GEORGE STREET, THE ROCKS

Digital Sign Traffic Safety Assessment

Sydney Trains

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The assessment team has undertaken assessments of similar advertising sign proposals elsewhere in NSW and Australia. In addition to the use of NSW guidelines, our assessments are founded on road safety auditing principles and traffic safety risk assessments. Where a significant change in road safety risk has been identified due to the proposal, potential treatment measures to mitigate the change in risk have been suggested. However, the adoption of any or all the treatment measures does not warrant that the site is absolutely safe from incidents in the future whether they be related or unrelated to the proposed sign.

Document Issue History

Report File Name	Version	Document Control		Date	Issued to
P6867.001R George Street The Rocks Digital Sign TSA	001	Prepared:	J. Wong S. Daizli	1/05/2025	Cordelia Maxwell-Williams, JCDecaux cordelia.maxwell-williams@jcdecaux.com
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CONTENTS

Tables

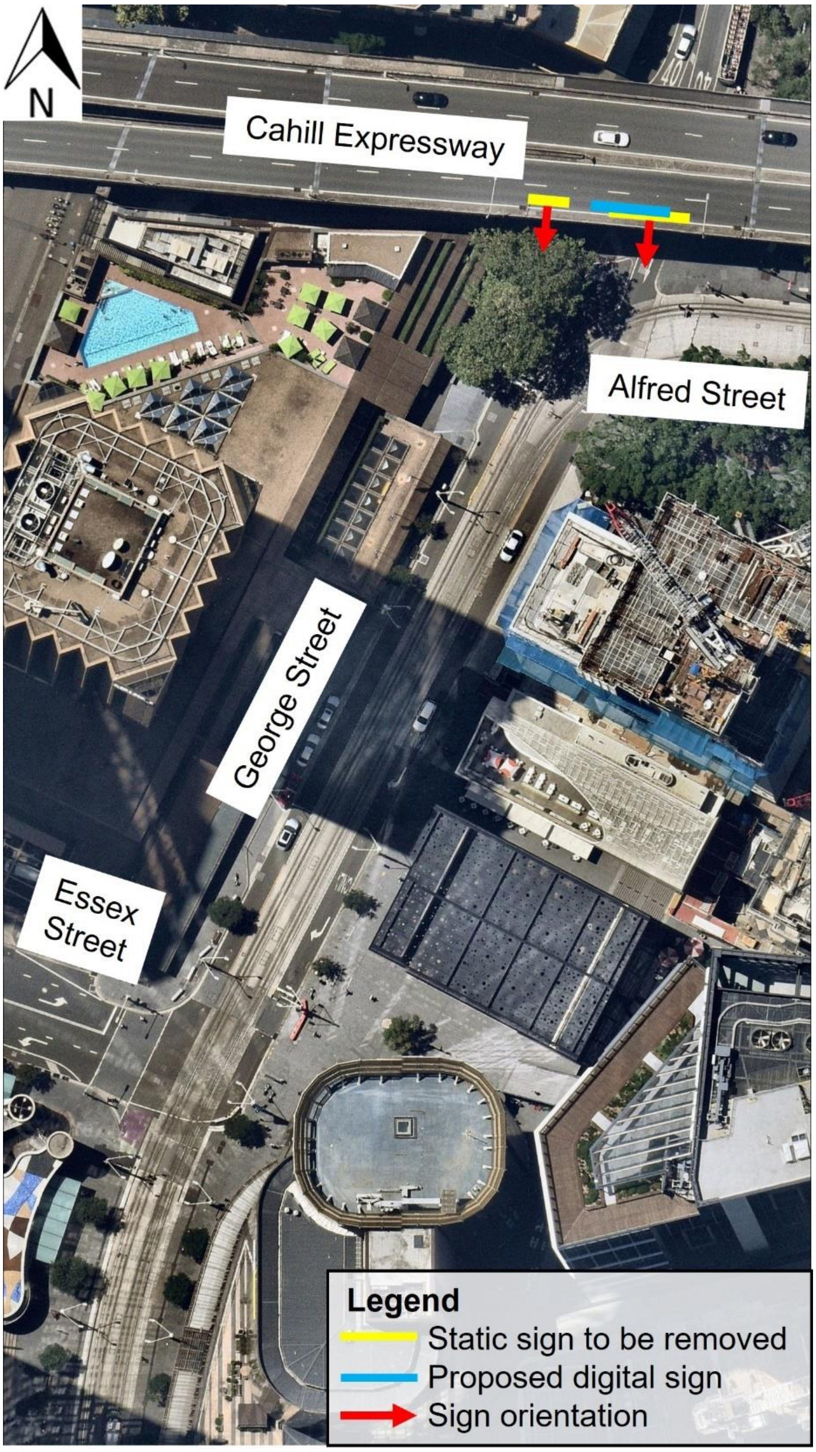
Figures

Appendices

1. INTRODUCTION

1.1 Background

Sydney Trains is seeking development approval for the removal of two existing static advertising signs and installation of a digital LED advertising sign. The signs are located on the southern face of the City Circle rail bridge over George Street in The Rocks as shown in Figure 1.1.



Adapted from Nearmap

Figure 1.1: Locations of the Existing Static Signs and Proposed Digital Sign

Bitzios Consulting has been engaged by JCDecaux (on behalf of Sydney Trains) to undertake a traffic safety assessment of the proposal.

1.2 Methodology

The process used to assess the impact of the proposal involved:

- A review of the viewing locations and sightlines to the existing static sign and hence the proposed digital sign to define the geographical scope of the assessment
- A review of the existing static sign and proposed digital sign specifications
- Site inspections during day and night conditions to understand the road user's perspective of the sign, then a driver sightline assessment using images captured from in-vehicle dash cam recordings
- A review of the most recently available five years of crash data in proximity to the sign
- A first-principles safety assessment of the proposed digital sign, including reviewing road approaches, driver sightlines, surrounding environment, proximity to traffic decision points and cognitive load on each approach
- A compliance assessment of the proposed digital sign against:
  - State Environmental Planning Policy (Industry and Employment) 2021 (Industry and Employment SEPP)
  - The Transport for NSW (Transport) Advertising Sign Safety Assessment Matrix
  - The *Transport Corridor Outdoor Advertising and Signage Guidelines: Assessing development applications under SEPP 64 (Department of Planning and Environment, 2017) (Signage Guidelines)*.
- A review of relevant research on the effects of digital signs in similar road environments, considering cognitive load, field of view and driver distraction effects.

2. Sign Viewing Locations

2.1 Sign Specifications

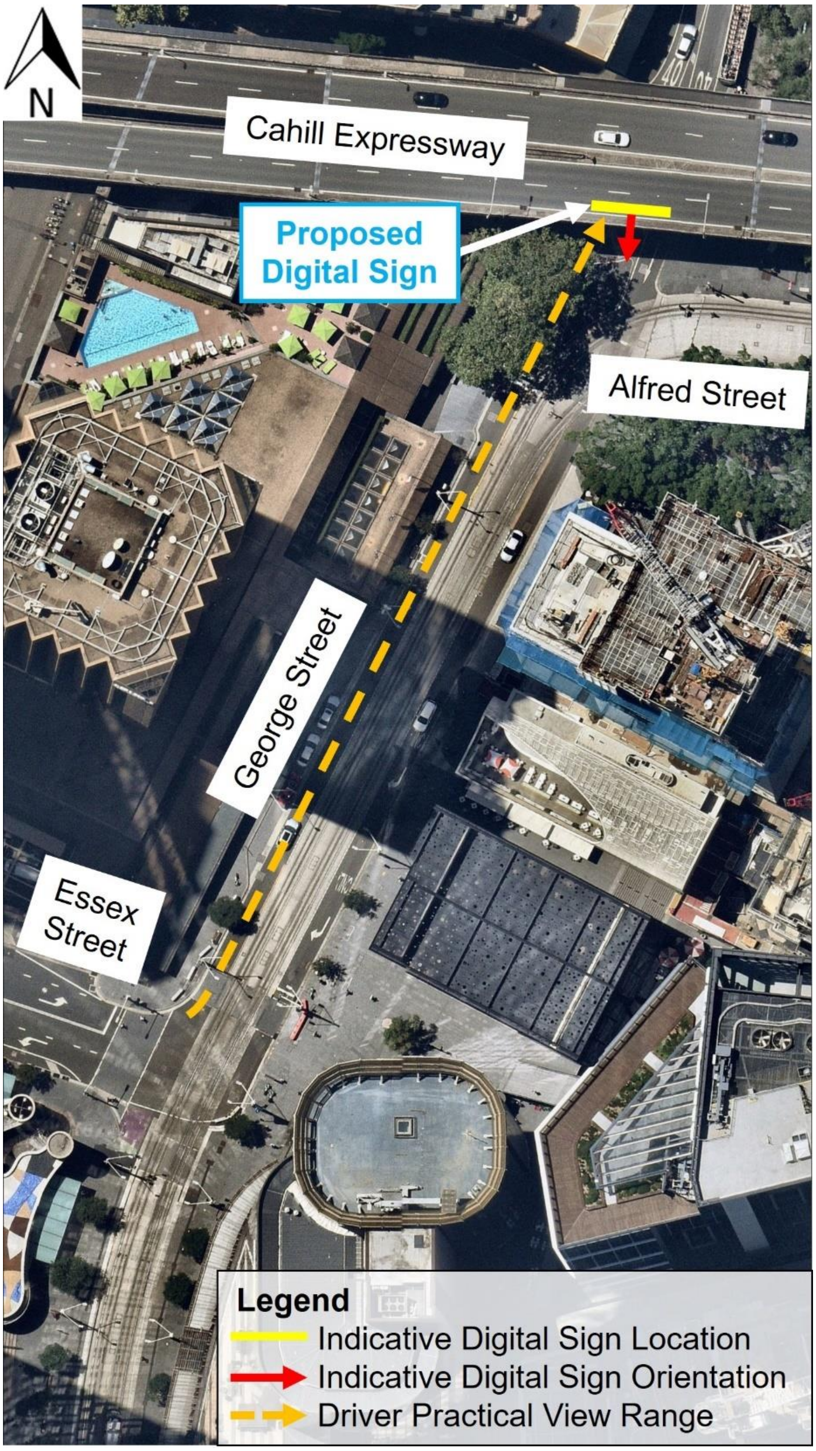
The specifications for the existing sign and the proposed digital sign, as well as other relevant site information, are summarised in Table 2.1 The proposed plan is provided in **Appendix A**.

Table 2.1: Details of the Existing Static Sign and Proposed Digital Sign

Attribute	Details
Location	Southern elevation of the City Circle rail bridge over George Street, The Rocks, NSW
Local Government Area	Sydney
Land use zoning	Under the Sydney Cove Redevelopment Authority Scheme
Existing and proposed facing direction	South
Existing and proposed type of advertisement/sign	Bridge advertisement – super 8
Existing display format	Internally illuminated general advertising
Proposed display format	Internally illuminated digital (LED)
Existing visual screen size	8.48m x 2.38m = 20.18sqm
Proposed visual screen size	7.936m x 2.048m = 16.25sqm
Proposed advertising display area	7.986m x 2.198m = 17.55sqm
Visual screen size greater than or equal to 20sqm?	No
Visual screen size greater than 45sqm?	No
Minimum vertical pavement clearance	4.4m
Structure higher than 8m above the ground?	No
Is the site located within 250m of and visible from a classified road under the *Roads Act 1993*?	No
Consent authority	NSW Minister for Planning and Public Spaces
Does the sign contain moving parts?	No
Is it a variable message sign?	No
Does it have any flashing or flickering content?	No

2.2 Viewing Approaches

The digital sign will be visible towards northbound drivers on George Street. The driver viewing range to the sign from this approach is illustrated in Figure 2.1.



Adapted from Nearmap

Figure 2.1: Driver Viewing Range to the Proposed Sign

2.3 Driver Views

The driver's view to the sign from George Street northbound during the day and night-time periods are shown in Figure 2.2 and Figure 2.3 respectively.

Figure 2.2: Daytime view from George Street northbound

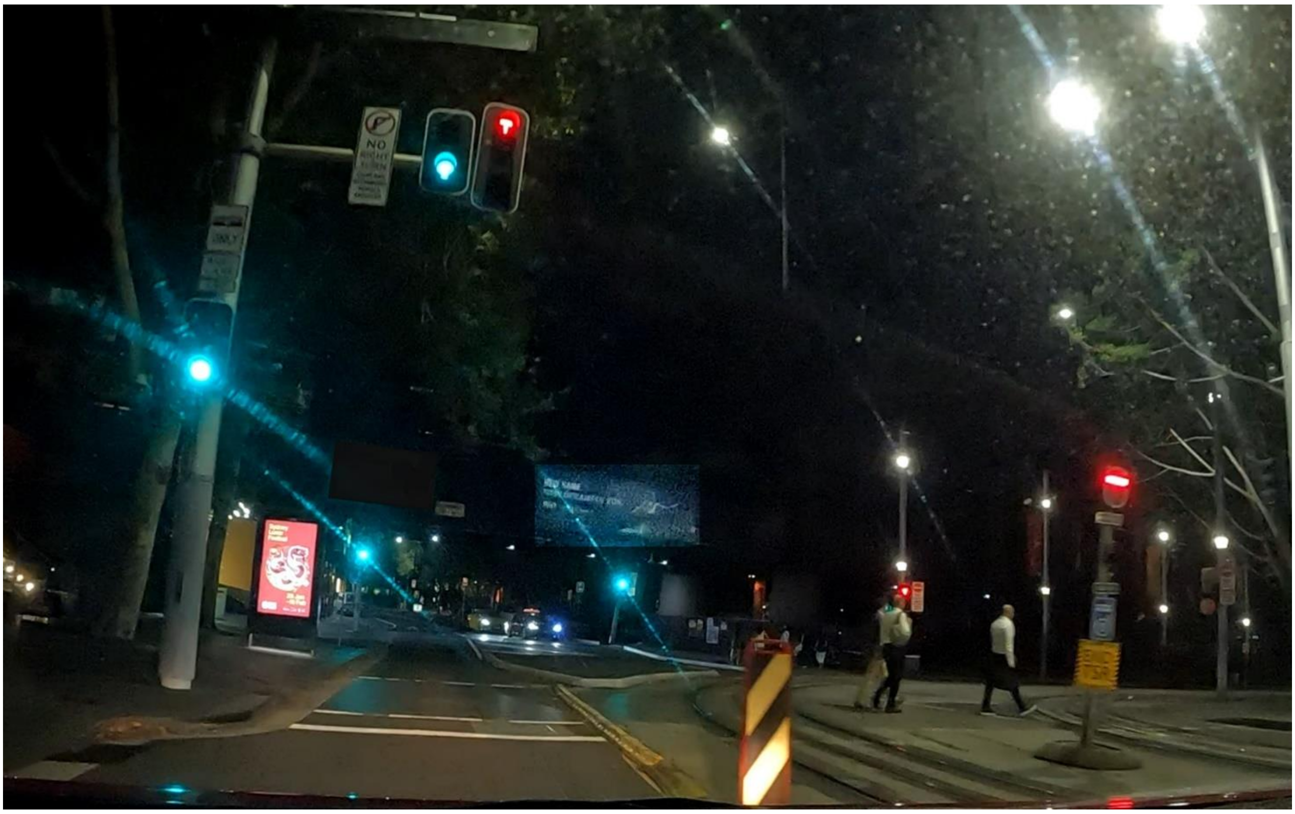


Figure 2.3: Night-time view from George Street northbound

3. NSW Government Criteria Compliance Assessments

3.1 Industry and Employment SEPP Schedule 5

The assessment against Schedule 5 of the Industry and Employment SEPP is provided in Table 3.1. The criteria are generic, and the details associated with the responses relevant to each criterion are provided.

Table 3.1: Assessment against Industry and Employment SEPP Schedule 5

Criteria	Response
8. Safety	
▪ Would the proposal reduce the safety for any public road?	The proposal would not reduce the safety to the public road because there are no on-road-related risks apparent in the crash data and all driving risks ahead of the driver would be instantly recognised to the extent they are now because the proposed digital sign would be in the background of the views to these risks.
▪ Would the proposal reduce the safety for pedestrians or bicyclists?	The change in pedestrian and cyclist safety risk is insignificant because these risks in the foreground will still be identified by drivers with the proposed digital sign in the background.
▪ Would the proposal reduce the safety for pedestrians, particularly children, by obscuring sightlines from public areas?	No sightlines for pedestrians and children will be blocked by the proposed digital sign as it will be above the roadway.

3.2 Transport for NSW Advertising Sign Safety Assessment Matrix

Table 3.2 details the assessment against the Transport Advertising Sign Safety Assessment Matrix.

Table 3.2: Assessment against the Transport Advertising Sign Assessment Matrix

Consideration	Response	Risk Rating	Risk Level
A. It obscures a view of an object/vehicle/pedestrian that creates a hazard	The proposed sign will be located above all surrounding objects/vehicles/pedestrians etc. and therefore does not obscure any view lines to create a hazard.	1	Low
B. Sign positioning relative to travel direction	The proposed sign will be positioned within a driver's ordinary field of view, in the background to driving-relevant information in the foreground (i.e. brake lights and indicator lights from vehicles). Only glance appreciation is required.	1	Low
C. It distracts a driver at a critical time	The proposed sign will be located adjacent to the George Street/Alfred Street signalised/light rail intersection. Whilst the sign will be located within a 'decision point', it is directly in the same forward view as driving decision inputs and the movements of vehicles, pedestrians or cyclists along this narrow, slow-speed environment would be recognised simultaneously with a glance to the sign.	2	Low
D. It interferes with the effectiveness and safety of a traffic control device (e.g. traffic signs, traffic signals or other traffic control devices)	The proposed sign will not interfere with a driver's ability to recognise any traffic control devices.	1	Low
E. Sign clutter	A small static advertising sign is located to the left of the subject sign, above the George Street northbound travel lane. There is also a digital street advertising sign on the western footpath within the Alfred Street intersection. The former sign will be removed as part of the proposal which will reduce the number of advertising signs.	1	Low

3.3 Transport Corridor Outdoor Advertising and Signage Guidelines

Table 3.3 details the assessment against the digital sign criteria in Table 3 of the *Signage Guidelines*.

Table 3.3: Assessment against the Signage Guidelines Digital Sign Criteria

Criterion	Response
a. Each advertisement must be displayed in a completely static manner, without any motion, for the approved dwell time as per criterion (d) below.	Conditions can be imposed by the consent authority to ensure that the sign is completely static for the specified dwell time.
b. Message sequencing designed to make a driver anticipate the next message is prohibited across images presented on a single sign and across a series of signs.	Conditions can be imposed by the consent authority to ensure there is no message sequencing that creates driver anticipation for the next message on the proposed sign or with any other signs.
c. The image must not be capable of being mistaken: i. for a prescribed traffic control device because it has, for example, red, amber or green circles, octagons, crosses or triangles or shapes or patterns that may result in the advertisement being mistaken for a prescribed traffic control device ii. as text providing driving instructions to drivers.	Conditions can be imposed by the consent authority to ensure that sign content, design, imagery and messages neither replicate nor can be mistaken for a prescribed traffic control device or instruction to drivers. For example, advertisements must not instruct drivers to perform an action such as 'Stop'.
d. Dwell times for image display must not be less than: i. 10 seconds for areas where the speed limit is below 80km/h ii. 25 seconds for areas where the speed limit is 80km/h and over.	The minimum allowed dwell time is 10 seconds based on the posted speed limit of 40km/h. Conditions can be imposed by the consent authority to ensure this minimum dwell time.
e. The transition time between messages must be no longer than 0.1 seconds, and in the event of image failure, the default image must be a black screen.	Conditions can be imposed by the consent authority to ensure that the sign has a transition time of no more than 0.1 seconds and a black screen in the event of image failure.
f. Luminance levels must comply with the requirements in Section 3 below.	The site is identified as Zone 3 as categorised in Section 3.3 of the *Signage Guidelines*. Acceptable luminance levels for this zone as specified in Table 6 of the *Signage Guidelines* are: no limit (full sun on face of signage), 6000cd/sqm (daytime), 700cd/sqm (twilight and inclement weather) and 350cd/sqm (night-time). Conditions can be imposed by the consent authority specifying maximum allowable luminance levels.
g. The images displayed on the sign must not otherwise unreasonably dazzle or distract drivers without limitation to their colouring or contain flickering or flashing content.	Conditions can be imposed by the consent authority to ensure that the sign's images comply with requirements to not contain flickering or flashing content.
h. The amount of text and information supplied on a sign should be kept to a minimum (e.g. no more than a driver can read at a short glance).	Conditions can be imposed by the consent authority to ensure that minimal text and information is supplied on a sign no more than a driver can read at a short glance.
i. Any sign that is within 250m of a classified road and is visible from a school zone must be switched to a fixed display during school zone hours.	The sign is not visible from a school zone.
j. Each sign proposal must be assessed on a case-by-case basis including replacement of an existing fixed, scrolling or tri-vision sign with a digital sign, and in the instance of a sign being visible from each direction, both directions for each location must be assessed on their own merits.	All relevant traffic directions have been assessed on their own merits.
k. At any time, including where the speed limit in the area of the sign is changed, if detrimental effect is identified on road safety post installation of a digital sign, RMS reserves the right to re-assess the site using an independent RMS-accredited road safety auditor. Any safety issues identified by the auditor and options for rectifying the issues are to be discussed between RMS and the sign owner and operator.	Noted.

Table 3.4 details the assessment against relevant road safety criteria in Section 3 of the *Signage Guidelines*.

Table 3.4: Assessment against relevant Signage Guidelines Road Safety Criteria

Criterion	Response
Road clearance	
a. The advertisement must not create a physical obstruction or hazard. For example: i. Does the sign obstruct the movement of pedestrians or bicycle riders? (e.g. telephone kiosks and other street furniture along roads and footpath areas)? ii. Does the sign protrude below a bridge or other structure so it could be hit by trucks or other tall vehicles? Will the clearance between the road surface and the bottom of the sign meet appropriate road standards for that particular road? iii. Does the sign protrude laterally into the transport corridor so it could be hit by trucks or wide vehicles?	The proposed sign will not obstruct the movement of pedestrians or bicycle riders or protrude into the transport corridor given it is located above the road.
Line of sight	
To maximise visibility of the road and minimise the time a driver's attention is directed away from the road, the following criteria apply to all advertising signage: **a.** An advertisement must not obstruct the driver's view of the road, particularly of other vehicles, bicycle riders or pedestrians at crossings.	The proposed advertisement will not obstruct the driver's view of the road, other vehicles, bicycle riders or pedestrians at crossings or direct a driver's attention away from the road because a momentary glance to the sign is in the same forward view as vehicles ahead.
b. An advertisement must not obstruct a pedestrian or cyclist's view of the road.	The proposed advertisement will not obstruct a pedestrian or cyclist's view of the road given it is located above the road.
c. The advertisement should not be located in a position that has the potential to give incorrect information on the alignment of the road. In this context, the location and arrangement of signs' structures should not give visual clues to the driver suggesting that the road alignment is different to the actual alignment. An accurate photo-montage should be used to assess this issue.	The proposed advertisement is deemed not to be located in a position that has the potential to give incorrect information on the road alignment. Day and night-time photo montages showing key approaches to the site are provided in **Appendix B**.
d. The advertisement should not distract a driver's attention away from the road environment for an extended length of time. For example: i. Does the sign obstruct the movement of pedestrians or bicycle riders? (e.g. telephone kiosks and other street furniture along roads and footpath areas)? ii. The sign should not be located in such a way that the driver's head is required to turn away from the road and the components of the traffic stream in order to view its display and/or message. All drivers should still be able to see the road when viewing the sign, as well as the main components of the traffic stream in peripheral view.	The proposed advertisement will not obstruct movement of pedestrians of bicycle riders given its location above the road. The sign is located and orientated so that only glance appreciation is required, meaning drivers would not need to turn directly in the ordinary forward view. Given that the sign is directly in the forward view, drivers would still instantly recognise and react to light, movement or colour ahead such as vehicles changing lanes or braking ahead of them, as they do now.
e. The sign should be oriented in a manner that does not create headlight reflections in the driver's line of sight. As a guideline, angling a sign five degrees away from right angles to the driver's line of sight can minimise headlight reflections. On a curved road alignment, this should be checked for the distance measured back from the sign that a car would travel in 2.5 seconds at the design speed.	The proposed sign will not create headlight reflections in the driver's line of sight given its proposed raised location and it will not tilt down towards them.

Criterion	Response
Proximity to decision making points and conflict points	
a. The sign should not be located: i. less than the safe sight distance from an intersection, merge point, exit ramp, traffic control signal or sharp curves ii. less than the safe stopping sight distance from a marked foot crossing, pedestrian crossing, pedestrian refuge, cycle crossing, cycleway facility or hazard within the road environment iii. so that it is visible from the stem of a T-intersection.	The digital sign does not meet criteria (a)(i) or (a)(ii). These criteria within the guidelines are not based on any causal relationship between digital signs and crashes in these locations and hence has no basis in the research.
b. The placement of a sign should not distract a driver at a critical time. In particular, signs should not obstruct a driver's view: i. of a road hazard ii. to an intersection iii. to a prescribed traffic control device (such as traffic signals, stop or give way signs or warning signs) iv. to an emergency vehicle access point or Type 2 driveways (wider than 6-9m) or higher.	Distraction means that either the driver's view is removed from the forward roadway for a significant period or the cognitive load imposed by the sign is excessive in a road environment that already imposes a prevailing very high cognitive load on drivers. Neither of these conditions exist with the proposal and a driver's view is exactly the same with the sign as without it.
Advertising signage and traffic control devices	
a. The advertisement must not distract a driver from, obstruct or reduce the visibility and effectiveness of, directional signs, traffic signals, prescribed traffic control devices, regulatory signs or advisory signs or obscure information about the road alignment.	The proposed advertisement will not distract a driver from or reduce the visibility and effectiveness of any traffic control devices because it is in the same view line and in the background of those devices which are in the foreground.
b. The advertisement must not interfere with stopping sight distance for the road's design speed or the effectiveness of a prescribed traffic control device. For example: i. Could the advertisement be construed as giving instructions to traffic such as 'Stop', 'Halt' or 'Give Way'? ii. Does the advertisement imitate a prescribed traffic control device? iii. If the sign is in the vicinity of traffic lights, does the advertisement use red, amber or green circles, octagons, crosses or triangles or shapes or patterns that may result in the advertisement being mistaken for a traffic signal?	The proposed sign will not interfere with stopping distances to any traffic control devices. Conditions can be imposed by the consent authority to ensure that sign content, design, imagery and messages neither replicate nor can be mistaken for a prescribed traffic control device or instruction to drivers. For example, advertisements can be conditioned to not instruct drivers to perform an action such as 'Stop'.

4. Traffic Safety Assessment

4.1 Basis of the Assessment

Given the absence of definitive guidelines and metrics to assess the proposal against, a 'first-principles traffic safety assessment has been completed in this section of the report considering relevant driving, walking and cycling views to the proposed sign and the likelihood and consequences of new distractions due to the digital sign.

The assessment of the proposed digital sign was undertaken on the basis of:

- Driver sightlines being approximated based on provided montages showing the digital sign proposal
- The display of content will be static for a minimum dwell time of 10 seconds with a transition time of no more than 0.1 seconds (consistent with the *Signage Guidelines*)
- Illumination / lighting levels for the digital sign will comply with the *Signage Guidelines* and hence maintain lighting levels to match the surrounding environment.

4.2 Site Inspections

Site inspections were undertaken on Thursday, 6 February 2025 during day and night-time hours (around 3:45pm and 9:15pm respectively). The weather was fine. The sign was not illuminated during the night-time inspection. In-vehicle video recordings were taken for further analysis and for use in compiling photo montages of the driver's perspective on the approaches to the site. The photo montages can be found in **Appendix B**.

4.3 Review of Crash Data

The most recent five years of crash data between 2019 and 2023 was obtained from Transport and used to assess the crash history within the driver practical viewing range to the proposed digital sign. The practical viewing range to the sign is from approximately 130m south-west along George Street. Crashes occurring between 2019 and 2023 involving vehicles travelling within this viewing range were used for the assessment.

As per Rule 287 (3) of the *Road Rules 2014*, crashes are only recorded if they are reported to the police and when:

- Any person is killed or injured
- Drivers involved in the crash do not exchange particulars; or
- When a vehicle involved in the crash is towed away.

The crash data was mapped by severity and road type and is presented in **Appendix C** along with an attributes table. Table 4.1 summarises the number of crashes per year by severity.

Table 4.1: Crash Severity in Proximity to the Site (2019-2023)

Year	Crash Severity					Total
	Fatal	Serious Injury	Moderate Injury	Minor/Other Injury	Non-casualty (towaway)	
2019	-	-	-	-	-	0
2020	-	-	-	-	1	1
2021	-	-	-	-	-	0
2022	-	-	-	-	-	0
2023	-	-	-	-	-	0
Total	**0**	**0**	**0**	**0**	**1**	**1**

As shown in the above table, only one crash was recorded between 2019 and 2023. It occurred in July 2020 in daylight and wet road surface conditions at the Essex Street signalised intersection. The crash was classified as ‘left-rear’ and resulted in a tow-away.

The site reveals a very low crash rate (less than one crash per year) when considering the straight and slow-speed road environment with excellent sightlines. Furthermore, the analysis of the crash records suggests that this is not an inherently unsafe driving location.

4.4 Approach Sightline Assessments

4.4.1 Description of Relevant Approaches

The relevant approaches in proximity to the sign are described in Table 4.2.

Table 4.2: Approach Attributes in Proximity to the Sign

Attribute	George Street northbound
Posted speed limit	▪ 40km/h High Pedestrian Activity Area
Decision points within view of the sign	▪ Alfred Street intersection, adjacent to the sign
Approach arrangement	▪ 1 through traffic lane and 1 right curve light rail track into Alfred Street
Practical advertising observation distance	▪ From approximately 130m south-west of the sign
Minimum duration of visibility	▪ 12 seconds at free-flow speed

4.4.2 Driver Sightline Assessment

Process

In-vehicle observations were undertaken to assess the subject site considering key decision points and the influence on or from traffic control devices. An assessment of still images taken from the driver’s perspective with a dash cam is presented in the following section. It should be noted that the assessment was undertaken based on a standard passenger car and as such a driver’s eye height may vary for larger and smaller vehicles.

The premise of the assessment is to ensure that the proposed location of the advertising sign maintains a driver’s ability to observe changes in movement (vehicle changes) or light (brake lights) ahead or to any traffic control devices and is not located as such that it may be confused with or confuse the interpretation of these traffic control devices.

The glance angle away from the forward roadway is also a consideration in relation to when the sign is most likely to be glanced to and how far away the sign glance angle is from the forward roadway.

The driver’s cognitive load specific to the driving environment on approach to the proposed sign is also considered. Typically, locations where advertising signs could have a greater influence crash risk are locations where rapid, complex, multi-factor decision making is required.

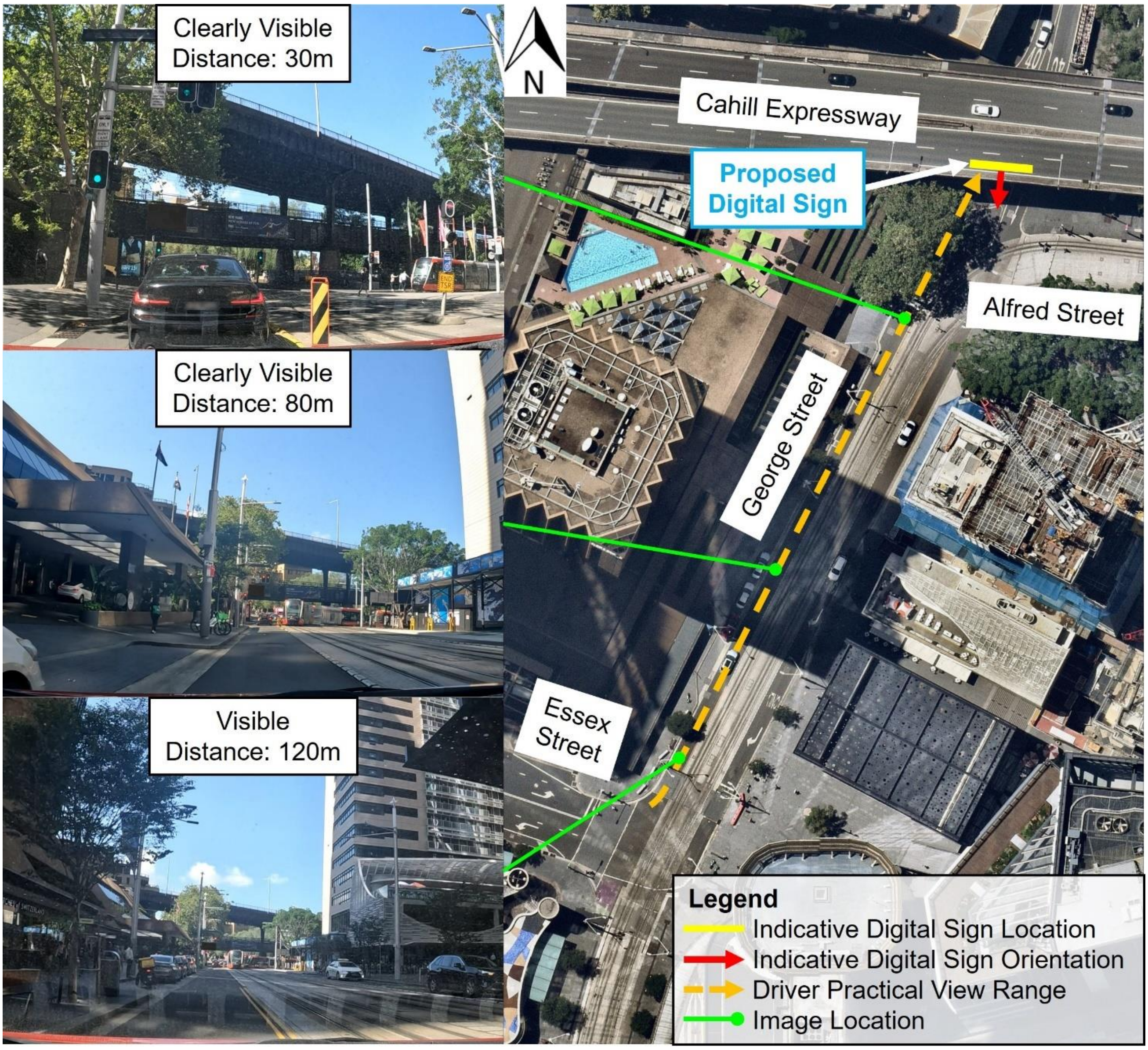
Assessment of George Street northbound

The northbound approach along George Street is straight and flat towards the proposed digital sign. Traffic speeds are very slow in the narrow single lane adjacent to, but separated from, the light rail line. There is also an indented taxi rank and an egress into the Four Seasons Hotel Sydney porte-cochere.

Given that the sign is in the direct, forward view, a glance to the sign would still allow drivers instantaneous recognition of vehicles changing lanes and/or braking ahead and to assess the risk of errant vehicles, pedestrians and cyclists coming into their path. All colour, movement and light changes would be instantly recognisable with a glance to the sign or other stimuli in the visual field (buildings, other advertising, pedestrians etc.). For example, a driver observing signal changes is in exactly the same view line as a glance to the sign and would be recognised and reacted to in exactly the same way as it would be now.

The driver distraction risks along George Street northbound associated with the proposed digital sign are insignificant in terms of worsening the risk of crashes.

The in-vehicle sightlines along George Street northbound are shown in Figure 4.1.



**Distances measured in Google Maps*

Figure 4.1: In-vehicle viewing range and views along George Street northbound

5. Literature Review

5.1 The Need for a Literature Review

The current *TfNSW Signage Guidelines* do not provide any clear nexus between driver behaviours approaching digital signs and the scale of change in crash probability in various driving and sign-location circumstances. In the absence of this guidance, reliance is needed on industry and academic research into the components of driving inputs, behaviours and outputs that are relevant to crash risk influences by digital signs.

5.2 Context

Crashes directly related to digital signs would typically fall into two categories:

1. Crashes due to the collision of a vehicle with the mounting structure of a digital sign where it is placed in a location where there is a reasonable risk of this occurring
2. Crashes which occur as a consequence of a driver being distracted by a digital sign.

The *TfNSW Signage Guidelines* generally provide well-researched information on the location of 'clear zones' and other areas where there is a reasonable risk of an object being collided with by an errant vehicle. However, the linkages between driver distraction (due to digital signs) and crashes are less well dealt with in the *TfNSW Signage Guidelines* and many of the criteria used have no direct relevance to the risk of distraction in time and in space on approach to digital signs located in different parts of the visual driving environment and in different driving environments.

The chain of events that is logically required to link a digital sign to increased crash probability is that:

A driver is aware of an external event (i.e. outside the vehicle) which is a digital sign display change and that the event distracts a driver sufficiently to lead to involuntary driver inattention and inability to recognise changes in either light, movement or colour ahead, which then leads to driver error at a critical time in a driving environment and driving circumstance that leads to a crash.

The majority of the research over the last 25+ years into the effects of digital signs on crashes does not identify a correlation between digital signs and higher crash rates nor does it identify any causation relationships. The consensus of the research also acknowledge that further research is required because firm conclusions are unable to be drawn.

A key reason for this may be either be that causal effects of digital signs on crash rates do not exist in many circumstances or that if they do exist, they are far too complex to measure because they are obscured by a very large number of other factors/variables that can cause a crash. Driving circumstances that lead to a crash are multi-faceted and inter-related and vary widely depending on the driving environment and driver characteristics.

5.3 Approach to Reviewing the Literature Review

In an attempt to 'break down' the chain of events where a digital sign could result in a crash, the available research has been disaggregated into the following topics:

- The relationship between driver distraction (generally) and crashes
- The relationship between digital signs and driver distraction (including distraction away from the forward view to traffic-relevant information and cognitive distraction or inattention)
- Studies which have attempted to interpret before vs. after installation crash statistics to see if there is a correlation between digital signs and increased crash rates (without defining a causal relationship).

Research on each of these topics is discussed in the following sections. Notwithstanding technological advancements in vehicles and in digital signs, it should be noted that literature from 10-20 years ago, is still referred to in more recent literature as earlier studies provide a foundation on the impacts of digital signs on driver distraction, often leading to more refined/targeted research in more recent studies.

5.4 Relationship between Driver Distraction and Crashes

There is consensus in the literature that the majority of crashes which occur in urban areas are due to driver error. Victor et al. (2005) highlights that human error is the cause of up to 92.6 percent of accidents on the road. In order to minimise the risk of crashes, drivers need to: be aware of external environmental influences, interpret the risks associated with these external environmental influences, make decisions, and carry out actions (Perez & Bertola 2011).

Austroads (2013) provides a comprehensive review of research on the effect of roadside advertising on road crashes. It found from its extensive literature review that *"while looking at an external object appears to be quite risky behaviour when it is engaged in, it is not a frequent cause of crashes overall"*.

Many studies have been undertaken to determine the main causes of both driver distraction and driver inattention, and how they contribute to an increase in crashes. Bates et al. (2021) states that *"'distraction' occurs when a driver engages in a secondary activity that removes attention from the primary task of driving safely. Distractions can be both inside (e.g., using a mobile phone or wearable technology, eating, drinking, talking with passengers) or outside a vehicle (e.g., looking at roadside advertising or navigating complex road contexts)"*.

A broader definition of distracted driving involves *"sharing attention between the primary task (driving) and a non-driving related secondary task. The non-driving related secondary task can be in-vehicle (e.g., mobile phones conversations, in-vehicle infotainment interactions, etc.) or external (e.g., reading roadside advertising signs, looking at non-related landscape elements, etc.)"* (Oviedo-Trespalacios 2019, p.86).

The most common secondary task examined was mobile phone use. Nearly half of drivers in the USA reported sending texts while driving. Research suggests that the reaction time of drivers who talk on a mobile phone while driving increases by approximately 18% and is said to be attributed to workplace attitudes and cultural norms. It also *"suggests that higher levels of vehicle automation can induce boredom and consequently cause drivers to divert their attention towards competing secondary tasks"* (Bates et al. 2021).

The literature is clear that distractions that divert the eyes of a driver from the forward roadway for prolonged periods or that add to prevailing cognitive load to create excessive cognitive load on the driver are the types of distraction that are more likely to create the potential for crashes.

5.5 Relationship between Digital Signs and Driver Distraction

Samsa (2015) conducted a study that used eye tracking technology to track participants' natural eye movements and prioritisation behaviour whilst driving. Several participants were each instructed to drive a single loop of the study route (14.6km section of a road through Brisbane and its surrounding suburbs to Woolloongabba) between 11am and 2pm. This study found that participants prioritised tasks based on the complexity of the driving demands, which was particularly evident during heavy traffic in AM and PM peak hours. The research found that in demanding driving environments, drivers will prioritise focusing on "on-road" factors such as the rate of cars braking and on pedestrian and cyclist movements over off-road factors such as billboards. Moreover, Samsa (2015) found no significant difference in driver prioritisation when comparing static billboards, digital billboards and on-premises signs. This research concluded that there is a smaller chance of driver distraction from digital billboards whilst driving in demanding environments.

The research of Decker et al. (2015) supported the glance time findings of other studies. This research summarised the results of 8 studies and concluded that the "*range of mean glance durations was 0.27 to 0.953 s (mean, 0.51) for passive billboards and 0.27 to 1.0 s (mean, 0.54) for active billboards*". This research did note "*strong evidence of substantial variability among individual billboards in each category"*.

The participants' glance behaviour was recorded and analysed in terms of the number of fixations and the duration of these fixations to both static and digital billboards in the work of Samsa (2015). Out of a total of 144 fixations toward four digital billboards, the average fixation duration was below 0.75 seconds. This is considered to be *"the equivalent minimum-perception reaction time to the slowing of a vehicle ahead"* (Samsa 2015, p.8). Less than 1% of the records presented an average fixation duration of above 0.75 seconds. This average was apparent for both static and digital sign types. Furthermore, Samsa's (2015) results showed that participants that fixated on a digital billboard for longer than 0.75 seconds tended to do so when travelling conditions were relaxed (i.e. car was stationary, or traffic was minimal).

Samsa's (2015) results followed those of Perez and Bertola (2011) which also used eye-tracking technology to survey driver behaviour when glancing to digital billboards. Perez and Bertola (2011) also found that the maximum glance duration off the centre of the road was 0.75 seconds and claimed that that these small glances away from the road generally occur when there is low demand from the road network, and that these glances are not likely to result in adverse or critical events. Overall, a number of studies have concluded that drivers glance at digital billboards at a mean rate of 0.5 seconds and almost all are less than 1.0 seconds.

Several crash data studies near digital billboard locations reported no significant relationship with crash occurrence, arguing that digital billboards have little to no impact on driver safety (Sisiopiku et al. 2015, p.11). However, laboratory studies confirmed that the presence of advertising billboards decreased driver control, increased mental workload, increased the time required to respond to a potentially dangerous event and increased driver error. Digital billboards also caused drivers to be less observant of stopping cars ahead of them and caused drifting into adjacent lanes. Some naturalistic studies concluded that there was no substantial distraction caused by the advertising signs and that gaze duration towards signs decreases as driving complexity increased. Other studies showed increased number of glances per sign and longer glances in the presence of digital advertising billboards compared to static billboards (Sisiopiku et al. 2015, p.12). Schieber et al. (2014) observed that drivers can display decreased performance after passing a roadside advertising sign.

Misokefalou et al. (2016) also conducted a study that used eye tracking technology to track participants' natural eye movements and prioritisation behaviour whilst driving. 87 participants were instructed to drive 51km on the Attica Tollway, the ring road of the Athens metropolitan area, and were assessed on their level of distraction caused by 69 out-of-vehicle elements, such as information signs, roadside advertising, variable message signs, toll buildings, noise barriers/panels etc. The study found that the average distraction time caused by advertising structures was 0.52 seconds when including 0-second distraction times (56% of all occurrences) and 0.86 seconds when excluding those drivers that did not glance. By comparison, distraction caused by road-related infrastructure was 0.98 seconds and by non-road infrastructure was 1.17 seconds when excluding those drivers that did not glance away from the forward roadway.

In summary, the literature presented in this section provides mixed findings on the distraction influences of digital signs. There is a growing body of research that suggests glance times to digital signs average at about 0.5 seconds for all drivers, or between 0.5 seconds and 1.0 second for those who elect to glance, which is a similar glance duration that drivers glance to other objects in their visual field before their eyes saccade to their next fixation point. Based on this, it is reasonable to conclude that digital signs are observed in a similar way to other interest points in the visual field (buildings, other vehicles, road signs, landscapes etc.) when driving, except perhaps that following the glance to them, that there is some small residual cognitive load imposed on the driver as they actively, or passively process the glance contents.

5.6 The Relationship between Digital Signs and Crashes

5.6.1 Distraction Duration

Sisiopiku et al. (2015) identified that 23% of crashes and near-crashes that occur in metropolitan environments are caused by drivers taking their eyes off the forward roadway for more than 2.0 seconds, and that nearly 80% of the crashes and 65% of near-crashes were caused by drivers looking away for up to 3.0 seconds. This type of distraction duration is more common with in-vehicle distractions that out-of-vehicle distractions which are typically much shorter.

This study also noted that an objective evaluation is still needed to determine if the presence of digital billboards really distracts driver attention or not and if so, to what extent.

5.6.2 International Examples

Despite the growing number of digital billboards present in Australia, there is still limited before and after installation crash studies that specifically target identifying a relationship between digital signs and crash rates and under what conditions. A selection of international research is presented below:

Tantala and Tantala (2010) was based on "26 existing, non-accessory, advertising digital billboards along routes with periods of comparison as long as 8 years in the greater Reading area, Berks County, Pennsylvania". This research looked at both temporal and spatial crash details around the electronic signs and compared the data to 51 non-electronic signs. The digital signs had message duration times of 6, 8 or 10 seconds. This research concluded that:

- *"The before and after rates of accidents near the twenty digital billboards show an 11.1% decrease within 0.5 miles of all digital billboards over eight years near twenty locations. Similar decreases and trends in both averages and peaks are observed for both smaller and larger vicinity ranges, and for specific groups of locations by duration time."*
- *"The accident statistics and metrics remain consistent, exhibiting statistically insignificant variations at each of the digital billboards. The metrics include the total number of accidents in any given month, the average number of accidents, the peak number of accidents in any given month, and the number of accident-free months. These conclusions account for variations in traffic-volume and other metrics."*
- *"The statistical evaluation of the Empirical Bayes method and actual versus predicted results show that the total number of accidents is comparable to what would be statistically expected with or without the introduction of digital technology and that the safety near these locations is consistent with the model benchmarked by 77 locations within Berks County."*

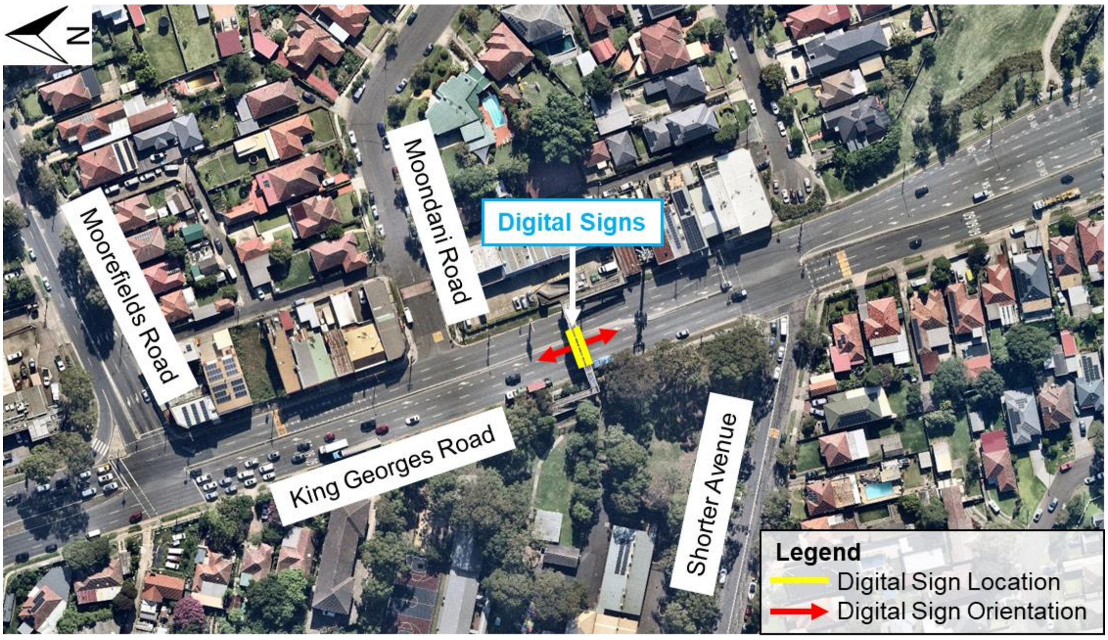
Pandey and Shafizadeh (2011) reviewed a range of traffic flow parameters upstream of electronic billboards on Highway 50 near Sacramento. The study concluded that *"the presence of the electronic billboard does not appear to have a significant negative impact in traffic performance (flow, speed, and lane occupancy) or incidents in the study section of the freeway"*.

Sisiopiku et al. (2015) undertook a crash analysis of ten sites in Florida and eight sites in Alabama, comparing statistics upstream and downstream each digital billboard location. The sites were selected so that they experienced the same traffic and geometric conditions both upstream and downstream (i.e. number of lanes, roadside features, no weaving manoeuvres etc.). There were totals of 377 crashes in Florida and 77 crashes in Alabama, and the data in both states revealed that the presence of digital billboards increased the overall crash rates in areas of billboard influence compared to control areas downstream between 25% (Florida) and 29% (Alabama), although the site-specific change varied. Certain types of crashes were linked to driver distraction, such as fixed object, sideswipe and rear-end, which were overrepresented at the digital billboard influence zones studied.

5.7 Before vs. After Installation Case Studies

King Georges Road, Beverly Hills

In May 2019, static signs were converted to digital signs on both sides of a pedestrian bridge over King Georges Road in Beverly Hills (see Figure 5.1). The crash data on approach to the bridge both pre- and post-installation of the digital signs was compared as shown in Table 5.1.



Adapted from Nearmap

Figure 5.1: Locations of the Digital Signs in Beverly Hills

Table 5.1: Crash Comparison Pre- and Post-installation, Beverly Hills Sign

Year	Crash Severity (Northbound | Southbound)										Total	
	Fatal		Serious Injury		Moderate Injury		Minor/Other Injury		Non-casualty (towaway)			
Pre-installation												
May-Dec 2014	-	-	-	-	-	-	1	2	1	1	2	3
2015	-	-	-	-	-	-	1	2	-	2	1	4
2016	-	-	-	-	-	-	-	1	-	-	-	1
2017	-	-	-	-	-	1	-	-	-	-	-	1
2018	-	-	-	-	-	-	-	1	-	1	-	2
Jan-Apr 2019	-	-	-	-	-	-	-	-	-	-	-	-
Total	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**6**	**1**	**4**	**3**	**11**
Post-installation*												
May-Dec 2019	-	-	-	-	-	-	-	1	-	1	-	2
2020	-	-	-	-	-	-	-	-	1	1	1	1
2021	-	-	-	1	-	-	-	1	-	-	-	2
2022	-	-	-	-	-	-	-	-	-	-	-	-
2023	-	-	-	-	-	1	-	-	-	-	-	1
Total	**-**	**-**	**-**	**1**	**-**	**1**	**-**	**2**	**1**	**2**	**1**	**6**

**Later crash data not available.*

The above table shows no increase in the annual crash rates after the installation of the digital signs.

Pacific Highway, Gordon

In May 2021, a digital sign was installed on the northbound face of the pedestrian overbridge of the Pacific Highway in Gordon (see Figure 5.2). The crash data both pre- and post-installation was compared as shown in Table 5.2.

Adapted from Nearmap

Figure 5.2: Location of the Digital Sign in Gordon

Table 5.2: Crash Comparison Pre- and Post-installation, Gordon Sign

Year	Crash Severity					Total
	Fatal	Serious Injury	Moderate Injury	Minor/Other Injury	Non-casualty (towaway)	
Pre-installation						
May-Dec 2016	-	-	-	-	-	-
2017	-	-	-	-	-	-
2018	-	-	-	-	-	-
2019	-	-	-	1	-	1
2020	-	-	-	-	-	-
Jan-Apr 2021	-	-	-	-	-	-
Total	**-**	**-**	**-**	**1**	**-**	**1**
Post-installation*						
May-Dec 2021	-	-	-	-	-	-
2022	-	-	-	-	-	-
2023	-	-	-	1	1	2
Total	**-**	**-**	**-**	**1**	**1**	**2**

**Later crash data not available.*

The above table shows no increase in the annual crash rates after the installation of the digital sign for this inherently low crash rate location.

5.8 Research Conclusion

In summary, the majority of the availability literature suggests that there is no correlation between introducing digital signs and increased crash rates, although a minority of studies exist which have found otherwise. The link between correlation and causation is what is missing in the research and is the key reason why the majority of studies call for more research.

Roadside digital advertising has been present in Australia for over 20 years. In the absence of the evidence of crashes initiated by or exacerbated by glancing to digital signs, it is reasonable to conclude that in most locations driving behaviours are not meaningfully affected by roadside digital advertising.

6. CONCLUSIONS

Sydney Trains is seeking development approval for the removal of two existing static advertising signs and installation of a digital LED advertising sign on the southern elevation of the City Circle rail bridge over George Street in The Rocks are summarised as follows:

- The proposed sign is consistent with the existing sign in terms of size, location and orientation, with the only change being converting the static sign to a digital format and a changing display at fixed time intervals
- The dimensions of the proposed sign will be relatively consistent with the dimensions of the existing sign with a visual screen size of 16.25sqm
- The proposed sign will not obstruct or interfere with the view of or restrict sight distances to any traffic decision points, traffic control devices, vehicles, pedestrians or cyclists given its location above the road
- The proposed sign is not expected to reduce the safety of any vehicle, pedestrian or cyclist movements given its location. It will be located in the background of an approaching driver's ordinary field of view and a glance to the sign will still permit co-incident recognition of vehicle, pedestrian and cyclist movements in the forward view and in the dominant foreground
- A review of available five years of crash data within 130m of the site showed a very low crash rate within the viewable sight distance to the sign with only one crash reported which resulted in a towaway only. As such, this is an inherently low crash risk location, mostly likely due to its straight and slow-speed road environment with excellent sightlines
- The proposed digital sign complies with the requirements of the Industry and Employment SEPP in terms of safety impacts for pedestrians and bicyclists, as well as the Transport Advertising Sign Safety Assessment Matrix in terms of obscurity, positioning and sign clutter
- The proposed digital sign is within the forward view which is the same view as other vehicles and directional signs. A driver's glance to the proposed sign will be no different to glances to multiple other stimuli in the forward view which is how drivers usually behave. Drivers do not 'read' or 'stare' at digital signs when driving and they continue to scan the road ahead with glances and saccades, with or without the presence of a digital sign. The incremental additional cognitive load imposed on a driver by the sign is very small. A glance to the digital sign, like the glances to other stimuli in the field of view, as demonstrated in the crash data, will not critically affect decision making
- The proposed digital sign should be conditioned to comply with the requirements of the *Transport Corridor Outdoor Advertising and Signage Guidelines* in terms of display and operational requirements, including:
  - Message displays remaining static
  - Sequencing of displays or messaging
  - Images not being mistaken for a traffic control device
  - Minimum dwell time
  - Transition of displays
  - Luminance levels
  - The use of flickering, flashing or moving content
  - Quantity/size of text used on message displays
  - A re-assessment of the digital sign should any detrimental effects on road safety be identified post-installation.

Given the above conclusions, the digital sign should be approved as proposed.

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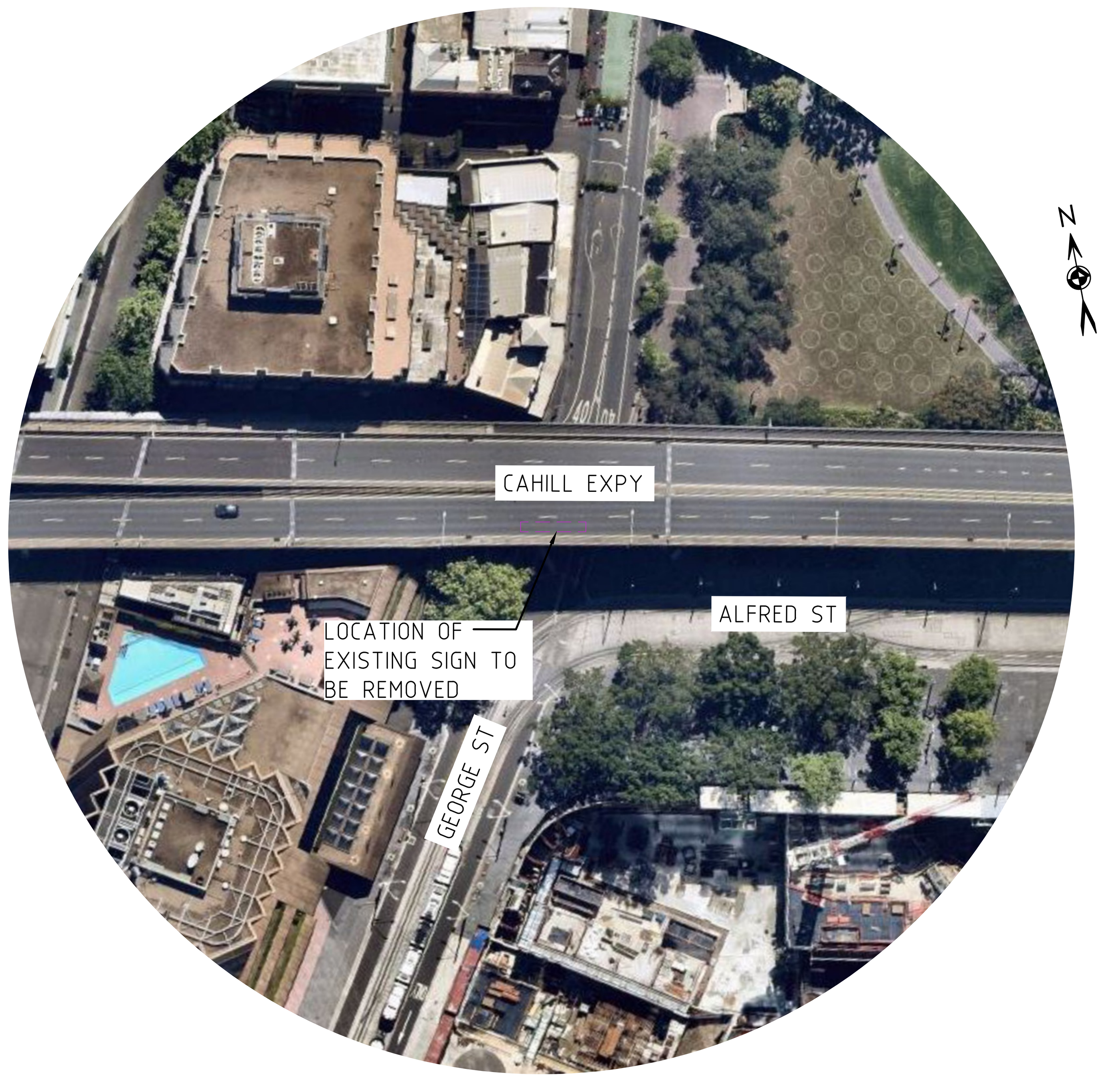
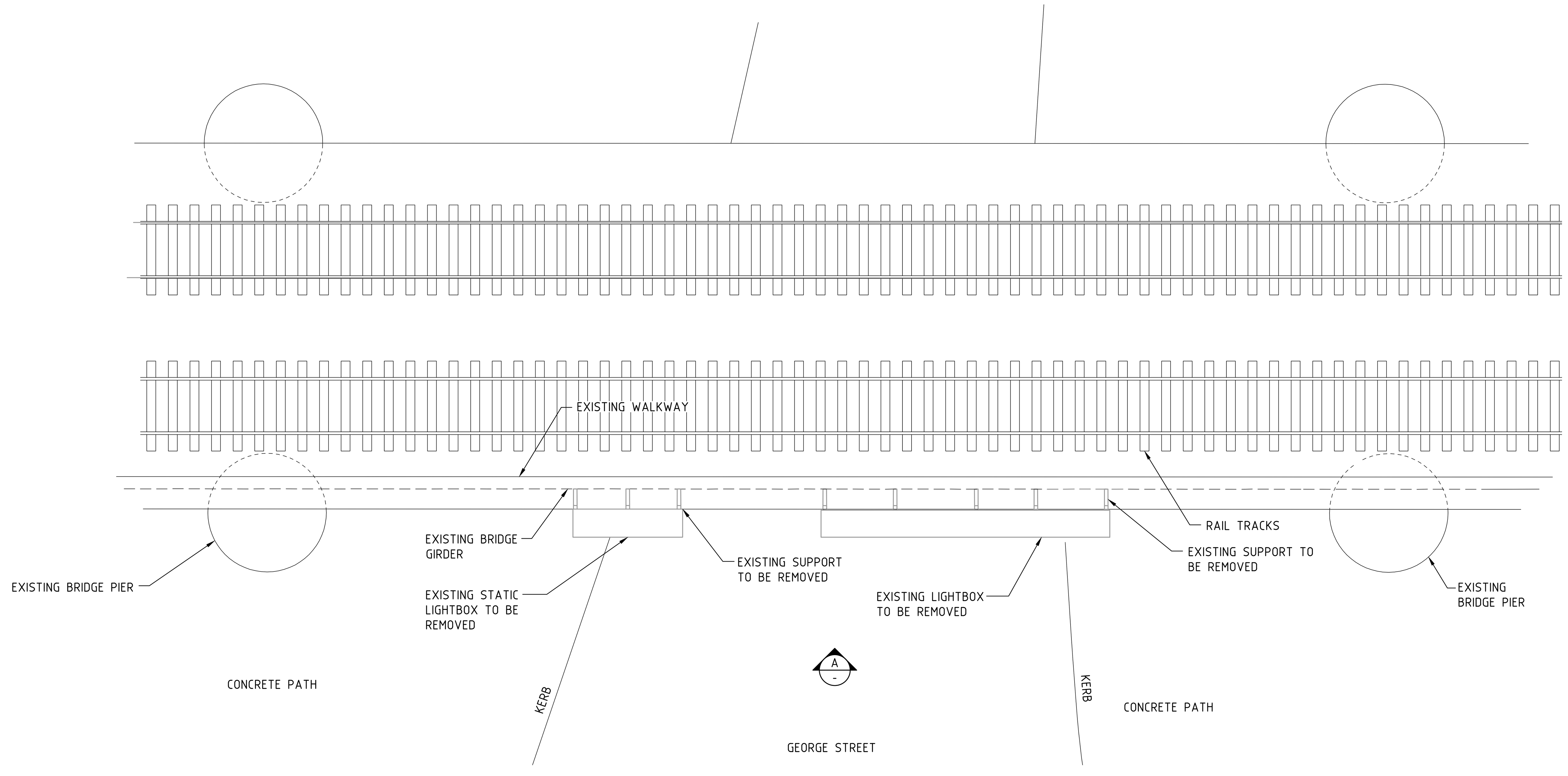
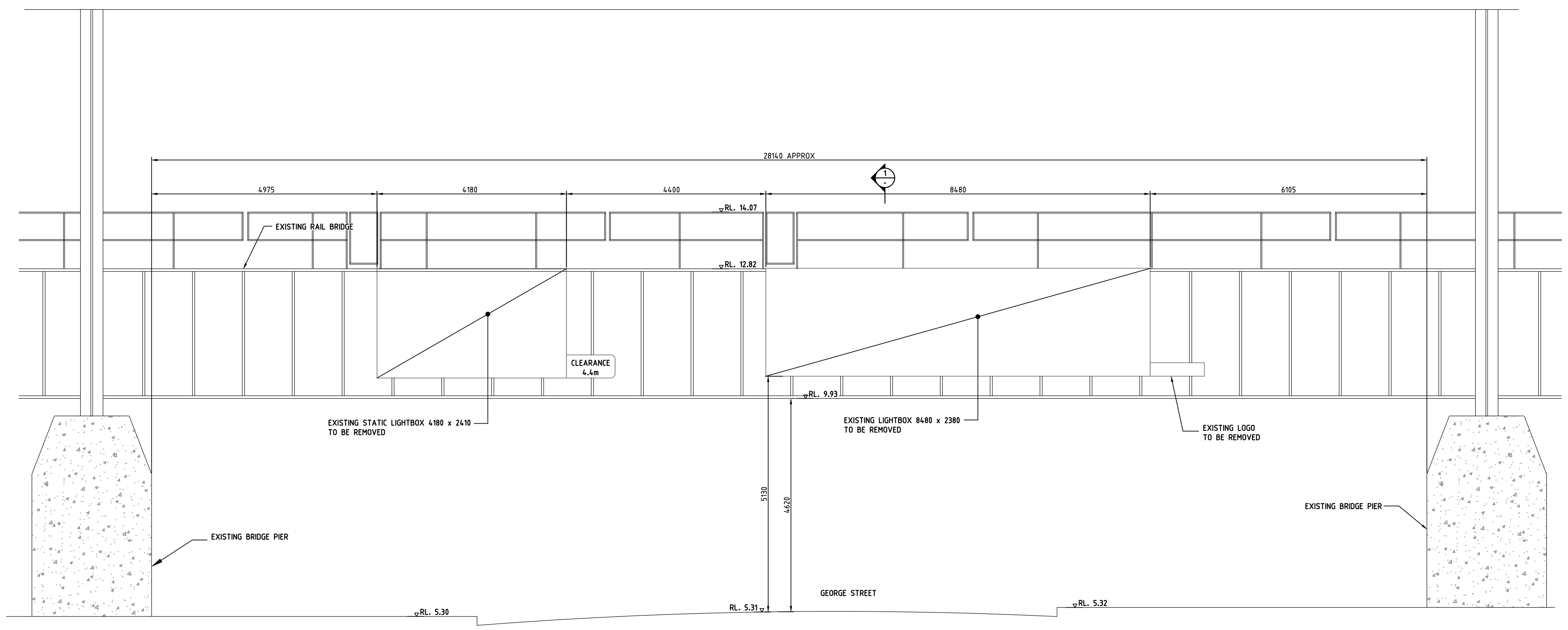
Appendix A: Proposed Signage Plan



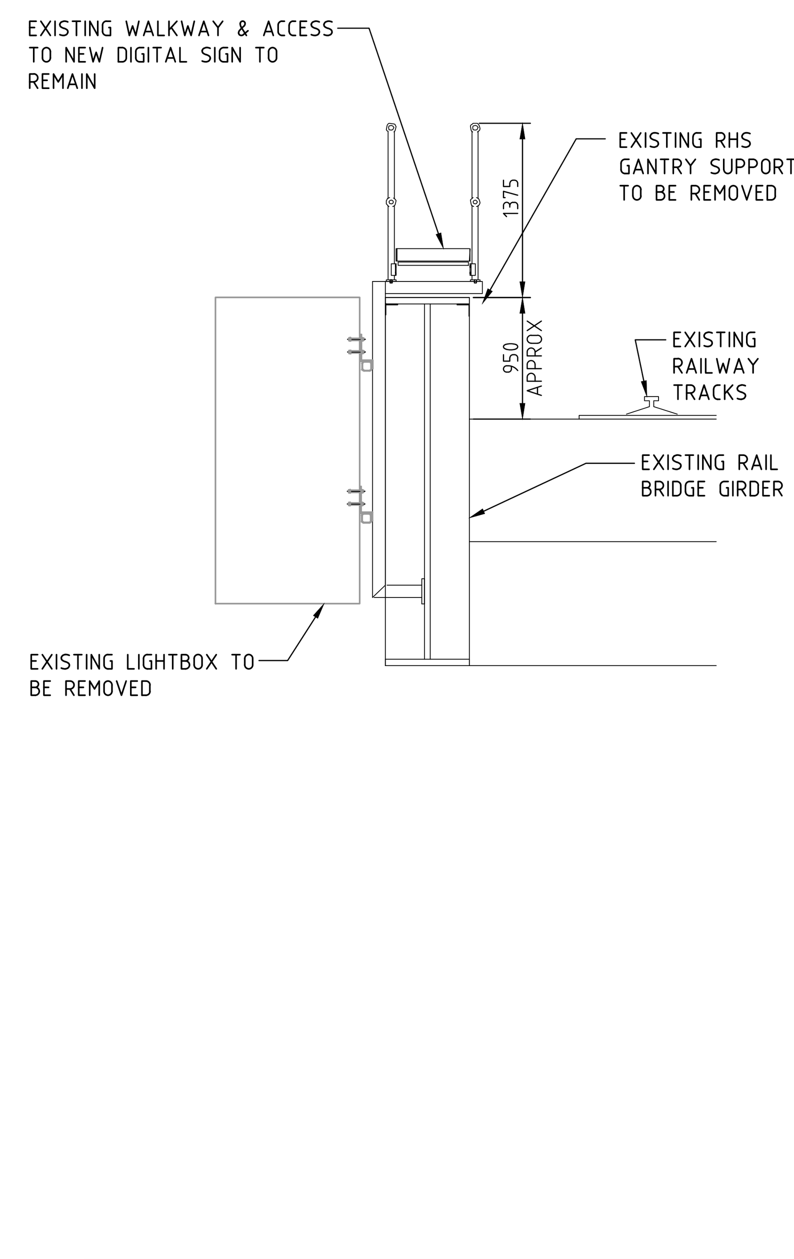
AERIAL PHOTO
NTS



SITE PLAN
SCALE 1:100



ELEVATION A
SCALE 1:100



SECTION 1
SCALE 1:50

NOT FOR CONSTRUCTION

ISS	DATE	COMMENT
A	03/11/21	ISSUED FOR APPROVAL
B	10/11/21	ISSUED FOR APPROVAL
C	23/01/25	ISSUED FOR APPROVAL

DBCE Dennis Bunt Consulting Engineers Pty Ltd
Suite 1, Building 8, 49 Frenchs Forest Road East, Frenchs Forest, NSW 2086
P.O. Box 652, Forestville, NSW 2087
Ph: 02 9451 3455 Fax: 02 9451 3466
Email: info@dbce.com.au
ABN 23 039 013 724

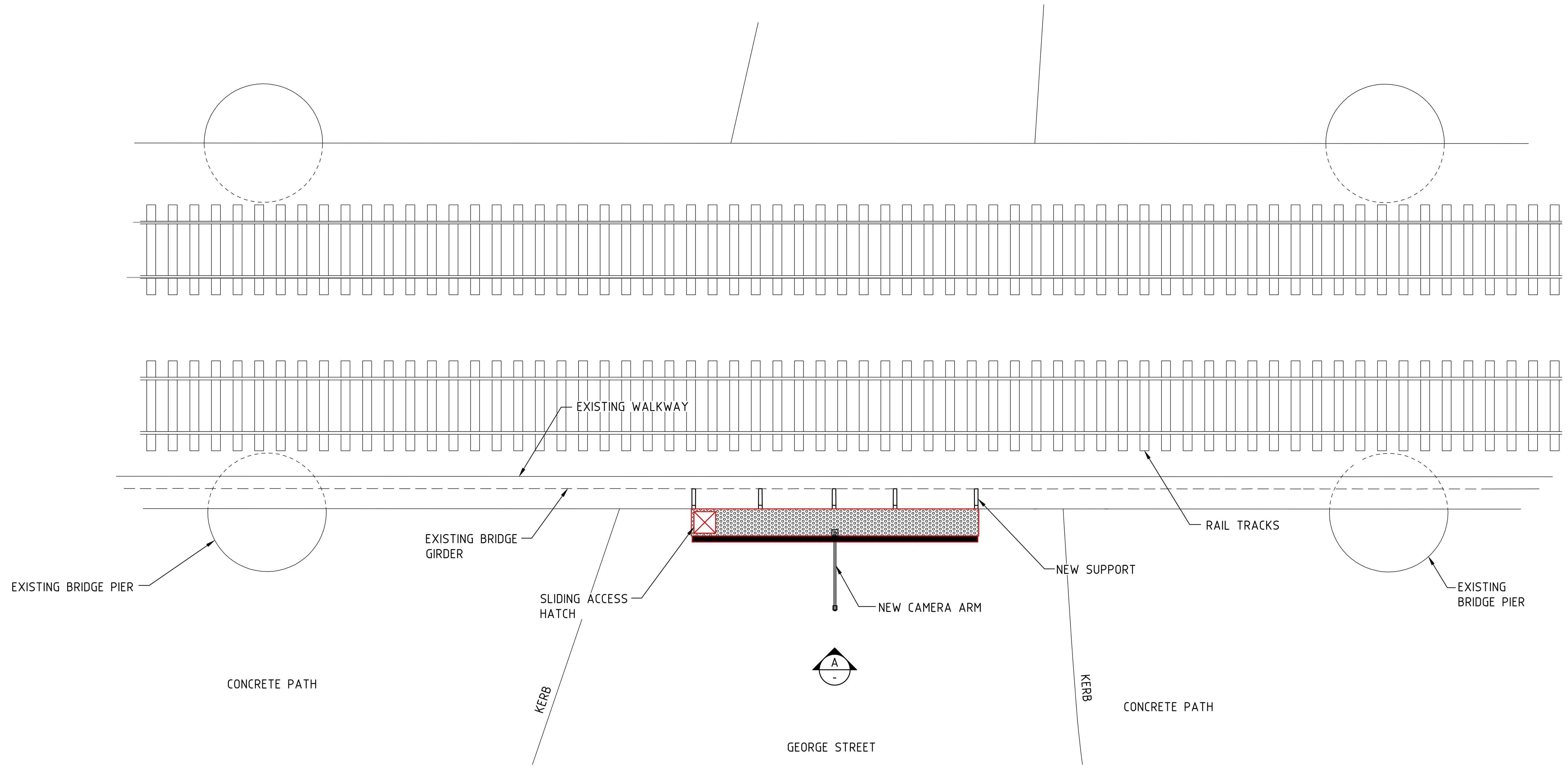
CLIENT: JCDecaux

PROJECT: GEORGE ST, THE ROCKS SUPER 8, NORTHBOUND

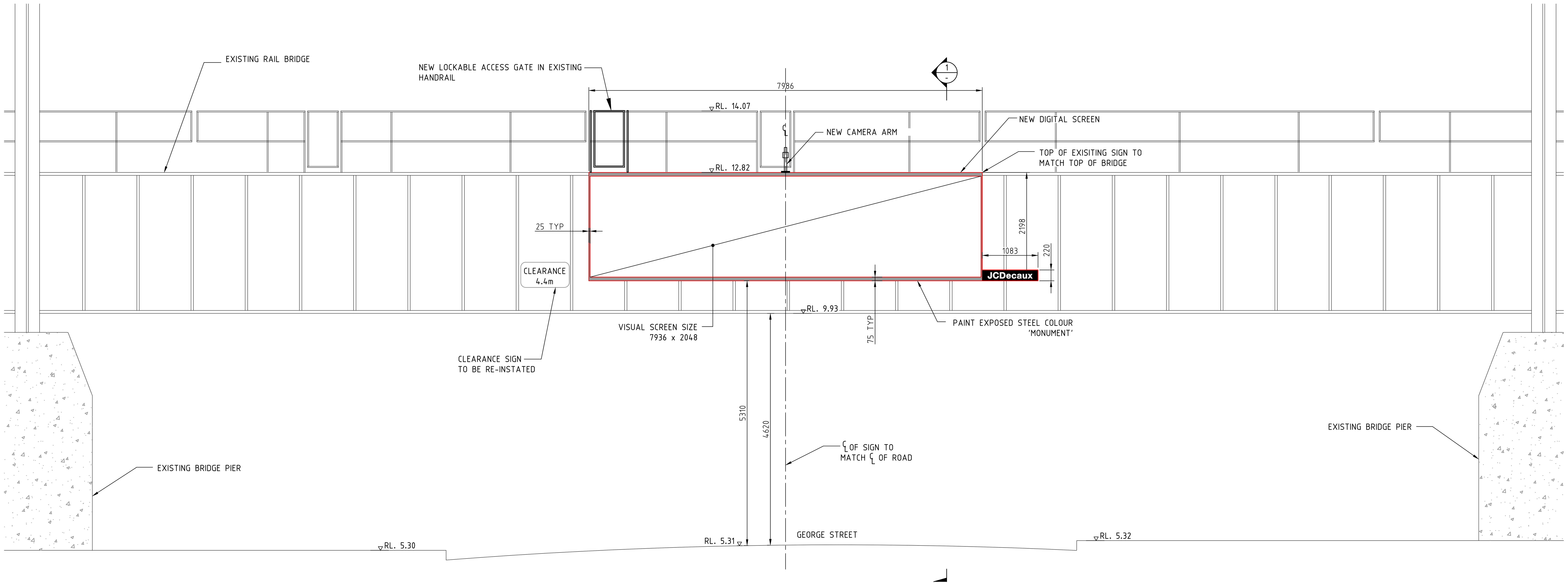
TITLE: EXISTING GENERAL ARRANGEMENT & SITE PLAN

DRAWN A.T	DESIGN J.L	DATE: JAN 25
JOB NO:	21253	DWG NO: DA01
SCALE @ A1: AS SHOWN		REV: C

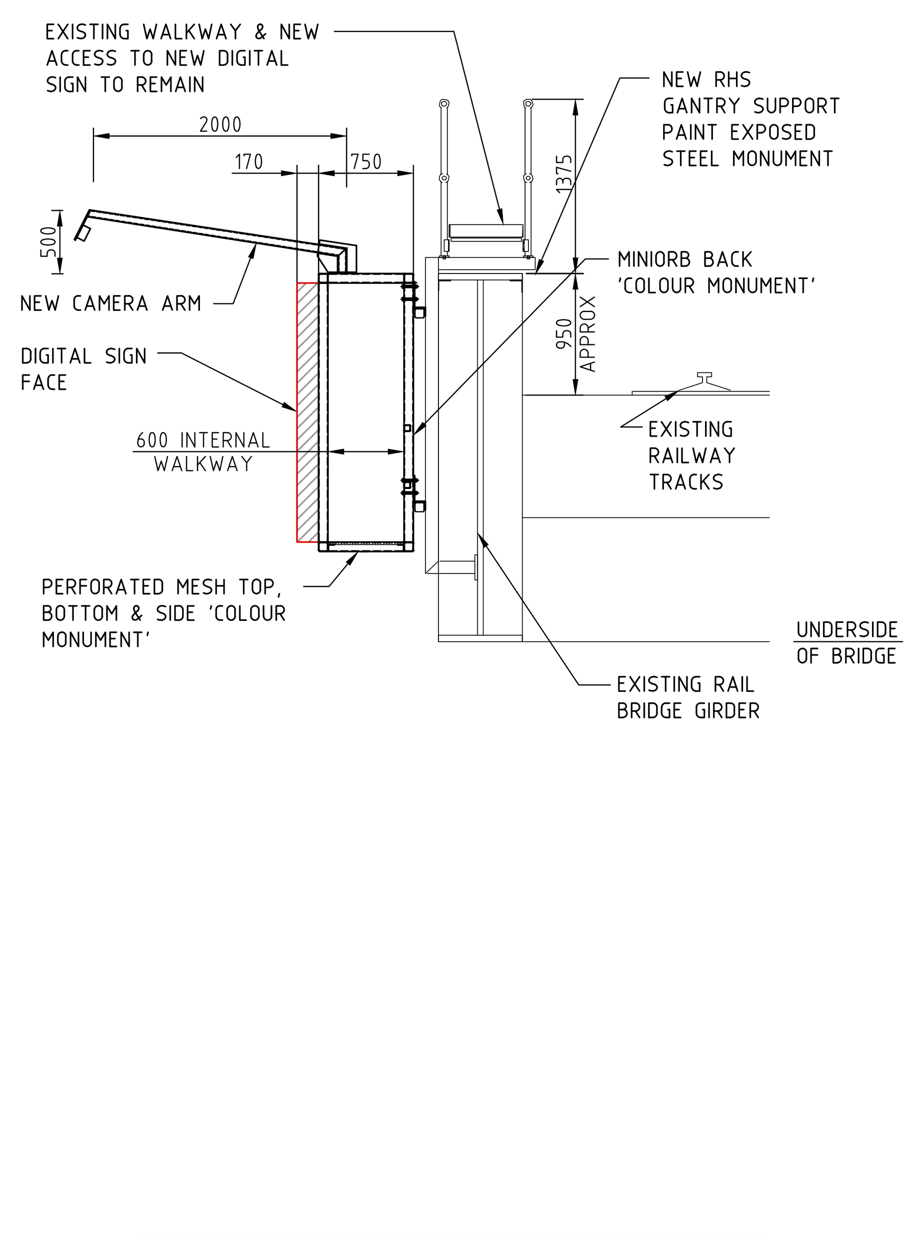
AERIAL PHOTO
NTS



SITE PLAN
SCALE 1:100



ELEVATION A
SCALE 1:50



SECTION 1
SCALE 1:50

NOT FOR CONSTRUCTION

ISS	DATE	COMMENT
A	03/11/21	ISSUED FOR APPROVAL
B	10/11/21	ISSUED FOR APPROVAL
C	16/11/21	ISSUED FOR APPROVAL
D	18/11/21	ISSUED FOR APPROVAL
E	23/01/25	ISSUED FOR APPROVAL

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Email: info@dbce.com.au
ABN 23 039 013 724

CLIENT: JCDecaux

PROJECT: GEORGE ST, THE ROCKS SUPER 8, NORTHBOUND

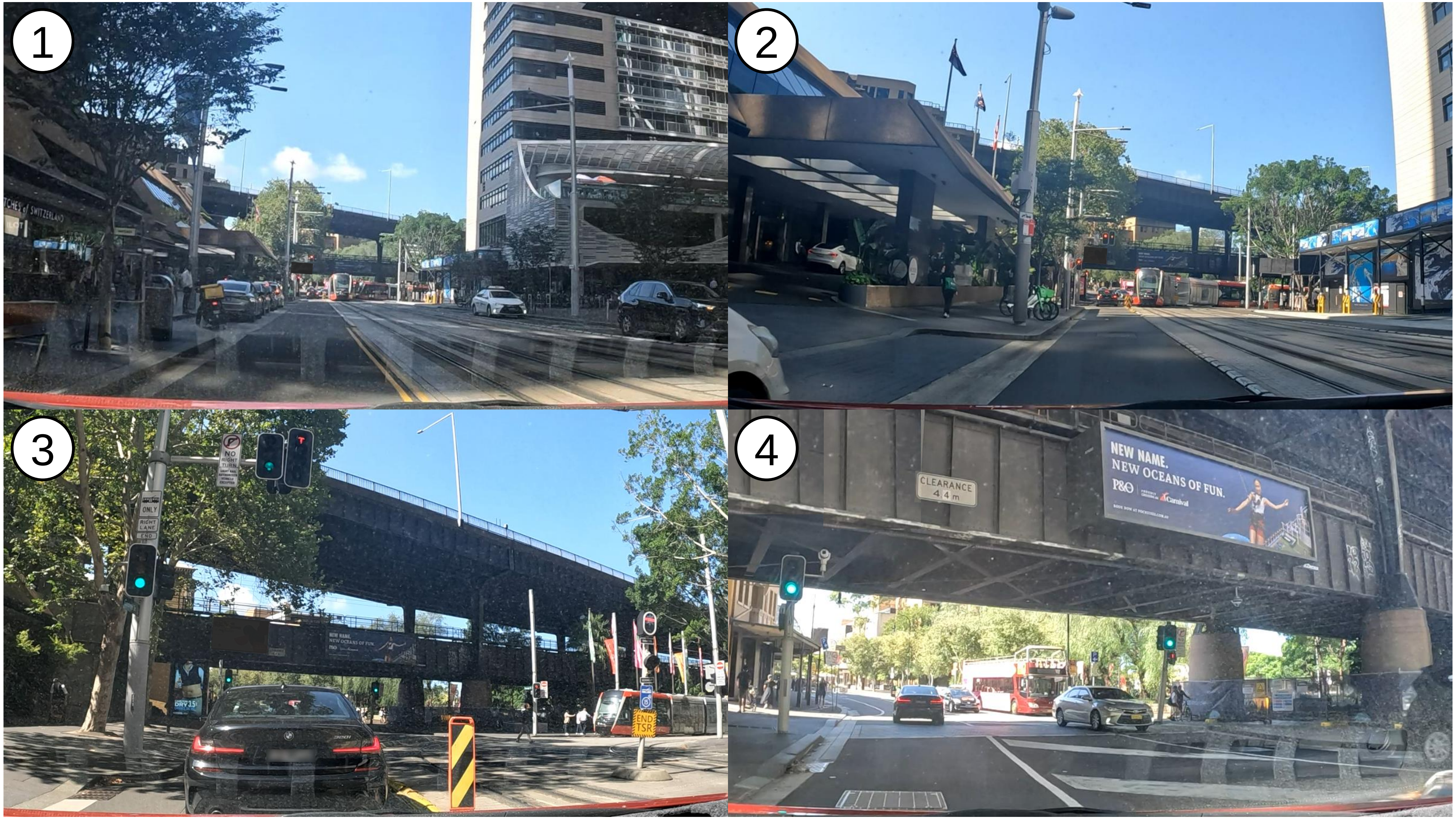
TITLE: PROPOSED DIGITAL SIGN GENERAL ARRANGEMENT & SITE PLAN

DRAWN A.T	DESIGN J.L	DATE: JAN 25
JOB NO:	21253	DWG NO: DA02
SCALE @ A1: AS SHOWN		REV: E

Appendix B: Photo Montages

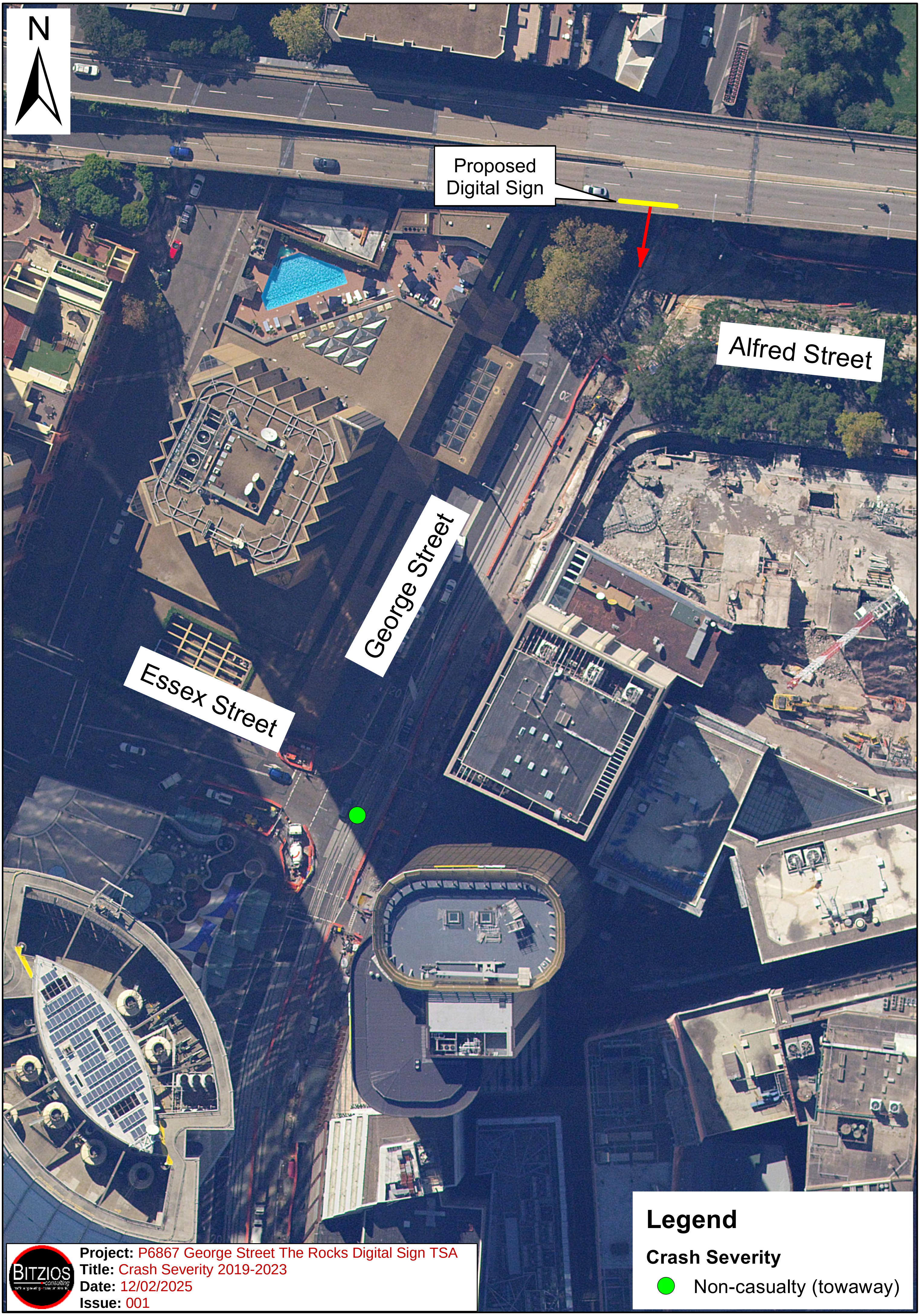
BITZIOS consulting
traffic engineering ▪ transport planning

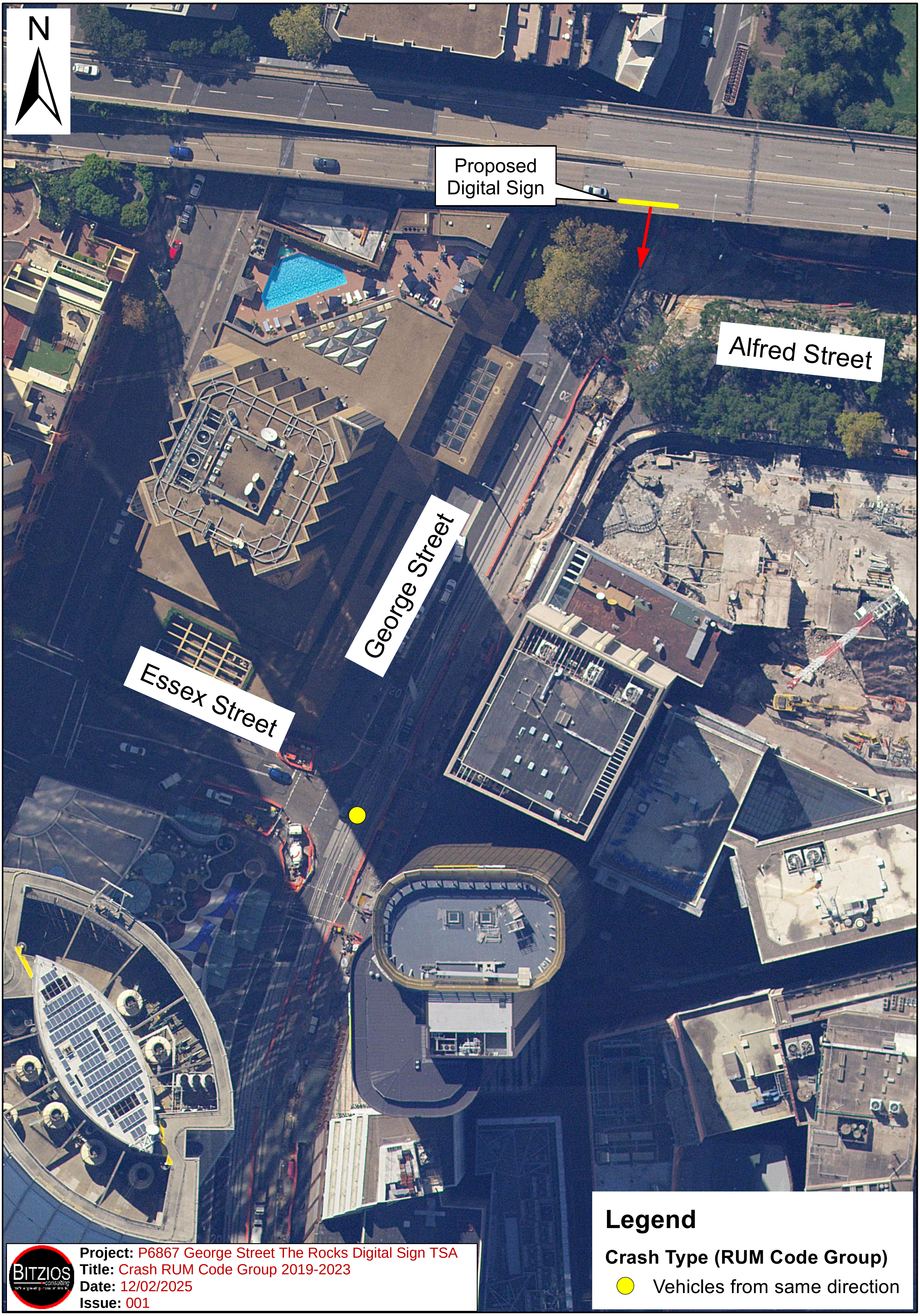
1. George Street northbound (Day)



1. George Street northbound (Night)

Appendix C: Crash Data


N
Proposed
Digital Sign
Alfred Street
George Street
Essex Street
Legend
Crash Severity
Non-casualty (towaway)
BITZIOS consulting
Project: P6867 George Street The Rocks Digital Sign TSA
Title: Crash Severity 2019-2023
Date: 12/02/2025
Issue: 001



BITZIOS consulting

Project: P6867 George Street The Rocks Digital Sign TSA
Title: Crash RUM Code Group 2019-2023
Date: 12/02/2025
Issue: 001

Crash ID	Degree of crash	Degree of crash - detailed	Reporting year	Year of crash	Month of crash	Day of week of crash	Two-hour intervals	Street of crash	Street type	Distance	Direction	Identifying feature	Identifying feature type	Town	Route no.	School zone location	School zone active	Type of location	Latitude	Longitude	LGA	Urbanisation	Conurbation 1	Alignment	Primary permanent feature	Primary temporary feature	Primary hazardous feature	Street lighting	Road surface	Surface condition	Weather	Natural lighting	Signals operation	Other traffic control	Speed limit	Road classification (admin)	RUM - code	RUM - description	DCA - code	DCA - description	DCA supplement	First impact type	Key TU type	Other TU type	No. of traffic units involved	No. killed	No. seriously injured	No. moderately injured	No. minor-other injured	Key traffic unit direction of travel
1237269	Non-casualty (towaway)	Non-casualty (towaway)	2020	2020	July	Monday	12:00 - 13:59	ESSEX	ST	0	Right on the spot	GEORGE	ST	SYDNEY		No	Not a school zone	T-junction	-33.86226	151.20773	Sydney	Sydney metro. area	Syd-Newc-Woll Gtr conurbation	Curved				Unknown / not stated	Sealed	Wet	Raining	Daylight	On	No traffic controls	40 km/h	Local	31	Left rear	302	Same - Rear left		Rear end	Tram	Large rigid	2	0	0	0	0	North

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