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Technical Guide for the Application of Road Safety Audits in Latin America and the Caribbean

Transport Division

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ABBREVIATIONS

BASt	Federal Highway Research Institute - Alemania
CFPV	Road Prevention Fund Corporation – Colombia
FHWA	Federal Highway Administration – Germany
iRAP	International Road Assessment Program
ISO	International Organization for Standardization
RSA	Road Safety Audit
RSI	Road Safety Inspection
PAHO	Pan-American Health Organization
PIARC	World Road Association
PIPCORD	Road Infrastructure Safety Protection
	Core- Research and Development for Road Safety in Europe
RISMET	Road Infrastructure Safety Management Evaluation Tools
SEETO	South East Europe Transport Observatory
Sétra	Services d'études sur les transports les routes et leurs aménagements
SWOV	Institute for Road Safety Research
UNISDR	United Nations Office for Disaster and Risk Reduction
WHO	World Health Organization

CONTENT

PREFACE

In Latin American and Caribbean (LAC) countries the risk of dying in a road traffic incident is significantly higher than other countries in the Western hemisphere. For example, in the Dominican Republic the fatality rate reaches 29.3 deaths per 100,000. This figure is considerably higher than the rates in high-income countries, such as the United States with a rate of 10.6 and Canada with 6, and on average reaches 10.2 deaths per 100 000.

In the region, road traffic injuries are the leading cause of death among young people between 15 and 29 years of age, and are the cause of the premature death of more than 117,911 people each year; particularly among vulnerable users such as pedestrians, cyclists and motorcyclists.[1] This is much higher than the 20% rate recorded in high-income countries.

Given these circumstances, having safe roads can contribute to mitigating this regional road safety crisis. To certify that the road network is truly safe, it is advisable to employ Road Safety Audits – RSA. These audits have proven to be an effective instrument to detect potential hazards in all stages of a road project and, particularly in planning, design and construction, and significantly reduce the risks of road accidents in the operation of the infrastructure.

RSAs strengthen the countries' road infrastructure. They have the capacity to achieve a direct reduction of the incident rate due to traffic and the severity of the injuries caused by these events.

Given the potential to mitigate loss of life, it is necessary to communicate the importance of carrying out RSAs to governments, designers and professionals working on road safety. Therefore, governments can use this document as a guide developed to identify existing risks, establish measures, define solutions, provide recommendations and offer examples.

1 Road Safety Strategy, Inter-American Development Bank. 2017.

1 INTRODUCTION

RSAs are a method of intervention on road projects which are recognized as effective, which contribute to the design, construction and operation of safer highways and urban roads.

This tool is used in many countries around the world, but some countries, such as United Kingdom, Australia and New Zealand, Denmark, Germany, Norway, the United States and Canada, have especially excellent results.

For example, Rune Elvik's Handbook of Road safety Measures (Norwegian Centre for Transport Research, 2009) highlights one study carried out on 13 construction projects in Denmark subjected to several RSAs whose recommendations produced a reduction between 25 and 28 total traffic related incidents per year, and another study carried out in Germany, which estimated that an RSA can prevent up to 70% of all road traffic incidents in the construction of new roads (Bast, 2002).

Taking into account the importance of the use of RSAs for the construction and operation of safe road infrastructure, the Inter-American Development Bank (IaDB), prepared a guide for the application of this tool in new projects in Latin America and the Caribbean countries.

The main purpose of this guide is to provide guidelines for the audit teams and road infrastructure agencies of the governments of LAC countries, in the application and comprehension of the concepts of the Road Safety Audits (RSA).

An RSA is a formal examination of a future road or road traffic project. An independent and qualified team reports the status of road safety, the potential risk of road traffic incidents, and identifies areas for improvement for the protection of all road users (Austroads, 2009). When RSAs are implemented regularly, it also improves the original design of road projects as designers can anticipate the concerns of an RSA.

1.1 Scope of this Guide

This guide was developed based on extensive international experience and progress in Latin America. It contains detailed information about the basic principles, the application process, the profiles and obligations of those in charge of RSAs.

1.2 Target Group

This guide is aimed, in the first place, at road safety audit teams. It is also of interest to authorities in relevant entities and to professionals and technicians related to the planning, design, construction and operation of urban roads and highways. It is ideal that considerations of road safety in the infrastructure are taken seriously by the relevant stakeholders.

1.3 Guide Contents

The guide is comprised of three chapters.

This **first chapter** consists of the introduction, in which the purpose and scope are established. In addition, the target group is defined.

The **second chapter** outlines all the theoretical principles that support the application of the RSA. It starts with the concept and principles of a safe system and discusses road safety strategies such as: Sustainable Security, Self-explanatory Roads, Zero Vision, and Forgiving Roadsides. These are examples of how road safety is managed, and how user safety is necessarily privileged over any another consideration.

The chapter continues with some road safety considerations that must be taken into account in the road safety audit; these are related to the human factor, vehicles and users, design consistency, pavement surface, signaling, demarcation, safety of pedestrians and cyclists, and risk factors, which must be known by the audit team. However, these factors should also be known by other stakeholders such as designers, engineers in training, and auditors in training, among others.

The guide is presented in the **third chapter,** which consists of four sections. The first section contains an introduction of the conceptual framework of the RSA. It includes the definition, the essential elements, the objectives, benefits, necessity, intervening parties, types of projects and stages on which they are developed. It highlights those fundamental principles that constitute an RSA and that addresses some concerns and doubts that may arise when contracting and performing an RSA. The second section contains detailed steps that must be followed in the application of the audits. The third section includes checklists for rural and urban roads, which correspond to a toolkit for the auditors and considers all the risk factors that must be reviewed. Finally, the fourth section develops the methodological model to evaluate and monitor the adoption of the recommendations of the RSA report.

In addition, suggestions are provided for the terms of reference used for contracting the audit team, checklists and a practical example of an RSA as annexes. The aim of this information is to provide a visualization of the application of the conceptual model that is developed throughout the guide.

2

THEORETICAL PRINCIPLES FOR THE APPLICATION OF RSAS

This chapter covers a series of principles of road safety management. They are seen from a comprehensive perspective, based in a philosophy focused on the interaction between all factors and an aspiration for maximum safety in road project designs. These principles provide guidance to the audit team regarding what considerations must be taken into account from the point of view of road safety for all users to perform the audit of a road project.

The chapter begins with the description of the road safety system approach focused on the protection of life. Afterwards, some guidelines to direct the action of the audit towards certain topics are provided. These include the human factor, users and vehicles, the consistency of the geometric design, the surface of the pavement, speed reducers, berms, rumble strips, signaling, pedestrians and cyclists and risk factors.

2.1 PRINCIPLES OF A SAFE ROAD AND ITS ENVIRONMENT

It is important that whoever orders, hires or carries out a road safety audit adopts the concepts and principles of a safe system. This means that the health and integrity of the users is the most important consideration.

In the development of a safe system, in which the design of a road traffic system is centered on the user, three international strategies are employed to respond to the risks of traffic incidents with victims in a road network: the Sustainable Safety Policy of the Netherlands, the Vision Zero of Sweden and the Forgiving Roadsides.

2.1.1 Sustainable Safety

The vision of Sustainable Safety started in the Netherlands in the early nineties, and it was updated in 2005 [2] (SWOV, 2013).

The principle of this vision is to prevent serious road traffic incidents and, when that is not possible, to reduce the risk of serious injuries. In order to achieve these objectives, road and transport systems must be tailored to the users. In addition, they must take into account their physical vulnerability, and predict that users sometimes make mistakes and do not always follow the rules. This is a comprehensive approach that evaluates all the factors that can impact road safety.

The objective of Sustainable Safety is to minimize these mistakes and violations of the rules as much as possible and limit the consequences by designing a mobility system tailored to human beings. First of all, the road, the environment and the vehicle must adapt to the capabilities of the users and offer assistance and protection (SWOV, 2013). On the other hand, information and education should prepare users for their role in traffic and their behavior should be monitored.

In order to have a sustainable and safe traffic, the Sustainable Safety Vision adopted five principles that are described in Table 1.

2 SWOV. *"Sustainable Safety: Principles, Misconceptions, and Relations with Other Visions". Netherlands. 2013.*

Table 1 Sustainable Safety Principles

N°	Principle	Description
1	Functionality	Mono-functionality of routes. This can occur through roads, highways and road accesses in a hierarchically structured road network. This prevents the unintentional use of the roads, which means that its use must follow the function of the road.
2	Homogeneity in mass (vehicles and users) or speed and direction	The consistency of speed, direction and mass (vehicle and users) of the vehicle at moderate and high speeds. This avoids large discrepancies in speed, direction and mass (vehicles and non-motorized users) to reduce the possibility of unexpected encounters with implicit risk.
3	Predictability of traffic behavior via a recognizable road design	This refers to the environment and the behavior of road users, supported by their expectations, through the consistency and continuity of road design. Prevention of uncertainty among road users improves the predictability of the route and the behavior of other road users.
4	Indulgence of the environment and the road user	Mitigation of injuries through a tolerant environment and anticipation of the behavior of road users. Forgiving roadsides can help limit the physical consequences of driving errors.
5	Awareness of the road user	Assessment of your own capacity and limitations in the task of driving.

Source: SWOV. *Sustainable Safety: principles, misconceptions, and relations with other visions*. Países Bajos. 2013.

The road safety measures adopted since the beginning of the Sustainable Safety vision comprise the categorization of roads, the implementation of 30 km/h and 60 km/h zones and the construction of roundabouts and berms. According to some estimates, the introduction of these road safety measures reduced deaths and serious injuries due to road traffic incidents in the Netherlands 6%, between 1997 and 2002.[3] (SWOV, 2013).

The Sustainable Safety Model also considers that the education, control and vehicle technology are an essential part of the sustainability of a safe traffic system.

3 Idem

2.1.2 Vision Zero [4]

Vision Zero, which is also considered a comprehensive approach, envisions an ideal traffic system in which no person will die or be seriously injured as a result of a traffic incident.

Vision Zero was introduced in Sweden in 1995 and was adopted by Parliamentary Resolution in 1997. It became the center for road safety operations in the country, and has represented important changes, both in the views of road safety and the work approach.

Vision Zero is comprised of several basic elements, each of which bears on road safety. They are related to ethics, human capacity and tolerance, responsibility and a scientific understanding that these components interact in the road transport system and that they are interdependent.

From an ethical point of view, no person should die or be permanently injured as a result of a road traffic incident. Therefore, the values of road safety must correspond to the value of safety of society in general.

Likewise, transportation systems must be designed taking into account biological tolerance against external violence, that is, what the human body can withstand. In this sense, there are scientifically established limit values based on the design of modern vehicles and roads. For example: more people survive if they are hit by a vehicle at 30 km/h or a safe car protects the occupants at speeds between 65-70 km/h in a head-on collision and at speeds between 45-50 km/h in a lateral collision, assuming everyone uses a seatbelt.

2.1.3 Forgiving Roadsides [5]

The first priority of forgiving roadsides is to reduce the consequences of road traffic incidents caused by mistakes in driving, vehicle malfunction or poor road conditions. This approach focuses on treatments to redirect the errant vehicles back to the traffic lane and to reduce fatal injuries or road traffic incidents by vehicles leaving the road. If the vehicle still hits an element of the road, the second objective is to reduce the severity of the incident. In other words, the road forgives the driver's mistakes by reducing the severity of road traffic incidents.

In summary, "forgiving roadsides" is defined as a road that is designed and constructed in such a way that it interferes with user error and mitigates the negative consequences of such errors. This allows the driver to regain control, stop or return to the road without damage or injury.

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4 Vägverket. (2015) Swedish Road Administration. SAFE TRAFFIC: Vision Zero on the move. Borlänge, Suecia.

5 La Torre Francesca. Forgiving Roadsides Design Guide. CEDR. 2012.

2.2 ROAD SAFETY CONSIDERATIONS FOR THE APPLICATION OF THE RSA

This section presents the main road safety considerations that should be taken into account in the application of the RSA that should be known to the audit team. These considerations are guidelines to direct actions within the audit, but they do not replace the knowledge and experience of the audit team. This is why the examination of the road should be done by experienced personnel. These considerations can be broken down into the three categories that affect road safety: infrastructure, vehicles and users.

2.2.1 Infrastructure

Consistency of the Geometric Design of a Road

The consistency of the design is related to the homogeneity of the geometric characteristics of a road, which influences the speed, comfort and safety of users.

The less these parameters vary, the radii of curvature, the length of straight lines, the widths, the slopes, the types of intersections and others, the better circulation conditions can be maintained.

Some geometric road design manuals incorporate procedures to determine the specific speed in each horizontal curve, in the straight sections, in the outline in profile, establish maximum ranges of variation of speeds, the relationship between contiguous radii of curve and others, and tend towards more homogeneous designs.

There are several procedures to detect points of inconsistency that can lead to road traffic incidents, such as:

* The profile of operating speeds: This consists of finding the speed of operation in each of the elements of the road section under study and representing this data in a graph that determines its variation. Significant changes indicate consistency problems.
* Alignment Comprehensive Indexes: Numerical representations of the geometric characteristics of the road that allow comparisons between different sections and recommend ranges for safer designs.
* Driver attention: High levels of attention are inherent to road tracings with low consistency rating,s which implies greater fatigue and risk of incidents.
* Others, which may include combinations of the above.

Pavement Surfaces

Pavement is designed, built and maintained to provide the user with a comfortable and safe surface to drive on. The friction of the pavement is a critical factor in road safety, especially in wet conditions. Proper friction allows better control of the vehicle and the ability to stop faster in case of a critical maneuver. The coefficient of friction is the indicator to measure the pavement friction.

The coefficient of friction of pavement is impacted by factors such as temperature, changes in season, condition of the pavement, humidity, speed of the vehicle, braking action, and tire properties, among others. In rainy conditions, if there is no adequate drainage, there is a dangerous condition known as hydroplaning. It occurs when there is a sufficiently deep water layer (measured in mm) between the tire and the pavement, which makes the tire lose contact with the surface and often results in the driver losing control of the vehicle.

For the safe operation of the vehicles on the surface of the pavement, it is necessary to take into account environmental and geometric factors, user types and adequate mix designs to ensure adequate drainage, comfort and maneuverability.

Speed Reducers

These elements are used to control the speed without becoming an additional danger. The speed reducer is a variation in the longitudinal pavement profile, designed to cause a slight oscillation in a vehicle that crosses it at low speed, and a feeling of lack of control for those vehicles that cross it at high speeds. There are several types of speed reducers used in different countries, according to the existing regulations in each. Several types of speed reducers stand out, including sound or rumble strips, parabolic, circular, or trapezoidal speed bumps and cushion type reducers, and different line drawing patterns on the pavement.

The speed reducer must be properly defined with retroreflective paint that makes it visible, with vertical warning signaling and it must be located, if possible, in a lighted area.

Berms

Berms can be paved or treated with soil stabilization. Their main functions are: allowing evasive maneuvers, granting space to stop the vehicle due to emergencies, facilitating traffic in special situations, facilitating traffic for detours, facilitating emergency vehicle circulation, operating as turning lanes, serving pedestrian traffic or as a bike path when the speed of operation is not higher than 60 km/h.

There are several factors that affect the functionality of the berms, such as the structural strength, the width and continuity, the cross slope, the lateral joint, the surface, the contrast with the surface of the road and the demarcation. Those differences will determine how safe the road is.

Each country has its own regulations regarding berm width. The important thing is that they should be safe. The International Road Assessment Program (iRAP) proposes, for safe roads, a berm width of 2.4 m on each side of a road.

Rumble strips

Rumble strips are located perpendicular to the traffic flow to generate a warning sound for drivers in places where it is necessary to reduce speed or watch out for a dangerous situation. This device is used to alert drivers when they are approaching changes in the road conditions or its environment. For example, sharp curves, entrances to villages on rural roads, proximity to toll stations, school zones, end of a road with the obligation to stop and other areas that may not be perceived properly by a driver who is not attentive.

In addition, in order to ensure that drivers do not exit the traffic lane on a road, some countries use rumble strips, also known as rumble strips. These are rough elements that modify the road surface on the lines of central or lateral demarcation producing an audible warning, announcing the possibility of invading the adjacent lane or leaving the road. Sound bands are used more frequently on straight roads or roads that have a history of traffic incidents by exit of track, especially due to micro-sleep episodes or distracted drivers.

Vertical Signaling

Signaling alone do not constitute road safety.

The main function of vertical signals is to communicate. Through this communication, instructions for proper road use are transmitted, the presence of hazards, routes and services are provided. To achieve their function, each signal must be visible and readable, both day and night, for all users in any situation, time or place. Signals should be located in places that allow visibility for users and allow adequate reaction time during a safe maneuver. Signals must be of adequate size and have legible fonts, short legends, symbols and appropriate forms and they must be retroreflective.

Signal visibility is based on its state and location, the material used, the environment and the distractions present, the cleanliness and condition of the windshield of the vehicle, the cleanliness of the signal and the user's vision. At night, certain additional considerations must be taken into account such as retroreflectivity, the condition of the vehicle's lights and the lighting of the location.

Some of the benefits of proper vertical signaling are: prevention, guidance, the degree of user satisfaction in the driving experience, the reduction of road traffic incidents and a better corporate image for the person responsible for the road operation.

Demarcation (Horizontal Signaling)

It is important that horizontal signaling features uniformity in its dimensions, design, symbols, characters, colors, frequency of use, circumstances in which it is used and type of material.

To guarantee the visibility of demarcations at night and in darker hours, the paints and materials should be reflective with glass microspheres, ribbons or others reflective material which guarantees their nocturnal visibility. In this case, the road safety auditor must ensure that the demarcation is visible at night, in order to meet the minimum standards of retroreflectivity required by the regulations of each country or international standards.

Like vertical signaling, the benefits of demarcation are evident in the reduction of road traffic incidents, better driving experience and a better corporate image for the person responsible for the operation of the road.

Demarcation is classified as follows:

* Longitudinal lines: They delimit lanes and roadways, indicate areas with and without prohibition to overtake or change lanes, zones with no parking and delimit lanes for exclusive use for certain types of vehicles.
* Cross-section lines: They are used in intersections to indicate places where vehicles must stop and to demarcate pedestrian or bicycle paths.
* Demarcations at roads intersections.
* Demarcation of parking lines.
* Demarcation of bus stops.
* Symbols and legends.
* Other demarcations

Delineators

Delineators are retroreflective devices of different shapes, colors and sizes. They are installed on the surface of the road, outside it or in vehicle containment systems. They can be placed on the sides of the road or to delineate the centerline.

The main function of the delineators is to capture the attention of the driver, so that he/she can perceive the characteristics of the road with enough time to safely carry out the necessary maneuvers.

Vehicle Containment Systems

Vehicle containment systems are devices in the margins of a road, entry ways and exits. The purpose of these devices are to retain and redirect vehicles that lose control and leave the road; so that road traffic injuries are limited, both for the occupants of the vehicle and for the other road users and people or objects located in the vicinity.

A collision with a vehicle containment system is a substitute for a different road traffic incident that would occur in the absence of this mechanism and has more predictable and less dangerous consequences. However this does not mean that the occupants of the vehicle are free of risk. The barriers and their terminals also constitute an obstacle in the margins of the road and should only be placed if their absence implies a risk of greater injury in the event of a road traffic incident.

The installation of vehicle containment systems should account for the type of traffic and users on the road in question. For example, if there are motorcyclists, heavier or lighter vehicles and other factors impacting the geometry of the road and the type of traffic, which will in turn indicate what types of traffic incidents are likely to occur.

Lighting

The objective of road lighting is to allow road users to move as safely and comfortably as possible at night. Satisfactory lighting must be continuous and uniform so that the driver can distinguish with certainty and detail the path that faces him and his surroundings, with enough time to perform necessary maneuvers for safe use of the road. Pedestrians and other vulnerable road users will also be able to distinguish the markings for crossing streets, vehicles and obstacles. To employ this type of lighting, several factors must be taken into account in addition to considering the economic and aesthetic aspects of the illuminated road when studying installation and maintenance costs.

Other Risk Factors

Table 2 presents the risk factors that are related to the road design, specifically with road outline, vertical, super elevation, signaling, vehicular operational and pedestrian infrastructure designs. These factors were selected based on past experience in carrying out RSAs.

Table 2 Risk Factors

RISK FACTORS

Outline Design

- Alignment of edges or axes incongruent with respect to paths and their safe traffic channeling
- Insufficient road width for vehicular paths
- Excessive section width generates dangerous expansion zone
- Insufficient cross-section width
- Insufficient median strip width
- Dangerous deflection angle
- Absence of required acceleration lane
- Absence of required deceleration lane
- Absence of horizontal curve at break point with deflection angle greater than 200
- Absence of required widening
- Parking bay does not allow safe approach or exit
- Roundabouts
- Cross-section change without safe transition
- Non-confluent lanes to the central island of the roundabout
- Insecure configuration of roadway exchangers
- Poorly located crosswalks
- Deficiency in joints in project boundary areas
- Design axis that does not exist or is inconsistent with the operation of the project
- Dangerous cross-linking
- Dangerous central island geometry, traffic channeling or main strip
- Insufficient length for acceleration lane
- Insufficient length for deceleration lane
- Presence of frontal or lateral obstacle
- Turn radius less than the minimum required for vehicle design
- Reverse paths
- Dangerous variations in radii of curvature

Vertical Design

- Dangerous coincidence of vertical curves with crossings, convergences or divergences
- Dangerous coincidence of vertical curves with horizontal curves
- Insufficient gauge
- Vertical curve length is less than required
- Slope greater than the maximum allowed according to the type of track and the speed of design
- Slope less than the minimum recommended
- Presence of dangerous gutters in convergence or divergence junction
- No vertical design
- Visibility limitations, problematic handling of specific speeds on slopes
- Problematic handling of longitudinal drainage
- General shortcomings of the vertical design

Curve Design

- Insufficient normal pumping
- Configuration of the curve incongruent with respect to the concatenation type
- Insufficient curve
- Relative slope of edges outside the recommended ranges
- No curve design
- Problematic handling of cross drainage
- Instability of the vehicle
- General deficiencies on the design of curves

Signaling Design

- Absence of horizontal demarcation
- Absence of vertical signaling
- Incomplete demarcation
- Unsafe or incongruent demarcation with respect to the geometry
- Excess of vertical signaling
- Incomplete vertical signaling
- Lateral location of signaling
- Night retroreflectivity
- Inappropriate location of signaling
- Low visibility of signaling
- State and maintenance of signaling
- Vertical signaling or inappropriate demarcations

Operational Vehicular Design

- Insufficient parking width
- Road capacity affected by parking areas
- The design limits or diminishes the current conditions of accessibility and connectivity
- Insufficient space for the accumulation of vehicles in queue
- No information regarding bus stop areas
- Unsafe location of bus stops
- Dangerous uncontrolled movement or with unsafe control
- Impacts to transit
- Impacts on accessibility
- Priority conflicts derived from operational design
- Access to premises, entry and exit of vehicles
- Returns

Pedestrian Infrastructure

- No pedestrian infrastructure
- Geometric deficiencies of pedestrian infrastructure
- Discontinuity in the pedestrian zone
- Obstacles in the pedestrian zone

2.2.2 Vehicles

As a fundamental principle, RSAs must consider all the users of the project. In this sense, the audit team should be clear about the differences between the types of vehicles and users expected in the area.

In general, there are three types of vehicles: motorized vehicles (trucks, buses, cars and motorcycles or similar), human-powered vehicles (pedestrians, cyclists, wheelchairs) and animal-powered vehicles.

Motorized vehicles include two categories, heavy vehicles and light vehicles. For each of these types there are differences both for the geometric design of the road and for their operation.

Heavy vehicles include cargo vehicles and buses for passengers' transportation. Table 3 shows the particular aspects for the heavy vehicle interaction and for the geometric design, these must be taken into account for these vehicles.

Table 3 Considerations for the Operation of Heavy Vehicles

OPERATION OF HEAVY VEHICLES

Road - Vehicle interaction	Geometric Design
Weight, length, width of vehicle	Lane width
Turning radii	Maximum and minimum slopes
Lateral stability, overturning thresholds	Visibility distances
Turning radios	Design of intersections
Widening	Curve widening
Rear widening	Pavement
Braking distance	Bridges or artwork
Elevation of the driver's eye	Gauge
Acceleration characteristics	Escape ramps
Rear overhang	Bus stops
Parking lots	Rest areas
Special lanes	Parking lots
Length of acceleration lanes	Special lanes
Limitation of the visibility of signaling (place signs on both sides)	Acceleration lanes

The considerations for the geometric design in relation to light vehicles are summarized in Table 4.

Table 4 Considerations for the Operation of Light Vehicles

OPERATION OF LIGHT VEHICLES

Geometric Design
Geometric design
Lane widths and berms
Visibility distance
Braking distance
Slopes
Acceleration lanes
Horizontal curves
Design of intersections
Ramps
Containment systems
Signaling
Conditions of the surface

For human and animal powered vehicles there are differences in the geometric design and in the operation of the road. Risks for these vulnerable users are differentiated according to the vehicles with which they interact in the traffic system.

Table 5 shows measures that can limit traffic incidents involving pedestrians and cyclists.

Table 5 Facilities for Pedestrians and Cyclists

FACILITIES FOR VULNERABLE USERS

Pedestrians	Cyclists
Pedestrian paths	Cycle routes
Sidewalks	Fences or physical barriers
Crossing: zebra, pelican, traffic light	Bridges for cyclists
Pedestrian islands	Shared space
Fences or physical barriers	
Pedestrian bridges or walkways	

In some Latin American countries, the population uses for transportation carts pulled by horses, mules or oxen for carrying small loads or recycling and these carts often circulate jointly on the same space of mixed traffic. An RSA should consider the following factors:

Table 6 Operation of Animal-Powered Vehicles

OPERATION OF ANIMAL-POWERED VEHICLES

Animal - powered vehicles	Animal species
Is it permitted by local regulation?	Cattle paths
Specific lane	Fences to contain cattle
Night visibility	Barnyards
Volume of vehicles	Passage of non-domestic or wildlife species
Signaling	Signaling
Priorities of passage	Priority of passage

2.2.3 The Human Factor

The human factor is an essential element in the operation of traffic systems. People are tasked with driving vehicles, participating as passengers and commuting on foot or by bicycle or other means to meet certain mobilization needs.

For this reason, it is important that road safety auditors understand the differences between drivers, consider the task of driving, understand how users receive and prioritize information, how they handle expectations, reaction times and the visualization process and the needs for good communication.

RSAs must take into account all the users on a road.

The differences between drivers can be understood through differences in driving skills, according to their experience, control activities, traffic channeling and navigation, lack of attention, distraction, fatigue, sleep, physical disability, and use of medications, alcohol or narcotics.

Expectations are associated with all aspects of the road: speed, layout, profile, geometric design, signaling and others. These may depend on the regional or local culture, the collective experience, the level and degree of training and the location of the road, its characteristics and signaling.

There is a close relationship between the infrastructure and the user. The primary objective should be that this relationship is as positive as possible, so that users commit the least amount of possible errors. Some factors that favor a better user - infrastructure relationship are:

Consistency of Speeds

The consistency of the operation speeds along a road is one of the criteria for evaluating the consistency of the geometric design. The geometric design consistency is the degree of consistency between the road behavior and the expectations of the driver. The expectations of the driver can be divided into two elements.

A priori expectations: The driver bases his decision criteria on the experience gained after driving on other roads. In order to meet these expectations, there must be a direct relationship between the type of road, the geometry of the road and the available equipment.

Ad hoc experience: The driver acquires experience from the perception of the characteristics of the road he/she travels. As a driver drives along a stretch of road, he/she expects the road to behave similarly in the following kilometers.

When estimating the consistency of a road, the most relevant variable is the speed of operation, which can be estimated via statistical models that are directly related to the geometry of the road.

Workload

With the development of intelligent transport systems, the analysis of workload as one of the factors that impacts the user has been increasingly relevant. It is necessary to evaluate whether or not the systems that are implemented in the infrastructure help the driver in his/her task or if, on the contrary, they increase the workload with excessive information that must be processed.

The workload can be defined as the cost incurred by humans to complete a task. The mental workload and the driver's performance are directly linked. To evaluate this factor, subjective methods can be implemented, as well as more precise measurements. It is necessary to take into account this factor before the implementation of innovative systems, to be certain that they are facilitating the driver's task, instead of creating a distraction.

Road Readability

Road readability is the degree to which the elements of the road contribute to minimize the vulnerabilities of the driver's expectations and to avoid the occurrence of road traffic incidents.

Roads with a good readability show the driver the layout of the road for several hundred meters. Generally, very curved roads in which the successive sections hide behind a change of grade or an intensely-closed curve, present bad readability.

Self-explanatory Roads

This concept originated in the Netherlands and refers to roads that encourage the driver to adopt a behavior compatible with the design and function of the road naturally. Self-explanatory roads are roads where the user is able to distinguish between different types of surfaces and maintain consistency along the route. These types of roads encourage the driver to behave intuitively. The objective of such roads is to use the simplicity and consistency of the design to reduce stress and avoid driver errors.

Pedestrians

On average, 27% of the deaths that occur in Latin America and the Caribbean in road traffic incidents are pedestrians. The sub region of Mesoamerica has the highest percentage, with 34% of all deaths (PAHO, 2015).

The RSA audit team must understand the principles of pedestrian road safety, which will allow for a better assessment of the environment and the quality and safety of the facilities for which they commute on foot. In this sense, they should abide by the recommendations of FHWA - USA that are expressed below.

As a general rule, three principles for pedestrian safety are identified:

A Walking as a Means of Transportation

A large part of the trips made by the population in Latin American countries are done on foot. People commute to work or school, go shopping or walk for recreational purposes. Mobilization on foot is also an element of connection between different means of transportation.

This activity is prone to high risks with the possibility of road traffic incidents when vehicles strike pedestrians. Therefore, it is necessary to accommodate pedestrians in a safe way and provide access and mobility in the different transport facilities. In urban areas, the pedestrian is the main user and the main priority for the design of public infrastructure.

Walking is also impacted by the physical barriers that the pedestrian encounters along the road, such as unprotected crosswalks, the absence of sidewalks, poor quality of walking surfaces, obstacles on the platforms and crossings, no crossings and the high speed of the vehicles.

B Pedestrian Characteristics

Pedestrians have a wide range of conditions that characterize them and that distinguish them from each other such as: walking speed, space needs, mobility, vision, cognitive skills, options to cross and waiting times. When designing pedestrian mobility facilities, it is important to consider seniors, people with mobility disabilities, and children among others.

C Factors that Contribute to Pedestrian Road Traffic Incidents

When conducting an RSA, the audit team should be aware of the factors that contribute to incidents where pedestrians are struck by vehicles, both by drivers and pedestrians themselves. Driver's behaviors include disrespect to the right of way, driving too fast, and distraction among others. The behavior of pedestrians includes, but is not limited to: inappropriate crossing, not respecting the right of way of vehicles and invading the road. Most of these behaviors are codified and are part of the police reports of road traffic incidents.

In addition, it is important that the audit team have an understanding of the places where pedestrian involved accidents may occur, when vehicles turn, back up, when the driver drives over the intersection or at the access points to buildings and other facilities.

When analyzing the safety of pedestrians, the road safety auditors should consider that the design of a project should correspond to the common behavior of pedestrians and not how pedestrians should behave.

Table 7 shows some guidelines for audit teams to consider when carrying out an RSA in order to guarantee pedestrian safety.

Table 7 Factors to Consider in an RSA for Pedestrians

GENERAL CONSIDERATIONS FOR PEDESTRIAN SAFETY

Connectivity / Convenience

- Pedestrian network
- Continuous
- Free of obstacles
- Comfortable
- Easy to use
- Exchange in urban areas
- In private developments
- In long roads

Construction

- Pedestrian routes separated from vehicular traffic
- Continuity of pedestrian routes
- Lighting of pedestrian routes
- Accessibility to pedestrian routes (stable ramps)

Needs

- Predominant groups (youth, children, people in wheelchairs, people with visual limitations)
- Presence of hospitals, schools, intermodal centers
- Origin matrix - destination

School Presence

- Adequate pedestrian facilities (sidewalk width)
- Adequate and effective signs
- Connectivity
- Direct access to buses
- Appropriate school exits
- Demarcation of school crossings

Speed

- Speeds of the design, regulated by signalization and in operation, compatible with the safety of pedestrians.
- Effect of speed on pedestrians

Behavior

- Pedestrian facilities follow the desired paths of pedestrians
- Pedestrian crossing through uncontrolled sites
- Use of pedestrian channeling
- Drivers give right of way to pedestrians

Continuity

- Sidewalk and continuous berms on both sides of the road
- Continuity for all groups of pedestrians
- Abrupt changes in the width of the sidewalk.
- Obstructions on the sidewalks
- Need to channel pedestrian flows (barriers, bollards, etc.)
- Obstruction of driver's visibility due to elements to channel pedestrians
- Orientation towards the pedestrian crossings
- Needs for channeling pedestrians

Quality Conditions and Obstructions

- Free of obstructions
- Suitable cross-sectional and longitudinal slope
- Suitable surface without abrupt changes
- Proper drainage
- Ongoing maintenance

Lighting / Visibility

- Adequate lighting
- The lighting provides visibility at night to pedestrians
- The visibility of pedestrians walking on sidewalks and berms is adequate

Traffic Characteristics

- Conflicts between pedestrians and cyclists
- Adequate pedestrian facilities (sidewalk width)
- Pelican-type pedestrian walkways
- Adequate and effective signaling
- Connectivity
- Direct access to buses
- Appropriate school exits
- Demarcation of school crossings
- Appropriate signaling

Access to buildings

- Safe visibility (driver – pedestrian)
- Elements that impede or diminish the driver's visibility on pedestrians
- Impact of pedestrian safety due to the density of access roads

Dessing and Location

Sidewalks

- Presence along the road
- Both sides of bridges
- Adequate width
- Adequate separation of the roadway
- They have ramps as an alternative to stairs

Berms

- Enough width
- Continuity
- Demarcation
- Maintenance
- Both sides of bridges
- Adequate separation of the roadway

Shelters

- Shelters in two-way roads

PEDESTRIAN SAFETY ON INTERSECTIONS

Continuity

- Sufficient waiting area for all groups of pedestrians
- Presence of ramps to direct pedestrians to the pedestrian crossing
- There is pedestrian crossing in all the arms of the intersection
- Convenient crossings as an alternative when pedestrians are not allowed through an intersection arm
- Proper guidance of pedestrians to the crossing
- Channeling needs
- Pedestrian walkways in roundabouts

Lighting / Visibility

- Lighting conditions
- Lighting allows drivers, cyclists and pedestrians to see each other easily
- Reduction of visibility by fixed objects (buildings, barriers, signs, posts)
- Reducción de la visibilidad por objetos fijos (edificios, barreras, señales, postes)
- Possibility that temporary objects reduce visibility (parking, loading)
- The location of the stop lines can reduce the visibility of drivers in relation to pedestrians
- Lighting allows nighttime visibility to pedestrians
- The visibility of pedestrians walking on sidewalks and berms is adequate

Traffic Characteristics

- Dangerous turning movements for pedestrians
- Enough time for pedestrians and vehicles turning to clear the intersection
- Priority of pedestrians over vehicles that turn
- Appropriate signage of pedestrian crossings
- Demarcation conditions.
- Pedestrian phases at the intersection

Access to buildings

- Conflicts of the access roads to buildings or properties near the crossing
- Conflicts with access roads to buildings near the stop line of the mid-block pedestrian crossing

Quality Conditions and Obstructions

- Adequate pavement at the crossing
- Sidewalk ramps level with the pavement surface

Dessing and Location

- Sidewalk radii appropriate for pedestrian volumes and mixed traffic
- Effects of radii on crossing distances
- Avoid skewed intersections
- Visibility distance in crossing area
- Accessible spacers, sufficient width
- Demarcation with sufficient width
- Properly planned corners and ramps

Cyclists

As in the case of pedestrians, the audit team must understand the principles of road safety for cyclists. This will facilitate the complete assessment of the environment and the quality and safety of the facilities on which they mobilize with bicycles. In this sense, the recommendations of FHWA - USA[8] , which are expressed below, are accepted.

A The Bicycle as a Mean of Transportation

Currently, the bicycle has a variety of uses ranging from recreational, carrying infants to and from the school, and adults traveling to work. This mode of transportation has grown significantly in recent years, and investment in road infrastructure improvements to accommodate cyclists has also increased. In this sense, care should be taken to ensure that bicycle facilities are safe and integrated into transport systems.

B Cyclists' Characteristics

It is important that the audit team understand the range of characteristics that cyclists have when using different types of facilities, determine how the designs fit the physical and operational attributes of bicycles and cyclists' skills. For this, space, length, stability, speed, deceleration and stoppage must be taken into account.

C Factors Contributing to Cyclist's Traffic Incidents

When conducting an RSA, the audit team should be aware of the factors that contribute to cyclists' road traffic incidents, such as: location (urban area, intersections), the design aspects of the project, speed and user behavior among others. These aspects must correspond to the common behavior of the cyclists indicated in Table 8.

8 FHWA. "Bicycle Road Safety Audit Guidelines and Prompt Lists." Washington. USA. 2012. ty Audit Guidelines and Prompt Lists". USA. 2007

Table 8 Factors Contributing to Cyclists' Traffic Road Incidents

A

Design and Location

- Both sides/directions of the road
- Speed and comfort
- Lanes and separate facilities
- Distance from vehicular flow
- Accommodation space for cyclists
- Slope
- Impact on calm traffic measures
- Impact of alerting bands
- Effect of parking areas

B

Conditions

- Cross-sectional slopes
- Accumulation of vegetation
- Impact on the circulation width by vegetation
- Potholes
- Surface defects
- Drainage grids
- Longitudinal joints and cracks
- Water stagnation

C

Continuity

- Continuity of routes and facilities
- Continuous changes in geometry (berms, lane width and tracks)
- Access to properties
- Conflicts with sidewalks and driveways

D

Lighting

- Lighting consistency
- Weak lighting

E

Signaling

- Consistency
- Clarity
- Location
- Spacing
- Multiple messages

F

Operation

- Appropriate context
- Appropriate for users' intentions
- Width

G

Obstructions

- Horizontal obstructions
- Vertical obstructions
- Signs and signals within the circulation area
- Vegetation within the circulation area

H

Lateral areas

- Free areas along the track
- Transferable slopes

I

Visibility

- Visibility distance
- Effects of vegetation on visibility
- Effects of elements near the edge of the track on visibility

J

Traffic lights

- Position, effectiveness
- Space for waiting cyclists
- Conflicting movements

Continuation of table Safety of cyclists in bridges and tunnels

A

Design and Location

- Both Sides/directions
- Slopes
- Distance between vehicles

B

Conditions

- Slip resistance
- Presence of fences
- Smooth, gap-free surfaces
- Slippery tiles
- Slippery tiles
- Vegetation
- Cross-sectional joints
- Longitudinal joints

C

Continuity

- Continuity of routes and facilities
- Changes in lane and track widths
- Changes in the location and structure of the bridge or tunnel

D

Lighting

- Lighting consistency
- Surface visibility and visibility of the circulation area
- Visibility between users
- Transitions

E

Signaling

- Prevention at the entry and exit of tunnels or bridges
- Visibility
- Clarity

F

Operation

- Appropriate context
- Appropriate for user interactions
- Width

G

Obstructions

- Horizontal obstructions
- Vertical obstructions
- Signs and signals within the circulation area
- Vegetation within the circulation area

H

Lateral areas

- Height of the railings
- Presence of potholes or bars that can hook the cyclist

I

Visibility

- Visibility distance
- Approach visibility of vehicles and pedestrians
- Presence of elements that restrict visibility (walls, railings)
- Visibility on both sides of elements near the edge of the road

J

Traffic lights

- Position, effectiveness
- Space for cyclists who are waiting
- Conflicting movements

Continuation of table
Safety of cyclists in
bridges and tunnels

A

Design and Location

- Conflicting movements
- Resting area in the vicinity of the intersection
- Continuous flow in the right turn lanes
- Acceleration and deceleration lanes
- Roundabouts
- U turns
- Conflicts with pedestrians
- Impact of calm traffic

B

Conditions

- Manhole covers
- Drainage grids
- Spacing of fence bars
- Level of the structures with the pavement

C

Continuity

- Continuity of routes and facilities
- Approach of lane termination for bicycles at the intersection
- Approach when the bicycle lane crosses the intersection

D

Lighting

- Visibility of all users
- Lighting consistency
- Lighting intensity

E

Signaling

- Consistency
- Clarity
- Location
- Spacing

F

Operation

- Conflicts with pedestrians
- Heavy vehicles
- Multiple lanes
- Conflicts in approaching intersections

G

Obstructions

- Horizontal obstructions
- Vertical obstructions

H

Lateral areas

- Obstacles in the lateral area of intersections

I

Visibility

- Visibility and stop distance
- Visibility of approaching vehicles and pedestrians in all the arms of the intersection

J

Traffic lights

- Position, effectiveness
- Space for cyclists who are waiting
- Conflicting movements

3

GUIDE FOR THE IMPLEMENTATION OF ROAD SAFETY AUDITS- RSA.

3.1 INTRODUCTION TO ROAD SAFETY AUDITS - RSA

This section presents the conceptual framework of the RSA, so that stakeholders are aware of their objectives and benefits.

3.1.1 Definition

The international development of RSAs has resulted in several methods of defining the process, but most are based on the definition adopted by the Australian guide (Austroads, 2009). This guide still defines what constitutes an RSA and assimilates the original concept developed in the United Kingdom.

The difference between present RSAs and those from the past is that the RSAs are left for new road projects and for the reconstruction of roads, and the Road Safety Inspections – RSIs, for the projects in operation.

As a result, the current, common concept of an RSA is:

> A road safety audit is a formal, systematic, proactive, documented and confidential examination of a future route or the reconstruction of an existing one. It is carried out by an independent, trained and multidisciplinary audit team. This team identifies the potential for road traffic related incidents and road safety performance for all the users of the project, and in turn, recognize and propose opportunities for improvement.

Annex 1 shows excerpts from an RSA performed on reconstruction projects.

3.1.2 Fundamental Principles

Although all the elements that stated above are of great importance in the development of an RSA, the following fundamental principles allow for clarifying doubts and dismissing concerns that arise when contracting and performing an RSA.

* The recommendations of an RSA **are not mandatory. It is up to the project developer to define the measures that are going to be implemented.**
* RSAs **do not replace** the responsibility of the designer.
* An RSA must take into account all of the users of a road project.
* **There is no definitive solution** to the problems that impact the safety of a road.

Likewise, the following premises, based on experience, should be taken into account.

* The earlier the auditors can intervene in the development of a project, the lower the cost of road safety. **IT IS BETTER AND EASIER TO PREVENT THAN TO REPAIR!**

* The audit is based **on how users behave** and not on how they should behave or how they would ideally behave.
* The **homogeneity of the treatments** applied. It is important to treat problems of similar characteristics with similar treatments to avoid confusing the user.
* The roads should be **self-explanatory.** The user should be able to anticipate what's coming as she moves down the road, that is, the signaling, condition and characteristics of the road should be predictable to avoid surprises.
* Priorities must be **rational.** There will always be a shortage of resources and it is not sufficient to show a path that would reduce the number of road traffic related incidents. It is necessary to show that the benefits outweigh the costs.
* Some results may be counterintuitive. For example, the excessive use of zebra crossings can generate an inappropriate feeling of safety among pedestrians
* The objective will never be to find a culprit; rather the objective is **to avoid the next road traffic related incident.**
* The concepts of cause and culpability must be dropped. Possible human errors should be considered and the concept of forgiving roads should be applied.
* Solutions have to be **based on solid technology.** We must understand the nature of the problem and analyze it impartially and objectively; arbitrary or emotional solutions are of little value.
* **There is no total solution.** The trauma of road traffic incidents is an inevitable consequence of mobility. No matter how many resources are provided to solve the problem, the problem will never disappear completely.
* Like other public health and safety problems, the goal should is not to eradicate the problem; but to **reduce its magnitude.**
* The focus should be **on consequences, not on incidents.** Many of the interventions tend to lower the severity, but increase the frequency of incidents.
* Each road traffic incident will have **different** consequences.
* **The exposure of road traffic** to dangerous situations must be reduced.
* High-speed roads must be provided by removing **pedestrians, bicycles, and animal-powered vehicles**, that in turn must have their own infrastructure.
* The elements of statistical analysis are the basis for **evaluating and interpreting road safety.**

3.1.3 Essential Elements

RSA as a Formal, Systematic and Proactive Examination

RSAs are carried out through a process that is organized with the aim of anticipating possible problems that impact the safety of road users. All those involved must be informed of the objectives pursued and the results obtained, through holding opening and closing meetings. The proceedings are recorded in minutes and on the presentation of a written report that includes the auditors findings, constituting a duly documented process. For the implementation and development of each different phase, sequential steps and specific procedures are followed that combine to form a systematic process.

Knowledge, Training and Experience

The audit team must be aware of the requirements for the safety performance of the project and the requirements of the area where the audit is taking place (geometric design, lateral zone, signaling, vehicular traffic, etc.), as well as possessing the training and experience necessary to carry out the audit process. These qualifications will allow the audit team to make sound findings that lead to recommendations for improvement. The contractor of the RSA must take special care in ensuring the relevant experience of the audit team. In the same way, the development of the RSA process should be used to train new auditors.

Independence from the Client and from the Audit Design

The audit team should be an independent and objective group that did not participate in any of the phases of the project, with the purpose of guaranteeing the objectivity of the RSA. Having been involved in the planning or development of the designs may result in a bias in the appraisals. This bias could lead to faulty analysis or errors in the decision-making process, which reduces honesty and transparency in the process. Those who participated in the audit design are necessarily not qualified to design what is safe.

Participation of Different Disciplines

A road project involves more elements than just the infrastructure. For example, what kind of users will benefit from the project or the type of environment in which it will operate. For this reason, it is recommended that the audit team consists of road design professionals and other disciplines, so that there is a comprehensive knowledge of road safety in different areas. For example, traffic engineering can help analyze the characteristics and composition of vehicle volumes, establish conflicts in traffic flows and mass differences between motorized and non-motorized traffic as well as reviewing the speed of traffic. The urban planner can, in the case of urban projects, examine the interaction of different transportation modes, the appropriate location of furniture and the facilities for vulnerable users. A traffic psychologist can help predict inappropriate behaviors from users, especially the most vulnerable.

3.1.4 What RSAs Are Not

Once the essential elements of the RSA are described, it is necessary that whoever contracts and whoever performs an RSA understands **what RSAs are not** about before they engage in the project (Austroad, 2009):

* It is not a control of compliance with local regulations. Compliance with the design regulations of a country does not guarantee that a road is safe.
* It is not an investigation to find guilty parties
* It is not a way of evaluating or grading a project as good or bad.
* It is not the means to classify or justify a project against others in a same program.
* It is not a way to qualify one option against another.
* It is not a substitution of controls over design.
* It is not a road traffic incident investigation.
* It is not a redesign project.
* It is not something that applies only to high-cost projects or only to projects that involve safety problems.
* It is not the name used to describe informal checks, routine inspections or consultations.
* It is not simply checking the road signals. Road safety is not only about signaling the road.

3.1.5 RSA Objectives

The objectives of an RSA are:

* To get the roads to operate at the highest possible levels of safety for all types of users.
* To establish the road traffic incident potential of all users of a future road project or the reconstruction of an existing road.
* To reduce the risk and severity of road traffic incidents caused by unsafe design.
* To guarantee the safe performance of all users of road projects.
* To reduce the need to perform corrective work to remedy deficient or incomplete designs.
* To establish opportunities to improve road safety performance and control potential risks.
* To give road safety the same importance as other design factors.
* To provide a source of knowledge and experience to improve the future design of road projects.

3.1.6 RSA Benefits

Entities such as Austroads in Australia, the US Federal Highway Administration and the World Road Association – PIARC, highlight the following benefits of RSAs:

* The construction of safer roads through preventing and reducing the severity of road traffic incidents.
* A reduction in the need to produce new schemes for road projects once they have been built.
* A reduction in the costs through identifying road safety problems and correcting them before projects are built.
* The establishment of a more uniform road environment that is intuitive for users.
* The consideration of the needs of all road users.
* The establishment of a more explicit consideration for the road safety needs of vulnerable users.
* The integration of multimodal road safety concerns.
* The consideration of human factors in all phases of the design.
* The improved awareness of the practice of safety road design.
* The enhanced possibility of improving rules and standards.
* The improvement of the understanding of road safety engineering.

3.1.7 RSA Needs

Currently, the need for RSAs is evident. Especially because of the road safety crisis in Latin America and the Caribbean, with more than 100,000 deaths per year, it is an urgent need to improve road safety for all users. In addition, the road systems of the countries in the region must be transformed into increasingly safer systems, in which the preservation of human life prevails over any other consideration. Finally, the benefits of the implementation of RSAs are evident in the better performance of road safety in the Latin American and Caribbean road networks.

Following the safety road design of a country does not guarantee that a road will be safe.

It should be ensured that the road systems of the countries in the region recognize the possibility of human error, be complete and accessible with the

necessary facilities for all users, especially the most vulnerable, such as people with reduced mobility, pedestrians and cyclists. In addition, it should be guaranteed that all attributes of a road are designed and built with the highest standards of road safety and that road traffic incidents caused by infrastructure are as infrequent as possible. In the longer term, RSAs are part of a larger process with the goal of eliminating deadly road accidents. The above can be achieved with the help of road safety audits.

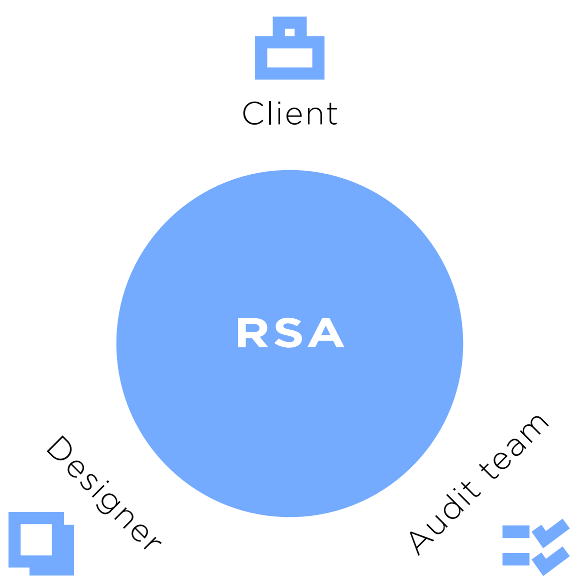
3.1.8 Types of Projects Subjected to an RSA

Overall, RSAs can be applied to any type of project either new or already in operation. However, modern RSAs are used on new or reconstructed roads, and Inspections or Road Safety Assessments are applied to the projects in operation.

3.1.9 Role of the Parties Involved in an RSA

The organization of an RSA includes three main parts: the client, the designer (or audited party) and the audit team, as shown in Figure 1, whose responsibilities are described below and summarized in Table 8.

Figure 1 Intervening Parties in the Organization of an RSA



The Client

The client is the organization that requests or contracts an RSA. In many cases, the client is responsible for the financing and final operation of the project and corresponds in most cases to the road authorities.

The Designer

The designer is the team commissioned by the client for the development of the designs. This includes not only the geometric design, but also the design of the lateral zone, the vehicle containment systems, the urban design, the drainage systems, the bridge design, signaling and all other designs that may impact road safety.

The Audit Team

The audit team is the team selected and hired by the client to perform the RSA. This team must be a group independent from the client and the audited party, and must not have participated in any other previous phase of the project. The team must possess solid knowledge in road safety, experience and training in conducting the road audit process. The team is composed of technicians who perform various functions, guided by a lead auditor, as will be described in the following section.

Table 9 Responsibilities of the Intervening Parties in an RSA

Intervening Parties in an RSA

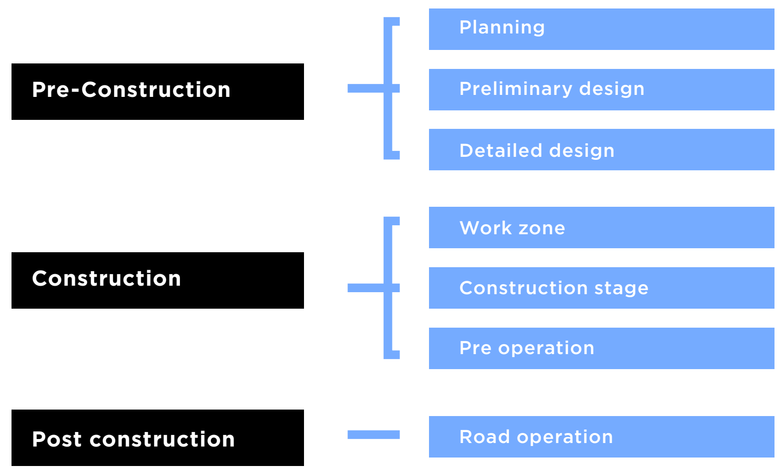
Audit team	Client	Designer
Participates in the RSA opening meeting	Determines which project will be audited	Delivers the documentation for auditing the client
Makes the checklist	Selects and hires the audit team	Decides on activities in response to the audit report
Audits, from the standpoint of road safety, every document delivered by the client	Creates the RSA guidelines	Answers the audit report in a documented manner
Conducts field visits during both day and night	Creates the RSA guidelines	Implements decisions by modifying the designs
Keeps minutes of meetings and other activities that are carried out	Holds a start of audit meeting with the audit team	
Prepares and presents the audit report	Hands over all documentation to the audit team	

3.1.10 Stages during Which an RSA can be Carried Out

The RSA can and should be applied to any of the phases and stages of a road project. Generally, projects are carried out in three stages, as indicated in Figure 2.

Figure 2 summarizes the different areas on which RSA can exert an influence. They are classified according to the different stages and phases of the project.

Figure 2 Phases and Stages of a Road Project Where an RSA can be Carried Out



RSA during the Pre-Construction Stage

The pre-construction stage is composed of the phases of planning, preliminary design and final design. During this stage there are better opportunities to improve road safety at a more efficient cost, before the project is built. See Figure 2.

A Planning Phase

In the planning or feasibility phase of the project, the RSA examines and influences aspects of the project impacting road safety such as:

Table 10
Aspects Subject to Examination in an RSA in the Road Project Planning Phase

Planning Phase
Scope of the project
Selected route
Continuity of the route
Isolation of the communities
Rupture of the communities
Increase in danger and risk due to automotive traffic
Selection of design standards
Impact on the existing network
Provision of exchangers and intersections
Control of accesses
Number of lanes
Consideration of all project users
Compatibility with the type of road and the expectations of the users
Location of obstacles on the edge of the road
Work or sales areas for traditional products
Vehicle flow (light, heavy, collective transport)
Facilities for users with reduced mobility

B Preliminary Design Phase

In this phase, the RSA reviews aspects related to the preliminary design as indicated in Table 11.

Table 11 Aspects Subject to Examination in an RSA in the Preliminary Design Phase

Preliminary Design Phase
Standards and regulations used
Cross-section
Horizontal alignment
Vertical alignment
Visibility distance
Lane width
Berms width
Deceleration lanes
Acceleration lanes
Returns
Pedestrian facilities
Cyclists facilities
Access
Turns
Drainage elements
Treatment of obstacles on the edge of the road
Connections with existing roads
Design consistency
Visibility of control devices
Platforms
Overpass, vertical and horizontal clearances
Facilities for users with reduced mobility

C Final Design Phase

In this stage, the RSA examines aspects related to the final design as those indicated in Table 12.

Table 12
Aspects Subject to Examination in an RSA during the Final Design Phase

Final Design Phase
Horizontal alignment
Vertical alignment
Cross-section: number and width of lanes, bike-lanes, berms, dividers, sidewalks, curbside
Intersections: traffic control devices, demarcation, signaling, access lanes, pedestrian traffic, traffic channeling
Drainage system
Free zone
Vehicle containment systems
Obstacles in the lateral zone
Facilities for pedestrians: ramps, accessible sidewalks for pedestrians with disabilities, signaling, defenses
Facilities for cyclists: bike-lanes and bike paths
Devices to calm traffic
Signaling
Returns
Accesses
Turn
Connections with existing roads
Design consistency
Visibility of control devices
Motorways
Traffic lights for special users

RSA during the Construction Stage

During the construction phase, RSAs are particularly concerned with the planning of work on the road, the changes in the design during construction, and road safety for users and workers both while the works are being carried out and before the opening of the road. See Table 13.

A Planning of Work on the Road

Regarding the planning of work on the road, the RSA seeks to eliminate potential dangers when pedestrian and vehicular traffic have to interact with workers and machinery in work areas. In this regard, RSAs should review the following concerns:

Table 13 Aspects Subject to Examination in an RSA on the Schemes of Work on the Road

Work on the Road
Early warning mechanisms for drivers
Restricted speed limits in the area
Pedestrian facilities
Detour management
Management of priorities of passage
Temporary signaling
Lane occupancy

B Changes in the Design during Construction

For changes in the design and depending on the type of modification, the same factors examined in the final design of the pre-construction stage should be considered. See Table 15.

C Pre-Opening of the Road

The RSA, at this stage of the project, aims to verify that the road safety needs have been taken into account for all users; to verify the safety of night operation; to verify if some of the recommendations from previous stages are missing, and if the road system has been built according to how it was designed. These verifications require a detailed inspection, both on foot and in a vehicle. See Table 14.

Table 14
Aspects Subject to Examination in an RSA during the Pre-Opening Phase

Pre-Opening of the Road
Road safety needs of all users
Verification of recommendations in previous RSA stages
Interaction of all the design elements
Access or connections
Night operation
Unplanned risks that appear after construction
Location and visibility of signaling
Removal of temporary signaling
Evaluate the safety of elements that are not included in the design
In transportation system stations, the opening direction of the doors, the alarms, fire extinguishers and other elements for the safety of the users should be verified

RSA during Post-Construction Stage

At this stage of the project, the RSA must confirm that users are using the road as intended in the road design. As part of the RSA, this verification must be carried out six months after the start of operations of the new road or the reconstruction of an existing one. However, for roads with more time in operation, a Road Safety Inspection must be carried out.

Table 15 Main Topics that should be assessed in an RSA According to the Stage and Phase of the Project

PRE-CONSTRUCTION STAGE

Planning Phase	Preliminar Design Phase	Final Design Phase
Scope of the project	Standards and regulations used	Horizontal alignment
Selected route	Horizontal alignment	Vertical alignment
Selection of design standards	Vertical alignment	Cross-section: number and width of lanes, bike-lanes, berms, dividers, sidewalks, curbside
Impact on the existing network	Visibility distance	Intersections: traffic control devices, demarcation, signaling, access lanes, pedestrian traffic, traffic channeling
Continuity of the route	Cross-section	Drainage system
Provision of exchangers and intersections	Lane width	Free zone
Control of accesses	Berms Width	Vehicle containment systems
Number of lanes	Deceleration lanes	Obstacles in the lateral zone
Consideration of all project users	Acceleration lanes	Facilities for pedestrians: ramps, accessible sidewalks for pedestrians with disabilities, signaling, defenses
Compatibility of the type of road with the expectations of the users	Roundabouts	Facilities for cyclists: bike-lanes and bike paths
Location of obstacles on the edge of the road	Returns	Devices to calm traffic
	Pedestrian facilities	Signaling
	Facilities for cyclists	Returns
	Access	Accesses
	Turns	Turns
	Drainage elements	Connections with existing roads
	Treatment of obstacles on the edge of the road	Design consistency
	Connections with existing roads	Visibility of control devices
	Design consistency	
	Visibility of control devices	

CONSTRUCTION STAGE

Works on the road	Pre-opening of the road
Early warning mechanisms for drivers	Road safety needs of all users
Restricted speed limits in the area	Verification of recommendations in previous RSA stages
Pedestrian facilities	Interaction of all the design elements
Detour management	Acces
Management of priorities of passage	Connection
Temporary signaling	Night operation
Lane occupancy	Unplanned risks that appear after construction
Conflict points between the works and the ordinary traffic of the road	Location and visibility of signaling
Night operation	Removal of temporary signaling
	Evaluate the safety of elements that are not included in the design

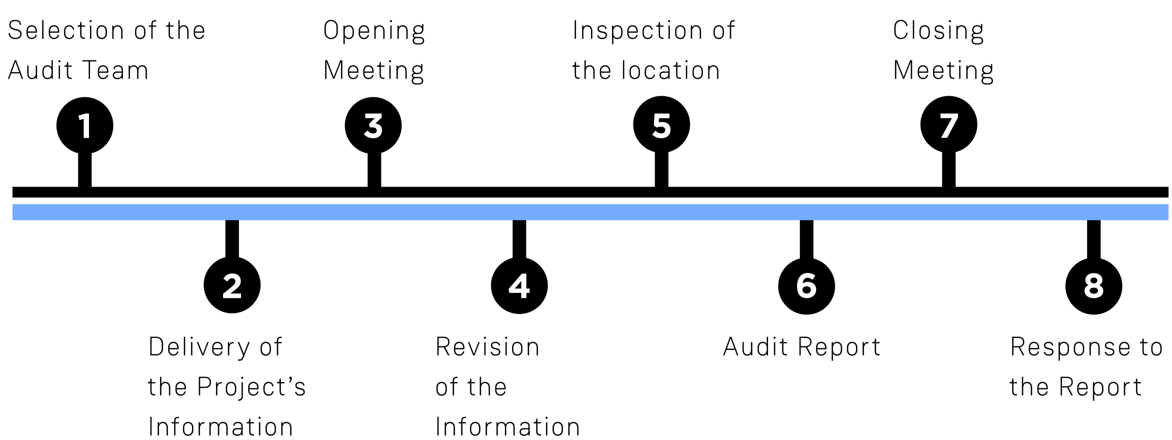
CHANGES IN THE DESIGN DURING CONSTRUCTION

3.2 METHOD FOR THE DEVELOPMENT OF ROAD SAFETY AUDITS

In this section, the steps that must be followed for the development of a road safety audit are presented. Overall, the process consists of the eight steps as indicated in Figure 3.

This process can be adjusted depending on the nature and size of the project, but they are all considered essential steps for the implementation of an RSA.

Figure 3 Steps for the Implementation of an RSA



3.2.1 Selection of the Audit Team

This step includes the selection of the team in charge of carrying out the RSA. As previously mentioned, the team must be an independent and impartial group. Team members must not have conducted any previous work on the audited project. Team members must also demonstrate knowledge in road safety, show experience in audit work and must be trained to properly carry out an RSA. See Section 3.1.9.

The selection and hiring of the audit team is the client's responsibility. The client can seek advice from a reputable road safety expert. A good practice is to conduct a contest based on merit.

The appropriate size of the audit team depends on the type and complexity of the project that will be audited. However, experience suggests that a team of four people is sufficient for even large projects. In medium projects, a team of two people may be

appropriate; and for small projects, the audit may be carried out by a single experienced individual (Austroads, 2009). However, the FHWA of the United States recommends that the audit team be made up of at least three people, to ensure that no aspect of the audit is overlooked (FHWA, 2006).

The group in charge of selecting the audit team should pay attention to the road safety experience and the importance of the audits carried out by the candidates. These two aspects must be certified; those responsible for the selection must check references and, if possible, have direct knowledge of some of the RSA work they developed.

The client must make sure that the audit team is made up of technicians who jointly possess a set of skills that will ensure that the most critical aspects of the project are addressed.

It is important to consider that putting in place road designs, signals, safety barriers, road safety campaigns, road safety plans, etc., do not by themselves constitute experience in the implementation of an RSA.

The members of the audit team should have experience in road safety, vehicular traffic operation, road design and knowledge of human factors. It is also advisable for large or complex projects that the team should have the support of temporary advisors on issues such as maintenance, pedestrian and cyclist safety, operation of commercial vehicles, intelligent transport systems, and design of special facilities such as: toll stations, bridges, tunnels, complex highway structures, roundabouts, and others.

A leading auditor who possesses greater training, experience and knowledge will lead the team. He/she will be in charge of the content of the final audit report and will be the point of contact with the client, the design team and the audit team. The lead auditor must have thorough knowledge of the RSA process and possess excellent communication and leadership skills.

3.2.2 Audit Team Structure

In general, the size of the audit team depends on the size, type of project, the complexity of the audit task and the resources available. Entities such as AUSTROADS recommend that, for significant projects, the audit team be composed of at least two experts; and for smaller projects one person with relevant experience may be sufficient. The RSAs performed by a single person, for budgetary or cost reasons, may not be fully effective. Likewise, it is sometimes the case that teams of more than four people can be unmanageable. The essential component of any audit team is road safety engineering experience (Austroads, 2009). The participation of at least one expert from the social area is recommended such as: a psychologist, sociologist or anthropologist. The specific profession and his/her specialty should be selected according to the nature of the project and the required RSA.

The different stages of a project may require different skills such as road safety expertise, traffic related incident investigation, road engineering or experience in directing an RSA; more than one of these skills can be found in a single person. The advantage of having a team is the exchange of experience, knowledge and approaches between experts (PIARC, 2011).

In summary, the audit team should be selected according to the type of project. It should have a lead auditor, assistant auditors, including a geometric design specialist or technical experts where applicable. In addition, the team can count on the assistance, as observers, of apprentice auditors.

Lead Auditor

The lead auditor is the key member of the audit team. He/she has professional training that complies with the requirements indicated in Table 16, to direct both the RSA process and the audit team. Ideally, a competent authority should establish these requirements, once the country has training programs and an established expectation of the experience required. Towards this end, engaging engineering faculties and engineering associations is vital.

Assistant Auditor

A professional who meets the requirements indicated in Table 16, responsible for fulfilling specific tasks and duties in the RSA.

Geometric Design Specialist

A civil or road engineer with specialization and experience in the design of urban roads, according to the requirements of the audited project.

Apprentice Auditors

A professional who is training to become a road safety auditor. He/she participates in the audit only as an observer.

Technical Specialist

A person who adds specific knowledge or experience to the audit team, but is not an auditor.

Social Area Specialist

A psychologist, sociologist or anthropologist who complements the engineering team. The specific professional and his/her specialty must be selected according to the needs of each project and its context.

3.2.3 Profile and Responsibilities of the Audit Team

Table 16 details the profile, experience required and responsibilities assigned to the members of the audit team, as a reference to be taken into account when contracting the RSAs. The experience is a necessary requirement for the implementation of the RSA and will help ensure high quality audits. Annex 2 presents a suggestion for the terms of reference that will be used for contracting the audit team.

Table 16
Profile and Responsibilities of the Audit Team

Position	Academic Profile	Experience	Responsibility
Lead Auditor	Professional training in civil or roads engineering and corresponding registry Experience in road safety engineering Experience in road safety engineering Training course in Road Safety Audits Training course and other activities related to topics such as: road signs, design of road containment systems, design of lateral zones, urban planning, design of traffic calming measures, etc.	At least 7 years of professional experience Leadership and project management skills Specific experience in road design, road reconstruction techniques and engineering and traffic management Understanding the behavior of road users Participation in no less than 5 RSAs in the last 5 years, 3 of which must correspond to road or urban projects similar to the project that is contracted	Agree on the object and scope of the RSA Define the number and specialties needed in the audit team Direct and carry out the RSA Manage the RSA process Intervene in the development of all stages of the audit Manage the audit team Ensure that the RSA is developed according to the terms of reference Analyze the information required for the RSA Define the checklists Organize and direct the field visit Prepare the RSA repor Make the RSA presentation
Assistant Auditor	Professional training and corresponding registry in that discipline Experience in road safety engineering Training course in Road Safety Audit	5 years of professional experience Have participated in at least one RSA in the last two years	Participate in the collection and analysis of information for the RSA Participate in the preparation of checklists Participate in the field visit when required Fill out checklists Participate in the preparation of the RSA report Participate in the presentation of the audit report
Geometric Design Specialist	Professional training and corresponding registry in that discipline Training course in Road Safety Audit	5 years of professional experience 2 years of experience in the design of road infrastructure Participation in the design of at least two road infrastructure projects in the last 5 years.	Audit the designs from the point of view of road safety. Establish design consistency Create checklists for the audit of the road infrastructure designs Participate in the field visit when required Fill out checklists Create the RSA report in everything related to his/her specialty Participate in the presentation of the audit report
Social Area Expert	Professional training and registration in disciplines such as anthropology, sociology or psychology Experience in analysis of human factors and impact of road projects in communities.	3 years of experience in project management with communities Experience in analyzing the social impact of road projects.	Determine the possible impacts of the project on the surrounding communities and their normal functioning Determine the human factors that could affect road safety in the design of the work Prepare reports analyzing the risk of situations that may arise with the communities and their respective mitigation measures

3.2.4 Delivery of Project Information

The second step in the audit process is the delivery by the client of all project documentation. This will allow the audit team to produce a detailed examination of the possible implications in road safety. It is advisable for the client to make a written statement of expectations.

Table 17 presents an example of the required information, which depends on the type of project to be audited.

Table 17 Information Required for the Development of an RSA

Intervening Parties in an RSA

Project Information	Traffic Studies	Design Studies	Environmental studies
Scope of the project	Volumes of automotive traffic	Geometric design	Weather conditions
Localization of the project	Volumes of pedestrians and cyclists	Intersection	Topographical conditions
Condiciones geofísicas	Volumes of motorcyclists	Roundabouts	Geophysical conditions
Road function	Location and type of travel generating centers	Signaling design	
Design standards used	Information on traffic related incidents (rehabilitation and reconstruction of roads)	Drainage design	
Exceptions to standards	Information on traffic related incidents on nearby roads (new roads)	Side zone design	
Concerns about road safety		Vehicle containment system design	
Reports on other RSA		Design of cut slopes and embankments	
Presence of obstacles in the lateral area of the road		Pedestrian facilities	
		Facilities for cyclists	
		Facilities for people with reduced mobility	

3.2.5 RSA Opening Meeting

The process of an RSA begins with this meeting between the client, the design team and the audit team.

The purpose of this meeting is to define the context of the RSA, specify its scope and objectives, get acquainted with the process development, deliver all documentation to the audit team, define the schedule of the audit and the agenda of the visit, delegate responsibilities, and establish communication channels between the audit team and the designers.

The design team must inform the audit team about the design criteria and standards used, the restrictions and exceptions adopted and their justification. However, the audit team must inform and establish the audit criteria taking into account not only compliance with local regulations, but also restrictions or exceptions that guarantee a route is safe.
It is important that at the end of the meeting the parties involved have a clear understanding of the roles and responsibilities of each party and understand the main purpose of the RSA: to identify hazards and potential risks of traffic incidents for the users of the project. In addition, if the restrictions and exceptions adopted in the designs impact road safety, they will be reported as findings.
In order to be clear, the design team should answer the questions that arise from the review of the documentation and the field visits.
The meetings will be recorded in minutes on the topics discussed, the commitments acquired, the decisions taken and the documents delivered and received.
The client must inform the design group about the opening meeting in advance, in order for the design team to have enough time to obtain a copy of all the required information.
Designers should take advantage of this space to express their concerns related to the road safety of the project.

3.2.6 Review of Project Information and Documentation

This step of the process examines the safety of the designs and background information. The objective is to establish the potential risk of road traffic incidents in the project design.

The review of this information is conducted in parallel with the field visit and should be examined before and after the site inspection.

The analysis of the documentation should be done as necessary and the checklists prepared in advance may be used. In the examination of the information, prior to the field visit, areas or sectors with possible road safety problems should be identified in order to be checked during the site inspection.

The revision of the blueprints and structural calculation reports is vital to understanding the interaction between the project and its users. The field inspection is critical to identify road safety problems on both new roads and those to be rebuilt, during the construction stage and during the pre-operational phase.

It is recommended that project information is reviewed by each member of the audit team individually, and later collectively.

The project should be examined from the point of view of the users, taking into account people with reduced mobility, pedestrians, cyclists, motorcyclists, drivers, vehicle occupants and different types of vehicles. It must be noted that users do

not generally behave as the designer intended, but as they must for ease, safety, comfort, time and economy. The movements by direction of circulation in each road section, and the individual movements in the intersections should also be observed and examined.

3.2.7 Detailed Inspection of the Project Site

The main objective of the site inspection is to analyze how the project interacts with the environment and nearby roads, and to identify potential conflicts and risks of traffic incidents for all users. The security of vulnerable users should also be carefully reviewed.

In general, field inspections should be conducted as part of each RSA, regardless of the stage, phase or type of project and should be performed during both day and night hours. The lead auditor is responsible for the completion of the site inspection during the preliminary design and scheduling a night visit for a later phase.

RSAs are limited to finding patterns, they are not an inventory of all the dangers

Experience shows that nighttime conditions are very different from daytime conditions; the risks are greater and in most cases it is necessary to make adjustments, especially for the road readability and vehicular traffic control devices, the demarcation and vertical signaling. Emphasis should be placed on the interrelation of the project with vulnerable users during night periods.

The inspection should be conducted from the point of view of all the different road users, including people with reduced mobility, pedestrians, young drivers, elderly drivers, car drivers, truck and bus drivers, cyclists, motorcyclists and residents of the area.

At this time, it is important to consider the aspects that must be taken into account in relation to the different user groups (Austroads, 2009):

* Underage pedestrians have a lower eye height to observe vehicles. Being short, they can be easily hidden from view by drivers. They can also act impulsively.
* Elderly pedestrians may be less agile, have reduced vision or hearing or may have a lower ability to judge the gaps and speed of vehicular traffic.
* Elderly drivers may be less able to recognize some characteristics of traffic control or less able judge deficiencies due to cognitive impairment.
* Truck and bus drivers have a higher eye height, this can lead to problems with demarcation; their field of vision can be reduced by vegetation that protrudes. Their vehicles take more time to stop and accelerate, they are wider and blind spots can pose bigger problems.
* Cyclists are more seriously affected by surface conditions, for example grates, gravel and slopes.
* People with disabilities may have poor vision and hearing, or difficulty moving around objects, near edges, between levels or at typical pedestrian speeds.

* Motorcyclists can accelerate rapidly, but are vulnerable to poor pavement conditions (Austroads, 2009).

* There cannot be shared spaces for pedestrians and vehicles over 30 km/h.

In order to record evidence, it is advisable to have video cameras, which can be installed in the vehicles used for field inspection.

Table 18 shows the main factors that should be taken into account during a field visit. Notwithstanding the fact that in during the audit other issues may arise that should be considered.

Table 18 Aspects to Consider During the Field Inspection

Field Inspection

What to review?	When?	How?	Who?
Adjacent areas to the road	During the day	Driving a vehicle	The entire team driving a vehicle
Transitions between the new road and existing ones	During the night	Walking on the Project site	The entire team, walking
Interactions with all user groups, especially vulnerable users	In adverse weather conditions, if possible	In both circulation directions	
All possible movements in sections of the road	Critical traffic conditions	Supported by photographic and video registries	
Right and left turns at intersections	Days of the week according to team criteria		
Acceleration and deceleration lanes	Rush and non-rush hours		
Facilities for pedestrians and cyclists and points of conflict with vehicular traffic			
Design consistency			
Climatic conditions, vegetation and topography			
Sites that generate travel or destinations			
Points or sectors identified by their incident rate, for improvements in roads			

The results of any audit should be reported to the client through a written report that includes relevant methodology, criteria used, findings that affect the road safety of users, recommendations to address the deficiencies found and conclusions of the RSA.

It should be remembered that the findings may include both conformities and nonconformities, and that objective evidence that indicates safe or unsafe characteristics of each finding must be provided. Evidence could come in the form of a photo, video, document, statement of facts or any other relevant information that can be verified.

RSAs are not obliged to provide an inventory of all the points in which similar findings are present. It is sufficient to show that there is at least one case in which unsafe conditions are present for the designer or the client to revise the same issue on the entire road.[10]

The recommendations for the treatment issues that present the risk of traffic incidents are conceptual elements that encompass the nature of the solution, but on which there are no specific details. The audit report simply provides the formal documentation on which the corrective actions will be based. When the audit team has not visualized a recommendation for a specific safety problem, it should be clear in stating the need for a more in-depth study.

There is no single model for the presentation of audit reports, but in general, the report must contain the sections and contents indicated in Table 19.

10 For example, it is very common to find trees or poles that cannot be surpassed in the free area and that are potentially dangerous. With the identification of some of these sites, it is sufficient to verify the finding and it is not necessary to make a list of all the trees or all the poles that are in those same circumstances on the road.

Table 19 Content of the RSA Report

3.2.8 RSA Audit Report

Introduction

Project name, stage of the RSA

Audit team

Names, professions, role of team members

Audit process

Date and purpose of the opening meeting

Rules and guidelines applied

Scope

Project description

Site

Objective

Reference maps

Assessment of findings

Assessment adopted to highlight the importance of a recommendation

Obligation to respond to the report

Manifestation that the designer is obliged to answer the RSA Report

Results of the RSA

Findings	Recommendations	Priorización
Road safety problems The findings that resulted from the audit examination ordered by subject are described, for example: Generalities Alignments Straight section Intersections Etc. Indicating stage and phase of the audited project	For each finding, the nature of the measure to treat the finding should be indicated at the conceptual level In case of no recommendations, indicate that the case should be investigated	Each recommendation must receive a rating that indicates the level of priority to eliminate the hazard. This rating is based on the level of risk
Potential damage Indicate the hazards encountered and the potential risks		
Evidence Attach evidence and reference location		

Note: The findings, recommendations and prioritization can be presented in a matrix, which facilitates the understanding of the results of the audit.

The audit report is confidential between the client and the audit team and the recommendations may or may not be adopted by the client.

3.2.9 RSA Closing Meeting

At the closing meeting of the audit, the findings and recommendations for the corrective actions presented by the audit team are discussed. For this reason the client, the design team and the audit team must be present.

It is recommended that this meeting be held before the presentation of the audit report and should be used before issuing a final report so that the designer or client can make clarifications to the audit team. At the same time, the audit team can clarify the recommendations, and also the designer can proactively contribute to defining solutions.

3.2.10 Responses to the Audit Report

The final step of the RSA is the response to the audit report. The objective is that once the client and the designer review the document, they can respond to the findings and give their opinion on the recommendations presented.

The RSA is a formal process. The client together with the designer must prepare and submit a written response. The response must indicate the actions to be taken or disagreements with any of the conclusions of the audit report. In addition, the RSA must specify the corresponding arguments or the reasons for not adopting any of the recommendations due to the project's limitations. All this must be justified.

The responses can include alternative measures such as adopting the recommendation and making the necessary adjustments in the design, partially accepting and making an alternative design or rejecting the change.

The decisions made by the client or the audited are autonomous, and require no further action from the audit team.

3.3 CHECKLISTS FOR THE IMPLEMENTATION OF THE RSA

Most manuals or guides for the implementation and development of an RSA recommend that checklists be used as an effective tool to support the members of the audit team in data collection during each stage of a project. They are also used for the analysis to cover all the aspects to be considered in the identification of deficiencies that may impact road safety.

In this sense, it should be clear that checklists are a means used during the RSA process and that they should not be considered the main product or tool for the RSA.

It is up to the audit team and each individual auditor to decide whether or not to use checklists, what lists to use and where applicable, to prepare their checklists according to: the specific objectives of the RSA, the project stage, the type of road, the functional classification, the environmental characteristics, the existing roads nearby, etc. There are many factors that can influence the potential dangers and risks on a road. These factors must be addressed for the assessment of road safety conditions.

Preparing or deciding on the use of checklists is a task that must be based on experience, as well as a complete understanding of the scope and objective of the audit. The auditors with the most experience can make a general list of aspects or issues to consider in each case and then decide whether to adapt existing checklists, add, tailor or eliminate aspects or add those that can be assigned in the distribution of work or are addressed jointly from the point of view of each specialist.

The RSA team selected by the lead auditor must have all the project information, the conditions, the regulations that govern the decisions, the assessments and studies carried out by the specialists or technicians in each field of design or implementation, weather data of the area, population, land use, maps, plans, etc. Depending on the quality and quantity of information that each auditor has access to, the quality of the information that can be extracted to determine the relevant aspects that define their checklists, and with these, the risk, hazard, evidence, compliance, noncompliance findings and conclusions of potential risks will be evaluated.

The documentation must identify all the areas considered in the analysis that may impact road safety and cover the entire area of influence of the project.

If an on-site inspection is required, the checklists are essential for the analysis of secondary information, to be reviewed before, during and after the inspection. It is easier to review documented aspects on a desk, rather than having to repeat the inspection in the field due to doubts, lack of confirmation or observations that were not made during the visit.

Depending on the type of route, emphasis should be placed on the aspects to be evaluated at each stage of the project and the need to incorporate these aspects into the checklists.

On rural roads, the fundamental characteristics that qualify a road as safe are related to the potential dangers for users of motor vehicles. On the

other hand, on urban roads, it is the vehicle that constitutes a danger to pedestrians. This conceptual difference changes the relevant considerations informing a checklist and how questions will be formulated for the subsequent analysis. The same variation occurs between the types and behaviors of users, among which the quantity and variety impact the interpretation of the dangers present on the road.

Typical checklists may include, but are not limited to the following sections:

* General features
* Geometry of the road
* Aspects of road furniture
* Signaling
* User type classification
* Special areas

The different sections of a checklist will vary according to the stage of the project, context and specific characteristics of the project. It is the responsibility of the audit team to design the checklists that will be applied to a specific project.

In conclusion, the use of checklists is optional and not mandatory during an RSA. The checklists are specific, adapted to the needs of each stage of the project, the type of road and the factors to be evaluated. It is wise to first make a general list of factors to consider in the evaluation and then decide which checklists can be used and adapted.

As reference lists for the evaluation of the RSA, those recommended by international guidelines can be used in the countries that apply RSAs systematically. It is important to recognize the difference between different checklists, and that it is the experience of the auditor that facilitates the choice of one list over another or how they are modified.

The fundamental difference between checklists in different countries lies in the number and variety of questions they develop relevant to each factor to be evaluated. Checklists from countries such as Australia, New Zealand, the United States, Puerto Rico, Chile and Canada include a large number of questions with great detail. Those applied in the United Kingdom, Spain and Mexico are general, and only refer to the main aspects that must be examined; which makes it easier for the auditor to introduce their own criteria. Introducing independent criteria should depend on two factors:

A The focus of the questions which can be intended to address technical aspects, or other factors that should be examined in an audit.

B The level of detail of each characteristic, either specifically or allowing the experienced auditor to apply personal security criteria that is, the checklists can be detailed or general.

In Annex 3, general and detailed checklists are described that can be useful as a basis for the preparation of specific checklists for each stage and project. The last list corresponds to the verification that the contracting entities of an RSA can make to verify the degree of compliance of the audit team according to the stage and the scope agreed upon. The specific checklists should be designed by the audit team taking into account the legislation applicable to the project, specific characteristics of the project and the context in which the project will be developed.

3.4 EVALUATION OF THE INTERVENTION MEASURES AS A RESULT OF THE RSA

This chapter examines the development of methodology meant to verify the implementation of the intervention measures adopted as a result of the recommendations of the RSA, through a quantitative and qualitative assessment process, which establishes to what degree the recommendations of the RSA report were implemented. It is important to keep in mind that the client is not obliged to adopt the recommendations, but the ones they accept must be fully implemented.

A. Objective

Evaluate, in a quantitative and qualitative manner, the results of the actions taken with respect to the implementation of the recommendations for the mitigation of the incident risks identified by the road safety audit.

Specific objectives

- I To know the level of implementation of the recommendations of the RSA, through direct consultation with those responsible for the project.
- II To verify in the field the implementations of the recommendations of the RSA, based on the report and the prior consultations.
- III To measure the level of implementation of the recommendations of the RSA, by using objective and subjective indicators previously defined and, based on this, the efficiency of said applications.
- IV To evaluate the result of the RSA, by statistical comparison between before and after.

B. Steps to Apply the Evaluation Methodology

To apply the evaluation methodology for the implementation of the RSA recommendations, the following steps should be followed:

- I Obtaining and studying the RSA report to know the characteristics of the audited project, objectives, scope, findings and recommendations.
- II Classify the recommendations of the RSA report by evaluation areas or parameters. For example: cross-section, horizontal alignment, free zone, etc.
- III Implement the evaluation methodology.

C. Method to Evaluate the Application of RSA Recommendations

The implementation of RSA recommendations can be evaluated through qualitative and quantitative measurements, the term, the complexity and the costs associated with each recommendation. The objective is to establish the degree of intervention or contextual factors that may explain non-adoption. This process consists of the following steps:

Figure 4 Steps for the Evaluation of the Implementation of the Recommendations of the RSA report

Clasification of findings. → Individual assessment of interventions. → Assessment of the set of interventions by check parameter.

D. Clasification of findings

This step classifies the interventions recommended by the RSA report in categories according to the risk factors found, which for the purpose of the methodology will be referred to as "evaluation parameters."

Table 20 shows a list of the main categories for the classification of the findings. Keep in mind that for each RSA the evaluation team must elaborate its own categorization due to a project's particular characteristics. The specific findings and risk factors for each category are presented in section 2.2.

Table 20 Evaluation Parameters

N°	Parameter
1	Vehicle operational design
2	Cross - section
3	Horizontal alignment
4	Vertical alignment
5	Pedestrian infrastructure
6	Infrastructure for cycles and motorcycles
7	Obstacles on the side of the road
8	Signaling
9	Maintenance and work on the road
10	Human behavior

Table 21
Evaluation Criteria

Criteria	Type of criteria	Definition	Ranges	Rating	Sourse
Implementation	Quantitative	Indicates the progress made in the implementation of the recommendation. In cases where it is Partial or Null it will be indicated if there will be future implementation or if the current status is final.	0 and 5 %	Null	Interviews with the people in charge of the project Field visits made Criteria and experience of the evaluation team
			Between 6 % and 90 %	Partial	
			Over 90 %	Total	
Complexity	Qualitative	Level of difficulty that the implementation of the recommendation represents.		Low	Interviews with project managers Criteria and experience of the evaluation team
				Medium	
				High	
Cost	Qualitative	Assessment in qualitative terms of the economic resources that are necessary for the implementation of the recommendation.		Low	Interviews with project managers Criteria and experience of the evaluation team
				Medium	
				High	
Time	Quantitative	Estimate in months of the average time that the implementation of the recommendation would require according to its nature and verification of compliance with the term.	Less than 3 months	Short term	Interviews with project managers Criteria and experience of the audit team
			From 3 to 6 months	Medium term	
			Over 6 months	Long term	

E. Individual Assessment of Each of the Recommendations

The scales of analysis to evaluate the implementation process starts with four criteria or variables: 1) Progress, 2) Time, 3) Complexity and 4) Approximate cost of implementation. Progress and time correspond to quantitative criteria, and cost and complexity to qualitative criteria.

Table 20 defines the evaluation criteria, the scales of assessment, the scale or ranges of measurement, the rating or measurement that is granted, and the source of the information for the rating.

In cases where progress is considered null or partial, it must be established if work is complete or if there is a possibility that further changes will be completed in the future.

For the assessment of each of the RSA recommendations in each evaluation parameter, each criteria will be rated (implementation, time, complexity and cost), applying the measurement scales described in Table 20. The measurement of each criteria is obtained from the interviews with the project managers, the field visits and the experience of the evaluation team.

The results obtained are recorded in an individual assessment matrix for each criteria evaluated. An example of the individual assessment matrix and the Ratings obtained is shown in Table 21. These partial results by intervention are the basis for assessing the set of interventions in each screening parameter.

F. Assessment of the Set of Interventions

Measurements of effectiveness, efficiency, complexity, and cost of compliance indicators for the interventions carried out in each check parameter are used, as well as for the total audited project in absolute and relative terms, according to the following criteria:

Effectiveness

Effectiveness can be established according to the level of implementation of the recommendations of the RSA, effectiveness is qualified with three possible ratings: total, partial and null.

The effectiveness index will be higher or lower based on the proportion of recommendations that are evaluated as total, partial (definitive or future) and null (definitive or future). If there are a large number of null ratings, this means that the project has low effectiveness.

Efficiency

Efficiency is defined based on compliance with the estimated deadline for the implementation of the RSA recommendations with a Yes or No.

The total efficiency of the project takes into account the implementation dates and the deadlines (short, medium and long) of the partial and total implementations from the moment in which the project managers have the RSA report. This does not mean that the evaluation of the criteria depends only on how quickly the recommendations were addressed.

The recommendations, regardless of whether they are short, medium or long term, may require different lengths of time to implement, depending on the characteristics and circumstances of the project and its administration. The evaluation should reflect this.

Complexity

Complexity can be placed in three categories: low, medium and high. Complexity is estimated based on the experience of the audit team.

Cost

Cost is measured via three categories: low, medium and high. Cost is estimated based on experience.

To establish the compliance index for the set of interventions, a matrix is drawn up to which the total results obtained for each check parameter are transferred for each evaluation criteria (see Table 21).

The analysis is done from the absolute variations that correspond to the total number of interventions in each category or from the relative variations that are calculated by dividing the total number of interventions for each column by the total number of interventions in each parameter.

Table 22 is an example of an individual assessment including calculations based on compliance indexes.

Table 22 Results of the Individual Evaluation of the Recommendations in Relation to the Progress of the Implementation

Interventions by evaluation parameter	Implementation					Term of the Implementation					Complexity			Cost			Total
		Partial		Null					Compliance								
	TOTAL	Definitive	Future	Definitive	Future	SHORT	MEDIUM	LONG	Yes	No	LOW	MEDIUM	LONG	LOW	MEDIUM	LONG	
Vehicle Operational Design	0	0	0	2	1	1	2	0	0	3	1	0	2	1	1	1	3
Intervention 1				x		x				x	x			x			
Intervention 2				x			x			x			x		x		
Intervention 3				0	x		x			x			x			x	
Obstacles Lateral to the Road	1	0	0	1	0	2	0	0	1	1	1	0	1	1	0	1	2
Intervention 1	x					x			x		x			x			
Intervention 2				x		x				x			x			x	
Pedestrian Infrastructure	4	0	0	3	0	4	3	0	4	3	3	0	4	3	1	3	7
Intervention 1	x	0	0	0	0	x	0	0	x		x			x			
Intervention 2	x					x			x		x			x			
Intervention 3	x					x			x		x			x			
Intervention 4	x						x						x		x		
Intervention 5				x			x			x			x			x	
Intervention 6				x			x			x			x			x	
Intervention 7				x		x				x			x			x	
Signaling	2	0	0	2	0	1	3	0	2	2	2	0	2	2	0	2	4
Intervention 1	x					x					x			x			
Intervention 2	x						x				x			x			
Intervention 3				x			x			x			x			x	
Intervention 4				x			x			x			x			x	
TOTALS	6	0	0	8	1	8	8	0	7	9	7	0	9	7	2	7	16

In the table above, the X in the cells corresponds to the rating assigned to each of the interventions. For example: The X of intervention 1 of the signaling parameter means that intervention 1 was fully implemented. To summarize the results of each evaluation parameter, the interventions are added within each type of implementation. For example: The signaling parameter has two interventions fully implemented and two interventions with no definitive implementation.

For the interpretation of the matrix:

Each cell of the matrix indicates the number of interventions by evaluation parameter. For example: the number 2 in the "null" column and "vehicle operation design" line indicates that there are two interventions in which implementation progress was not done and it will be not considered in the future (definitive).

The relative results in table 23 for each evaluation parameter are calculated by the percentage of interventions for each column with respect to the total number of interventions. For example: The value of 50% displayed in the "total implementation" column and "obstacles lateral to the road" line refers to the percentage of the interventions in this category that were implemented relative to the total (in this example 1 out of 2).

The percentage of the total number of interventions for each evaluation parameter is obtained by dividing the number of total interventions considered in that parameter by the total number of project interventions. For example: the value of 13% in the "total" column (far left) and "lateral obstacles to the road line" refers to two interventions out of the total of 16 project interventions.

Likewise, the total value for each type of implementation (total, partial, null) are obtained by the percentage of the total number of interventions carried out per type of implementation, over the total number of project interventions. For example: 44% of the total implementation column corresponds to the percentage of 7 interventions with total implementation, over 16 project interventions.

Table 23 Compliance Index of the Set of Interventions by Evaluation Parameter

Absolute Results

		Effectiveness				Efficiency		Complexity			Cost			
		Implementation Progress				Compliance								
		Partial		Null										
Evaluation Parameter	TOTAL	Definitive	Future	Definitive	Future	Yes	No	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH	**TOTAL**
NUMBER OF INTERVENTIONS PER CHECK PARAMETER														
Operational Vehicle Design	0	0	0	2	1	0	3	1	0	2	1	1	1	3
Obstacles Lateral to Road	1	0	0	1	0	1	1	1	0	1	1	0	1	2
Pedestrian Infrastructure	4	0	0	3	0	4	3	3	0	4	3	1	3	7
Signaling	2	0	0	2	0	2	2	2	0	2	2	0	2	4
TOTALS	**7**	**0**	**0**	**8**	**1**	**7**	**9**	**7**	**0**	**9**	**7**	**2**	**7**	**16**

Relative Results

		Effectiveness				Efficiency		Complexity			Cost			
		Implementation Progress				Compliance								
		Partial		Null										
No	TOTAL	Definitive	Future	Definitive	Future	Yes	No			HIGH	LOW	MEDIUM	HIGH	**TOTAL**
% OF INTERVENTIONS PER EVALUATION PARAMETER														
Vehicle Operational Design	0%	0%	0%	67%	33%	0%	100%	33%	0%	67%	33%	33%	33%	19%
Obstacles Lateral to Road	50%	0%	0%	50%	0%	50%	50%	50%	0%	50%	50%	0%	50%	13%
Pedestrian Infrastructure	57%	0%	0%	43%	0%	57%	43%	43%	0%	57%	43%	14%	43%	44%
Signaling	50%	0%	0%	50%	0%	50%	50%	50%	0%	50%	50%	0%	50%	25%
TOTALS	**44%**	**0%**	**0%**	**50%**	**6%**	**44%**	**56%**	**50%**	**0%**	**56%**	**44%**	**13%**	**44%**	**100%**

G. Conceptualization for the Analysis of the Evaluation Criteria

Overall project effectiveness: Achieved through relative values that indicate the percentages of total, partial and null implementations.

Overall complexity of the project: By its classification (high, medium or low).

General cost of the project: Regarding its classification (high, medium or low).

Participation of evaluation parameters: Number of factors or parameters per type. This allows for the evaluation of the distribution of findings in order to determine the predominance of a specific type.

Effectiveness in the progress of the implementations by parameter: Number of total, partial and null implementations per parameter. This allows for evaluation of the factors or parameters with higher and lower efficiency indexes.

Effectiveness vs. Complexity: This allows for the evaluation of the relation of the effectiveness and the complexity of the project according to the levels of implementation and the classification of complexity (high, medium or low).

Table 24 continues with the example that was developed above and presents the relationship in absolute and relative terms between the effectiveness and complexity of the implementation of the RSA recommendations.

Table 24 Effectiveness vs. Complexity Results.

	Absolute Results				Relative Results			
	Effectiveness				Effectiveness			
		Partial	Null			Partial	Null	
Complexity	TOTAL	Definitive or future	Definitive or future	TOTAL	TOTAL	Definitive or future	Definitive or future	TOTAL
Low	6	0	1	7	38%	0%	6%	44%
Medium	0	0	0	0	0%	0%	0%	0%
High	1	0	8	8	6%	0%	50%	56%
TOTALS	**7**	**0**	**9**	**9**	**44%**	**0%**	**56%**	**100%**

Effectiveness vs. Cost: This comparison elucidates the relationship between the effectiveness and the cost of the project, according to the levels of implementation and classification of the cost (high, medium and low).

Table 25 continues with the example that has been developed and presents the relationship in absolute terms between the effectiveness and the costs of implementing the recommendations of the RSA.

Table 25 Relative and Absolute Results of Effectiveness vs. Cost

	Absolute Results				Relative Results			
	Effectiveness				Effectiveness			
		Partial	Null			Partial	Null	
Complexity	TOTAL	Definitive or future	Definitive or future	TOTAL	TOTAL	Definitive or future	Definitive or future	TOTAL
Low	6	0	1	7	38%	0%	6%	44%
Medium	1	0	1	2	6%	0%	6%	13%
High	0	0	7	7	0%	0%	44%	44%
TOTALS	**7**	**0**	**9**	**16**	**44%**	**0%**	**56%**	**100%**

H. Rating of the Project

Once the measurement of the effectiveness, efficiency, complexity and cost indicators has been developed, a comprehensive rating of these factors and their subsequent analysis aimed at obtaining a rating for the project is carried out.

I. Rating of Effectiveness

Taking into account the effectiveness indexes and the respective relative values, the result of calculating the participation of each type of implementation is determined for the different levels of application, on a scale of 0 to 1. The implementations that have been carried out as a whole obtain the highest rating (1.00) and, consequently, the lowest rating is obtained by the Definitive Null implementations (0.00), as shown in Table 26.

Table 26 Rating Distribution for Different Types of Implementation

Implementation	Category	Rating
Null	Definitive	0,00
	Future	0,30
Partial	Definitive	0,60
	Future	0,85
Total	**N/A**	**1,00**

Tomando en cuenta lo anterior, la eficacia se determina mediante la sumatoria del producto de la participación dada por el resultado de cada tipo de implementación y el peso asignado, de acuerdo con la siguiente ecuación:

$$\text{Effectiveness} = \sum (\text{Participation x Rating})$$

Consequently, the effectiveness corresponds to the level of achievement of the objectives set out in the recommendations of the RSA.

J. Rating the Efficiency, Complexity and Cost of the Project

Effectiveness contributes to 80% of the rating, and the relative values of complexity, cost and efficiency contribute the remaining 20%. The distribution by rating for the last three criteria is indicated in Table 27.

Table 27 Ratings and Contributions of the Different Levels of Measurement of Each Evaluation Criteria

Criteria	Measurement	Rating	Contribution
Complexity	Low	0,3	10%
	Medium	0,6	
	High	1	
Cost	Low	0,3	5%
	Medium	0,6	
	High	1	
Total	**N/A**	**1**	**5%**

Efficiency is the achievement of the results in relation to the time criteria used or required to implement the recommendation of the RSA with respect to the estimated initial term.

The rating of these three criteria is given by the sum of the product of the ratings, the contributions of each type of measurement, and the weight obtained from the initial evaluation. It is expressed in the following equation called partial rating:

Partial Rating(partial) = ∑Participation x Rating x Contribution

K. Total Rating of the Project

The final rating corresponds to the integral balance of the management carried out when implementing the recommendations of the RSA. Each project will have a final rating associated with the participation of each evaluation criteria (effectiveness, efficiency, complexity and cost). Once the ratings of the efficiency, complexity, cost and general efficiency rating are determined, the final indicator can be calculated.

When adding the contribution made by the effectiveness with the contribution made by the partial rating, we obtain the final indicator, which is represented in the following equation.

Final Indicator=(% Effectiveness+% Partial Rating)

Final indicator=0.8(Effectiveness scored)+0.1(Complexity scored) +0.05(Cost scored)+0.05(Overall Efficiency)

The scored effectiveness and the integral management indicator are obtained from the following table.

Table 28 Comprehensive Management Balance of the Entire Audited Project

Effectiveness							Efficiency	
	Partial		Null					
TOTAL	Definitive	Future	Definitive	Future	General Rating	Contribution 80 %	General	Contribution 5.0 %
Scores								
1,00	0,60	1	0%	6%				
Total relative participation					**45,8%**	36.7%	**0,0%**	0,0%
44%	0%	0%	50%%	6%				

Complexity				
Low	Medium	High	General Rating	Contribution 10.0 %
Scores				
0,30	0,60	1,0		
0%	44%	56%	**82,2%**	8,2%

Cost				
Low	Medium	High	General Rating	Contribution 5%
Pesos				
0,30	0,60	1,0		
56%	0%	44%	**61,1%**	3,1%

Final indicator
48%

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5

ANNEXES

5.1 ANNEX 1

PRACTICAL EXAMPLE OF A ROAD SAFETY AUDIT

This annex presents the analysis of a generic case that exemplifies an RSA in the reconstruction project of an urban road section. The images and recommendations were compiled from different RSAs by Engineer Juan Emilio Rodríguez Perrotat.

5.1.1 Compiled Information

In order to carry out the RSA, the following information was utilized:

* Interviews with professionals responsible for supervision.
* Background of the existing work.
* Field trip with day and night site visits and interviews with local people, in particular pedestrians waiting at bus stops in the construction area.
* Project blueprints
* Security requirements for the consultant team for the design of the executive project.

5.1.2 Project Description

The project consists of the final design and the complete and detailed implementation of the works corresponding to the extension and rehabilitation of a section of urban route, including a bridge. The driving speed of the project will be 60 km/h. The designer must improve the available radii to the extent that the right of way available will allow.

5.1.3 Current Situation

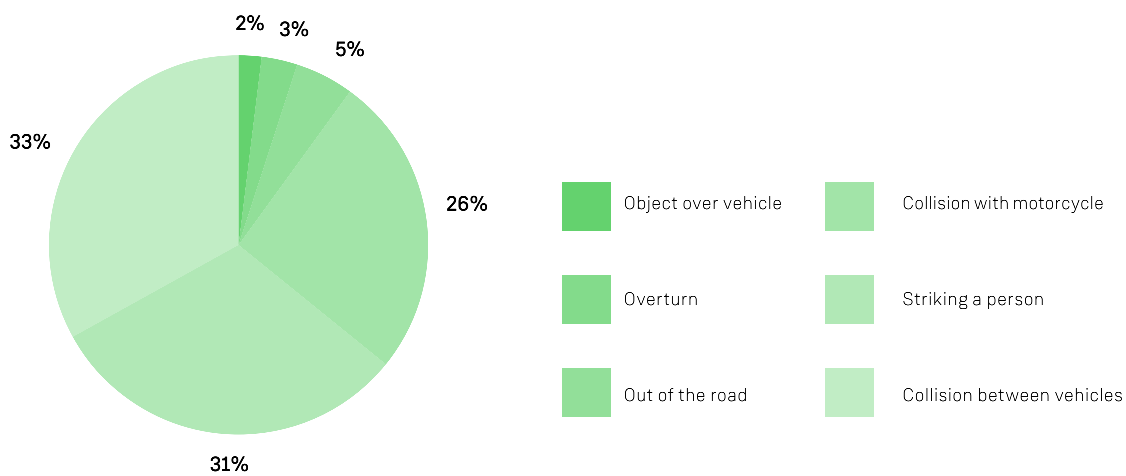
The current project is in operation, there is congestion at certain times of the day in which the service level drops to critical levels. It should be noted that this is not only on a section, but also in the surrounding arteries and in the distribution of the network of the sector. In addition, dangerous situations were observed, especially at night with vulnerable users. The situations observed occurred, in general, when turns are made from the route to the cross streets or in the inverse movement of incorporation. On the other hand, lighting does not always appear sufficient. In terms of capacity, at certain times there is a system of ascent lanes with an informal methodology.

Vulnerable users are not adequately considered or protected. The use of land is intense and varied, from residential to commercial and industrial. The right-of-way is inconsistent and difficult to expand. All types of users have been observed on this road, including a strong presence of buses, cargo transportation vehicles, motorcyclists and pedestrians.

5.1.4 Topographic Characteristics

The outline presents a significant slope in much of its extension, as well as the passing of a river, which is done by means of a bridge located after vertical and horizontal adjusted curves.

Figure 5 Classification of Incidents in the Area of Study



5.1.5 Road Incidents

The amount and type of road traffic incidents that occurred in recent years were analyzed. A map was generated in which these are located to accurately assess the areas of greatest risk.

5.1.6 Requested Road Safety Requirements

For each particular project, road safety requirements will be requested. These requirements may vary from project to project. They may be established in a bidding document, national or local regulations, or simply established by whoever requests the RSA. For the purposes of this example, since it is a compilation, the requirements are not attached, as they vary by case.

5.1.7 Project Constraints

The project is an arterial road linking two sectors of the metropolitan area of the city, and the road also provides local services, so it has easy access for local residents and businesses. This means that the road has a mixed use function that makes it difficult to define an adequate speed for the mentioned requirements. In addition, the use of surrounding land, which restricts the possibility of expansion of the right-of-way and the topography of the sector, both constrain possible changes when defining the geometry of the work.

5.1.8 Site Visits

The path was covered three times, two visits during the day and one at night. The objective was to observe the behavior at different times of the day, with different composition and traffic load and under different visibility conditions.

5.1.9 Interviews

During the visits, interviews were conducted with pedestrians and local residents to learn more about the traffic in the area.

5.1.10 Findings

Geometry and Cross-Section of a Road

The effort to provide mobility to the sector is acknowledged, while also considering local accessibility and vulnerable users (such as pedestrians), in addition to considering topographical and right-of-way restrictions. However, the following suggestions are made.

By virtue of the characteristics of the route section analyzed, it is recommended to define the priority of use of the road: regional connection or accessibility to nearby areas (residential, commercial and industrial). This will define the restrictions on the left turns and the average speed of use. While the presence of pedestrians and other vulnerable users is recognized, this leads to reflection about the ideal speed.

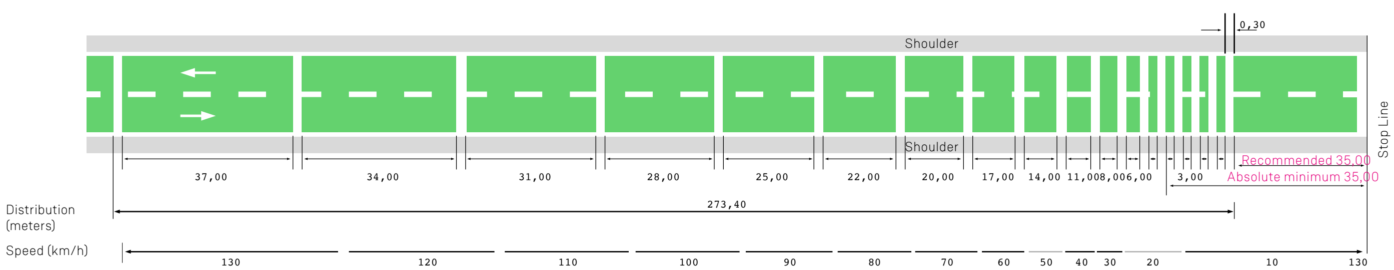
In this sense, a study regarding the possibility of death due to the speed of collision with a vulnerable user is required, which indicates a very high probability of death in the case of such a collision in this sector.

The proposal is to analyze the possibility of reducing the allowed speed to 50 km/h. This aspect is reinforced at the moment of the analysis of different road safety parameters, including the intersections, the vulnerable users and the speed expected for the use of this road. The latter will also favor the consistency of the section, so that several studies promote unifying the speed for more uniform driving (ideally, the variation should not exceed 10 km/hour). In this sense, for this new speed, the time needed to travel the stretch only increases 20 seconds.

Due to the possibility of crossing the road to the opposite hand, especially by motorcyclists, as well as the probability of serious frontal collisions, the placement of a median strip for opposite flows is recommended.

In addition, rumble strips are suggested in the vicinity of places where speed reduction is required, such as important crossings, the curve before the bridge and in the vicinity of pedestrian crossings. Analyzing vulnerable users and the consistency of the project strengthens this recommendation. Next, a sketch is presented.

Figure 6 Location of the rumble strips



The continuous lines of white color and of 0.30 m minimum width (in the direction of the road) have a maximum thickness compatible with the general dimensions of the road markings. Repeatedly, they must produce a sound and vibration effect inside the vehicle when it passes over.

The repetition of the lines in a gradual successive approximation shortens the distances between them, and induces the driver to decelerate until the optical-sound effect is repeated in the same interval of time. The space between lines is defined as the section to which a certain speed is associated.

Shoulders

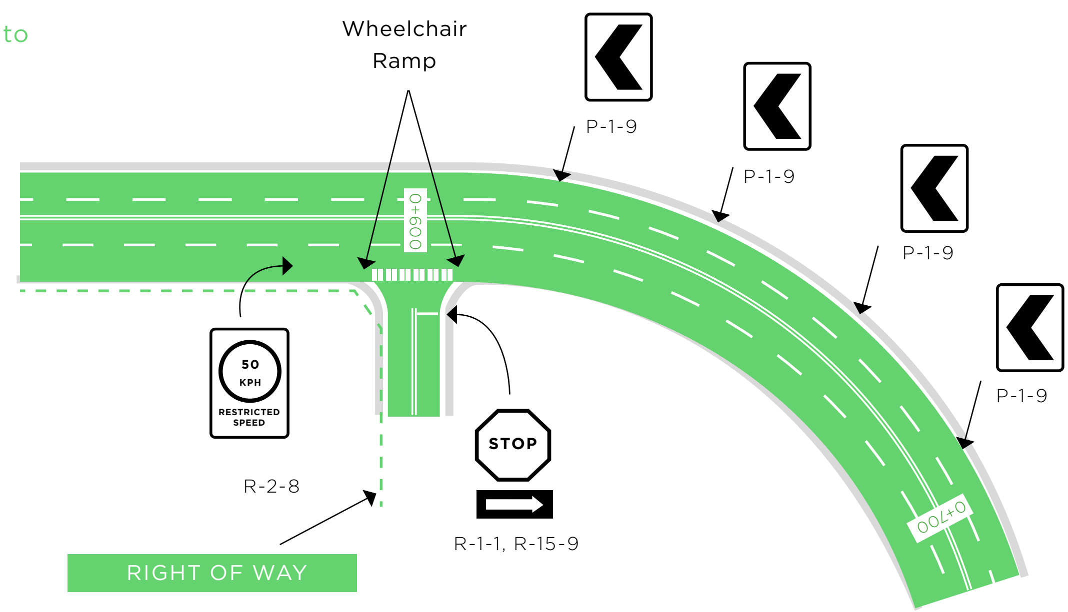
As observed in the typical sections to be adopted, the shoulder has a width of 1.25 m and has not been contemplated in the sector of the bridge. This width does not allow for the vehicle's full stop in an emergency without invading the main lanes. However, taking into account the restrictions on the right-of-way in the sector, one could at least provide a transition space between the main road and the sidewalk to separate vulnerable users and allow a space for bicycle circulation, apart from the flow of the main road, which is an improvement on the current situation.

Median Strip

From the speed observed in vehicles that circulate during off hours and especially at night, there was a concern about the observed speed increase, high considering the current conditions, which can be aggravated by the increase in number of lanes. A median strip can contribute to a reduction in speed due to the narrowing visual effect it has on drivers.

It is possible to think about providing continuity to the New Jersey central barrier to the whole stretch, placing a yellow border or installing frangible vertical delineators. Undoubtedly, its effectiveness decreases in the indicated order of solution, although the latter requires less installation space, which is advantageous, considering the restrictions of the-right-of-way. In the following images, the listed options are displayed.

Figure 7 Proposal to Improve Safety



In the previous image, the vehicles will turn left; in fact, those maneuvers were observed without visibility from the curve. The installation of a median strip will prevent such potentially dangerous maneuvers. On the other hand, a New Jersey central barrier type will also prevent pedestrian crossings at dangerous locations.

Turn Bays

In abscissa zero turns are allowed, but the demarcation indicated in the project plans does not indicate this. In addition, due to the diverse visual pollution of the sector, it is recommended to pay attention to the level of retro-reflection of the vertical signals that will be installed.

An analysis of better clarity and precision of turn lanes in crossing of avenues of zero abscissa is recommended. The same reference is provided for the channeling traffic islands of same sector flows. In this sense, it is recommended to apply a rail separator and traffic islands over elevation with a cable barrier.

It is also suggested to reduce lane crossings in stopping sectors, prior to turns, by demarcating the lane with a continuous line.

Regulations for Circulation

Taking into account the traffic volumes observed, both for the main roads and for turns and incorporations to the route, the use of traffic lights at the main intersections is suggested. They will allow a safe crossing for pedestrians and vehicular turns. There is the possibility of allowing safe access to the cross street near the school (today there is only one pedestrian traffic light) by installing a complete traffic light that also regulates vehicular traffic. This can be a valuable tool to reduce traffic related incidents in the area, due to the fact that risky maneuvers were observed at nighttime when vehicles entered the main road. The following image provides more detail and also there is no prevision of a ramp for people with disabilities in the direction of crossing the main roads.

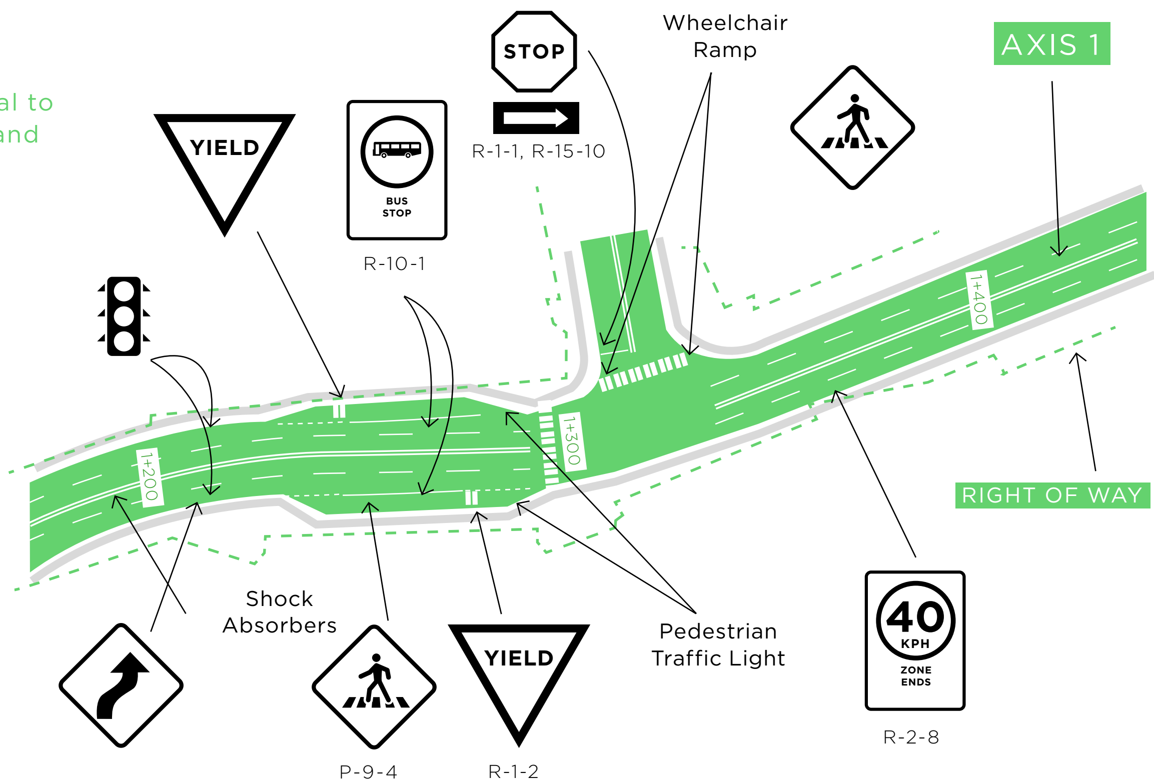


Figure 8 Proposal to Improve Safety and Traffic Flow

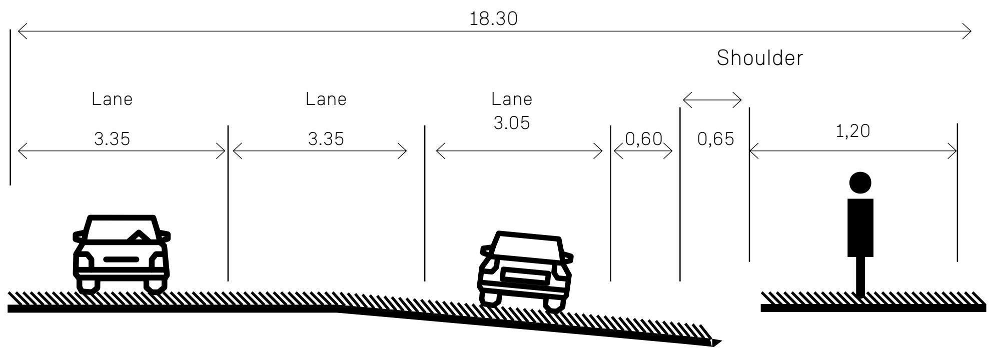
It should also be noted that vehicles that wish to turn need to wait for their chance in the fast lane, in a place after a curve, so other drivers may not be provided with adequate time to notice these stoppages.

On the other hand, it is suggested to include a sector of continuous white line on the axis of each direction, to avoid lane crossings in the meters before the intersections.

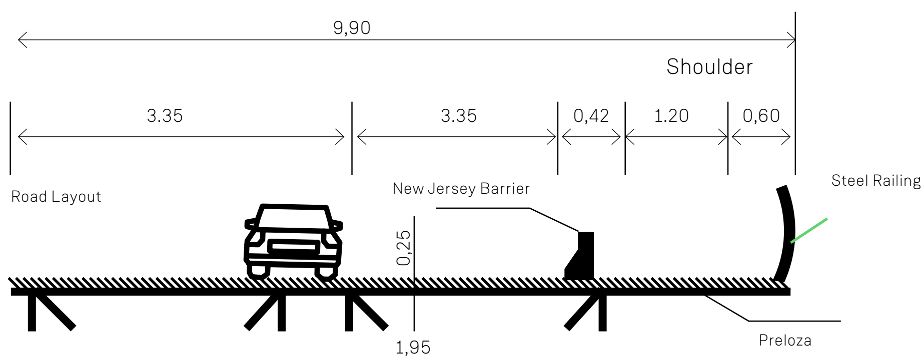
Pedestrian crossings: The following configurations have been considered for pedestrian sidewalks.

Figure 9
Typical Cross-sections
of the Project

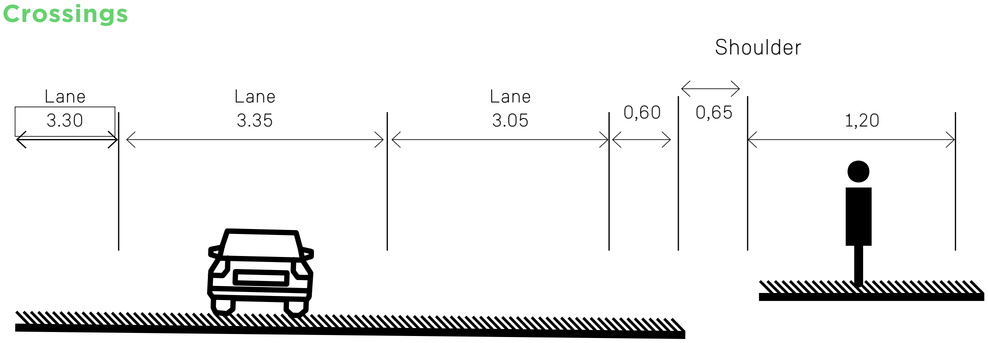
Typical Cross-Section



Bridge

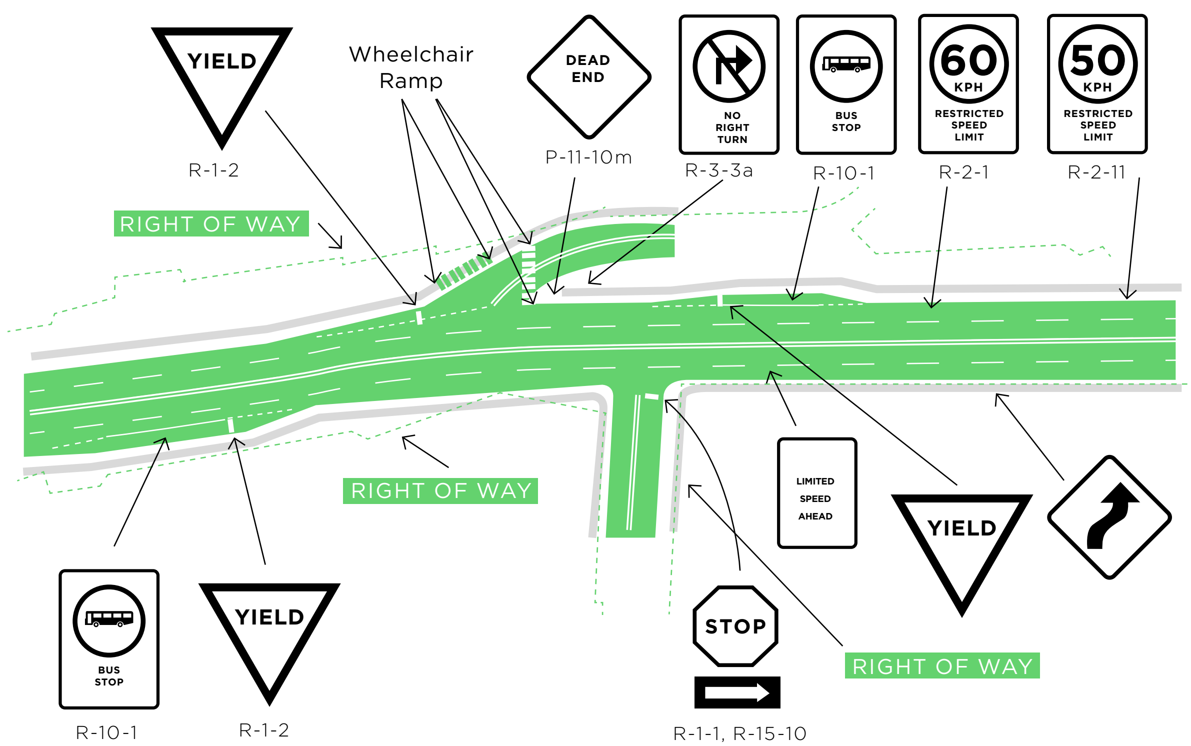


Crossings



From these images it is possible to notice that the expected width is very tight, especially if one takes into account the important presence of pedestrians and bus stops. In addition, the passage of wheelchairs in the opposite direction can be difficult. The right-of-way restrictions are recognized, but as far as possible it is recommended to review this aspect. On the other hand, it is recommended to consider the possibility of including pedestrian crossings in the bus stop sector, which could coincide with the proposed traffic lights. It is recommended to indicate detailed specifications for the widths and slopes of the ramps for people with disabilities, as in the case of the image shown below.

Figure 10 Details for Ramps and Slopes for Ramps for People with Disabilities

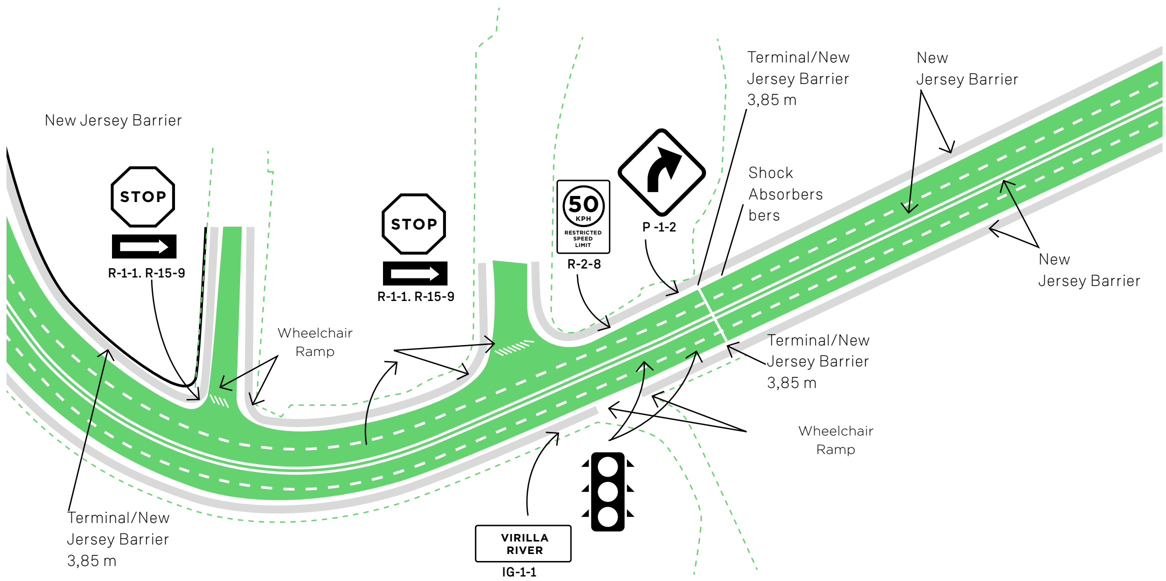


In addition, considering the strong presence of pedestrians and the proximity to health centers and schools, it may be necessary to provide the traffic lights with audio signals for people with visual disabilities.

Demarcation and Vertical Signaling

In the revision of the project plans the warning signals of proximity in crossings or transit incorporations were not observed, therefore further consideration is suggested.

Figure 11
Proposed Signaling



Road Layout Consistency

The general outline of the work was analyzed through methodologies to evaluate the consistency of the layout, similar to what is mentioned in this guide. In this case, the application of the Lamm criteria is highlighted in order to determine the consistency levels, applying the Perez Model of Spain for the calculation of the speed of operation in the curve, and the Crisman Model for the case of straight sections.

From this analysis, it is possible to conclude that the layout presents an acceptable or good continuity of road speed, although it is possible that the speeds reached are higher than those of the planned design. For this reason, we recommend measures that contribute to the communication of an adequate message to the user in relation to the speed that is expected to be adopted to circulate in the section. In this sense, the placement of a central separator, the rumble strips prior to the sectors of greatest potential conflict (closed curves, pedestrian crossings in the vicinity of bus and school stops, traffic lights at intersections that contemplate turn lanes and pedestrians) can contribute to reduce the potential risk of road traffic incidents.

5.1.11Conclusions and Recommendations

Initially, it is necessary to consider the purpose that is intended for the road under analysis. It is pointed out, in this case, that the first step should be a forming a precise definition of the road's purpose. In addition to the technical purpose established, the needs of all road users should also be considered.

In this sense, it is recommended to validate the final proposal to be adopted, by holding new meetings with key stakeholders. In this regard, it is considered that the first task is to define the degree of importance that the route will have for medium and long-range travel mobility, versus the level of accessibility that will be given to neighbors and adjacent industries.

A first approximation may be to preserve the character of a passageway and high mobility for people and vehicles that cross the area, from and to other places in the country, while, at the same time facilitating the accessibility of the neighbors, industrial and commercial centers in certain pre-selected spots along the project. For the latter consideration, it is necessary to use regulation and the participation of the local municipality, since the streets and municipal roads will act as collectors towards these entry and exit points of the road project.

Likewise, it seems convenient to build consensus and commitments between these institutional actors, considering the different levels of competence and jurisdiction in the area of the road.

Another possibility is to start a process of transformation of the road towards a more urban condition, in which traffic controls are installed (traffic lights), as long as urban and industrial development demands it depending on the future growth of the area. This alternative will promote greater accessibility for adjacent users, at the expense of medium and long-distance mobility.

In addition, it is necessary to indicate that for the current situation it should be considered that traffic regulation through traffic lights at some intersections that are distant from each other and that could regulate the speed would provide better security to the accesses and exits of the project and to the intersection for vulnerable users.

In the event that the first alternative is adopted, it is possible to define short, medium and long-term actions according to the levels of investment and natural terms of implementation, considering the importance of reducing the risk levels for the different users of this road. In this sense, it is possible to point out the following:

A. **Short-term actions:** To adopt the recommendations presented in the previous sections such as adequacy of demarcations, vertical signaling, traffic lights, protection of obstacles and situations of potential danger. Include a median strip in the new construction work.

B. **Medium-term actions:** To construct or redesign the intersections with adequate traffic channeling for turns. Extension of acceleration and deceleration sections in the accesses to the highway and in sections for bus stops or for public transport, and development of bike lanes.

C. **Long-term actions:** To build overpasses at intersections. In this case, joint planning with the municipality is required in order to carry out adequate territorial planning and orga-

nizing the circulation by area, as well as the adequate restriction of the property line to avoid access to individuals without adequate control and organization.

It is recommended to carry out traffic studies that include all the movements of passage, entry and exit to the road, the revision of future land use plans of the areas near it, speed records and origin/destination surveys, time distribution according to demand, etc., so that the best opportunity and operational functioning of the alternative chosen for each case can be defined with technical precision.

In addition, taking into account different local and international experiences, it is recommended to keep a uniformity of solutions along the project outline. This way, the user behavior will improve because he/she must always act in a similar way when facing similar solutions (uniformity criteria) and favors the readability of the road. It is necessary to address protection needs for all users, especially those with the greatest vulnerability. In the case at hand, it has been possible to observe all types of users, that is, in the areas of urban or industrial/commercial development, pedestrians, cyclists, motorcyclists and light and heavy vehicles are present.

It is also necessary to indicate the desirability of carrying out a review regarding the characteristics, extent and convenience of the proposal for the implementation of the protection barriers and their terminals, since, although the application of behavioral norms is enunciated, this is not adequately reflected in the project. Furthermore, it seems convenient to separate the opposite directions of circulation by means of a median strip, such as a concrete barrier, cable barrier or at least additional demarcations.

As for the pedestrian crossings, it is observed that these users cross the road at several different points. Therefore, it is recommended to reinforce the current crossings according to what was indicated in this report. Additionally, it is recommended that these be analyzed as soon as possible in terms of their location, lighting and signaling.

5.2 ANNEX 2

TERMS OF REFERENCE FOR CONTRACTING ROAD SAFETY AUDITS IN LATIN AMERICA AND THE CARIBBEAN

5.2.1 Background

Circumstances such as the growth of the road network, the increase and diversity of vehicle fleets (small vehicles share the road with large vehicles), the age difference of the drivers, the economic restrictions in the construction of the roads, the economic development of the countries and technological progress, have contributed to a potential increase in traffic incidents.

Technical vehicle failures, human factors or roads and their environment have traditionally accounted for the occurrence of traffic related incidents. Different factors are involved in the occurrence of a traffic incident, the vehicle (mechanical failures), the driver (human errors), the road and the environment. These elements could act individually or together to cause a traffic incident.

Before 1960, roads were designed and built without considering the protection of users or their physical and psychological limitations. Between the years 1960 and 1970, the construction and operation of roads began trying to mitigate the severity and consequences of traffic related incidents. By the 1970s, the countries that make the greatest investments in road infrastructure had taken an interest in roads with higher safety standards, highlighting the need to prevent collisions, instead of mitigating their consequences. Despite this progress, in less developed countries road infrastructure projects are still being designed with low safety standards, motivated by the need to reduce construction costs.

Infrastructure projects that are designed and built with limited road safety standards are prone to develop sites or critical sections of traffic related incidents, which are identified over time. Carrying out studies that identify and analyze the critical sites of higher incident rate is a reactive measure to address road safety problems, based on facts that have caused injuries or human losses. It is often observed that these critical sectors were not analyzed during the road projects design.

With the purpose of proposing a methodology that allows the detection of errors in road safety aspects previous to the incidents, in 1987 in England, Road Safety Audits appeared in the designs of infrastructure projects. The aim was to detect safety deficiencies in the plans before the construction of the projects so as to correct the errors by modifying them instead of implementing corrective measures later on. It is evident that this is a more beneficial approach for countries and for society in general, if road safety problems are detected and solved before a road is built.

Safety Audits are applicable to all stages of a road project: planning, design, construction (or reconstruction) and operation. However, in some countries the Road Safety Audit - RSA, covers the study in the first three stages mentioned and

Road Safety Inspection - RSI, when the work is carried out on a road in operation. In many cases, when performing an RSI, some security problems are detected that could be expensive to solve and that it would have been possible to correct during the design stage at a low cost if an RSA had been conducted.

The need to conduct Road Safety Audits in road infrastructure projects has been recommended for some time in different countries. The World Health Organization and the World Bank, on the occasion of declaring 2004 as the World Year of Road Safety, presented the so-called World Report on Road Traffic Injuries, in which they highlight the importance of the application of audits.

As part of the declaration of the Decade of Action for Road Safety 2011-2020, the United Nations presented the Global Plan of Action, which is highlighted in section 2.2, initiatives that provide results, the design of safer roads and the demand for independent road safety audits for new construction projects. In pillar 2 Safer Roads and Mobility, 6 priority activities are defined, one of which highlights the need to promote the creation of new safe infrastructures, in which better safety standards are set for new designs and investments in roads.

[The background of the country where the RSA will be held should be mentioned. Data on the condition of the transportation sector, challenges regarding the history of traffic incidents, existing policies and programs to mitigate the problem, the context and relevance of the project under study for the country, and showcase some experiences or expectations (as the case may be) of the RSA in the country.]

5.2.2 Justification

[This section should include a brief description of the project and the need to carry out the intended RSA. In addition it should include the context of the country, the relevant area and the project, statistics (if applicable), the type of RSA that is required and other relevant information.]

5.2.3 Objectives

General Objective

To carry out the RSA of the project Name of the Project (description of the project), between the site, population and kilometer and the site, population and kilometer, with the objective of identifying the conditions that create road traffic incident risks for different users of the road (people with reduced mobility, pedestrians, cyclists, motorcyclists, users of public transportation and occupants of vehicles or those that apply to the specific project) and to present general recommendations to improve road safety as a result.

Specific Objectives

* To identify the elements of road infrastructure that constitute potentially dangerous conditions for road users (applicable especially in the case of an existing road that is going to be reconstructed).
* To analyze the historical behavior of road incidents in the road project under study, according to the information available (applicable to a road under reconstruction).
* To identify and analyze the conditions of potential risks and road safety in the geometric design, drainage works, lateral zones, visibility, speeds, horizontal and vertical signaling, vehicle containment systems, measures to pacify traffic, etc.

* To recommend cost-efficient alternatives to improve the conditions of the infrastructure that seeks to mitigate or eliminate risk conditions of road users.
* (If applicable) to review RSAs carried out in the past in the project and verify the actions taken.

5.2.4 Scope

[The section of the road to be audited must be defined in detail, indicating its starting point and end point, number of kilometers, number of roadways, number of lanes per roadway, number of intersections regulated by "stop" signal, by traffic lights or crossings, etc. In addition, any other information and relevant characteristics of the project should be mentioned.]

5.2.5 Methodology

The methodology to develop the RSA includes the description of the techniques that will be used to carry out the work, based on the Technical Guide for the Application of Road Safety Audits in the Countries of Latin America and the Caribbean, published by the Inter-American Bank of Development - IDB, and contemplating the methods and procedures that will be used for the development of the work, which will allow the fulfillment of the stated objectives.

The methodology for the evaluation of each proposal will be a critical part of the process and the pertinence of the proposed methods and the innovation, consistency and solidity thereof will have to be evaluated.

The methodology must include at least:

* Basic conceptual elements
* Techniques to be applied, the use of which will increase the likelihood of positive outcomes.
* Methods and techniques to be used by the auditor.
* Activities or tasks to be performed that comply with those stated in these ToRs.

5.2.6 Activities

For the development of the activities of the RSA the proponent must consider at least the following points:

A Meeting with the contracting entity to sign the commencement of the study, record and present a Work Plan that includes the schedule of activities with the estimated timelines.

B Description of the secondary information required for the development of the RSA, based on the provisions of the Technical Guide for the Application of Road Safety Audits in the Countries of Latin America and the Caribbean, published by the Inter-American Development Bank - IDB. To fulfill this task, the auditor must prepare a diagnostic report with the information collected.

C Description of the field visit, depending on the type of project to be audited and information that can be compiled through videos, photographs, measurements on existing roads, checklists, etc.

D Intermediate meetings with the contracting party to present the diagnosis of the findings and risk analysis.

E Prepare a report highlighting the recommendations on road safety, applicable to the roads studied, in accordance with international technical standards for the construction and operation of safe roads.

F Prepare a presentation of the RSA report, during the final meeting with the contracting party, where the presented recommendations are supported.

[The proponent must describe with precision the tasks and main activities that will be implemented, defining their sequence and articulation, in addition to the products and results that are expected to be obtained that allow achieving the general objective and the specific objectives of the service to be contracted. It must be taken into account that the activities and tasks must be described specifically for each project.]

5.2.7 Key Staff for the Development of the RSA

For the composition, definition of profiles and responsibilities of the audit team, considerations should be given to what is included in the Technical Guide for the Application of Road Safety Audits in the Countries of Latin America and the Caribbean, published by the Inter-American Development Bank - IDB.

This guide establishes that the size of the audit team depends on the magnitude, type of project, the complexity of the audit task and the available resources. There must be at least one expert and the assistant team will depend on the needs and complexity of the project. In general, four members are considered a sufficient quantity for almost any project.

The recommended composition for an audit team is the following:

Lead Auditor

The lead auditor is the main member of the audit team, with professional training that meets the requirements indicated in Table A.1, to direct both the RSA process and the audit team. Ideally, a competent authority should establish these requirements once the country has training programs, and to the extent that the respective experience is acquired. For this, the participation of engineering faculties and engineering associations is vital.

Assistant Auditor

A professional who meets the requirements indicated in Table A.1, responsible for carrying out specific tasks and duties in the RSA.

Geometric Design Specialist

A civil or road engineer with a specialization and experience in the design of urban or regional roads, depending on the audited project.

Apprentice Auditors

A professional who is training as a road safety auditor, he/she attends the audit only as an observer.

Technical Expert

A person who brings specific knowledge or experience to the audit team without being an auditor.

Social Area Expert

A psychologist, sociologist or anthropologist who complements the engineering team. The specific professional and his/her expertise must be selected according to the needs of each project and the context in which it is located.

Profile and Responsibilities of the Audit Team

Table A.1 presents the required profile, experience and internationally assigned responsibilities for the members of the audit team, as a reference for contracting the RSA. Experience is a requirement for the realization of the RSA and will help ensure high quality audits.

Table A.1
Profile and Responsibilities of the Audit Team

Position	Academic Profile	Experience	Responsibility
Lead Auditor	Professional training and registration in civil engineering, roads or other similar professions, which include training in the design and construction of road infrastructure Knowledge on road safety engineering Training course in Road Safety Audits Training course and other activities related to topics such as: road signs, design of road containment systems, design of lateral zones, urban planning, design of calm traffic measures, etc.	7 years of professional experience as a minimum Show leadership and project management skills Specific experience in road design, road reconstruction techniques and engineering and traffic management Understanding the behavior of road users Have participated in no less than 5 RSA, 3 of which must correspond to road or urban projects similar to the project that is contracted.	Agree on the object and scope of the RSA Define the number and specialties that will make up the audit team Direct and carry out the RSA Manage the RSA process Intervene in the development of all stages of the audit Manage the audit team Ensure that the RSA is developed according to the terms of reference Analyze the information required for the RSA Define checklists Organize and direct the field visit Prepare the RSA report Prepare the presentation of the RSA
Assistant Auditor	Professional training and registration in their disciplines Knowledge in road safety engineering Training course in Road Safety Audit	5 years of professional experience Have participated in at least one RSA	Intervene in the collection and analysis of information for the RSA Participate in the preparation of checklists Participate in the field visit when there is room for it Fills out checklists Participate in the preparation of the RSA report Participate in the presentation of the audit report
Geometric Design Specialist	Professional training and registration in civil engineering, roads or other similar professions that include training in the design and construction of road infrastructure Training course in Road Safety Audit	5 years of professional experience 2 years of experience in road infrastructure project design Involvement in the design of at least two road infrastructure projects	Audit designs from road safety's point of view Establish design consistency Prepare checklists for the audit of road infrastructure designs Participate in the field visit when there is room for it Complete checklists Prepare the report of the RSA regarding its specialty Participate in the presentation of the audit report
Social Area Expert	Professional training and registration in disciplines such as anthropology, sociology or psychology Experience in analysis of human factors and impact of road projects in communities	3 years of experience in project management with communities. Experience in analyzing the social impact of road projects	Determine the possible impacts of the project on the surrounding communities and their normal operation Determine the human factors that could affect road safety in the design of the work. Prepare reports analyzing the risk of situations that may arise with the communities and their respective mitigation measures

5.2.8 Deliverable Products

The Contractor (audit group) must submit the following reports or products:

Report 1: Work plan and schedule of activities which include the estimated timelines.

Report 2: Compilation of information and diagnosis, field visit.

Report 3: Identification, analysis and proposals for mitigation and risk management.

Report 4: Final audit report that includes the findings and recommendations.

Note: For short-term projects, reports 3 and 4 can be presented in a single report. These reports must contain all the required information, duly justified and with the corresponding evidence to be understood. The reports should clearly present the following: the manuals or standards applied, design drawings, incident statistics (if applicable), and comparisons with international best practices.

5.2.9 Budget

The cost of an RSA varies according to the type of project, size, complexity and current stage. For example, if the project is in the design phase, the RSA cost can range from 5 to 10% of the design cost. However, if the same project is in the construction phase or it is a project that will involve reconstruction, the costs will increase significantly because it requires a greater number of specialists for its evaluation.

5.2.10 Minimum Resources and Facilities

The availability of the following resources should be considered for the implementation of the Road Safety Audit:

* Office
* Vehicle, to make field visits both day and night
* Computer equipment
* Printing equipment
* Safety clothing for those attending the field visit (if done): reflective vest, helmet and safety boots.
* Photo and video cameras to maintain evidence of the findings during field visits
* Software

5.2.11 Payment Method

The contracting entity must specify the costs that will constitute the proponent's remuneration, the currency in which the payment will be made, the form calculation and payment milestones (it is recommended to use the reports and deliverables indicated above). Then, based on this, the consultant will prepare the proposal, which will be indicated in this section. In each proposal the conditions and percentages of payment must be established: Down Payment (%), Partial Payments (%) and Final Payment (%).

5.2.12 Delivery of the Project's Information

This section describes the delivery, by the client, of all project documentation that allows for a detailed examination of the possible implications for road safety. It is recommended that, if possible, the client should make a written statement of the expected results.

The following table indicates the required information, which depends on the type of project to be audited.

Table A.2 Required Information for the Implementation of an RSA

Required Information			
Information of the Project	**Traffic Studies**	**Design Studies**	**Environmental Studies**
Scope of the project	Volumes of traffic vehicles	Geometric design	Weather conditions
Project localization	Volumes of pedestrians and cyclists	Intersection	Topographical conditions
Road functions	Volumes of motorcyclists	Roundabouts	Geophysical conditions
Design standards used	Location and type of travel generating centers	Signal design	
Exceptions to standards	Information on traffic related incidents (road rehabilitation and reconstruction)	Drainage design	
Concerns about road safety	Information on traffic related incidents on nearby roads (new roads)	Lateral area design	
Reports of other RSA		Design of vehicle containment system	
Presence of obstacles in the lateral zone of the road		Design of slopes and embankments	
		Pedestrian facilities	
		Facilities for cyclists	
		Facilities for people with reduced mobility	

5.2.13 Selection and Evaluation Criteria

The following aspects should be taken into consideration for the evaluation of the proposals:

A **Experience:** The specific experience of the firm and the personnel in the performance of Road Safety Audits or Inspections must be assessed through previous contracts or through the invoicing analysis. This should include the number of similar contracts completed, experiences in the region, country or locality.

B **Quality** of the methodology and proposed work plan.

C **Ratings** of the lead auditor and the geometric design specialist.

D **Value** of the proposal.

It will be possible to deliberate on the factors to be evaluated, in order to do so, the distribution of points on each factor must be defined objectively, understanding that the proposals that do not meet the minimum requirements established in these terms of reference should not be considered. As an example, deliberations such as the following are given, based on a total of 100 points:

A **Firm experience:** Between 0 and 10 points. 0 without prior experience and 2 points for each similar RSA project.

B **Quality of the methodology and the proposed work plan:** Between 0 and 15 points. This evaluation should be done by reviewing compliance with project requirements and prior assessment of the context for the specific approach of the RSA methodology.

C **Ratings of the lead auditor and geometric design specialist:** Between 30 and 40 points, awarded based on the number of projects in which these figures participated and where they served in a role similar to the one to which they are applying.

D **Value of the proposal:** Between 30 and 40 points, it will be calculated in a deliberative manner with the cost of the other bidding proposals.

It must be taken into account that the minimum experience requirements and knowledge of the personnel only enable people with the ability to develop a good quality RSA. In addition, by having a guidance document that delimits the content of the findings report and recommendations that should be used as a basis, the quality of the methodology, work plan and the value of the proposal can be considered as evaluation factors.

5.3 ANNEX 3

CHECKLISTS

From the considerations mentioned in chapter 2, general checklists can be made, and from those ones, specific checklists depending on each project can be done.

5.3.1 Rural Roads

PLANNING STAGE FOR NEW RURAL ROADS

General Aspects	
1	**Scope of the project:** justification of the road, road function, compatibility with land use, and compatibility with the existing road network traffic..
2	**Design parameters:** standards used, classification of the road, type, hierarchy, connection with the existing road network.
3	**Traffic:** traffic studies, volumes, anticipated trip generators, developments for land use, design volumes, diverted traffic, attracted traffic, existing road networks, exchangers, traffic composition.
4	**Transportation:** type of planned loads, passenger routes, origins, destinations, use of the road for transportation.
5	**Design speeds:** subdivision into homogeneous speed sections, speed changes.
6	**Environmental conditions:** forecasts to mitigate climatological, geophysical, topographic, and environmental effects of the road, noise, landscaping and floods.
7	**Effects:** in communities, water, fauna, flora, crops, ecosystems in general, effects wind, fog, ice, dawn, dusk, etc.
8	**Impacts:** on the existing road network, development forecasts, future land use.
9	**Provisions of construction by stages:** future extensions, future connections, future extensions or realignments.
10	**Adjacent urban developments:** considerations of speed, access, mobility, pedestrian crossings, new constructions, development of local activity, functionality and urban operation.

11	**Provisions for maintenance and road management:** spaces for routine work, newspapers, and damages caused by temporary closures of roads.
12	**Proposed routes:** technical feasibility, safe environments, physical restrictions of the landscape, special crossings.
13	**Location of bridges:** road safety effects.
14	**Access control:** road exchangers, access to properties, future access, dangerous environments, location and returns.
15	**Provision of roundabouts:** radii, visibility, additions, exits, ring lanes, pedestrian traffic and other users.
16	**Crossings with other modes of transportation:** railways, highways, bike lanes and motorways.
17	**Running surface:** type, general and special characteristics.
18	**Interaction with neighboring sectors:** pedestrian paths, accesses, stops, functional areas, refuge areas, capacity and effects.
19	**Location of tolls:** types, booths, provisions for protection of officers.
20	**Service provisions:** rest areas, overlooks, services to offer, gas stations, restaurants, mechanic workshops, provisions for entry/exit of vehicles, parking areas and pedestrian zones.
21	**Emergency provisions:** location of emergency vehicle locations, accessibility, operational and functional schemes, codes, facilities for crossings, returns, location of service centers and scheduled travel times.
22	**Provisions for signaling design:** vertical signs, demarcations, stripes, raised signs, variable message signs, signaling for special users, location, posts and poles, compatibility with existing signaling, expected signaling patterns and lighting areas.
23	**Motorways:** separation of lanes, speeds, crossings, turns, uses of shared areas, protection in redirection and contention barriers.
24	**Planned bike paths:** segregation, geometric design, special signals for cyclists and drivers of vehicles, maneuverability, location, junctions, turns, uses of shared areas, facilities for users, and areas of incorporation, slopes, ascent/descent ramps, bridges or descending steps.
25	**Pedestrians:** pedestrian network, pedestrian paths, refuge zones, fences, walkways, level crossings, pedestrian bridges, protection elements, guardrails, special signaling for drivers and pedestrians, inclusive mobility, ramps, stairs, vehicle going up or down, crossings at intersections, pedestrian phases at traffic lights, continuity, access to buildings, impacts due to track density, conflicts with other road users, shared spaces with cyclists, situations and danger effects.
26	**Non-motorized vehicles:** type, lanes of use, operability, anticipated volumes, operating speeds, interaction with other vehicles, special signaling.
27	**Provisions for animals on the road:** type of animals, fence design, fences, special signaling, cost, fauna crossings, location, visibility, and special provisions.

28	**Special areas planned:** school zones, controlled access, parking, shelters, user protection systems, and speed reducers.
29	**Other:** safety aspects not covered, unforeseen uses, extra-dimensioned vehicles, land use, development centers or unforeseen travel generators.

PRELIMINARY DESIGN STAGE NEW RURAL ROADS

General Aspects

1	**Design parameters:** standards used, classification of the road, type, hierarchy, connection with the existing road network.
2	**Verification of previous recommendations:** recommendations in the planning stage.
3	**Traffic:** traffic studies, volumes, scheduled trip generators, developments for land use, design volumes, diverted traffic, attracted traffic, existing road networks, and exchanges.
4	**Transportation:** type of planned roads, passenger routes, origins, destinations, use of the road for transport.
5	**Vehicle design:** vehicle type, dimensions, impacts to traffic and impacts to accessibility.
6	**Design speeds:** subdivision into homogeneous speed sections, speed changes.
7	**Environmental conditions:** forecasts to mitigate climatological, geophysical, and topographic effects, environment of the road, noise, landscaping.
8	**Provisions of construction by stages:** future extensions, future connections, future expansions or realignments, construction by stages.
9	**Anticipated traffic management plan:** safety while building, detours, fencing, protection of workers, speed on site, temporary signaling, entry/exit of machinery, temporary closures, socialization, etc.
10	**Adjacent urban developments:** considerations of speed, access, mobility, crossings on villages, new constructions, development of local activity, functionality and urban operation.
11	**Provisions for road maintenance and management:** spaces for routine work, periodic works, and affectations due to temporary road closures.

Geometry Of The Road

12	**Horizontal alignment:** draft, straight lines, curves, minimum radii, degrees of curvature, angles of deflection, visibility in curves, overtaking zones, reading of outline by the driver, between tangencies, braking distance and visibility, stopping distance.

13	**Vertical alignment:** maximum and minimum slopes, provisions for vertical curve lengths, visibility distances.
14	**Design consistency:** relationship of contiguous curves, speed profile.
15	**Anticipated cross- section:** lanes, provisions for special lanes, lane widths, bank widths, crown widths, cross-section changes.
16	**Berms:** expected widths, internal berm, external berm, intended uses.
17	**Drainage:** curbs, drain, curbside, ditches, surface and subsurface drainage, types of hydraulic sections.
18	**Median strip:** planned widths, possible obstacles, transferability treatment, and unevenness.
19	**Location of bridges:** widths, heights, lengths, planned crossings or pedestrian areas.
20	**Lateral or free zone:** minimum width needed, operational, environmental, visual and auxiliary functions, slopes, lateral obstacles, treatment of lateral zones, areas for the user's protection.
21	**Access control:** flows and capacity in road exchangers, access to properties, future accesses, dangerous environments, location, returns, acceleration and deceleration lanes.
22	**Provision of roundabouts:** radii, visibility, entries, exits, ring lanes, special signaling, and pedestrian traffic.
23	**Crossings with other transportation modes:** railways, motorways, bicycle lanes, and motorways.
24	**Running surface:** type, general and special characteristics, planned zoning.

Road Furniture Aspects

25	**Interaction with neighbors of the sector:** pedestrian paths, accesses, stops, functional areas, refuge areas, capacity, and affectations.
26	**Location of tolls:** types, booths, provisions for the protection of workers.
27	**Escape or braking ramps:** justification, location, design, type, special signaling, channeling lanes, visibility, maneuverability, vehicle entry, length, state of ground, recovery area.
28	**Service provisions:** rest areas, overlooks, services to offer, gas stations, restaurants, mechanical workshops, provisions for vehicle entry/exit, parking areas, pedestrian zones.
29	**Emergency provisions:** location sites for emergency vehicles, accessibility, operational and functional plans, codes, facilities for crossing, returns, location of first aid centers, travel times planned.
30	**Provisions for signaling design:** vertical signaling, demarcations, reflective strips, elevated signaling, variable message signs, signaling for special users, location, posts, compatibility with existing signs, expected signaling patterns, lighting areas.
31	**Planned motorways:** separation of lanes, widths, speeds, intersections, turns, uses of shared areas, separation of lanes, protection in redirection and contention barriers.

32	**Planned bike paths:** segregation, geometric design, special signaling for cyclists and drivers of vehicles, maneuverability, location, widths, crossings, turns, uses of shared areas, facilities for users, areas of incorporation, slopes, ascent/descent ramps, bridges or overpasses.
33	**Pedestrians:** pedestrian network, pedestrian paths, platforms, shelter areas, fences, walkways, overpasses, pedestrian bridges, protection elements, guardrails, special signaling for drivers and pedestrians, inclusive mobility, ramps, stairs, ascent/descent of vehicles, intersections, pedestrian phases of traffic lights, continuity, access to buildings, impacts due to road density, conflicts with other road users, spaces shared with cyclists, situations and danger effects.
34	**Non-Motorized vehicles:** type, lanes of use, operability, anticipated volumes, operating speeds, interaction with other vehicles, special signaling.
35	**Provisions for animals on the road:** type of animals, design of fences, special signaling, cost, fauna crossings, location, visibility, and special provisions.
36	**Design of segregation elements:** type, length, height, location, comprehensiveness, continuity, section for entry/exit of vehicles.
37	**Planned school areas:** special signaling, traffic lights, ascent/descent zones, parking lots, shelters, pedestrian paths, user protection system, and speed reducers.
38	**Other:** safety aspects not covered, unforeseen uses, extra-dimensioned vehicles, land uses, development centers or unforeseen travel generators.

DEFINITIVE DESIGN STAGE NEW RURAL ROADS

General Aspects

1	**Road functionality:** type of road, road hierarchy, modification of design parameters, new general characteristics, and other special road characteristics.
2	**Verification of previous recommendations:** recommendations in the preliminary design stage, interaction of the functional aspects.
3	**Traffic:** planned trip generators, developments for land use, design volumes, diverted traffic, attracted traffic, existing road networks, and exchanges.

4	**Transportation:** type of planned loads, passenger routes, origins, destinations, use of the road for transport.
5	**Vehicle design:** vehicle type, vehicles allowed/not allowed, acceptable dimensions, impacts to traffic, impacts to accessibility.
6	**Design speeds:** homogeneous speed sections, speed changes.
7	**Environmental conditions:** provisions to mitigate climatological, geophysical, topographic, environmental effects of the road, noise, landscaping.

Geometry Of The Road

8	**Horizontal alignment design:** straight lines, curves, and minimum radii, degrees of curvature, deflection angles, cants, cants transition, visibility in curves, overtaking zones, tangencies, distance and braking visibility, stopping distance.
9	**Vertical alignment design:** maximum and minimum slopes, visibility, length of vertical curves, mapping losses.
10	**Design Consistency:** relationship of contiguous curves, speed profile, inconsistencies, shared uses.
11	**Cross-section design:** rails, special rails, widths of lanes, sidewalk widths, crown widths, pumps, widening, rear widening, cross-section changes.
12	**Berms:** widths, internal berm, external berm, intended uses, lateral slope, and berm transition.
13	**Curb design:** location on the lateral zone, types of hydraulic sections, widths, depth, side slopes, counter curbs, curb crossings, crossing.
14	**Median Strip:** widths, obstacle treatment, transferability treatment, glares, unevenness.
15	**Curbside:** height, rounded edges, crossing.
16	**Drainage:** lateral location, height of starting points, covers, crossing for all types of vehicles on the road.
17	**Bridge design:** widths, planned signaling, railings, crossings or pedestrian areas contemplated, elements of protection before and after, transition elements.
18	**Lateral or free zone:** minimum width required, design of lateral zones, operational, environmental, visual, auxiliary functions, slopes, homogeneity of surfaces, lateral obstacles, crossing, side zones, areas for user protection.
19	**Treatment of lateral obstacles:** trees, location and design of posts, treatment of slopes, buildings and surrounding constructions.
20	**Access design:** controlled/non-controlled, flows and capacity in road exchangers, access to properties, hazardous environments, location, returns, acceleration and deceleration lanes, ascent/descent ramps, intersections, joint areas, traffic islands.
21	**Roundabouts design:** radii, visibility, incorporations, exits, ring lanes, special signaling and pedestrian traffic.
22	**Running surface:** type, general and special characteristics, structural design of pavements, zoning, and drainage of the planned surface, design color, speed reducers, berms and rumble strips provided.

Road Furniture

23	**Stop design:** location, type, functional areas, planned signals, refuge zones, capacity, structural design, and protection elements.
24	**Planned SOS posts:** location, type, architectural and structural design, provisions for user protection, visibility, special signaling.
25	**Toll design:** location, types, booths, special signaling design, provisions for protection of workers.
26	**Redirection and containment elements:** technical design, justification, containment level, work widths, rigidity, length, terminals, transition elements, anchors, uniformity.
27	**Collision shock absorbers:** design, justification, location, level of containment, homogeneity, work area, special signaling.
28	**Escape or braking ramps:** justification, location, design, type, special signaling, channeling, visibility, maneuverability, vehicle entry, length, surface state, recovery area.
29	**Traffic lights:** location, design, special signaling, cycles, phases, sequences, posts.
30	**Rest areas:** location, special signaling design, services to offer, vehicle entry/exit areas, parking areas, pedestrian zones.
31	**Overlooks:** location, design of areas and special signaling.
32	**Services:** location of gas stations, restaurants, mechanical workshops, functional area designs, special signaling and vehicle entry/exit.
33	**Speed reducer design:** justification of calm traffic measures, alert bands, bumps, functionality**.**
34	**Lighting:** lighting areas, post design, heights.
35	**Emergency vehicles:** location of venues, accessibility, operational and functional schemes, codes, facilities for passage, returns, location of service centers, estimated travel times**.**

Signaling

36	**Vertical signaling design:** type, size, shapes, colors, pictograms, messages, location, height, characteristics of day and night visibility, consistency with demarcation.
37	**Demarcation:** design of continuous and segmented lines, central and lateral lines, widths, characteristics of day and night visibility, design of parking areas, traffic channeling, shelters, uniformity, symbols, characters, colors, frequency of use, circumstances in which they are used, types of materials provided, consistency with vertical signaling.
38	**Reflective strips:** planned designs, type, size, delineation, spacing, demarcation, color, daytime and night visibility characteristics, and crossing.
39	**Elevated signaling:** messages, posts, location.

40	**Variable message signaling:** location, messages, day and night visibility characteristics.
41	Signaling for pedestrians, cyclists, and motorcyclists.

User Differentiation

42	**Planned motorways:** separation of lanes, signaling, speeds, crossings, turns, widths, uses of shared areas, separation of lanes, and protection in redirection and contention barriers.
43	**Planned bike paths:** differentiation, geometric design, special signaling for cyclists and drivers of vehicles, maneuverability, location, crossings, turns, widths, usage of shared areas, facilities for users, areas of incorporation, slopes, ascent/descent ramps, bridges or descending steps.
44	**Pedestrians:** pedestrian network, pedestrian paths, refuge zones, fences, walkways, level crossings, pedestrian bridges, protection elements, surface condition, railings, special signals for drivers and pedestrians, inclusive mobility, ramps, stairs, vehicle ascent/descent, intersection steps, pedestrian traffic light phases, continuity, access to buildings, impairments due to track density, conflicts with other road users, spaces shared with cyclists, situations and danger effects.
45	**Non-Motorized vehicles:** type, lanes of use, operability, anticipated volumes, operating speeds, interaction with other vehicles, special signaling.
46	**Provisions for animals on the road:** type of animals, design of fences, fences, special signaling, cost, fauna crossings, location, visibility, special provisions.
47	**Differentiation element design:** type, length, height, location, comprehensiveness, continuity, openings for entry/exit of vehicles.

Special Zones

48	**Planned school areas:** special signaling, ascent/descent zones, parking lots, refuge, pedestrian crossings, user protection system, and speed reducers.
49	**Urban crossings:** maximum speed allowed, special signaling, pedestrian paths, pedestrian crossings, vulnerable users, road furniture, crossings, turns, entry and exit of vehicles, parking areas, speed reducers.
50	**Intersections:** location, type, special signaling, visibility, vehicle incorporation/exit, maneuverability, turns, crossings, level situations, uneven situations, ascent or descent ramps, road geometry, speeds, users allowed/not allowed, system of protection for users.
51	**Other:** safety aspects not covered, unforeseen uses, extra-dimensioned vehicles, land uses, development centers or unforeseen travel generators.

PRE-OPERATIONAL STAGE NEW RURAL ROADS

General Aspects

1	**Functionality of the road:** type of road, road hierarchy, design parameters, general characteristics, special characteristics of the road.
2	**Verification of previous recommendations:** recommendations in the final design stage, interaction of the functional aspects.
3	**Traffic:** travel generators, land use, design volumes, priority conflicts, day and night operation, and readability for drivers, exchangers, crossings, and turns.
4	**Transportation:** type of loads, type of passengers, origins, destinations, use of the road for transport.
5	**Design vehicles:** vehicle type, vehicles allowed/not allowed, acceptable dimensions, impacts to traffic, and impacts to accessibility.
6	**Design speeds:** homogeneous speed sections, problematic speeds, test vehicle travel speeds, sudden speed changes, and signalized speed.
7	**Environmental conditions:** climatological, geophysical and topographic.
8	**Design/construction stage:** construction status, cleaning, removal of debris, removal of temporary or obsolete signaling.

Geometry Of The Road

9	**Horizontal alignment:** curvature, minimum radii, degrees of curvature, deflection angles, curbs, cants, visibility in curves, vehicle instability, visibility.
10	**Vertical alignment:** maximum and minimum slopes, visibility, and length of curves, mapping losses.
11	**Design consistency:** relationship of contiguous curves, speed profile, inconsistencies, shared uses.
12	**Cross- section:** rails, special rails, lane widths, pumps, widening, rear widening, cross-section changes.
13	**Berms:** widths, obstacles, lateral slope, and crossings.
14	**Curbs:** width, depths, side slopes, counter curbs, curb crossings, obstacles and crossings.
15	**Median strip:** widths, obstacles, crossings, dazzle, and unevenness.
16	**Curbside:** height, rounded edges, crossings.
17	**Drainage:** lateral location, height of heads, covers, crossings.

18	**Bridges and pontoon bridges:** width, day and night visibility, special signaling, railings, pedestrian crossings, front and back protection, and transition elements.
19	**Lateral zone:** minimum width needed, area of concern, functions, lateral obstacles, crossings and areas for user protection.
20	**Lateral obstacles:** trees, posts, stones, and collision elements, elements to cross.
21	**Lateral slopes:** separation, slopes of inclination, crossing, abysses, rock shedding.
22	**Accesses:** road exchangers, access to properties, returns, acceleration and deceleration lanes, visibility, readability for drivers, functionality, operability, operating speeds, ascent/ descent ramps, intersections, junction areas, traffic islands.
23	**Roundabouts:** Radii, speeds of operation, visibility, incorporations, exits, annular lanes, special signaling, pedestrian traffic.
24	**Running surface:** Type, general and special characteristics, zoning, vehicle-surface interaction (friction), surface drainage, flooding, surface uniformity, damage and surface color, action of speed reducers, berms and rumble strips mainly.

Road Furniture

25	**Stops:** location, lateral separation, special signaling, refuge zones, capacity, structure, protection system, and passenger ascent/descent zone.
26	**SOS posts:** location, user refuge, visibility, special signaling and industrial security elements.
27	**Tolls:** location, types, booths, speeds, special signaling, protection of officials, shelters, traffic islands, and collision shock absorbers.
28	**Redirection and containment elements:** types, location, height, work area, dynamic deflection, rigidity, installation, embedment, length, terminals, transition elements, anchors, discontinuities, day and night visibility, uniformity.
29	**Collision shock absorbers:** location, level of containment, type, homogeneity, work area, installation, visibility, special signaling, operating status.
30	**Escape or braking ramps:** location, type, special signaling, visibility, maneuverability, vehicle entry, length, state, and recovery area.
31	**Traffic lights:** location, installation, visibility, special signaling, operability, phase operation, cycles, posts.
32	**Rest areas:** location, special signaling, services, entry/exit of vehicles, parking areas, pedestrian zones.
33	**Overlooks:** location, special signaling, capacity, parking areas, parking, passenger ascent/descent zones, and pedestrian zones.
34	**Services:** gas stations, restaurants, mechanical workshops, location, special signaling, entry/exit of vehicles.

35	**Speed reducers:** measures of calm traffic, alert bands, bumps, justification and functionality.
36	**Lighting:** necessity, type of lighting, school zones, pedestrian paths, intersection zones, population crossings, bridge areas, high risk sectors.
37	**Emergency vehicles:** location of sites, alarms, calls, special access, facilities for crossing, returns, location of service centers, travel times.

Signaling

38	**Vertical signaling:** size, shapes, colors, pictograms, messages, location, height, daytime visibility, night reflectivity, consistency with demarcation.
39	**Demarcation:** central and lateral lines, widths, day and night visibility, stops lines, parking, traffic channeling, refuges, uniformity, symbols, characters, colors, frequency of use, circumstances in which they are used, types of materials used, consistency with the vertical signs.
40	**Reflective strips:** location, type, size, delineation, spacing, demarcation, color, day and night visibility, and crossing.
41	**Elevated signaling:** messages, posts/poles, location.
42	**Variable message signaling:** location, messages, day and night visibility.
43	**Signaling for pedestrians, cyclists and motorcyclists.**

User Differentiation

44	**Motorways:** lane separation, signaling, speeds, crossings, turns, widths, uses of shared areas, separation of lanes, track edges or obstacles in drainage works, protection in redirection and contention barriers, sliding surfaces.
45	**Bike paths:** differentiation, continuity, special signage for cyclists and drivers of vehicles, location, crossings, turns, widths, uses of shared areas, facilities for users, areas of incorporation, slopes, geometry of the road, ramps of ascent/descent, bridges or descending steps.
46	**Pedestrians:** mobility, predominant groups, volumes, pedestrian network, pedestrian paths, refuge zones, fences, walkways, level crossings, pedestrian bridges, protection elements, surface condition, guardrails, special signage for drivers and pedestrians, inclusive mobility, ramps, stairs, ascent/descent of vehicles, intersection steps, traffic lights with pedestrian phases, continuity, access to buildings, affectations due to the road's density, conflicts with other road users, shared spaces with cyclists, situations and danger effects.
47	**Non-Motorized vehicles:** type, lanes of use, operability, anticipated volumes, operating speeds, interaction with other vehicles, special signaling.
48	**Animals:** presence, type of animals, fences, special signaling, cost, control measures, fauna crossings, location, visibility, and special provisions.
49	**Differentiation elements:** type, length, height, location, installation, visibility, comprehensiveness, continuity, sections for entry/exit of vehicles.

Special Zones

50	**School areas:** special signaling, ascent/descent zones, parking lots, refuges, pedestrian paths, user protection system, speed reducers.
51	**Urban crossings:** maximum speed allowed, special signaling, pedestrian paths, pedestrian crossings, vulnerable users, road furniture, crossings, turns, entry and exit of vehicles, parking areas, speed reducers.
52	**Intersections:** location, type, special signaling, visibility, vehicle incorporation/exit, maneuverability, turns, crossings, level situations, uneven situations, ascent or descent ramps, road geometry, speeds, users allowed/not allowed, user protection system.
53	**Other:** elements not designed, assessments of day and night travel.

General Aspects

1	**Functionality of the road:** type of road, road hierarchy, design parameters, general characteristics, special characteristics of the road, special characteristics during the construction.
2	**Verification of previous recommendations:** recommendations in the final design stage, interaction of the functional aspects.
3	**Traffic:** travel generators, land use, traffic in the work area, current volumes, conflicts of priority, day and night operation, readability for drivers, exchangers, crossings, turns.
4	**Transportation:** type of cargo, type of passengers, origins, destinations, use of the road for transport
5	**Advance warning mechanisms for drivers:** diffusion, socialization of the project, temporary signaling.
6	**Vehicles:** vehicle type, vehicles allowed/not allowed, acceptable dimensions, impacts to traffic, impacts to accessibility, current volumes, composition of traffic.
7	**Operating speeds:** sections of homogeneous speed, reduction of speed in works, maintenance of day and night speed, problematic speeds, speeds in work zones, abrupt changes in speed, signalized speed.
8	**Environmental conditions:** climatological, geophysical and topographic.
9	**Traffic management plan:** plan and operation on site, zoning, detours, temporary signs of work, channeling, closures, traffic controllers, construction barriers, protection for workers, machinery on the road, effectiveness of the plan, modifications.
10	**Deviations:** temporary signaling, visibility, channeling, maneuverability of all vehicles allowed, state of the roads for diversion, effectiveness of deviation.
11	**Design/construction stage:** construction areas, access to work sites, maintenance of areas in operation, cleaning, removal of debris, removal of temporary or obsolete signaling as work progresses.

Geometry Of The Road

12	**Cross-section:** lanes, special lanes, lane widths, cross-section changes.
13	**Berms:** temporary use of berms, widths, obstacles, lateral slope, crossing.
14	**Curb:** height, rounded edges, crossing.
15	**Median strip:** widths, obstacles, crossings, glare, unevenness.
16	**Curbside:** height, rounded edges, crossing.

17	**Drainage:** visibility, lateral location, height of heads, covers, crossing.
18	**Bridges and pontoons bridges:** width, day and night visibility, special signaling, railings, pedestrian crossings, front and back protection, and transition elements.
19	**Lateral zone:** lateral obstacles, crossing, and areas for user protection.
20	**Lateral obstacles:** trees, posts, stones, collision elements, elements to cross
21	**Lateral slopes:** separation, slopes of inclination, crossing, abysses, rock shedding.
22	**Accesses:** road exchangers, access to properties, returns, acceleration and deceleration lanes, visibility, readability for drivers, functionality, operability, operating speeds, ascent/descent ramps, intersections, junction areas, traffic islands.
23	**Roundabouts:** radii, speeds of operation, visibility, incorporations, exits, annular lanes, special signaling, pedestrian traffic.
24	**Running surface:** type, current state for vehicular circulation, damages of the construction works, general and special characteristics, zoning, vehicle-surface interaction (friction), surface drainage, waterlogging, uniformity of surface, damages, color of the surface, action of speed reducers, berms and rumble strips mainly.

Road Furniture

25	**Stops:** location, lateral separation, special signaling, refuge zones, capacity, structure, protection system, and passenger ascent/descent zone.
26	**Tolls:** location, types, booths, speeds, special signage, protection of workers, refuges, traffic islands, collision shock absorbers.
27	**Redirection and containment elements:** types, location, height, work area, dynamic deflection, rigidity, installation, embedment, length, terminals, transition elements, anchors, discontinuities, day and night visibility, uniformity.
28	**Collision shock absorbers:** location, level of containment, type, homogeneity, work area, installation, visibility, special signaling, operating status, traffic risks, visibility obstructions.
29	**Escape or braking ramps:** location, type, special signaling, visibility, maneuverability, vehicle entry, length, surface state, recovery area.
30	**Temporary traffic lights:** location, installation, visibility, temporary special signaling, operability, phase operation, cycles, posts, operation provisions and temporary operation**.**
31	**Services:** gas stations, restaurants, mechanical workshops, location, special signaling, entry/exit of vehicles.
32	**Speed reducers:** measures of calm traffic, rumble strips, highlights, justification, functionality, temporary reducers.

33 **Lighting:** visibility of work on the road and day and night traffic restrictions, need for temporary lighting, lighting type, school zones, pedestrian paths, intersection areas, crossings in towns, bridge areas, high risk sectors.

34 **Emergency vehicles:** location of sites, alarms, calls, special access, facilities for crossing, returns, location of service centers, travel times.

Signaling

35 **Temporary vertical signaling:** size, shapes, colors, pictograms, messages, location, height, daytime visibility, night reflectivity, consistency with demarcation, relevance with existing signs, coverage or removal of signaling that do not apply during construction.

36 **Demarcation:** central and lateral lines, widths, day and night visibility, stop lines, parking, channeling, refuges, uniformity, symbols, characters, colors, frequency of use, circumstances in which they are used, types of materials used, consistency with the vertical signaling, coverage of marks that do not apply during construction, use of necessary temporary demarcation.

37 **Auxiliary traffic controllers:** clothing, located where needed, training, location, functions, stop and go signs, whistles, day and night visibility, attention hours.

38 **Delineators and traffic channeling:** location, location on the road, sizes, shapes, lengths, types, visibility, proximity, alerts, user considerations during the works, parking, breakdowns.

39 **Elevated signaling:** messages, posts, and location.

40 **Variable message signaling:** location, messages, day and night visibility.

41 **Signaling for pedestrians, cyclists and motorcyclists.**

User Differentiation

42 **Motorways:** lane separation, signaling, speeds, crossings, turns, widths, uses of shared areas, separation of lanes, track edges or obstacles in drainage works, protection in redirection and contention barriers, sliding surfaces.

43 **Bike paths:** differentiation, safe access during construction, continuity, special signaling for cyclists and drivers of vehicles, location, crossings, turns, widths, uses of shared areas, facilities for users, areas of incorporation, slopes, geometry of the road, ramps of ascent/descent, bridges or descending steps.

44 **Pedestrians:** mobility during construction, predominant groups, access for the elderly and disabled, volumes, pedestrian network, pedestrian paths, refuge zones, fences, walkways, level crossings, pedestrian bridges, protection elements, surface condition, railings, special signaling for drivers and pedestrians, inclusive mobility, ramps, stairs, ascent/descent of vehicles, intersection steps, pedestrian phases of traffic lights, continuity, access to buildings, impairments due to track density, conflicts with other road users, shared spaces with cyclists, situations and danger effects.

45	**Non-Motorized vehicles:** type, lanes of use, operability, anticipated volumes, operating speeds, interaction with other vehicles, special signaling.
46	**Animals:** presence, type of animals, fences, special signaling, cost, control measures, fauna crossings, location, visibility, and special provisions.
47	**Elements of differentiation:** type, length, height, location, installation, visibility, understanding, continuity, zones for entry/exit of vehicles.

Special Zones

48	**School areas:** special signaling, ascent/descent zones, parking lots, refuges, pedestrian paths, user protection system, speed reducers.
49	**Urban crossings:** maximum speed allowed, special signaling, pedestrian paths, pedestrian crossings, vulnerable users, road furniture, crossings, turns, entry and exit of vehicles, parking areas, speed reducers.
50	**Intersections:** warnings, location, type, special signaling, visibility, vehicle incorporation/exit, maneuverability, turns, crossings, level situations, uneven situations, ascent or descent ramps, road geometry, speeds, users allowed/not allowed, user protection system.
51	**Other:** elements not designed, appreciations of day and night travel.

5.3.2 Urban Roads

DESIGN STAGE FOR URBAN ROADS

General Aspects

1	**Scope of the project:** objectives, justification, future plans, function of the road, context, road hierarchy
2	**Verification of previous recommendations:** previous audits, interaction of the functional aspects, and previous studies on the design area.
3	**Mobility:** accessibility, impacts on each type of user, temporary mobility, future mobility, routes.
4	**Existing infrastructure:** effects, contributions, mobility on the existing road network, activities that take place in the environment.
5	**Incident rate:** records of traffic related incidents in the area, loss analysis, causes, sites or sectors of concentration of claims, previous mitigation measures.

6	**Traffic:** mobility and traffic studies, travel generators, future land use, design volumes, priority conflicts, day and night operation, readability for drivers, exchangers, crossings, turns, special lanes for mass transport.
7	**Transportation:** transport systems, type of cargo, type of passengers, origins, destinations, use of the road for transport, special loading/unloading schedules, cargo transport routes, special school or tourism routes.
8	**Design vehicles:** background, vehicle type, vehicles allowed/not allowed, acceptable dimensions, impacts on traffic, and impacts on accessibility.
9	**Design speeds:** concordance with the road hierarchy, homogeneous speed sections, problematic speeds, sudden changes in speed, designed speed.
10	**Environmental conditions:** climatological, geophysical and topographic.
11	**User behavior:** vulnerable population, special signaling measures, spaces, social services, gathering points, possible queues on the urban space, waiting places.
12	**Design stage:** work plan, construction areas, access to work sites, maintenance of areas in operation, cleaning, removal of debris and removal of temporary or obsolete signaling as the work progresses.
13	**Design of traffic management plan:** plan and operation on site, zoning, detours, temporary signs of work, channeling, enclosures, traffic controllers, construction barriers, protection of workers, access of machinery on the road.
14	**Detour plan:** temporary signaling, visibility, channeling, maneuverability of all vehicles allowed, state of the roads for detours.
15	**Provisions for the socialization of the project:** information, participation conditions, population criteria, local organizations, levels of affectation, potential agreements, proposed solutions.
16	**Institutional coordination:** institutional responsibilities, coordination for the development of the project, applicable regulations, specific conditions of construction, urban planning, organizational structure for decision making, control organisms, evaluation criteria and assessment of the functioning of the infrastructure.

Urban Space

17	**Urban arrangement:** pedestrian/vehicle priority, public transport/private transport, connections with other modes and road corridors in the environment, compatibility with future land use.
18	**Elements of urban space:** pedestrian protection elements, stops, parking, street vendors, billboards, infrastructure of public services, access and security to garages and public places.
19	**Passenger mobility:** transfers between modes of transportation, physical and operational compatibility of modes of transportation in the area, stations, travel continuity, effects on other types of users.

20	**Tree planting:** treatment of gardens, green areas, landscaping, trees to remove, proximity to the area of vehicular flow, trees as obstacles in pedestrian areas, pots.
21	**Pedestrian surfaces:** shape, type, continuity, state during construction, tablets for the blind, crossings for pedestrian chairs, access ramps to platforms, curbside, drainage areas, rails or walkways.
22	**Pedestrians:** mobility, predominant groups, volumes, pedestrian network, pedestrian paths, refuge zones, level crossings, pedestrian bridges, protection elements, surface condition, special signaling for drivers and pedestrians, inclusive mobility, ramps, stairs, vehicle ascent/descent, intersection crossings, pedestrian traffic light phases, continuity, access to buildings, impairments due to track density, conflicts with other road users, spaces shared with cyclists, situations and danger effects.

Geometry Of The Road

23	**Horizontal alignment:** curvature, minimum radii, degrees of curvature, deflection angles, cants, visibility in curves, vehicle instability, visibility.
24	**Vertical alignment:** maximum and minimum slopes, visibility, length of curves, path losses.
25	**Cross-section:** rails, special rails, lane widths, pumps, widening, rear widening, Cross- section changes.
26	**Berms:** widths, obstacles, lateral slope, crossing.
27	**Curbs:** width, depth, side slopes, counter curbs, curb crossings, obstacles, and crossings.
28	**Median strip:** widths, obstacles, crossing, glare, and unevenness.
29	**Curbside:** height, rounded edges, crossing.
30	**Drainage:** lateral location, height of heads, covers, crossing.
31	**Bridges and pontoon bridges:** width, night and day visibility, special signaling, fences, pedestrian crossings, front and back protection, elements of transition.
32	**Lateral obstacles:** trees, posts, rocks, collision elements, crossing elements.
33	**Access:** exchangers, access to properties, returns, acceleration and deceleration lanes, visibility, readability for drivers, functionality, operation speeds, ascent/descent ramps, crossings, junction areas, traffic islands.
34	**Roundabouts:** radii, speeds of operation, visibility, incorporations, exits, ring lanes, special signaling, and pedestrian traffic.
35	**Running surface:** type, general and special characteristics, zoning, vehicle-surface interaction (friction), surface drainage, flooding, surface uniformity, damage, surface color, action of speed reducers, berms and rumble strips mainly.

Road Furniture

36	**Stops:** location, lateral separation, special signaling, refuge zones, capacity, structure, protection system, passenger ascent/descent zone.
37	**Urban tolls:** location, types, booths, speeds, special signaling, protection of workers, shelters, traffic islands, and collision shock absorbers.
38	**Redirection and containment elements:** types, location, height, work area, dynamic deflection, rigidity, installation, embedment, length, terminals, transition elements, anchors, discontinuities, day and night visibility, uniformity.
39	**Collision shock absorbers:** location, level of containment, type, homogeneity, work area, installation, visibility, special signaling, and operating status.
40	**Escape or braking ramps:** location, type, special signaling, visibility, maneuverability, vehicle entry, length, road state, and recovery area.
41	**Traffic lights:** location, installation, visibility, special signaling, operability, phase operation, cycles, posts.
42	**Services:** gas stations, restaurants, mechanical workshops, location, special signaling, entry/exit of vehicles.
43	**Speed reducers:** measures for calm traffic, alert bands, bumps, justification and functionality.
44	**Lighting:** need, type of lighting, school zones, pedestrian paths, intersection zones, population crossings, bridge areas, high risk sectors.
45	**Emergency vehicles:** location of sites, alarms, calls, special access, facilities for crossing, returns, location of service centers, travel times.

Signaling Of The Vehicle Area

46	**Vertical signaling:** size, shapes, colors, pictograms, messages, location, height, daytime visibility, night reflectivity, consistency with demarcation.
47	**Demarcation:** central and lateral lines, widths, day and night visibility, stop lines, parking, traffic channeling, refuges, uniformity, symbols, characters, colors, frequency of use, circumstances in which they are used, types of materials used, consistency with the vertical signaling, demarcation of pedestrian crossings.
48	**Reflective strips:** location, type, size, delineation, spacing, demarcation, color, day and night visibility and crossing.
49	**Elevated signaling: messages, posts, and location.**

50 **Variable message signaling:** location, messages, day and night visibility.

51 **Signaling for pedestrians, cyclists, motorcyclists.**

User Differentiation

52 **Motorways:** lane separation, signaling, speeds, crossings, turns, widths, uses of shared areas, separation of lanes, track edges or obstacles in drainage works, protection in redirection and contention barriers, slippery surfaces.

53 **Bike paths:** differentiation, continuity, special signage for cyclists and drivers of vehicles, location, crossings, turns, widths, uses of shared areas, facilities for users, areas of incorporation, slopes, geometry of the road, ramps of ascent/descent, bridges or depressed crossings.

54 **Non-Motorized vehicles:** type, lanes of use, operability, anticipated volumes, operating speeds, interaction with other vehicles, special signaling.

55 **Elements of differentiation:** type, length, height, location, installation, visibility, comprehensiveness, continuity, zones for entry/exit of vehicles.

Special Zones

56 **School areas:** special signaling, ascent/descent zones, parking lots, refuges, pedestrian paths, user protection system, speed reducers.

57 **Intersections:** location, type, volumes, design for future demand, change of hourly, daily, and occasional flow, special signaling, visibility, vehicle incorporation/departure, maneuverability, turns, crossings, level situations, uneven situations, ascent or descent ramps, road geometry, speeds, users allowed/not allowed, user protection system, surface condition, cants, pumping, drainage, gauges.

58 **Other:** elements not designed, appreciations of day and night travel.

CONSTRUCTION STAGE URBAN ROADS

General Aspects

1 **Scope of the project:** objectives, justification, function of the road, context, and road hierarchy.

2 **Verification of previous recommendations:** previous audits, recommendations in the final design stage, and interaction of the functional aspects.

3	**Traffic management plan:** preconstruction stage, plan and operation on-site, zoning, detours, temporary signs of work, channeling, enclosures, traffic controllers, construction barriers, protection of workers, machinery on the road, effectiveness of the plan, modifications.
4	**Detours:** capacity and levels of service of the roads, temporary signaling, visibility, channeling, maneuverability of all vehicles allowed, state of the roads for detours, effectiveness of detour.
5	**Mobility:** accessibility, impacts on each type of user, temporary mobility, routes, treatment of pedestrians and residents of the sector.
6	**Existing infrastructure:** impacts, mobility on the existing road network, activities that take place in the environment.
7	**Incident rate:** records of collisions and almost collisions in the construction area, incident rate analysis, causes and feedback measures for the incident rate presented on site.
8	**Traffic:** flows, backflows, provisions for trip generators, priority conflicts, day and night operation, readability for drivers, exchangers, crossings, turns, user visibility.
9	**Transportation:** special temporary lanes and routes for mass transportation, type of cargo, type of passengers, special loading/unloading schedules, cargo transportation routes and special routes for school and tourism.
10	**Advance warning mechanisms for drivers:** diffusion, socialization of the project, temporary signaling.
11	**Vehicles:** vehicles allowed/not allowed, acceptable dimensions, maneuverability, impacts on traffic, impacts on accessibility, transport of machinery.
12	**Operation speeds:** concordance with the road hierarchy and speed on work site, homogeneous speed sections, problematic speeds, sudden changes in speed, signalized speed.
13	**Environmental conditions:** climatological, geophysical and topographic.
14	**Behavior of users:** vulnerable population, inter-visibility of pedestrians and cyclists, special signaling measures, spaces, social services, concentration sites, queues on the urban space, waiting places.
15	**Design/construction stage:** work plan and schedules, construction areas, access to work sites, maintenance of operating areas, cleaning, removal of debris, and removal of temporary or obsolete signaling as work progresses.
16	**Special measures for separation of work lanes:** depth of excavations, differentiation with lanes in use, elements of redirection and temporary containment, protection of workers, compliance with industrial safety and environmental management standards.
17	**Socialization of the project:** information, participation conditions, population criteria, local organizations, levels of affectation, temporary access problems, compliance with agreements, proposed solutions.
18	**Institutional coordination:** institutional responsibilities, coordination for the development of the project, applicable regulations, specific conditions of construction, urban planning, organizational structure for decision making, control organisms, evaluation criteria and assessment of infrastructure functioning.

Urban Space

19	**Elements of temporary urban space:** pedestrian protection elements, stops, parking lots, street vendors, billboards, public services infrastructure, security access to garages and public places.
20	**Mobility of passengers in construction areas:** transfers between modes of transport, physical and operational compatibility of modes of transportation in the area, stations, continuity of trips, effects on other types of users.
21	**Pedestrians:** mobility, predominant groups, volumes, pedestrian network, pedestrian paths, refuge zones, fences, walkways, overpasses, pedestrian bridges, protection elements, surface condition, guardrails, special signaling for drivers and pedestrians, inclusive mobility, ramps, stairs, ascent/descent of vehicles, intersection steps, traffic lights pedestrian phases, continuity, access to buildings, affectations due to road density, conflicts with other road users, shared spaces with cyclists, situations and danger effects.

Geometry Of The Road

22	**Cross-section:** on-site lanes, special temporary lanes, lane widths, pumps, widening, rear widening, cross-section changes.
23	**Berms:** widths, obstacles, lateral slope, crossing.
24	**Curb:** width, depth, side slope, counter curb, crossings curb, obstacles, and crossings.
25	**Median strip:** widths, obstacles, crossings, glare, unevenness.
26	**Curbside: height, rounded edges, crossing.**
27	**Drainage: lateral location, height of heads, covers, crossing.**
28	**Bridges and pontoons bridges:** width, day and night visibility, special temporary signaling, railings, pedestrian crossings, front and back protection, transition elements.
29	**Accesses:** road exchangers, access to properties, returns, acceleration and deceleration lanes, visibility, readability for drivers, functionality, operability, operating speeds, ascent/descent ramps, intersections, joint areas, traffic islands.
30	**Affected roundabouts:** radii, operating speeds, visibility, additions, exit lanes, special signaling, and pedestrian traffic.
31	**Running surface:** type, general and special characteristics, zoning, vehicle-surface interaction (friction), surface drainage, flooding, surface uniformity, damage, and surface color, action of speed reducers, berms and rumble strips mainly.

Road Furniture

32	**Stops:** location, lateral separation, special signaling, refuge zones, capacity, structure, protection system, passenger ascent/descent zone.

33	**Urban tolls:** location, types, booths, speeds, special signaling, protection of workers, refuges, traffic islands, collision shock absorbers.
34	**Redirection and containment elements:** types, location, height, construction area, dynamic deflection, rigidity, installation, embedment, length, terminals, transition elements, anchors, discontinuities, day and night visibility, uniformity.
35	**Collision shock absorbers:** location, mobile collision shock absorber, level of containment, type, homogeneity, construction area, installation, visibility, special signaling, operating status.
36	**Traffic lights:** modification of existing phases, temporary traffic lights, location, installation, visibility, special signaling, operability, phase operation, cycles, posts.
37	**Services:** gas stations, restaurants, mechanical workshops, location, special signaling, entry/exit of vehicles.
38	**Speed reducers:** measures for calm traffic, alert bands, highlights, justification and functionality.
39	**Lighting:** need, type of lighting, school zones, pedestrian paths, intersection zones, pedestrian crossings, bridge areas, high risk sectors.
40	**Emergency vehicles:** location of sites, alarms, calls, special access, facilities for crossings, returns, location of service centers, travel times.

Signaling

41	**Temporary vertical signaling during construction:** size, shapes, colors, pictograms, messages, relevance, location, height, daytime visibility, night reflectivity, consistency with the demarcation, lighting devices.
42	**Temporary demarcation:** removal of confusing previous markings, central and lateral lines, widths, day and night visibility, stop lines, parking, channeling, refuges, uniformity, symbols, characters, colors, frequency of use, circumstances in which they are used, types of materials used, consistency with vertical signaling.
43	**Reflective strips:** location, type, size, delineation, spacing, demarcation, color, day and night visibility, and crossing.
44	**Elevated signaling:** messages, posts, and location.
45	**Variable message signaling:** location, messages, day and night visibility.
46	**Pedestrian paths:** signaling for pedestrians, adaptation of pedestrian crossings, cyclists, motorcyclists.

User Differentiation

47	**Motorways:** separation of lanes, temporary signaling, maneuverability and temporary operation, speeds, crossings, turns, widths, uses of shared areas, separation of lanes, track edges or obstacles in drainage works, protection in redirection and contention barriers, slippery surfaces.

48 **Bike paths:** differentiation, continuity, special temporary signage for cyclists and drivers of vehicles, location, crossings, turns, widths, uses of shared areas, facilities for users, areas of incorporation, slopes, geometry of the track, ascent/descent ramps, bridges or descending steps.

49 **Non-Motorized vehicles:** type, lanes of use, operability, anticipated volumes, speeds of operation, interaction with other vehicles, special temporary signaling.

50 **Elements of differentiation:** type, length, height, location, installation, visibility, comprehensiveness, continuity, zones for entry/exit of vehicles.

Special Zones

51 **School zones:** special temporary signaling, ascent/descent zones, parking lots, refuges, pedestrian paths, user protection system, speed reducers.

52 **Intersections:** special temporary signaling, visibility, vehicle incorporation/departure, maneuverability, turns, crossings, level situations, uneven situations, ascent or descent ramps, road geometry, speeds, users allowed/not allowed, user protection system, superficial condition, cants, pumping, drainage, gauges.

53 **Other:** elements not designed, considerations for day and night travel.

PRE-OPERATIONAL STAGE URBAN ROADS

General Aspects

1 **Scope of the project:** objectives, justification, future plans, function of the road, context, and road hierarchy.

2 **Verification of previous recommendations:** previous audits, recommendations in the design stage, interaction of the functional aspects.

3 **Mobility:** accessibility, impacts on each type of user, temporary mobility, future mobility, routes.

4 **Existing infrastructure:** impacts, contributions, mobility on the existing road network, activities that take place in the environment, connection of the new road with the existing one.

5 **Incident rate:** records of traffic related incidents in the area, analysis of the incidents, causes, sites or sectors with majority of incidents, previous mitigation measures.

6 **Traffic:** travel generators, future use of the land, design volumes, priority conflicts, day and night operation, readability for drivers, exchangers, crossings, turns, special lanes for mass transport.

7	**Transportation:** transport system, type of cargo, type of passengers, origins, destinations, use of road transport, special loading/unloading schedules, cargo transportation routes, special school routes.
8	**Design vehicle:** background, vehicle type, vehicles allowed/not allowed, acceptable dimensions, impacts on traffic, and impacts on accessibility.
9	**Design speed:** agreement with road hierarchy, homogenous speed sections, problematic speeds, sudden speed changes, signalized speed.
10	**Environmental conditions:** climatological, geophysical, and topographic.
11	**User behavior:** vulnerable population, special signaling measures, spaces, social services, and concentration sites.
12	**Design/ construction stage:** cleaning, removal of debris, removal of temporary or obsolete signaling as work progresses.
13	**Institutional coordination:** institutional responsibilities, evaluation criteria and assessment of infrastructure functioning.

Urban Space

14	**Urban arrangement:** pedestrian/vehicle priority, public transport/private transport, connections with other modes and other roads, compatibility with future land use.
15	**Installed urban space elements:** elements that protect pedestrians, stops, parking lots, street vendors, billboards, public service infrastructure, secure access to garages and public places.
16	**Passenger mobility:** transfers between means of transportation, physical and operational compatibility of means of transportation in the area, stations, travel continuity, effects on other types of users.
17	**Tree planting:** taking care of gardens and green areas built, landscaping, proximity to the area of vehicular flow, trees as obstacles in pedestrian areas, pots.
18	**Pedestrian surfaces:** shape, type, continuity, current state, construction defects, tablets for the blind, crossings for pedestrian chairs, ramps to access to platforms, curbside, drainage areas.
19	**Pedestrians:** mobility, predominant groups, volumes, pedestrian network, pedestrian paths, refuge zones, fences, walkways, overpasses, pedestrian bridges, protection elements, surface condition, rails, special signaling for drivers and pedestrians, inclusive mobility, ramps, stairs, ascent/descent vehicles, intersection crossings, traffic lights, continuity, access to buildings, affectations due to road density, conflicts with other road users, shared spaces with cyclists, situations and danger effects.

Vehicular Road Geometry

20	**Horizontal alignment:** curvature, minimum radii, degrees of curvature, deflection angles, cants, and visibility in curbs, vehicle instability, visibility.
21	**Vertical alignment:** maximum and minimum slopes, visibility, length of curves, mapping losses.
22	**Cross-section:** rails, special rails, lane widths, pumps, widening, rear widening, cross-section changes.
23	**Berms:** widths, obstacle, lateral slope, crossing.
24	**Curb:** width, depth, side slopes, counter curbs, crossing curbs, obstacles, crossings.
25	**Median strip:** width, obstacles, crossing, glare, unevenness.
26	**Curbside:** height, round edges, crossing.
27	**Drainage:** lateral location, height of heads, covers and crossing.
28	**Bridges and pontoon bridges:** width, day and night visibility, special signaling, fences, pedestrian crossings, front and back protection, transition elements.
29	**Lateral obstacles:** trees, posts, rocks, collision elements, crossing elements.
30	**Access:** road exchangers, access to properties, returns, acceleration and deceleration lanes, visibility, readability for drivers, functionality, operability, speed operations, ascent/descent ramps, intersections, junction areas, and traffic islands.
31	**Roundabouts:** radii, speeds of operation, visibility, incorporations, exits, ring lanes, special signaling, and pedestrian traffic.
32	**Running surface:** type, general and specific characteristics, zoning, vehicle-surface friction, surface drainage, flooding, surface uniformity, damage, and surface color, action of speed reducers, berms and rumble strips mainly.

Road Furniture

33	**Stops:** location, lateral separation, special signaling, refuge zones, capacity, structure, protection system, passenger ascent/descent zone.
34	**Urban tolls:** location, types, booths, speed, special signaling, protection for workers, refuges, traffic islands, collision shock absorbers.
35	**Redirection and containment elements:** types, location, heights, work area, dynamic reflection, rigidity, installation, embedment, length, terminals, transition elements, anchors, discontinuities, day and night visibility, uniformity.

36	**Collision shock absorbers:** location, level of containment, type, homogeneity, work area, installation, visibility, special signaling operating status.
37	**Traffic lights:** location, installation, visibility, special signaling, operability, phase operation, cycles, posts.
38	**Services:** gas stations, restaurants, mechanical workshops, location, special signaling, entry/exit of vehicles.
39	**Speed reducers:** measures of calm traffic, alert bands, justification, and functionality.
40	**Lighting:** need, type of lighting, school zones, pedestrian paths, intersection zones, pedestrian crossings, bridge areas, high risk sectors.
41	**Emergency vehicles:** site of locations, alarms, calls, special access, facilities for crossing, returns, location of service centers, travel times.

5.3.3 Detailed List for Client Verification

PPROJECT:
AUDITOR:
RSA STAGE:
DATE:

Question		Comments
1	Have all road users been considered?	
2	Have vulnerable users been considered?	
3	Have all vehicles on the road been considered?	
4	Have traffic volumes been considered?	
5	Has the vehicle composition been considered?	
6	Have the travel generating sites been taken into account?	
7	Was the day visit carried out?	
8	Was the night visit carried out?	
9	Has the design consistency been revised?	
10	Have the side areas to the road been revised?	
11	Has the running surface been checked?	
12	Have potentially dangerous obstacles been detected?	
13	Are there concerns about the environment of the road?	
14	Have the intersections been checked?	
15	Has the vertical signaling been revised?	
16	Has the road demarcation been revised?	
17	Has the temporary signaling been checked?	
18	Have traffic lights been revised?	
19	Has the risk factor been calculated for each insecure aspect?	

20	Have the factors that contribute to risk been reviewed?
21	Have the redirection and containment elements of the road been revised?
22	Have the evidences of the findings been presented?
23	Have recommendations been made on these findings?
24	Has the monitoring stage been established?