

## **Land Use Planning Measures Promoting Road Safety**

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## **Abstract**

The number of road victims is decreasing in Québec, despite the increase in the number of vehicles in operation and in the number of driver's licence holders. However, in 2015, there were still 361 fatalities, 1580 serious injuries and 35 400 minor injuries. Further efforts are thus necessary to improve the road safety record.

In that context, the integration of transportation planning and urban planning is a very promising course of action. The decisions regarding land use largely define travel needs, travel modes and, more particularly, traffic and safety conditions. Because these decisions are taken before the urban development of a territory and because they have a long-term effect, they may be an efficient way to prevent road safety issues.

The definition of general policies on land use, the delimitation of urbanization perimeters, and the localization of growth areas determine the volume of traffic on the road network and, consequently, the risks of collisions. Land occupation density also influences the frequency of accesses and intersections with the adjacent road which, as many studies have shown, has an impact on road safety.

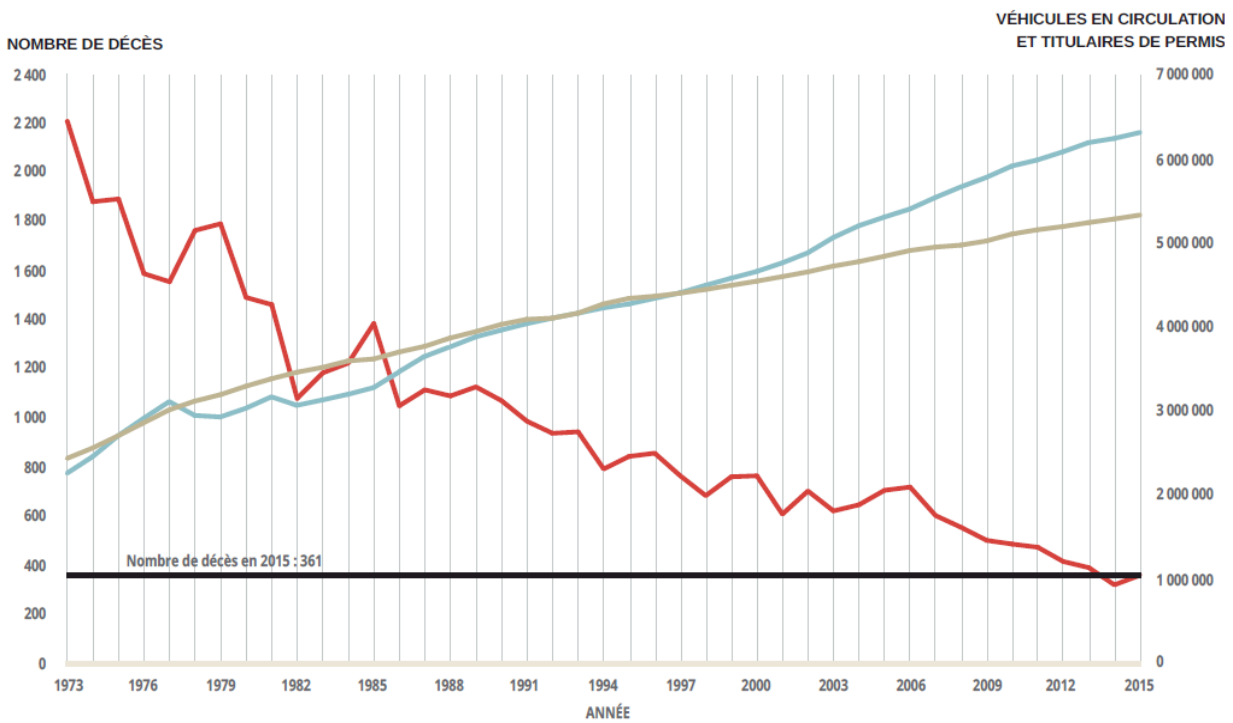
Some regional county municipalities (RCMs) have taken road safety in consideration when preparing their land use plan. Two examples will help highlight the most efficient land use planning measures to prevent road safety issues: Charlevoix-Est RCM and l'Assomption RCM.

# Land Use Planning Measures Promoting Road Safety

## 1. Road safety record in Québec

In Québec, the number of road collisions has been decreasing over the past decades, despite the increasing number of drivers and vehicles in operation. The year 2014 presented the lowest number of road victims since 1973 with 336 fatalities, 1570 serious injuries and 34 300 minor injuries (Fig. 1).

Figure 1. Evolution of the number of fatalities, vehicles in operation and driver's licence holders



Note : Depuis 1989, les nombres de décès excluent les victimes d'accidents n'impliquant que des véhicules utilisés hors du réseau routier.

■ Décès  
■ Titulaires de permis  
■ Véhicules en circulation

Source: Société de l'assurance automobile du Québec

The steady improvement of the road safety record since 2007 is due in part to the commitment of all the stakeholders, meeting in the Table québécoise de la sécurité routière (Québec Road Safety Task Force, TQSR). The role of this forum, which was created in 2005, is to make recommendations to the Minister of Transport. The group published three reports for a total of 73 recommendations, which led to the adoption of legal measures and the implementation of many other actions.

However, the number of road victims increased in 2015, with 361 fatalities, 1580 serious injuries and 35 400 minor injuries. This shows that more efforts and new approaches are needed to make roads safer. Land use planning measures are part of the avenues that need to be explored.

The integrated planning and transportation approach was actually the ninth recommendation of TQSR's second report: "Develop and implement an integrated approach to urban and regional planning and transportation by emphasizing active and alternative transportation modes at both the municipal and regional levels." (15)

More recently, the integrated approach to land use planning and transportation is advocated in the government's sustainable development strategy entitled *Stratégie gouvernementale de développement durable 2015-2020*, published in October 2015 (9), and in the *2030 Energy Policy*, adopted in April 2016, which promotes, as a means to act on the travel patterns of individuals and freight transportation, "the development of territories by planning workplaces, living environments and places of consumption so as to take into account the energy dimension." (7)

## **2. Land use planning and road safety**

The integrated approach to land use planning and road safety seems to be a promising avenue because these two fields are closely connected. The most innovative road safety strategies, such as strategies based on the Safe System approach (2,14), take into account the road-vehicle-user aspect, but also land use planning. The long-term objective of this approach is to eliminate deaths and serious injuries as a result of road collisions, by working on all the components of the system.

Several decisions define travel needs, travel modes, as well as traffic conditions, which all have an impact on users' safety and the functionality of the road network. Conversely, decisions made regarding road network planning have an impact on land use planning.

Proper land use planning may be an efficient way to prevent road safety problems in a sustainable way because the decisions can be taken before the urban development of a lot or an area, or before a new road is built. It is indeed important to intervene as soon as possible to integrate transportation and land use planning.

However, this integrated approach presents major challenges, mainly because of the number of parties involved, the distribution of jurisdictions among them and their sometimes competing interests.

The Québec province has over 1100 local municipalities gathered into 87 regional county municipalities (RCM) and two metropolitan communities: Québec and Montréal. Most local municipalities are small: the two thirds have less than 2000 inhabitants and only 10 cities have more than 100 000 inhabitants.

Land use planning is governed by the *Act respecting land use planning and development* (6); it is a shared responsibility between the provincial government and the municipalities. The government adopts policy directions regarding land use. Metropolitan communities must adopt a metropolitan land use and development plan, and RCMs must adopt a land use and development plan. Each of these documents must address land transportation issues. Lastly, local municipalities must adopt a planning program and by-laws (construction, zoning, subdivision, conditions for the issue of a building permit, etc.). A conformity mechanism ensures coherence between the objectives of each level of government.

Responsibility for the road network is shared between the ministère des Transports, de la Mobilité durable et de l'Électrification des transports (MTMDET) and the local municipalities. The Ministère is in charge of autoroutes and national, regional and collector roads, which represent about 29 000 km, while the local municipalities are in charge of the local road network located in their territory, which represents 105 000 km.

Many other actors are involved in the urban development and transportation management process, such as land owners (who can also be managers of transportation networks), promoters and residents living along roads.

The interests at stake can be major, particularly on the economic front. For example, a large-scale commercial project along a national road represents income for the promoter and the municipality concerned, but will increase the traffic flow, which could require infrastructure works that could be costly for the Ministère.

### **3. Land use planning measures promoting road safety in Québec**

The measures aimed at promoting safety on the road network, whether it is under the responsibility of a municipality or of the Ministère, include the definition of general policies on land use and the type of use allowed in each part of the territory, the delimitation of urbanization perimeters, the localization of growth areas and of major projects generating movements, land occupation density and lot subdivision rules. The terms and conditions for delivering planning permits can also be included in a process integrating road safety issues.

Provisions regarding these issues were adopted by several local and regional municipalities. Examples from two RCMs will be presented.

Situated north east of the Montréal metropolitan community, the l'Assomption RCM is made up of six municipalities and has a population of 120 000. With a continuous economic and demographic growth for decades and a territory located largely in a protected agricultural zone, the RCM must deal with densely developed urban areas where vacant lots are rare. A significant increase in the demand for transportation, which has been almost entirely based on the use of cars, also causes increasingly more frequent congestion problems despite major road infrastructures. The revised land use and development plan adopted by the RCM in 2012 defines clear objectives in response

to the economic and demographic growth, and encourages the use of public transport over cars (12).

The Charlevoix-Est RCM, located in a rural and tourist area, encompasses seven municipalities and 16 000 residents, of whom 9 000 live in the city of La Malbaie. Two national roads (138 and 170) and one regional road (362), under the jurisdiction of the MTMDET, pass through the territory. As urban development along these roads and the multiplication of direct accesses started presenting an ever-growing road safety risk, the RCM adopted, in 1995, robust provisions to restrict development and control accesses. The provisions were later integrated into the RCM's land use and development plan (13).

### 3.1 Transportation planning

Land transportation planning must necessarily be part of an RCM land use and development plan. RCMs must plan the organization of road and railway networks. It is an opportunity to promote more sustainable mobility, ensure functionality of the road network and increase public transportation ridership.

The main measures aimed at integrating transportation and road safety include functional classification, street networks in new urban housing developments and the inclusion of different networks (bicycle, off-highway vehicles, trucks, etc.).

#### *Functional classification of the road network*

Establishing a functional classification of the road network is an essential step in managing and planning transportation. Classifying the road network helps standardize and rationalize the operations required on the network, taking into account the network's main function in terms of mobility (local or through traffic) and access to adjacent properties.

The primary road network, which is under the responsibility of the Ministère, includes autoroutes, national roads, regional roads and collector roads. Municipalities classify the network under their responsibility into three main categories: arterial roads, municipal collectors and local roads.

#### *Street networks in new urban housing developments*

This network should be designed according to functional classification principles, by ensuring proper connectivity between streets and facilities for pedestrians and cyclists. Guidelines on street geometric design can also be adopted.

If associated with measures providing for proper density and diversity of uses in new areas, a good design of the transportation network will provide residents with the choice between different transportation modes for short-distance trips. These could be made on local streets without requiring the use of freeways or arterial roads.

### *Integrating different networks*

Land use plans include the planning of networks for bicycles and off-highway vehicles. It is crucial that the layout of the paths ensure users' safety, particularly when they cross the primary road network.

In addition, municipalities can prohibit vehicular traffic, such as heavy vehicle traffic, on public roads under their responsibility. The definition of a heavy vehicles network, which is aimed at directing them to the most appropriate road network, helps find a balance between the needs related to economic development and the necessity to ensure road users' mobility and safety. The definition of the heavy vehicles network in land use planning helps harmonize the traffic rules for these vehicles in primary and municipal road networks, in the various municipalities and in the neighbouring RCMs.

### *Example*

In its land use and development plan, the l'Assomption RCM adopted regulations concerning road network design and public transportation: "When designing the road network for any new urban sector to be developed, the municipalities must promote mixed use of the public right-of-way for all collector and arterial roads in order to accommodate a public transportation circuit. The municipalities must specifically give priority to the safety and comfort of pedestrians and cyclists when planning public spaces and the road network." (12).

### *Road safety benefits*

In terms of road safety, an increase in active transportation (walking, cycling) and a decrease in motorized traffic usually have a positive impact. Researches suggest that in cities with the highest mode share for walking and cycling, the risks of fatal and severe injuries crashes for vehicle occupants, pedestrians or cyclists are lower than in cities where the vehicle mode share is higher. The street network is also denser and connectivity is greater in cities having the largest number of pedestrians and cyclists (8).

## 3.2 Defining urbanization perimeters

In their land use plans, RCMs must define the urbanization perimeters. These perimeters include already urbanized spaces and spaces where urban extension will be favoured.

A good practice consists in avoiding linear perimeters along roads, in particular transit roads, to prevent too many private accesses which could compromise road safety and

functionality. It is important to favor compact villages or built-up areas equipped with a proper network of local streets and collector roads that connect to transit roads.

Moreover, urbanization perimeters along transit roads should not be too long. If a 50 km/h speed limit zone is too long and not consistent with the environment, transit drivers tend not to respect the limit. In addition, travel times between regions increase. Lastly, clear boundaries should be favoured between rural and urban environments.

### *Example*

In its land use plan, the l'Assomption RCM indicated its intention to maintain occupation density and limit urban spread (figure 2).

### *Road safety benefits*

Road safety on transit roads through urban areas is a key issue: 23% of the injury crashes that take place on the road network under the responsibility of the MTMDET occur in urban areas<sup>1</sup>. As speed is one of the main factors of crashes, it is also essential that drivers respect the 50 km/h speed limit.

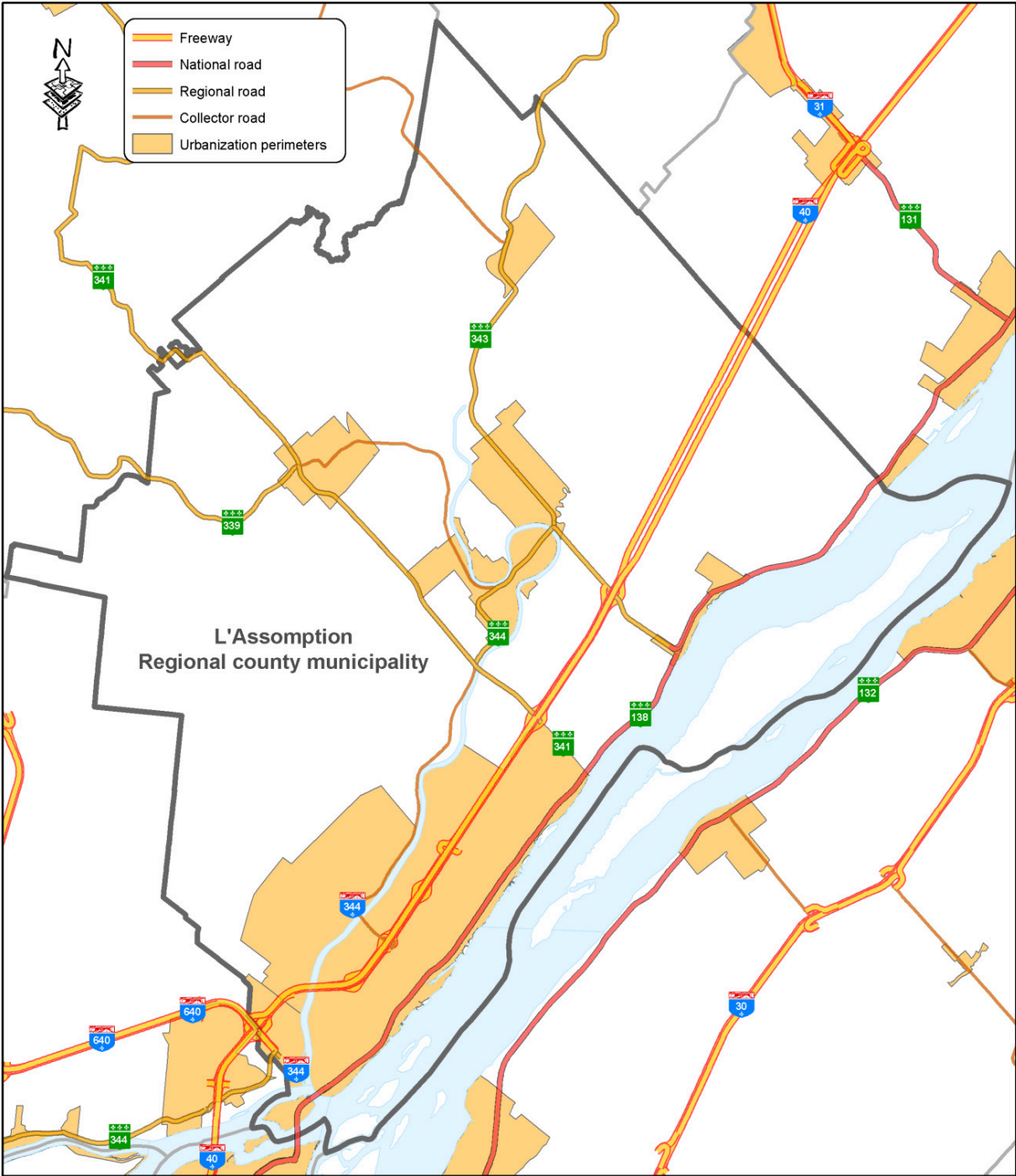
In urbanized areas, transit traffic adds to local traffic generated by dwellings, businesses and service outlets, as well as pedestrians and cyclists. If the urban population density is high enough, roads can be laid out so as to accommodate traffic for all these users in good safety conditions; a 50 km/h speed limit and equipment such as sidewalks, bikeways, traffic lights and urban equipment are generally recommended (11). A short length of urbanization perimeters along transit roads will facilitate such a redevelopment.

Along roads, clear boundaries between different environments will help motorists adjust their driving behaviour, including their driving speed. Clear boundaries between rural and urban environments facilitate the implementation of a gateway that reinforces this message. The distinction is even more important in the case of heavy traffic volumes on transit roads.

<sup>1</sup> Data from the Société d'assurance automobile du Québec, 2010-2012. Processed by the ministère des Transports. Roads with a speed limit of 60 km/h or less.



Figure 2. Urbanization perimeters in the l'Assomption RCM



### 3.3 Localization of projects generating significant movements

RCMs must determine, in their land use plans, the general policies on land use, that is, the current and future land use designation of each part of its territory, namely residential, commercial, industrial, recreational, agricultural and forest. They also define the uses compatible with land use designation.

The localization of urban growth areas and of projects generating significant movements should be selected taking into account the capacity of the road network and the potential impacts on road safety. This way, it will be possible to anticipate the work required to maintain good safety conditions before buildings are constructed.

For this reason, RCMs may require, in their land use plans, that a promoter conduct a traffic and safety study before delivering the planning permit required for the construction of a major project, such as a large shopping centre. RCMs or municipalities can also carry out this type of studies before deciding on some general policies on land use.

#### *Example*

In its land use and development plan, the l'Assomption RCM defines clear objectives in response to the economic and demographic growth, and encourages the use of public transportation over cars. It also adopts several provisions concerning projects that generate movement of people.

“Any new development or redevelopment project that creates a significant volume of movement of people must, before approval by the municipality, be supported by an assessment of access to transit and an assessment of the impact on traffic flow and safety and of the road network capacity to manage increased traffic. (...) This assessment must, prior to receiving the authorization by the municipality, have received notice from the regional public transit network of the l'Assomption RCM.” (12)

#### *Road safety benefits*

A traffic and safety study is used to verify the capacity of the existing road network to absorb additional movements generated by the project, for the different transportation modes (vehicles, public transportation, walking, cycling), and to analyze various scenarios aimed at maintaining a safe and efficient road network.

### 3.4 Provisions regarding subdivision, zoning and building

In their land use plans, as well as in their planning program and by-laws, regional and local municipalities define standards regarding minimum lot dimensions, land use, parking, construction of buildings as well as private accesses and intersections along roads. These provisions, usually adapted according to the functional classification of the road network and the local environment, contributes to a proper management of

accesses and intersections, whose impact on safety is well documented (1, 3, 4, 16, 17) and, as such, are an integral part of the road safety strategy

The most efficient land use planning measures in rural areas, for lots along transit roads with high traffic volume and vehicles driving at high speed, are as follows:

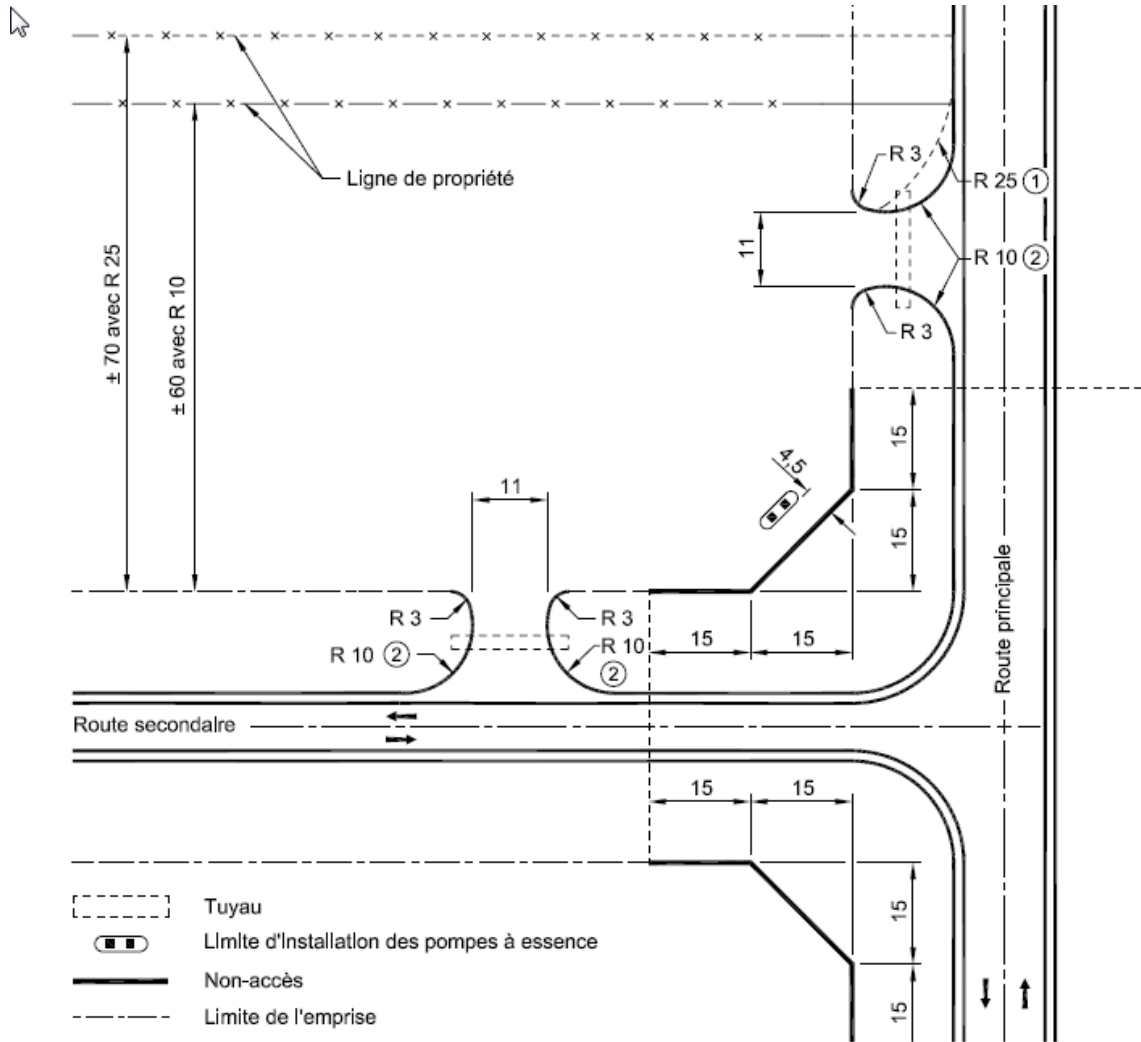
- Impose sufficient minimum width for lots and restrict the number of accesses to one per lot (except for certain large surface businesses). Subdivision standards are particularly efficient as they help prevent the need for new accesses before the lots are defined and built.
- Require minimum spacing between intersections.
- Restrict residential, institutional, commercial and industrial use with direct access to the road, and limit land occupation density so as to restrict as much as possible new movements (vehicles, pedestrians, cyclists) and risks of conflicts between entry and exit manoeuvres on the road.
- Impose sufficient setback for the construction of buildings, so that vehicles always enter the road moving forward, with good visibility on traffic, and not backward.
- Regulate the location of accesses to a lot so as to have the best visibility conditions when entering or exiting the lot.
- Impose geometric design standards for entries, in compliance with the MTMDET standards (figure 3).

### *Example*

Several of these measures are in the land use and development plan revised of the Charlevoix-Est RCM. They are applicable to land along national and regional roads (transit roads under the management of the MTMDET) and are adapted to four categories of road corridors defined by the RCM: urban corridors (29 km), two types of rural corridors, corridors outside of urbanization perimeters (105 km) and priority corridors (17 km) (see Figure 4).

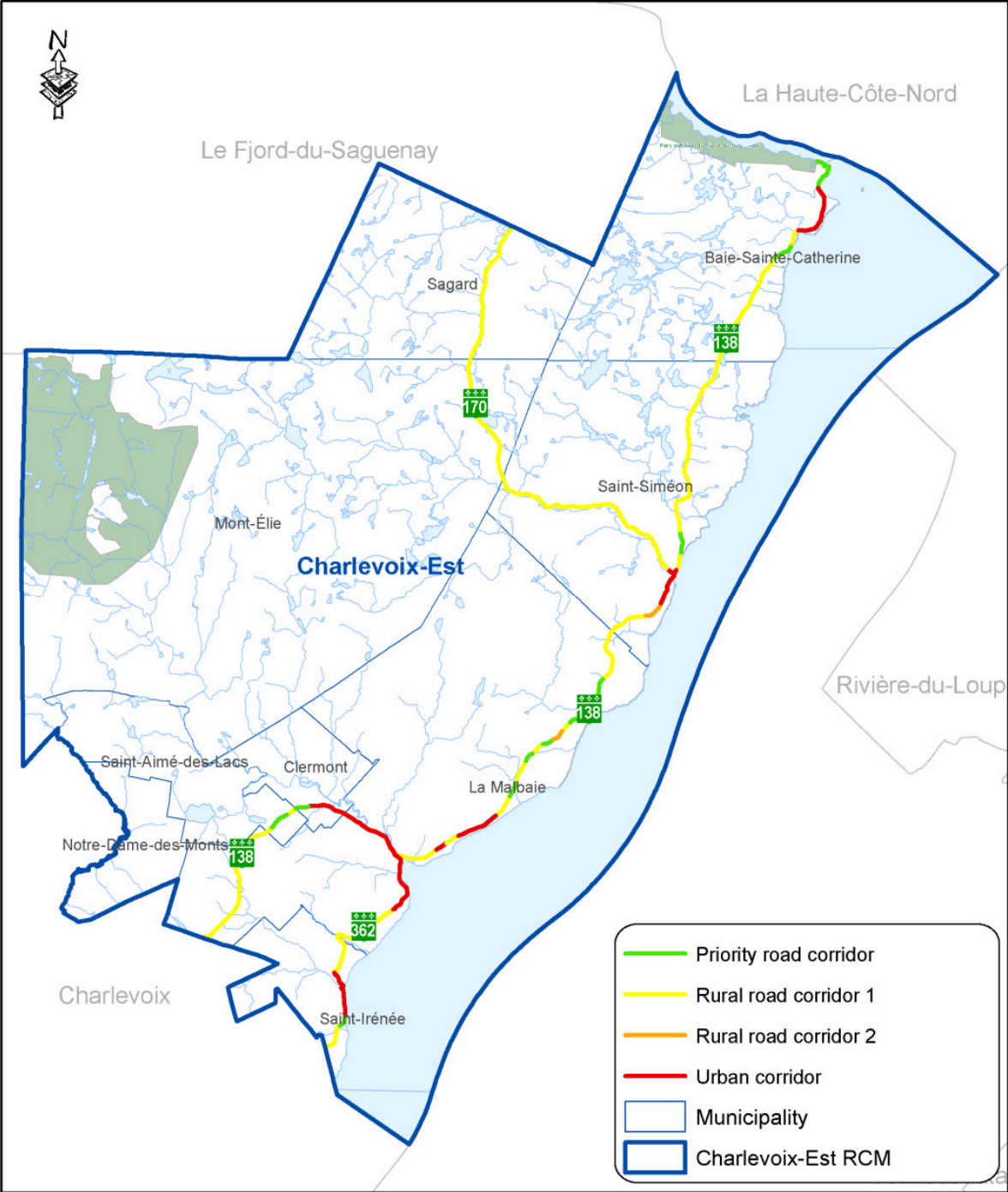
Priority corridors are segments where the geometry, topography and visibility present significant limitations to the addition of accesses and the development of residential, commercial, public or institutional buildings. More restrictive provisions apply to this type of sector.

Figure 3. Road design standards for property access.  
Commercial access in rural areas at intersection.



Source : Ministère des Transports, de la mobilité durable et de l'électrification des transports. *Normes, Ouvrages routiers. Tome 1. Conception routière.* Chapitre 10. Accès. Dessin 008.

Figure 4. Road corridors along roads of the primary road network. Revised land use and development plan of the Charlevoix-Est RCM, 2012



### *Road safety benefits in the Charlevoix-Est RCM*

An evaluation conducted by the Ministère showed that the measures in effect since 1995 along national and regional roads in the territory of the Charlevoix-Est RCM proved to be effective in controlling urban development and accesses, particularly in priority corridors. In 2012, building density is much lower in rural areas (5.5 built lots per km) than in urban areas (39 built lots per km). It is a bit less dense in priority corridors (4.9 built lots per km), where measures are stricter, than in rural corridors (5.6 built lots per km)<sup>2</sup>.

Between 2002 and 2012, the increase in the number of accesses and intersections in priority and rural corridors is virtually nil (1%), while in urban areas, it is 8%. In 2012, access density in priority and rural corridors is lower than 10 accesses per km (see Table 1), which is representative of the majority of primary roads in rural areas in Québec.

Measures adopted by the RCM and enhancements made to infrastructures by the Ministère have contributed to a good level of safety on national and regional roads in the Charlevoix-Est RCM. The accident rate and the injury accident rate on the RCM's national and regional roads, whether in urban, suburban or rural areas, are lower than the average accident and injury accident rates for roads of the same categories in similar areas (see Table 1).

Priority corridors present higher accident rates than rural corridors, even if the access frequency is slightly lower. By definition, these corridors are road segments where the geometry, topography and visibility present significant limitations.

#### 3.5 Issuance of planning permits

Owners who want to subdivide their land or erect a building must obtain a permit issued by the municipality. In addition, if the land is located along a road of the primary network, owners who want to build an access to their property must also obtain an authorization from the Minister. Under the *Act respecting roads*, where the Minister “authorizes the construction of an access, he shall determine its location and the requirements of its construction.”

The harmonization of permit delivery procedures is an effective means of collaboration among the different parties, which will help better integrate road safety issues into an urban development project. For example, local and regional municipalities may require that a Ministère's authorization or opinion regarding road access be submitted with a planning permit application, when the land concerned is located along a road of the primary network.

<sup>2</sup> Assessment roll data from the Charlevoix-Est RCM. Processed by the MTMDET for lots inventoried on a land strip of 100 m on both sides of the road.

Table 1 - Number of accesses and safety indicators on the primary road network of the Charlevoix-Est RCM and of Québec

National and regional roads in the RCM					Two-lane national and regional roads in Québec	
		Number of accesses per km (2012)	Accident rate*	Injury accident rate**	Average accident rate*	Average injury accident rate**
Priority corridors	Total	7.6	1.24	0.24		
	90 km/h zones		1.06	0.19	1.04	0.29
Rural Corridors	Total	9.2	1.01	0.24		
	90 km/h zones		0.88	0.22	1.04	0.29
Urban corridors	Total	32.5	1.59	0.31		
	50 km/h zones		2.46	0.41	2.86	0.52
	70 km/h zones		1.42	0.30	1.48	0.39
Total		11.7	1.24	0.26		

\* Number of accidents per million vehicle.kilometers.

\*\* Number of injury accidents per million vehicle.kilometers.

Sources:

Accesses: 1999-2000 visual surveys from air photos of the ministère des Ressources naturelles, 2005-2006 low level air photos of the ministère des Transports, 2012 orthophotos of the Communauté métropolitaine de Québec and 2011-2012-2013 low level air photos of the ministère des Transports. Inventory of intersections and accesses to lots, whether built upon or not.

Accidents: data from the Société de l'assurance automobile du Québec, 2010-2012.

Processed by the MTMDET.

Traffic volume and speed limits: MTMDET.

### Example

The Charlevoix-Est RCM provides that "in road corridors of routes 138, 170 and 362, new thoroughfares with an intersection with these roads cannot be created by cadastral operation without a written notice from the ministère des Transports regional branch, stating that the planned thoroughfare will not increase the risk of crashes in the sector and will not have a significant impact on the road's service level (fluidity, safety, speed, etc.)." (13)

### *Road safety benefits*

Requiring the Minister's opinion or authorization concerning the road access at the time of an application for land subdivision or the construction of a building helps take into account road safety issues before the project is authorized by the municipality. The project can then be adjusted if necessary, for example, by locating the access at the most appropriate place on the site.

## **4. Conclusion**

In Québec, the number of fatalities and injuries caused by road collisions has been constantly decreasing over the past decades, with sometimes increases from one year to the next, however. To keep improving the road record, innovative actions are required and land use planning measures are part of it. The interconnection between land use planning and transportation networks are increasingly recognized.

There are numerous examples of land use planning measures adopted by local and regional municipalities in Québec. The definition of general policies on land use, the delimitation of urbanization perimeters, and the localization of growth areas determine the volume of traffic on the road network and, consequently, the risks of collisions. Land occupation density along a road also influences the frequency of accesses and intersections with the adjacent road; many studies have shown the impacts of this aspect on road safety.

A study conducted in a regional county municipality in Québec corroborates the results of other similar studies. These results confirm that land use planning should be considered as a promising avenue for improving road safety in the long term.

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