Safe System Assessment Guidelines

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TRANSPORT FOR VICTORIA

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Part 1 – Understanding Safe System Assessments

1.1 The Safe System

The Safe System is a road safety philosophy that requires roads to be designed and managed so that death and serious injury are avoidable. The basic principles are:

1. Humans are fallible and will inevitably make mistakes when driving, riding or walking.
2. Despite this, road trauma should not be accepted as inevitable. No one should be killed or seriously injured on our roads.
3. To prevent serious trauma, the road system must be forgiving, so that the forces of collisions do not exceed the limits that the human body can tolerate.

The Safe System philosophy underpins Victoria's strategic approach to road safety. It is commonly divided into four core interrelated pillars – safer roads, safer speeds, safer vehicles and safer road users. A fifth pillar, post-crash response, has been identified by the World Health Organisation (2011).

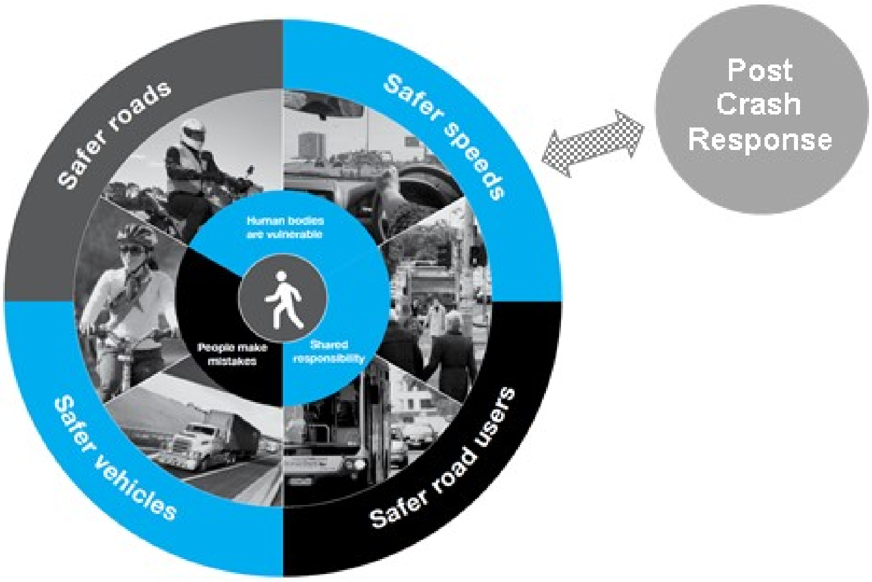


Figure 1 – The Pillars of the Safe System
(Source: *Towards Zero 2016//2020 Victoria's Road Safety Strategy & Action Plan*)

Safer Roads Relates to both the road itself and the roadside. This considers ways to design, operate and maintain the road network to reduce the chance of a crash occurring as well as the consequence when one does occur.

Safer Speeds Relates to the speed at which vehicles are likely to travel on the road. Factors that influence operating speeds include posted speed limits, the level of compliance with the speed limit and physical constraints. Unsafe speeds can increase both likelihood and consequence of a crash.

Safer Vehicles Relates to the safety features, including intelligent technologies that are incorporated into vehicles of different types, which contribute to crash avoidance and / or reducing the severity of crashes.

Safer Road Users	Relates to road user behaviour, driver / rider training and licensing, levels of compliance and personal safety equipment, particularly in the case of vulnerable road users such as cyclists and motorcyclists.
Post Crash Response	Relates to emergency medical and rescue response, trauma care (both at the scene and in hospital) and injury rehabilitation.

1.2 Purpose

The purpose of this document is to provide guidance to VicRoads projects, planners, designers, regions and the broader industry on the process of undertaking a Safe System Assessment (SSA).

VicRoads is developing policies and practices to ensure that road improvement projects developed and delivered through its programs and across the Victorian road network consider road safety outcomes. To achieve a meaningful transition towards Safe System, all VicRoads and Victorian Government road infrastructure projects are required to consider adoption and implementation of outcomes to reduce fatal and serious injuries. To facilitate this, SSAs are to be conducted on VicRoads and Government funded projects in accordance with these Guidelines. The requirements specified in these Guidelines do not apply to developer funded works at the present time. However, it is envisaged that they will ultimately apply to all projects on roads for which VicRoads is the responsible authority.

The approach will assist in achieving the road safety goal of reducing lives lost on Victoria's roads to fewer than 200 by 2020, reducing serious injuries by 15% and beyond 2020, working towards zero deaths and serious injuries on our roads, as outlined in both the Towards Zero Road Safety Strategy and VicRoads (2017) Corporate Plan.

The concept of SSA is relatively new and still being refined within VicRoads and industry. It is important to note that this document and future requirements are subject to change as we continually review and assess the application of SSA across a wide variety of projects. Guidance within this document is considered to be best practice at the time of publishing.

1.3 What is a Safe System Assessment?

SSA is a tool that has been developed to assess the extent to which a proposed infrastructure project aligns with Safe System principles and the objective to eliminate fatal and serious injuries. The process allows project options to be compared with a base case (i.e. existing conditions) and with each other. A SSA will identify areas where the risk of fatal and serious injury (FSI) crashes is high and identifies design changes which, if adopted, would improve alignment with the Safe System approach. If Safe System principles are being followed and applied correctly, there should be a trend towards zero in the SSA scores when progressing from existing conditions to the initial design options and, finally, to the adopted design.

The methodology for conducting SSAs was developed by Austroads. Guidance on the process and further background information can be found in Austroads *Research Report AP-R509-16, Safe System Assessment Framework*, which is available online from Austroads website (Note: an account is required to download the report).

A SSA provides the following benefits:

- A way of determining how well a project proposal aligns with Safe System principles
- A method to compare project design options from a Safe System perspective
- Information on design and scope changes that will move a project proposal closer to the Safe System objective of eliminating the risk of fatalities and serious injuries

- A method to assist planners, designers and project managers to progress the Safe System approach from theory to practice
- A sound basis for the planning and design of road infrastructure.

1.4 When to Undertake a Safe System Assessment

SSAs are most valuable when conducted during the early stages of a project when adjustments to the design and / or scope of the project are more readily accommodated. For major projects in particular, this is at the preliminary business case and options assessment stage of project planning. Benefits can also be realised at the preliminary concept or functional design stage and, to a lesser extent, beyond.

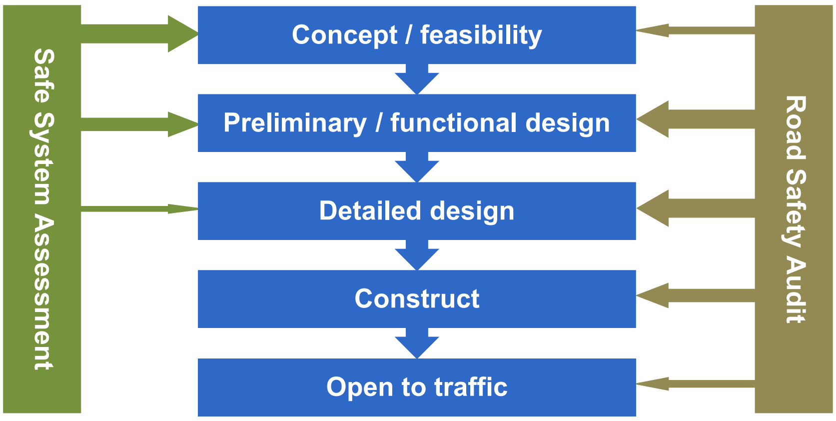
Project options should be developed considering multiple project objectives and design constraints, including operational, safety, environmental and community impacts. Once options have been developed, a SSA can be undertaken to compare options and determine their relative alignment with Safe System objectives to achieve improved road safety outcomes.

VicRoads Project Review Committee (PRC) requires SSAs to be conducted for all projects that are submitted for its consideration. This will usually be at PRC 2 when project options are being considered. Detailed discussion should be included within PRC and Business Case reports to address how the project proposal aligns with Safe System and how recommendations from the SSA have been considered in the development of project options. Relevant requirements are referenced within VicRoads PRC and Business Case development guidelines (available internally). VicRoads requirements for SSAs are detailed in Section 1.6.

Generally, a SSA will only need to be conducted at one stage of project development but utilised as development and design proceeds. However, if there are subsequent changes to the design scope that are likely to impact on Safe System alignment, the SSA should be reviewed and repeated as necessary.

SSA and Road Safety Audit (RSA) should be used during project planning and design as complementary tools to maximise road safety outcomes. Figure 2 shows a general indication of the stages at which SSAs and RSAs have the greatest benefit. VicRoads *Road Safety Audit Policy and Procedure* specifies requirements for RSAs during the development, design and implementation of road projects. Additional information on the relationship between SSA and RSA is presented in Section 1.7.

Steps in developing a project



(Note: Arrow widths are indicative of the relative benefit)

Figure 2: When to Undertake Safe System Assessments and Road Safety Audits

1.5 Accreditation of Safe System Assessors

VicRoads has established a register of practitioners who are considered proficient at facilitating SSAs, reporting on findings and recommending treatment options to improve alignment with Safe System principles. The Register can be accessed on VicRoads website .

The Register has evolved from a series of peer reviews carried out by VicRoads, with the intent of ensuring SSAs are delivered to a high standard and appropriate content is provided in reports in accordance with these Guidelines. To maintain a high standard moving forward, VicRoads will conduct periodic reviews of SSAs carried out by registered officers.

Practitioners who have already undertaken a SSA and are looking to be considered for inclusion on the Register are required to demonstrate their involvement in facilitating assessments and provide VicRoads with an example report (or reports). If judged to be of an appropriate standard, the officer will be added to the Register.

For those who are just starting out or are looking to develop further knowledge and capability, VicRoads recommends that practitioners:

- Attend a Safe System Principles and / or a Safe System Assessments training course, and
- Work with practitioners who are currently on VicRoads register to build capability and an understanding of the SSA process and requirements.

Section 2.3 provides guidance on selecting a SSA team.

1.6 VicRoads Corporate Requirements

SSAs are to be undertaken in accordance with Table 1. Details of the type and scope of assessment (i.e. full or rapid) are set out in Section 2.2. Regardless of whether a formal SSA is undertaken, Safe System principles should be applied to all projects.

Project Cost	SSA Requirements	Type of Assessment[2]
> $5M	A SSA **must** be conducted (including all projects submitted to the Project Review Committee)	Full SSA for **ALL** projects Rapid SSA may be conducted if a Full SSA has been undertaken at an earlier stage (i.e. for a repeat assessment)
$2M to $5M	A SSA is **desirable** and is the preferred method to consider alignment of the project and design options with Safe System principles. Where a SSA is not undertaken, documentation of how the project has considered Safe System alignment shall be provided within the PRC / RRC report, design report, or other suitable record.	Full SSA for: • Complex projects • Projects with a significant risk of FSI crashes • Innovative projects Rapid SSA for: • Projects with a low risk of FSI crashes • Repeat assessments for projects for which a Full SSA has been undertaken at an earlier stage
< $2M	A SSA is **optional**. The benefits of conducting a SSA and the risk factors[1] associated with the project should be considered in determining the need for a SSA. Where a SSA is not undertaken, documentation of how the project has considered Safe System alignment shall be provided within the Regional Review Committee (RRC) report, design report or other suitable record.	Rapid SSA where it has been determined that a formal assessment is required

Table 1: VicRoads Requirements for Safe System Assessments

Notes 1. Examples of risk factors that might warrant an SSA include (but should not be limited to):
- A history of FSI crashes
- Repeated community complaints regarding safety
- High numbers of vulnerable road users
- High volume of heavy vehicles
- Treatment options that are innovative or complex

2. Refer to Section 2.2 for details of assessment types.

1.7 Safe System Assessments and Road Safety Audits

A SSA does not replace the need for a RSA to be conducted for a project. A SSA evaluates a project's alignment with Safe System principles and identifies ways to improve the alignment with a focus on minimising fatal and serious injuries. It investigates the inherent risk of the infrastructure and includes consideration of road user exposure. A SSA also looks further to consider solutions or strategies that address all pillars of the Safe System. RSAs usually focus on the likelihood of a crash, regardless of severity, to ensure that no hazards are built into the road environment when a project is implemented.

SSA and RSA should complement each other to maximise the road safety outcomes of a project. Table 2 highlights the key similarities and differences between the two.

VicRoads RSA Policy currently specifies that an audit is required at all stages of a project from feasibility to pre-opening / post-opening for projects with an estimated cost of more than $10M. Where a SSA is undertaken, a project can be exempted from any requirement to conduct a RSA at the same stage. Generally, this means that for projects with an estimated cost exceeding $5M, a SSA will replace a RSA which would usually have been required at the feasibility stage.

It is envisaged that Safe System principles and findings will benefit and influence RSAs as knowledge and experience is developed across industry. We will continually review and assess how these two processes align throughout the stages of a project. Further work is also being undertaken by Austroads to inform future requirements for RSAs.

RSAs that are conducted on projects for which a SSA has been completed in an earlier stage of the project development process should include a review of the SSA to ensure that the design remains consistent with the outcomes of the SSA. It is recommended that this requirement is included in the RSA brief when procuring RSA services. If significant changes have been made to the design it may be appropriate to recommend that a further SSA should be undertaken.

Scope	Road Safety Audit	Safe System Assessment
Identifies issues that impact the likelihood of crashes	✓	✓
Identifies issues that impact the severity of crashes	sometimes	✓
Identifies issues that impact the exposure to crashes	×	✓
Provides recommendations for improved road safety outcomes	✓	✓
Considers all road users	✓	✓
Focuses on fatal and serious injuries only	×	✓
Focuses on all crashes (fatal, serious injury and other injury)	✓	×
Investigates safer vehicles	×	✓
Investigates safer people	sometimes	✓
Investigates the impact on maintenance	sometimes	✓
Investigates the impact on post-crash care	×	✓
Makes recommendations to redesign the project if required	×	✓
Encourages innovative design to improve harm minimisation	×	✓

Table 2: Comparison of Safe System Assessment and Road Safety Audit

Part 2 – Undertaking a Safe System Assessment

2.1 Steps of a Safe System Assessment

This part of the Guidelines sets out the steps in undertaking a SSA and briefly explains what is involved in each step. Figure 3 summarises the steps in the process and the associated responsibilities. Some of the steps may be omitted or simplified for a Rapid SSA, as indicted in following sections.

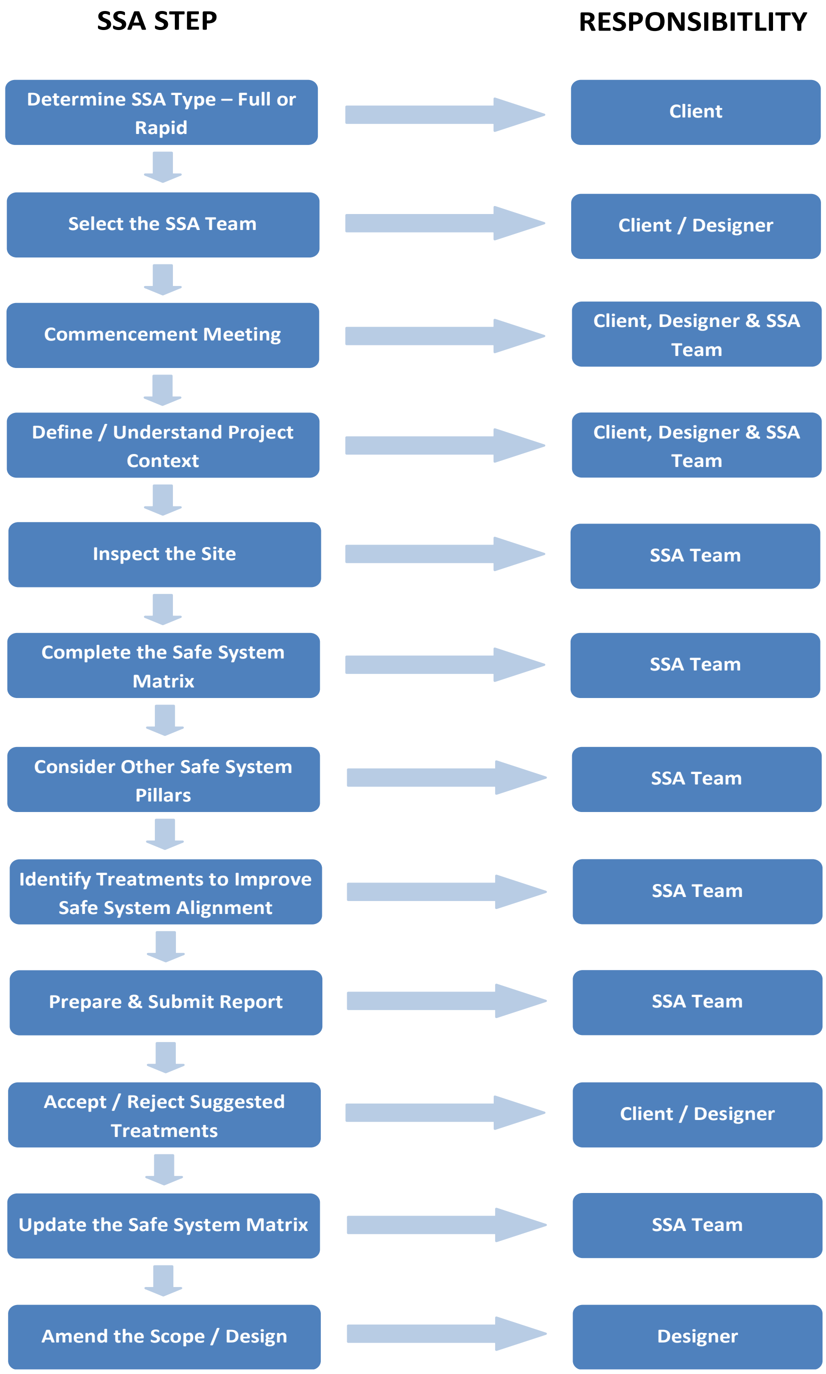


Figure 3: Steps in the SSA Process

2.2 Type and Scope of Safe System Assessment

When deciding how to conduct a SSA there are two alternative levels of detail to be considered – full assessment or rapid assessment. The choice depends principally upon the cost and complexity of the project but will also be influenced by the risk of high severity crashes. Table 1 (Section 1.6) specifies VicRoads requirements regarding when an assessment should be conducted and the type of assessment. All steps illustrated in Figure 3 should be completed for a Full SSA. A number of steps may be omitted for a Rapid SSA. Table 3 outlines the scope of each assessment type.

Type of Assessment	Scope of Assessment
Full SSA	Completion of the following activities (includes all components of the SSA Framework as per Austroads (2016)): • Commencement meeting • Project background & context • Workshop (optional) • Site inspections • Assessment of existing conditions and design options using the SSA Matrix • Consideration of other Safe System pillars • Identification of design changes to improve alignment with Safe System principles • Full SSA report • Consideration and adoption / rejection of suggested design changes • Advise the SSA Team of accepted design changes and re-score if necessary • Amend the project design / scope
Rapid SSA	Completion of the following activities: • Commencement meeting (if required) • Project background & context • Assessment of existing conditions and design options using the SSA Matrix • Identification of design changes to improve alignment with Safe System principles • Rapid SSA report • Consideration and adoption / rejection of suggested design changes • Advise SSA Team of accepted design changes and re-score if necessary • Amend the project design / scope

Table 3: Type and Scope of Safe System Assessment

2.3 Select the SSA Team

A SSA team should be formed after identifying the type of SSA to be undertaken. The team should include personnel who are experienced in undertaking SSAs. It is recognised that in the short term this may not always be possible because of the limited number of practitioners that have been trained or are experienced in conducting a SSA. If required, further advice and assistance is available from VicRoads Safe System Engineering, Road & Traffic Design.

As outlined in Section 1.5, VicRoads has established a register of practitioners who are considered proficient in conducting SSAs. It is recommended that key team members, including the lead assessor, be drawn from the Register.

Guidance on the composition of SSA teams is as follows:

Full SSA: Should be undertaken by a team of a minimum of two to four members. This should include at least two members who must be knowledgeable regarding Safe System and its application and be independent of the project being assessed. Other team members may be associated with the planning / design of the project or provide a diverse range of experience that may be relevant to the project. For example, if the project is on the Principal Freight Network or Principal Bicycle Network, consideration should be given to including practitioners experienced in these fields.

Rapid SSA: The assessment may be undertaken by an individual who is knowledgeable regarding the Safe System and its application. This person must also have experience in conducting SSAs and should be independent of the project being assessed. However, a team consisting of a mix of skills relevant to the project being assessed is preferred. If a Rapid SSA is conducted by an individual, it should be peer reviewed by a person who is also knowledgeable regarding the Safe System and its application. If a Rapid SSA is being undertaken on a project for which a Full SSA had been conducted at an earlier stage, it is recommended that the original team be reconvened to ensure consistency.

2.4 Commencement Meeting

A commencement meeting should be convened for a Full SSA as most of the SSA team are likely to be unfamiliar with the project. A commencement meeting is optional for a Rapid SSA but should be conducted if the client / design team or the SSA team consider that it is necessary.

The commencement meeting provides an opportunity for the project team (designers and project personnel) to provide the background and context of the project to the SSA team. This includes the purpose of the project, known issues and items to note from a design, planning or construction perspective (Austroads 2009). The SSA team should be provided with all the information and data required to enable the SSA Matrix and other parts of the assessment to be completed.

Information to be provided to the SSA team should include, but not be limited to:

- The project purpose and objectives
- Design plans for each of the options to be assessed
- Traffic and road user data – current and projected volumes for general traffic, heavy vehicles, pedestrians and motorcyclists (estimated if actual data is not available)
- Crash data and any known safety issues
- Road classification / function (e.g. Movement and Place classification, Principal Freight Network route, OD route, Principal Bicycle Network route etc.)
- Any relevant community / stakeholder issues (the SSA team is not expected to engage the community or stakeholders)
- Current / planned land uses (particularly those which generate pedestrians, bicyclists or heavy vehicles) and access requirements.

At the commencement meeting, agreement should be reached on the format of the assessment i.e. will the project to be assessed as a whole or is it to be divided into components? For projects that involve treatments over an extended route length or complex projects comprising a number of different treatment elements (e.g. a road duplication with several intersection upgrades) it may be appropriate to assesses different components of the design independently. Appendix A provides guidance based on some typical scenarios.

The commencement meeting may be included as part of a SSA workshop (refer to Section 2.7).

2.5 Understanding the Project Context

Defining and understanding the context of the project is the first step of the actual assessment. Austroads (2016) sets out prompts (refer to Table 4) to assist with this part of the assessment. Additional considerations are listed in the “Comments” column of Table 4.

This step must be completed for all SSAs to ensure project context and objectives are understood by the assessor(s). There is benefit in Table 4 being completed by the client and / or the designer, together with the SSA team, as it can result in a better understanding of the project context. This step can be incorporated into a workshop, if a workshop is conducted as part of the assessment process (refer to Section 2.7).

Prompts	Comments
What is the reason for the **project**? Is there specific crash type risk? Is it addressing specific issues such as poor speed limit compliance, road access, congestion, future traffic growth, freight movement, amenity concerns from the community, maintenance/asset renewal, etc.	Where appropriate, reference should be made to the Investment Logic Map and Benefit Management Plan for problem definition and the objectives of the project.
What is the **function** of the road? Consider location, roadside land use, area type, speed limit, intersection type, presence of parking, public transport services and vehicle flows. What traffic features exist nearby (e.g. upstream and downstream)? What alternative routes exist?	Refer to Movement and Place assessment for function of the road. Is the road part of a freight route or bicycle route? Refer to network maps for heavy vehicles https://www.vicroads.vic.gov.au/business-and-industry/heavy-vehicle-industry/heavy-vehicle-map-networks-in-victoria
What is the **speed** environment? What is the current speed limit? Has it changed recently? Is it similar to other roads of this type? How does it compare to Safe System speeds? What is the acceptability of lowering the speed limit at this location?	*Refer to any available data on vehicle speeds and information regarding compliance to speed limits.*
What **road users** are present? Consider the presence of elderly pedestrians, school children and cyclists. Also, note what facilities are available to vulnerable road users (e.g. signalised crossings, bicycle lanes, school speed limits, etc.)	
What is the **vehicle** composition? Consider the presence of heavy vehicles (and what type), motorcyclists and other vehicles using the roadway.	Does the presence of heavy vehicles increase the risk of particular crashes types (run-off-road, intersection, cyclist etc.)?

Table 4: Template for Setting the Project Context (Source: Austroads (2016))

2.6 Site Inspection

A daytime site inspection should be undertaken for all Full SSAs and is desirable, but optional, for Rapid SSAs. Night-time inspections should also be considered, particularly if activity is high after dark or if the SSA team considers that there may be an elevated risk of crashes involving any road users at night. The client or designer may be involved in the site inspections at the discretion of the SSA team.

In addition to getting a feel for the road environment, the following characteristics should be inspected to confirm and supplement the information provided to the SSA team:

- The road environment beyond the limits of the project. This may include transition points to the existing network, road geometry of adjacent sections and the presence of intersections just beyond the project limits.
- Condition of the road pavement and shoulders.

- Changes to the road environment since time of the feature survey or aerial imagery, including recent barrier installations, new intersections or driveways and new bus stops.
- Presence and approximate numbers of cyclists, pedestrians, heavy vehicles and motorcyclists (particularly important if data is not available).
- Existing provisions for pedestrians and cyclists (footpaths, shared paths, bicycle lanes, pedestrian crossings etc.)
- Presence of schools, childcare centres, retirement villages and other community facilities that might generate high risk or vulnerable road users.
- Presence of local industries or commercial activities that generate freight movements (including provisions for loading and unloading of goods).
- Identification of possible “other” crash types (e.g. involving driveways, wildlife etc.), for consideration when completing the SSA Matrix.
- Identification of any unique road user behaviours such as pedestrians crossing at an uncontrolled location or vehicles “rat running” through local streets.

2.7 The Safe System Assessment Matrix

The SSA Matrix (Table 5) is to be completed for all assessments. It is used to assess the extent to which existing conditions and project options align with Safe System principles. This is achieved through a scoring system which considers seven crash types and the exposure, likelihood and severity associated with each crash type. Each combination is assigned a score out of four. The exposure, likelihood and severity scores for each crash type are multiplied to give a product out of 64. These are then added to determine the total SSA score, with a maximum of 448. A score of zero or close to zero indicates a high level of alignment with the Safe System.

Information regarding the crash types and guidance on scoring is proved in Sections 2.8.1 and 2.8.2 respectively.

It is important to note that while the total score is used to check alignment with Safe System principles, there is a level of subjectivity based on the individuals or groups undertaking the analysis. Thus, scores for different roads or projects **MUST NOT** be compared against one another, but rather the existing conditions and concept design / design options for a single project should be assessed by the same SSA team and compared to determine whether the project is trending towards zero. The existing conditions and concept design(s) are assessed before potential treatments are identified that may be accepted to produce a revised design that is more closely aligned with a Safe System.

Commentary on factors that either increase or decrease the risk should be provided in each cell of the matrix to provide some reasoning behind the adopted scores (refer to the SSA report templates and sample report on VicRoads website).

	Run-off-road	**Head-on**	**Intersection**	**Other**	**Pedestrian**	**Cyclist**	**Motorcyclist**
Exposure	/ 4	/ 4	/ 4	/ 4	/ 4	/ 4	/ 4
Likelihood	/ 4	/ 4	/ 4	/ 4	/ 4	/ 4	/ 4
Severity	/ 4	/ 4	/ 4	/ 4	/ 4	/ 4	/ 4
Product	**/ 64**	**/ 64**	**/ 64**	**/ 64**	**/ 64**	**/ 64**	**/ 64**
						TOTAL SSA SCORE	**/ 448**

Table 5: Safe System Assessment Matrix (Source: Austroads (2006))

In the case a Full SSA, it is recommended that a partnership approach be used to work through the development of the SSA Matrix. This can be achieved through a workshop involving representatives of the project team, designers, the client and other stakeholders (e.g. subject matter experts). The workshop could also include other components of the assessment process, such as the project briefing (which would normally occur during the commencement meeting) and understanding the context.

A workshop would generally not be required for a Rapid SSA.

2.8.1 Crash Types

As discussed above, a SSA considers seven crash types. These are described in Table 6.

Crash Type	Description
Run-off-road	A crash that occurs when a vehicle leaves the roadway to the left or right without impacting another vehicle. Includes run-off-road crashes at intersections. Does not include crashes involving motorcyclists or cyclists as they are considered separately.
Head-on	A crash that occurs when one vehicle crosses onto the wrong side of the road and impacts head-on with another vehicle. Includes head-on crashes at intersections. Does not include crashes involving motorcyclists or cyclists as they are considered separately.
Intersection	Crashes occurring at intersections, including side impacts involving vehicles from adjacent directions, collisions between right turning and opposing vehicles and rear-end crashes. Does not include run-off- road, head-on, pedestrian, cyclist or motorcyclist crashes at intersections (these crash types are considered separately).
Other	Any relevant crash types that are not covered by the specific categories in this table. May include crashes involving vehicles entering or leaving driveways, side swipes, collisions with parked vehicles, loss of control without leaving the carriageway and crashes involving animals.
Pedestrian	All crashes involving pedestrians, including persons boarding or alighting from a vehicle and anyone working on the road or roadside.
Cyclist	All crashes involving cyclists.
Motorcyclist	All crashes involving motorcyclists.

Table 6: Crash Types Used in the Safe System Assessment Matrix

2.8.2 Scoring

Table 7 provides guidance on how to score each category. Half scores (e.g. 2.5) may be used for likelihood or severity where it is considered that the situation being assessed falls between the guidance provided in two adjoining rows of Table 7. Generally, half scores would not be used for exposure.

It is recognised that there will be a level of subjectivity in scoring depending on the person(s) undertaking the assessment. As such it is necessary that the assessment of existing conditions and all proposed design options is undertaken by the same SSA team. Scores for a particular project should not be directly compared against those of another project.

Practitioners may find it difficult to differentiate between *road user exposure* and *crash likelihood* as these factors are usually combined as likelihood in traditional risk assessment methods. In the SSA process, exposure and likelihood are considered separately. **Exposure** is the number of road users that have the potential to be involved in the particular crash type. **Likelihood** reflects the probability that an individual road user (vehicle occupant, pedestrian, cyclist or motorcyclist) will be involved in a crash. In some cases, the volume or number of vehicles or particular road users affects likelihood. Table 8 provides further guidance on factors to be considered when assessing exposure and likelihood.

Score	Road user exposure	Crash likelihood	Crash severity
0	There is no exposure to a certain crash type. This might mean that there is no side flow or intersecting roads, no cyclists, no pedestrians or no motorcyclists.	There is only minimal chance that a given crash type can occur for an individual road user given the infrastructure in place. Only extreme behaviour or substantial vehicle failure could lead to a crash. This may mean, for example, that two traffic streams do not cross at grade or pedestrians do not cross the road.	Should a crash occur, there is only minimal chance that it will result in a fatality or serious injury to the relevant road user involved. This might mean that kinetic energies transferred during a crash are low enough not to cause a fatal or serious injury (FSI), or that excessive energies are effectively redirected / dissipated before being transferred to the road user. Users may refer to Safe System critical impact speeds for different crash types, while considering impact angles and roadside hazards / barriers that are present.
1	Volumes of vehicles that might be involved in a particular crash type are particularly low, therefore exposure is low. For run-off-road, head-on and “other” crash types, AADT is < 1,000 veh/day For cyclist, pedestrian and motorcycle crash types, volumes are < 10 units/day	It is highly unlikely that a given crash type will occur.	Should a crash occur, it is highly unlikely that it will result in a fatality or serious injury to any road user involved. Kinetic energies are fairly low during a crash or the majority are effectively dissipated before reaching road user.
2	Volumes of vehicles that might be involved in a particular crash type are moderate, therefore exposure is moderate. For run-off-road, head-on and “other” crash types, AADT is between 1,000 and 5,000 veh/day For cyclist, pedestrian and motorcycle crash types, volumes are 10 to 50 units/day	It is unlikely that a given crash type will occur.	Should a crash occur, it is unlikely that it will result in a fatality or serious injury to any road user involved. Kinetic energies are moderate and the majority of the time are effectively dissipated before reaching the road user.
3	Volumes of vehicles that might be involved in a particular crash type are high, therefore exposure is high. For run-off-road, head-on and “other” crash types, AADT is between 5,000 and 10,000 veh/day For cyclist, pedestrian and motorcycle crash types, volumes are 50 to 100 units/day	It is likely a given crash type will occur.	Should a crash occur, it is likely that it will result in a fatality or serious injury to any road user involved. Kinetic energies are moderate, but are not effectively dissipated before reaching the road user.
4	Volumes of vehicles that might be involved in a particular crash type are very high or the road is very long, therefore exposure is very high. For run-off-road, head-on and “other” crash types, AADT is > 10,000 veh/day For cyclist, pedestrian and motorcycle crash types, volumes are > 100 units/day	The likelihood of individual road user errors leading to a crash is high given the infrastructure in place (e.g. high approach speed to a sharp curve, priority movement control, filtering right turn across several opposing lanes, high speed).	Should a crash occur, it is highly likely that it will result in a fatality or serious injury to any road user involved. Kinetic energies are high enough to cause a FSI crash and it is unlikely that the forces will be dissipated before reaching the road user.

Table 7: Safe System Assessment Matrix Scoring System (Source: Austroads (2016))

Crash Type	Exposure Measures	Typical Likelihood Factors
Run-off-road	Total volume of vehicles (AADT) using the road	• Horizontal and vertical alignment • Pavement condition • Shoulders – width, sealed or unsealed • Number, type and offset to roadside hazards such as poles, trees, steep batters etc. • Presence of barriers, barrier type and position • Speed limit and operationing speed • Volume of heavy vehicles • Potential for driver fatigue
Head-on	Total volume of vehicles (AADT) using the road	• Horizontal and vertical alignment • Pavement condition • Number and width of lanes • Separation between opposing traffic streams • Median or centre line barriers • Overtaking opportunities • Speed limit and operating speed • Volume of heavy vehicles • Potential for wrong way movements
Intersection	Total volume of vehicles (AADT) entering the intersection	• Intersection type – cross, T, multi-leg, grade separated etc. • Intersection control – signalised, roundabout, STOP or GIVE WAY • Intersection features – dedicated turns lanes, channelization, movement bans etc. • Number of conflict points and complexity • Minor road volumes and movements • Volume of heavy vehicles • Right turn volumes
Other	Total volume of vehicles (AADT) using the road	• Varies according to the crash type being considered
Pedestrian	Number of pedestrians	• Controlled or uncontrolled crossings • Crossing type (signalised, zebra, wombat, grade separated etc.) • Pedestrian characteristics (young, elderly, mobility impaired, intoxicated etc.) • Presence of a refuge or median • Volume of traffic • Speed of traffic • Crossing distance and number of lanes • Separation from vehicular traffic, including heavy vehicles
Cyclist	Number of cyclists	• Cyclist characteristics (age, commuting, recreational, training etc.) • Presence and type cycling infrastructure (separated paths, on-road bicycle lanes, wide kerbside lanes, bike boxes, controlled crossings, refuges etc.) • Volume of motorised traffic • Separation from motorised traffic, including heavy vehicles • Speed limit and operational speed of traffic
Motorcyclist	Number of motorcyclists – assume 1% of AADT if specific data not available	• Horizontal and vertical alignment • Pavement condition • Number and width of lanes • Speed limit and operating speed • Number and type of roadside hazards • Volume of other vehicles • Sight line restrictions • Right turn control at intersections

Table 8: Exposure Measures and Typical Likelihood Factors

2.9 Additional Safe System Components

A SSA is primarily focussed on road and roadside infrastructure and speed. However, the framework also includes consideration of the other pillars that comprise the Safe System (i.e. road users and vehicles). Consideration is also given to post-crash care, which is often recognised as the fifth pillar of the Safe System. These other pillars are taken into account by completing Table 9, which includes prompts relating to a number of common issues. Comments in response to the prompts and any other relevant issues should be provided by the SSA team.

Experience to date indicates that input from Victoria Police can add value to a SSA by increasing the understanding of local issues, particularly those relating to road user behaviour, enforcement activities and safety. Information from Police can be used in Table 9.

Consideration of these additional Safe System components is not required for a Rapid SSA.

Pillar	Prompts	Comments
Road user	Are road users likely to be alert and compliant? Are there factors that might influence this? What are the expected compliance and enforcement levels (alcohol / drugs, speed, road rules and driving hours)? What is the likelihood of driver fatigue? Can enforcement activities be conducted safely? Are there special road users (e.g. entertainment precincts, elderly, children, on-road activities, motorcyclist route), distraction by environmental factors (e.g. commerce, tourism) or risk-taking behaviours?	
Vehicle	What level of alignment is there with the ideal of safer vehicles? Are there factors that may attract large numbers of unsafe vehicles? Is the percentage of heavy vehicles too high for the proposed / existing road design? Is this route used by recreational motorcyclists? Are there resources in the area to detect non-roadworthy, overloaded or unregistered vehicles and thus remove them from the network? Can enforcement activities be undertaken safely? Has vehicle breakdown been catered for?	
Post-crash care	Are there issues that might influence safe and efficient post-crash care in the event of a severe injury (e.g. congestion, access, stopping space)? Do emergency and medical services operate as efficiently as possible? Are other road users and emergency response teams protected during a crash event? Are drivers provided the correct information to address travelling speeds on the approach and adjacent to the incident? Is there reliable information available via radio, VMS etc? Is there provision for e-safety (i.e. safety systems based on modern information and communication technologies, C-ITS)?	

Table 9: Additional Safe System Components (Source: Austroads (2016))

2.10 Potential Treatments

Following completion of the assessment of existing road conditions and the proposed design options, the SSA team should review the results and identify areas where the FSI crash risk can be reduced. Particular attention should be given to the highest risks identified by the SSA Matrix scores as these will be the areas where the greatest gains are possible. The SSA team should document suggested treatments and design changes so that they can be considered by the client. Generally, the SSA team is not expected to re-score the project with the suggested design changes prior to consideration and a decision from the client to either accept or reject each suggestion.

Table 10 lists a number of treatments and measures that may be considered in order to reduce the risk of FSI crashes. Not all of these treatments will be applicable to every situation and the list is not exhaustive. A more comprehensive list of treatments is included in Austroads (2016) *Safe System Assessment Framework* (Section 4.6 and Table 4.5). Both Table 10 and Table 4.5 of Austroads (2016) provide an indication of which components of risk (i.e. exposure, likelihood and severity) will be influenced by the treatment. The SSA team should also consider whether there are any emerging or innovative treatments, which have recently been developed or are being trialled, that may be relevant to the project being assessed.

Treatment suggestions made by the SSA team are to be classified as primary or supporting treatments. **Primary treatments** are those that have the potential to eliminate or come close to eliminating the risk of FSI crashes. **Supporting treatments** are effective in reducing the risk of FSI crashes but not to the extent of a primary treatment (i.e. there is a residual moderate or significant FSI crash risk). Primary treatments should be given priority, however, it is recognised that some may not be feasible due to constraints such an environmental, other project objectives and cost.

	Run-off-road	Head-on	Intersection	Other	Pedestrian	Cyclist	Motorcyclist
Exposure	• Promote use of alternative, higher quality routes	• Promote use of alternate, higher quality routes	• Close intersection • Left-in / left-out treatments • Direct traffic to higher quality intersection	• Consider specific treatments for the identified crash type(s)	• Separation (footpath) • Reduce traffic volume	• Separation (cycle path) • Reduce traffic volume • Shared use path	• Separate motorcycle lanes
Likelihood	• Lower speed • Sealed shoulders • Audio-tactile linemarking • Improved skid resistance • Consistent design	• Lower speed • One-way traffic • Audio-tactile linemarking • Improved skid resistance • Consistent design • Ban overtaking	• Grade separation • Lower speed • Roundabout • Raised platforms • Left-in / left-out treatments • Ban movements • Turning lanes • Delineation	• Consider specific treatments for the identified crash type(s)	• Separation (crossing) • Lower speed • Pedestrian refuges • Pedestrian signals • Improved skid resistance • Improved lighting • Improved sight distance	• Separation (crossing) • Lower speed • Bicycle lane • Bicycle box at intersections • Improved skid resistance	• Lower speed • Shared motorcycle / bus / taxi lanes • Consistent design • Improved skid resistance
Severity	• Roadside & median barriers • Wide run out areas • Lower speed	• Median barriers • Wide median • Lower speeds	• Grade separation • Lower speed • Roundabout • Raised platforms • Left-in / left-out treatments • Ban movements	• Consider specific treatments for the identified crash type(s)	• Lower speed (below 40 km/h)	• Lower speed (below 40 km/h)	• Lower speed • Motorcycle-friendly barrier systems

Table 10: Potential Treatments

2.11 Safe System Assessment Reports

A Full SSA report should include the following:

- ☐ Executive summary
- ☐ Description of the Safe System Assessment process
- ☐ Identification of the type of assessment i.e. a Full SSA
- ☐ List of the members of the assessment team
- ☐ List of meetings, workshops and site inspections
- ☐ Project background
- ☐ The context of the project (using the template in Table 4)
- ☐ Description of the project and the design options being assessed
- ☐ Safe System Assessment Matrix (Table 5), with scores and commentary on factors considered in determining the scores, for existing conditions and design options
- ☐ Commentary on other Safe System components (using the template in Table 9)
- ☐ Suggested treatments / changes to the proposed design which would improve alignment with Safe System principles

A simplified report covering the scope outlined in Table 3 may be used for a Rapid SSA.

VicRoads has developed report templates for a Full SSA and a Rapid SSA. The templates and a sample report are available on VicRoads website. Reports prepared by consultants should be generally consistent with VicRoads templates and include similar content.

2.12 Respond to Suggestions

A SSA will usually suggest a number of measures that can increase a project's alignment with Safe System principles. These measures will also have varying levels of feasibility and ease of implementation due to site constraints, environmental impacts or funding limitations. It is expected that some design changes will be accepted while others may not be viable or may be considered for future implementation. However, it is important to consider how the project fits within an overall route strategy and the benefits of achieving a high level of alignment with Safe System principles in the short term, which will negate the potential need to revisit the site in the future.

Noting the above, it is important that project managers and designers give due consideration to suggestions that are feasible and provide improved alignment with the Safe System. When considering suggestions, it is important that the project team also responds to any potential design change they do not support with robust reasoning. Reasons for not adopting suggestions should not simply be based on maintaining existing conditions (e.g. retaining an existing speed limit or existing median treatment) as these conditions will have been considered during the SSA. Simplistic responses without supporting reasoning, such as "too expensive" and "don't agree", should also be avoided as they are not defendable if challenged.

To close out the assessment and provide feedback, the SSA team should be advised of any proposed changes to the design or scope in response to the SSA report. If necessary, the SSA team can be requested to re-score the project, incorporating the design and scope changes that have been accepted.

The project team should also consider any suggestions made by the SSA team that relate to the other Safe System pillars i.e. roads users, vehicles and post-crash care. This may require advice from the appropriate business area (e.g. Road User and Vehicle Access). Coordination and implementation of resulting actions that are beyond the scope of the project would generally be the responsibility of the relevant region.

2.13 Implement changes

The final step of the SSA process is to ensure that accepted suggestions that increase alignment with Safe System principles are implemented. It is the responsibility of the Project Manager to ensure that the design and scope are amended to incorporate the accepted changes and that they are implemented during construction. If necessary, the amended design and scope can be referred to the SSA team for review to ensure that appropriate changes have been implemented and not misinterpreted by the designer.

Approval of amended designs and project scope should follow established procedures.

2.14 Further Information

Further information about these guidelines or Safe System Assessments in general, can be provided by contacting Safe System Engineering, Road & Traffic Design or via the following email: safesystemengineering@roads.vic.gov.au .

References

Austroads 2009, *Guide to Road Safety Part 6: Road Safety Audit,* Austroads, viewed 9 November 2017, <https://www.onlinepublications.austroads.com.au/downloads/AGRS06-09>.

Austroads 2015, *Research Report AP-R498-15 – Improving the Performance of Safe System Infrastructure,* Austroads, viewed 13 March 2018, <https://www.onlinepublications.austroads.com.au/items/AP-R498-15>

Austroads 2016, *Research Report AP-R509-16 – Safe System Assessment Framework*, Austroads, viewed 27 October 2017, <https://www.onlinepublications.austroads.com.au/items/AP-R509-16>.

Austroads 2017a, *Research Report AP-R498-15 – Understanding and Improving Safe System Intersection Performance,* Austroads, viewed 13 March 2018, <https://www.onlinepublications.austroads.com.au/items/AP-R556-17>

Austroads 2017b, *Technical Report AP-T330-17 – Safe System Infrastructure on Mixed Use Arterial Roads,* Austroads, viewed 13 March 2018, <https://www.onlinepublications.austroads.com.au/items/AP-T330-17>

State Government Victoria 2016, *Towards Zero 2016//2020 Victoria's Road Safety Strategy & Action Plan,* Victorian State Government, viewed 25 October 2017, <https://www.towardszero.vic.gov.au/__data/assets/pdf_file/0010/183556/STU_0206_RS_STRATEGY_2016_web.pdf>.

World Health Organisation 2011, *Global Plan for the Decade of Action for Road Safety2011-2020,* Wold Health Organisation, viewed 13 March 2018, <http://www.who.int/roadsafety/decade_of_action/plan/global_plan_decade.pdf>

VicRoads 2017, *Corporate Plan 2017-2021,* VicRoads, viewed 26 October 2017, <https://www.vicroads.vic.gov.au/~/media/files/documents/utilities/vrcorporateplans/vicroads-corporate-plan_20172021_web.pdf?la=en>.

Appendix A – Assessment of Long Route and Complex Projects

The purpose of this appendix is to provide guidance on the method of assessing projects where the proposed works are over an extended length of road. For an intersection upgrade, the limits of a Safe System Assessment will generally be clear (i.e. the assessment limits will usually coincide with the limits of the project) and the assessment can be conducted using a single set of SSA matrices to score existing conditions and each project design option. This will also be the case for a road project for which the proposed works are generally homogeneous over a length of road e.g. the duplication of a road between two major intersections. However, for projects that extend over significant length of road, the SSA may need to be divided into two or more components with the design options for each component to be scored independently.

The suggested methods of analyses for several typical scenarios are discussed below.

Scenario 1: A 20 km length of winding rural arterial road, on which there are several low standard horizontal curves, is proposed to be upgraded with a combination of treatments including wide centreline markings, curve alignment markers, tactile edge lines and installation of flexible barriers at selected high-risk locations (i.e. non-continuous barrier). The proposed treatments cover a significant proportion of the route although there are some short segments which will remain untreated.

The objective of the SSA in this case should be to assess the whole of the 20 km length in order to determine the extent to which the proposed treatments improve alignment with Safe System principles. Accordingly, the project would not be divided into segments and a single set of SSA matrices should be completed for existing conditions and each design option. Any intersections along the route would be assessed within these matrices.

Scenario 2: An outer urban arterial road is to be duplicated over a length of 3.5 km. As part of the project, three major intersections are to be modified. Two are currently roundabouts and one is traffic signal controlled. There are also several local residential streets that intersect the arterial road.

Under this scenario, the preferred approach is to separate the major intersections from the rest of the project. Each of the major intersections would generally be assessed independently i.e. for each intersection, SSA matrices would be completed for existing conditions and each design option.

The balance of the project (i.e. the mid-block segments between the major intersections together with all of the minor intersections) would be assessed and scored separately.

Scenario 3: Overtaking opportunities are to be improved over a 160 km length of rural highway by constructing overtaking lanes. Five locations have been selected and several design options are to be assessed, including 2+1 treatments with flexible barrier in a narrow median and wide median treatments without a barrier. Alternative treatments to provide access to minor intersecting roads are also to be assessed.

Under this scenario it is not practical to assess the whole of the route as only a small proportion is actually being treated. Each location at which a passing lane is proposed should be assessed separately. However, it is likely that there will be a degree of consistency between each of the assessments.