone of road users.
- 4-27.4 Each hoarding panel shall abut/overlap the next panel with a gap no greater than 50mm between the bottom of the panel and the ground.
- 4-27.5 The Contractor shall ensure the details of the hoarding are endorsed by a competent person prior to the commencement of the installation.



Provision of half-height hoarding shall be minimally 35m





Recommended height of opaque hoarding is 800mm from road level

Examples of Half-height Hoarding

4-28 New Devices

4-28.1 Recommendations for use of new temporary traffic control devices shall be subject to evaluation and approval by the Authority.

APPENDIX I – Temporary Signs for Cycling Path



APPENDIX II – Examples of TCPs

Generic Component Parts of the common Traffic Control Zone Traffic arrangement for single lane closure of two or more lane carriageway Traffic arrangement for closure of fast lane Traffic arrangement for works on side-table with provision for footpath Traffic arrangement for works at inner/outer road bends Traffic arrangement for works on roads with speed limit of 70 km/h and above Traffic arrangement for closure of centre lane Traffic arrangement for closure of slow lane after a T-junction Traffic arrangement for closure of slow lane after a cross-junction Traffic arrangement for works on roads with speed limit of 70 km/h and above

Traffic arrangement for single lane closure of a one-lane two-way carriageway (Shared right of way)

Generic Component Parts of the common Traffic Control Zone



*LB : Longitudinal Buffer

		Table 18: 1	Distances of Tem	porary Signs/Devic	ces	
Distance	Expressway 90/80 km/h	Major Road 70 km/h	Major Road 60 km/h	Major Road 50 km/h	Primary Access 50 km/h	Local Access 40 km/h
а	120 m	100 m	80 m	60 m	60 m	30 m
b	120 m	100 m	80 m	60 m	60 m	30 m
с	240 m	200 m	160 m	120 m	120 m	60 m
d	200/150 m	120 m	80 m	40 m	40 m	20 m
*LB	60m	30m	20m	10m	10m	10m
e	100/75 m	60 m	40 m	20 m	20 m	10 m
f	30 m	30 m	30 m	30 m	30 m	30 m(Optional)

Traffic arrangement for single lane closure of two or more lane carriageway



Traffic arrangement for closure of fast lane





Traffic arrangement for works on side-table with provision of footpath

Traffic arrangement for works at inner/outer road bends

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Note:

- 1. The competent person should inspect onsite to determine the locations where the advance warning signs such as "caution", "works ahead", "lane status" and "first lateral shift marker" signs are to be placed. These signs should be mounted with rotating lights and be sited before the bend/crest and clearly visible for a long distance to alert all motorists when they are travelling along the straight segment of the road before the bend/crest.
- 2. The start of the taper should begin from the first lateral shift marker and extend until the end of work zone. The min merging taper shall meet the requirement of table 3-3.



Traffic arrangement for works on roads with speed limit of 70 km/h and above

Traffic arrangement for closure of centre lane



Traffic arrangement for closure of slow lane after a T-junction











Code of Practice for Traffic Control at Work Zone

Traffic arrangement for single lane closure of a two-lane two-way carriageway (Shared right of way)



APPENDIX III - Truck Mounted Attenuator

Guidelines for use Truck Mounted Attenuator (TMA) for Road Works

1. General

The primary objective of these guidelines is to provide a standard guidance for the application for TMA to be used on public roads. Refer to Figure A for the Process for Use of TMA for Roads Works.

2. Definitions

"TMA" used refers to truck-mounted attenuator.

"User" used hereinafter is defined as the contractor/agencies who are using the TMA (regardless of self-ownership or rental) on public roads of posted speed of 70 km/h or more.

"Operator" used hereinafter is defined as the person who has been trained and certified by TMA manufacturer authorised trainer/centre to correctly perform the TMA He may also double up as the shadow vehicle driver.

"Shadow Vehicle" is defined as the LTA-approved truck where the TMA is mounted on.

"NCHRP" refers to National Co-operative for Highway Research Program commissioned by American Association of State Highway and Transportation Officials and US Federal Highway Administration.

"MASH" refers to Manual for Assessing Safety Hardware. The rewrite of NCHRP 350 and was review by the ASSHTO Technical Committee on Roadside Safety (TCRS).

3. Compliance

Truck mounted attenuator unit mounted on the shadow vehicle shall meet both the mandatory and optional requirements as stated in the NCHRP 350 Report TL-3 or the AASHTO Manual for Assessing Safety Hardware TL-3 (MASH).

The TMA shall have documentary evidence to prove that it has been successfully crash tested following the procedures set forth in the NCHRP Report 350 or MASH.

To allow the use of collision attenuator or TMA on the public roads, User shall ensure the following report/letter to Road Asset Regulation & Licensing (RARL) of LTA to show the compliance of the above-mentioned standards:

- 1. A copy of crash summary report, together with sequential photos from ISO certified test centre qualified to conduct NCHRP Report 350/MASH impact tests; or
- 2. A copy of acceptance letter/report from United States of America Federal Highway Administration (FHWA)

4. Installation

The TMA shall be installed by a workshop authorised by the TMA manufacturer in accordance with the Drawings approved by Vehicle Approval & Control (VAC) of LTA.

5. Warning Devices and Retro-reflective Sheeting

TMA warning devices and retro-reflective sheeting shall meet the following requirements:

- 2 rotating lamps positioned beside the arrow-board and 1 rotating lamp at the rear of TMA. Rotating lamps installed on TMA shall comply with the latest prevailing version of United Nations Economic Commission for Europe (UNECE) Regulation 65 on Special Warning Lamps;
- 2) Retro-reflective sheeting of black and florescent yellow green affixed at rear of TMA and rear of shadow vehicle. The retro-reflective sheeting specifications shall meet Type IX and above of the prevailing version of *ASTM D4956*.
- 3) The flashing arrow board shall be mounted 2.5m above the road surface. The arrow board shall conform with the following specifications:
 - a. Arrow board shall be a minimum of 1.8m (L) x 0.9m (H);
 - b. Flashing lamps shall flash at a minimum rate of 65 flashes per minute during operations;
 - c. Comprise a minimum of 15 flashing lamps with 140mm in diameter.
 - d. Flashing arrow shall be clearly visible and legible from a minimum distance of 700m during day and night operations.

2 rotating lamp position beside the arrow-board and 1 at the rear of TMA



Truck Mounted Attenuator Warning Devices and Retro-reflective Sheeting

6. Longitudinal Buffer Distance

For mobile operations, the driver of the shadow vehicle shall remain in the vehicle at all times. The shadow vehicle shall be properly spaced behind the working vehicle. The shadow vehicle shall maintain a minimum longitudinal buffer distance of $30^{(1)}$ m behind the working vehicle. This distance shall remain constant as the work progresses down the road / expressway.

For stationary operations, the shadow vehicle shall be properly spaced behind the work crew and maintain a minimum longitudinal buffer of $15^{(1)}$ m behind the start of work area.

Types of TMA operation	Minimum Longitudinal buffer distance (m)
Mobile TMA	30 ⁽¹⁾
Stationary TMA	15 ⁽¹⁾

Note:

(1) Cross-check with TMA manufacturer's recommended longitudinal buffer distance and adopt the longer buffer distance to be implemented on site.

Longitudinal Buffer Distance for TMA

7. TMA Manufacturer Trainer/Centre

The authorised training centre shall keep records and issue certificates to TMA operators. The certificate shall contain following details:

- Name of the operator
- NRIC /FIN
- Date of training
- Model and serial number of TMA

TMA Operator shall produce the certificate for inspection, whenever is required by the Authority during their routine audit checks.

8. TMA Inspections, Maintenance and Repairs

To maintain the crashworthiness of the TMA, User shall ensure regular maintenance and inspection, are carried out by TMA manufacturer's authorised workshop.

User shall keep a copy of maintenance/inspection/and repair records issued by the manufacturer's authorised workshop to ensure proper operation and the safety performance of the TMA. Requirements for inspection, maintenance and repair to be carried out by authorised workshop shall meet the requirements specified by the manufacturer.

Process for the use of TMA for Road Works Truck mounted attenuator unit mounted on the shadow vehicle shall meet both the mandatory and optional requirements as stated in the NCHRP 350 Report TL-3 level or the AASHTO Check Truck Mounted Manual for Assessing Safety Hardware TL-3 (MASH). Attenuator (TMA) Compliance To allow the use of collision attenuator or TMA on the public roads, User shall ensure the following report/letter to Road Asset Regulation & Licensing (RARL) of LTA to show the compliance of the above-mentioned standards: 1) A copy of crash summary report, together with sequential photos from ISO certified test centre qualified to conduct NCHRP Report 350/MASH impact tests; or 2) A copy of acceptance letter/report from United States of America Federal Highway Administration (FHWA) Prior to deployment of TMA on the public roads, the User shall ensure that the TMA manufacturer had appointed an authorised workshop and certified product trainer/training centre in Singapore. User shall ensure the following documents via the VITAS under the Drawing Approval Approval of Shadow Vehicle is application to Vehicle Approval & Control (VAC) of LTA for approval: approved by: (1) An A3-sized technical drawing, endorsed by a Professional Engineer (Mechanical) showing the: • Vehicle Approval a) Plan view – with stowed and deployed state of the TMA; &Control of LTA Side view - with stowed and deployed state of the TMA; b) Installation certified and c) Front view; d) Rear view - with stowed and deployed state of the TMA; and issued by authorise Details such as - Weight Summary, Dimensions, Component's Annotation, e) Travelling Condition and etc. (2) Weight distribution and Stability calculations - endorsed by the same PE. (3) Certificate of endorsement for the drawing approval application by the same PE. (4) Technical specifications of the shadow vehicle and TMA, as well as compliant certification of the TMA. Issuance of the Notice of Drawing Approval with approval code. User shall ensure the TMA is installed by a workshop authorised by the TMA manufacturer in accordance with the Drawing approved by VAC. The certificate of installation issued by the workshop shall contain the following details: Shadow vehicle registration plate number; a) Date of TMA installation; b) c) Model and serial number of TMA: d) Approval code. User shall ensure TMA operators are trained and certified by TMA manufacturer authorised trainer/centre. **Engage Trained TMA Operators** The authorised training centre shall keep records and issue certificates to TMA operators. The certificate shall contain following details: a) Name of the operator, b) NRIC /FIN, c) Date of training, d) Model and serial number of TMA. User shall ensure the certifications for TMA installation and TMA operator training are Display of Certification at available for inspection, whenever is required by the Authority during their routine audit Site checks.



APPENDIX IV – Good and Poor Temporary Traffic Control at Work Sites

Do's and Don'ts for Advance Warning Signs



* Distance between advance warning signs spaced according to COP.

* Advance warning signs mounted on stable support.





* Well maintained reflective sheeting and aluminium plate.



* Clear view of advanced warning sign.

* Advance warning signs placed on stable support





* Rotating lamp provided.

* Well maintained reflective sheeting.



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Do's and Don'ts for Advance Warning Signs



- * Overlapping advance warning signs.
- * Duplicate advance warning signs.



- * Worn out reflective sheeting.
- * Mixture of incorrect display and underlaying markings.





- * Inappropriate placement of advance warning sign.
- * Wording on advance warning sign partially blocked by landscape.



- * Worn out reflective sheeting and aluminium plate.
- * No rotating lamp.



Do's and Don'ts for Tapering Provision



* Sufficient tapering distance.



* Sufficient tapering distance.

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* Sufficient tapering distance.







Do's and Don'ts for Tapering Provision



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Do's and Don'ts for Water-Filled Barricades Provision



* Water-filled barricades interlocked.

* Adequate provision delineation at work.

*Reflective disc provided.



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* Water-filled barricades interlocked.

* Adequate provision delineation at work.

*Reflective disc provided.





* Water-filled barricades not interlocked.

* Insufficient water-filled barricades at work zone.

*No reflective disc.



* Improper use of water-filled barricades to shield deep excavation

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Do's and Don'ts for Safe Alternative Walkway Provision



* Proper provision of safe alternative walkway.



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* Proper provision of safe alternative walkway.





* Unsafe temporary walkway on the road.



* No safe alternative walkway provided.

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Do's and Don'ts for Deployment of Portable Traffic Light System



* Proper deployment of portable traffic light system with temporary *STOP line and STOP HERE on Red light sign.*





* Proper provision of *Traffic Lights Ahead sign.*





* Inconsistency in display on portable traffic light and STOP/GO sign.

*Improper deployment of potable traffic light. No tapering. *Missing STOP line and STOP HERE on Red light sign.*



* Incorrect temporary traffic lane occupation on shared right of way.



APPENDIX V – Sign Dimensions

1)	Sign P1	(Pedestrian Walkway)
2)	Sign W1	(Caution)
4)	Sign W2 - W12	(Works Ahead – Services Departments)
5)	Sign W13	(Works Ahead – Private Development)
6)	Sign W14	(Men at Work)
7)	Sign W15	(Road Narrow on Left Ahead)
8)	Sign W16	(Road Narrow on Both Sides Ahead)
9)	Sign W17	(Road Narrow on Right Ahead)
11	Sign W18	(Centre Lane Closed Ahead)
12)	Sign W19	(Right Lane Closed Ahead)
13)	Sign W20	(Left Bend Ahead)
14)	Sign W21	(Right Bend Ahead)
15)	Sign W22	(Series of Bends Ahead – Left First)
16)	Sign W23	(Series of Bends Ahead – Right First)
17)	Sign W24	(Roundabout Ahead)
18)	Sign W25	(Traffic Lights Ahead)
19)	Sign W26	(Shoulder Lane Closed Ahead)
20)	Sign W27	(Work Access Ahead)
21)	Sign W28	(Other Hazards Ahead)
22)	Sign W29	(Merge Ahead)
23)	Sign W30	(Left Lane Merged With Centre Lane Ahead)
24)	Sign W31	(Centre Lane Merged With Left Lane Ahead)
,	8 -	(Centre Lane Merged With Left Land and Right Lane
25)	SignW32	Shifted Ahead)
26)	SignW33	(Distance Supplementary Plate)
27)	SignW34	(Arrow Direction Supplementary Plate)
28)	SignW35	(Slow)
29)	SignW36	(Stop Here on Red Light)
30)	Sign I 1	(Project Information)
31)	Sign I 2	(Project Information – LTA)
32)	Sign I 3	(Project Information – Services Department)
33)	Sign I 4	(Coming Your Way)
34)	Sign I 5	(Avoid Congested Road)
35)	Sign I 6	(Count Down Sign)
36)	Sign I 7	(No Lane Markings)
37)	Sign I 8	(Temporary Traffic Arrangement Map)
38)	Sign I 9	(Start of Work Zone – Road Works)
39)	Sign I 10	(Start of Work Zone – Viaduct Works)
40)	Sign I 11	(Start of Work Zone – Bridge Works)
41)	Sign I 12	(Start of Work Zone – Underpass Works)
42)	Sign I 13	(Start of Work Zone – Cable Works)
43)	Sign I 14	(Start of Work Zone – Pipe-Laying Works)
44)	Sign I 15	(End of Work Zone)
45)	Sign I 16	(Start of Work Zone – Drain Works)
46)	Sign I 17	(Road Diversion)
47)	Sign I 18	(Road Closed)
48)	Sign I 19	(Road Resurfacing)
49)	Sign I 20	(Beam Launching)



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Sign W19 (Right Lane Closed Ahead)

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Sign	Size	r	a	b	с	d	e	f	g	h	i	j	k
c 45°	600 X 300	15	15	500	175	20	60	N.A	N.A	N.A	N.A	N.A	N.A
Sign W34 (Arrow Direction Supplementary Plate)	900 X 350	15	15	700	240	70	80	N.A	N.A	N.A	N.A	N.A	N.A
	900 X 900	30	24	200	N.A								
Sign W25 (Slow)	1200 X 1200	30	24	250	N.A								



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Sign	Size	r	a	b	С	d	e	f	g	h	i	j	k
Road Works Completing	1300 X 1500	30	16	345	100	140	70	90	195	60	100	195	N.A
Sign I 2 Sample of Project Information Sign of Land Transport Authority See Note: 10 &11	2000 X 2200	30	24	515	150	210	105	135	305	90	150	305	N.A
PowerGas Pte Ltd Gas Works Completing	1300 X 1500	30	16	345	100	140	70	90	195	60	100	195	N.A
31 Dec 2001 31 De	2000 X 2200	30	24	515	150	210	105	135	305	90	150	305	N.A

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0	J.

Sign	Size	r	а	b	с	d	e	f	g	h	i	j	k
b ci d e Start Here	1300 X 1700	30	16	400	100	140	70	90	195	60	100	195	N.A
Sign I 4 "Coming Your Way" Sign See Note: 7, 8, & 9	2000 X 2500	30	24	542	150	210	105	135	305	90	150	305	N.A
Avoid d: Avoid Upp Paya Lebar Rd Serangoon North	1700 X 2000	30	16	397	100	140	120	70	90	195	60	195	100
Sign I 5 "Avoid Congested Road" Sign See Note: 7, 8, & 9	2600 X 3000	30	24	584	150	210	180	105	135	305	90	305	150

Sign	Size	r	a	b	С	d	e	f	g	h	i	j	k
e C		30	140	70	200	180	80	60	280	90	100	100	100
D. Clementi Ave 6	4378 X 1985	Ι	m	n	N.A								
C'Wealth Ave West		16	100	140	N.A								
iscertay)		r	a	b	с	d	е	f	g	h	i	j	k
ON 28 AUG 38 T		30	210	105	300	270	120	90	420	135	150	150	150
Sign I 6 "Count-Down" Sign	6542 X 2985	i	m	n	N.A								
See Note: 13 & 14		24	150	210	N.A								
(Organisational Name and		r	а	b	с	d	e	f	g	h	i	j	k
No Lane Markings Drive With Care	1600 X 1300	30	424	100	140	70	90	195	60	195	16	100	N.A
CTelephone Hotline) See Note No. 9 Sign I 7 "No Lane Markings" Sign See Note: 7, 8, & 9	2400 X 1900	30	577	150	210	105	135	305	90	305	24	150	N.A

Sign	Size	r	a	b	с	d	e	f	g	h	i	j	k
a <u>c</u>		30	140	70	200	180	80	60	280	90	100	100	100
by Clementi Ave E	4254 V 1621	1	N. A	N.A									
	4334 A 1031	16	N. A	N.A									
		r	а	b	с	d	е	f	g	h	i	j	k
(Boon Lay)		30	210	105	300	270	120	90	420	135	150	150	150
	6505 X 2451	1	N. A	N.A									
Sign I 8 Temporary Traffic Arrangement Map See Note: 15, 16 & 17		24	N. A	N.A									
+-[r	а	b	с	d	е	f	g	h	i	j	k
a (Organisational Name and Logo) See Notes below Road Works	1100 X 1200	30	360	100	140	70	16	N.A	N.A	N.A	N.A	N.A	N.A
Sign I 9 Start of Work Zone – Road Works Sign See Note: 7, 8, & 12	1700 X 1800	30	540	150	210	105	24	N.A	N.A	N.A	N.A	N.A	N.A

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Sign	Size	r	а	b	с	d	e	f	g	h	i	j	k
a (Organisational Name and Logo) See Notes below Underpass	1100 X 1200	30	360	100	140	70	16	N.A	N.A	N.A	N.A	N.A	N.A
Sign I 12 Start of Work Zone – Underpass Works Sign See Note: 7, 8, & 12	1600 X 1800	30	540	150	210	105	24	N.A	N.A	N.A	N.A	N.A	N.A
a (Organisational Name and Logo) See Notes below Cable Works	1200 X 1200	30	360	100	140	70	16	N.A	N.A	N.A	N.A	N.A	N.A
3.5 km Sign I 13 Start of Work Zone – Cable Works Sign See Note: 7, 8, & 12	1800 X 1800	30	540	150	210	105	24	N.A	N.A	N.A	N.A	N.A	N.A

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Sign	Size	r	а	b	с	d	e	f	g	h	i	j	k
(Organisational Name and Logo) See Notes below bi c d Pipe-Laying	1200 X 1200	30	360	100	140	70	16	N.A	N.A	N.A	N.A	N.A	N.A
Works For 2.0 km J Sign I 14 Start of Work Zone – Pipe-Laying Works Sign See Note: 7, 8, & 12	1800 X 1800	30	540	150	210	105	24	N.A	N.A	N.A	N.A	N.A	N.A
a (Organisational Name and Logo) See Notes below End of Work Zone	1700 X 1600	30	363	345	100	140	70	260	32	16	N.A	N.A	N.A
Sign I 15 End of Work Zone Sign See Note: 7, 8, & 12	2600 X 2400	30	545	515	150	210	105	325	40	16	N.A	N.A	N.A

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Sign	Size	r	a	b	с	d	e	f	g	h	i	j	k
a (Organisational Name and Logo) See Notes below	1200 X 1200	30	360	100	140	70	16	N.A	N.A	N.A	N.A	N.A	N.A
For 5.0 km Sign I 16 Start of Work Zone – Drain Works Sign See Note: 7, 8, & 12	1700 X 1800	30	525	150	210	105	24	N.A	N.A	N.A	N.A	N.A	N.A
a (Organisational Name and Logo) See Notes below Road Diversion	1400 X 1500	30	410	100	140	70	16	90	195	60	100	195	N.A
Sign I 17 Road Diversion Forecast Sign See Note: 7, 8, & 9	2100 X 2200	30	555	150	210	105	24	135	305	90	150	305	N.A

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Sign	Size	r	a	b	С	d	e	f	g	h	i	j	k
a (Organisational Name and Logo) See Notes below b	1000 X 1200	30	360	100	140	70	16	N.A	N.A	N.A	N.A	N.A	N.A
Alexandra Road Closed Sign I 18 Road Closed Sign See Note: 7, 8, & 12	1500 X 1800	30	540	150	210	105	24	N.A	N.A	N.A	N.A	N.A	N.A
(Organisational Name and Logo) See Notes below	1400 X 1500	30	410	100	140	70	16	90	195	60	100	195	N.A
Gign I 19 Road resurfacing Sign See Note: 7, 8, & 9	2100 X 2200	30	555	150	210	105	24	135	305	90	150	305	N.A

Sign	Size	r	a	b	с	d	e	f	g	h	i	j	k
(Organisational Name and Logo) See Notes below													
Beam Launching	2300 X 1700	30	402	100	140	70	16	90	195	60	100	195	N.A
1 DDAM To 5.DDAM (Telephone Hotline) See Note No. 9	3500 X 2500	30	545	150	210	105	24	135	305	90	150	305	N.A
Sign I 20 Beam Launching Sign See Note: 7, 8, & 9													

Code of Practice for Traffic Control at Work Zone

Notes:

- 1. Recommended sizes of logo for the best effect are: Size of Signs Size of Logo Expressways (1200 X 1200): 260 X 260 Other Roads (900 X 900): 200 X 200
- 2. Relevant Authorities and Departments may design their own layout for their logo to fit into the space.
- 3. A white background of the same size may be used when necessary to bring out the logo. However it must be of wide-angled prismatic retro-reflective sheeting with the logo silk-screened on this white sheeting.
- 4. The logo may be of any shapes but preferred to be within the square size defined above.
- 5. If there are more than one department within the organisation that will be working on the road, the relevant authorities may choose to include their Departmental Name within the logo for identification.
- 6. Relevant Authorities and Departments should advise the Road Asset Regulation & Licensing Division of Land Transport Authority on their preferred layout.
- 7. The name and logo of the employing organisation working on the road shall be displayed on the white band at the top of the sign.
- 8. The respective organisation may design their preferred layout within this white band and shall inform the Manager, Road Asset Regulation & Licensing Division of Land Transport Authority on this preferred layout.
- 9. Respective departments and boards shall also be indicated their telephone hotline at the bottom of the sign.
- 10. This is a suggested project signboard for organisations working on public road.
- 11. The dimensions and requirements is as sign I1 described earlier.
- 12. This sign shall be used to supplement other information signs like Sign I1 that provides telephone hotline number, therefore it is not necessary to repeat the telephone number on this sign.
- 13. This sign shall be used to supplement other information signs, e.g. I8 or I18, for a day-to-day countdown of the implementation of temporary traffic arrangement.
- 14. The overall layout of this sign, together with the information sign it is supplementing, shall be approved by LTA.
- 15. This sign is to inform the motorist of a new but temporary traffic scheme ahead and shall not be treated as a directional sign.
- 16. This sign shall be manufactured according to the latest specifications from the Traffic Management Division of Land Transport Authority.
- 17. The layout of the sign shall be approved by Land Transport Authority together with the proposed traffic scheme.

APPENDIX VI - Guidelines for the Deployment of Portable Traffic Light System for Shared Right of Way

Guidelines for Portable Traffic Light

1. Definitions

Portable traffic light is a device deployed to direct traffic whilst road works are being carried out. It is required to meet both the physical display and operational requirements of conventional traffic signals.

"Applicant" used hereinafter is defined as any person who makes or has made an application under Regulation 5 of the Regulations and includes a person whose application has been granted by the Authority. The Applicant is responsible for all temporary traffic management, planning the work and risk assessments. The Applicant shall engage qualified traffic consultant to assess site-specific factors such as schools, zebra-crossings, permanent traffic signals, road geometry, length of road works, commercial and industrial activities and etc., and determine timings for the portable traffic lights. During deployment, they shall also monitor vehicular flow at intervals and adjust the timing if necessary.

"User" used hereinafter is defined as the contractor/agencies who deploy portable traffic signals for road works, do not need the authority's permission to use them but should notify and/or consult the authority when planning the works.

2. Compliance to Standards

The portable traffic light shall conform to the requirements for traffic signals and traffic signal equipment specified in BS 505 Road Traffic Signals, Road Traffic (Traffic Signs) Rules or equivalent.

3. Assembly

The portable traffic light signals for vehicles shall be a 3-colour system consists of red, amber and green lights arranged vertically with the red light placed above the amber light and the green light placed below the amber light.

The effective diameter of the lens of each light shall be at least 200mm.

The minimum luminous intensity of the lights shall be as follows:

Туре	Minimum Intensity
	(Candela/cd)
Red light (200mm)	236
Amber light (200mm)	295
Green light (200mm)	295

The portable traffic lights shall operate under the hot and humid temperature in Singapore.

To ensure all equipment function without any detriment under external environment.

To ensure no sharp edges in the mounting brackets or panel casing which might cause injury to commuters or pedestrians.

The base of portable traffic light shall be painted in alternate orange and black colour (see colour scheme).



4. Traffic Control Signals Requirements

In order not to confuse motorists, portable traffic lights cannot be deployed where motorists' straight line-of-sight could be distracted by permanent traffic lights along the same road. Alternative traffic control arrangements such as authorised traffic marshals to regulate traffic could be deployed for such cases.

The minimum height clearance of the traffic light signals from the ground surface shall be 2,290 mm with adjustable provision to suit the geometry of the approach and site condition.

The traffic signal control operation shall be operated using the master and slave concept where the traffic lights at both end must communicate with each other at all times. No two traffic lights shall have all-green at the same time for different traffic approaches. If the controller detects some faults, causing lack of communication between the 2 traffic lights, it shall shut down and a warning signal shall be generated and alert the user accordingly.

Depending on the road works area (length), the portable traffic light system shall allow the user to program and set the red, amber, green and all-red lights timings.

The timings for the red signal (assessed and determined by qualified traffic consultant) shall be programmed such that the last vehicle is able to clear the length of the road works area at any time. Thereafter, an all-red phase shall be provided for an extra three seconds (minimum) to hold signals on red to both approaches. The determining factors in all red timing are the length of work zone and prevailing speed limit of the road. This is to allow vehicles to safely clear the shared lane to avoid head-on traffic movements.

The portable traffic lights shall be designed to allow manual intervention by user in overriding the control of traffic signal in any event that required the user to do so.

Power and signal cable routes should avoid areas where there is pedestrian traffic. If this is unavoidable the cable route, as a minimum, should be covered with a ramp suitable for wheelchair use. If power and signal cables cross a carriageway, User to cut slots in the road surface so that the cables can be buried temporarily. This area is to be resurfaced after the removal of portable traffic light system.

For wireless communication systems, there shall be no interference to the wireless transmission.

To alert motorists and increase prominence to the presence of the portable traffic lights, an advance warning sign showing traffic lights in operation ahead will be required. In addition, a "*Stop Here on Red Light*" sign will also be required to guide motorists on where to stop their vehicles when the traffic light is red for their bound. Please refer to **Appendix II** for details of the traffic control arrangements.

5. Maintenance

Access to the signal control panel must be restricted to prevent unauthorised changes to timings. Information on maintenance arrangements and fault reporting; i.e. contact numbers for Project Owner and contractor should be available at all times.

User shall perform daily site checks to ensure the deployed portable traffic lights are in proper working conditions. These checks shall include but not limited to the following:

- Safety and reliability of signals and lamp integrity
- Power and signal cables, for security and damage
- Timings, to correspond with traffic condition
- Power supply, to ensure continuous operation
- Cleaning of signal head lenses