



## D2.3 Data model schema report

**FORCIP+:** Forest Roads for Civil Protection



<b>Project title</b>	Forest Roads for Civil Protection (FORCIP+)
<b>Call identifier</b>	Call for proposals 2015 for prevention and preparedness projects in the field of civil protection and marine pollution
<b>Project acronym</b>	FORCIP+
<b>Starting date</b>	15-01-2016
<b>End date</b>	15-07-2017
<b>Funding scheme</b>	Directorate General Humanitarian aid and civil protection - ECHO
<b>Contract no.</b>	ECHO/SUB/2015/718661/PREP20
<b>Deliverable no.</b>	D2.3
<b>Document name</b>	FORCIP+D2.3.pdf
<b>Deliverable name</b>	Data model schema report
<b>Work Package</b>	Task B
<b>Date</b>	15-06-2016

**FORCIP+ Consortium**



**CO**  
**The Aristotle University (AUTH)**  
**Greece**



**BE4**  
**Centro de Servicios y Promoción Forestal y de su Industria**  
**de Castilla y León (CESEFOR)**  
**Spain**



**BE3**  
**Slovenian Forestry Institute (SFI)**  
**Slovenia**



**BE1**  
**Office National des Forêts (ONF)**  
**France**



**BE2**  
**Università degli Studi di Firenze - Dipartimento di Gestione**  
**delle risorse Agrarie, Alimentari e Forestali (UNIFI)**  
**Italy**

## ABBREVIATIONS

Term	Explanation
1NF	First Normal Form
FTC	Firefighting traffic capacity
SDB	Spatial data base



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FORCIP+ ECHO/SUB/2015/718661/PREP20 11 -12/02/2016

## **EXECUTIVE Summary**

The scope of this deliverable is to set a common data model directly linked with firefighting activities, either fire prevention or fire suppression. Partners will create an inventory in each country using this data model, so that it can be used as a common reference for these emergencies in different regions of Europe.

## 1. INTRODUCTION

The common data model is intended to be a useful tool that contributes to the standardization progress either in road network inventories or firefighting emergencies.

The data model is a graphic and alphanumeric representation of the road network considered essential in forest fire situations, but still useful for any other forest emergency.

The inventory includes not only the forest road network but also the roads which connect forest areas with the main road network (public roads). This network will not be a subject of inventory in this project, but it has to be taken into account since it is impossible to perform network analysis without it.

The data model focuses on the functional aspects with regard to the spatial occupation looking for a simplification of the reality. Therefore only the main axis of the road will be collected avoiding the inclusion of the road surface, since polygons would increase the difficulty of editing and data maintenance, without adding extra information. Consequently, the representation of each road will be a line.

It is important to highlight that the road network will be split into segments of homogeneous road sections with the same traffic capacity, thus it will be possible to distinguish the best route or even the accessibility of the forest based on the type of vehicle considered.

In order to complete the relevant information with regard to forest roads and their capacity to support the movement of different types of vehicles and meet the firefighting requirements, the data model includes the possibility of collecting complementary infrastructures.

The same idea of reality simplification will be applied in the case of infrastructures, so it implies a prompt representation of them.

## 2. ARC-NODE STRUCTURE

Connectivity is defined through the arc-node structure. Each arc will be defined by two endpoints: the **from-node** indicating where the arc begins and the **to-node** indicating where it ends (Figure 1). Connection is determined by common nodes, if they share a common node it will be possible to turn on this point and travel along the other segment. On the contrary, if they do not share a common node it will mean that they are in different levels.

The **basic unit of inventory** has been set on the basis of the *specific attribute* Firefighting traffic capacity (*FTC*), this way, a change in the value of this attribute will determine the end of the road segment and a node will be placed.

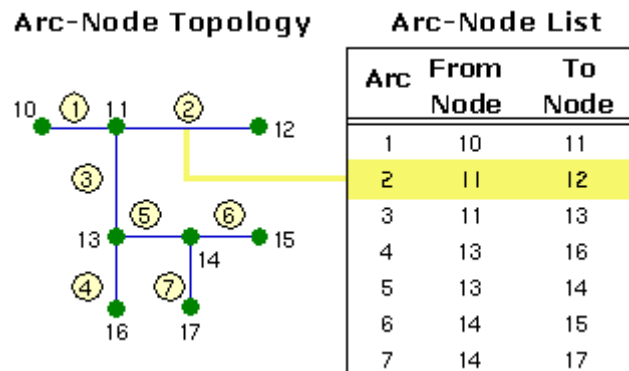


Figure 1 Arc Node Structure

In this case, arcs 1, 2 and 3 are connected since they share a common node.

## 3. DATA MODEL

The data model represents the first step in the generation of the Road Inventory. In this stage the *logical data model* which symbolizes the data organization and its relationships (serves as the basis for the creation of the physical data model), and the *physical data model* (derived from the logical data model) which consists of a detailed view of the data type and its description as well as the database-specific implementation of the logical data model are defined.

### 3.1. Physical data model

In this section, the objects, elements and its attributes, which altogether comprise the Spatial Data Base (SDB), are represented. They consist of:



1. **Base cartography layer:** the layer that results from B.2. Action (see” A cartography base. Report of sources used” deliverable).
2. **Model definition:** the Road Network will contain the following elements:
  - Public Roads object: linear geometry – external source.
  - Inventory roads object: linear geometry – inventory source.
  - Infrastructure objects: point geometry – inventory and external sources.
    - i. Water point
    - ii. Hydrant
    - iii. Passing place
    - iv. U\_Turn area
    - v. Bottle neck
    - vi. Crossroad

**Note:** each point type has been considered as a separate object with its own attribute table instead of one point object (with an attribute “Type”) due to the different nature of the selected objects. In addition, the selected option allows for:

- *keeping customized information for each object*
- *collecting more information with more attributes*
- *maintaining the data easier since the information is less confusing*
- *enhancing the possibility to extend the data model in the future*

Linear objects have a correlation with the real transport network which supports the traffic. For these objects there is a need to know their condition, connection, main characteristics and auxiliary infrastructure or limiting events (bottle necks) that could lead to modification of their traffic capacity. Linear objects are made up of segments (minimum functional unit of the network).

Infrastructure and bottle necks have a special nature; therefore they will be represented as a separate point layers. To improve the accuracy of this information, they will be provided with their own entities, since considering them as part of the road characterization would involve the loss of their geographical location.

#### **Public Roads:**

It is very important to set the external data source for each partner that will be used in the project **to connect with** the inventory roads. Based on the alternative selected the attributes were chosen.

The selected source must meet the requirements for its use in the Satellite Navigation System requirements.

### **Inventory Roads:**

This object represents all the different roads collected in the inventory needed to fulfill the objectives of the project Forcip+. The following table shows the attributes considered in order to characterize the roads.

#### ***TB\_Inventory Road***

<b>Field Name</b>	<b>Field Description</b>	<b>Definition</b>	<b>Domain</b>
Id	Segment code	Integer	-
Name	Traditional road name	Text	-
FTC	Firefighting traffic capacity	Text	FTC
Length	Segment length	Decimal	-
Date	Inventory date	Date	-

In addition some other information will be collected in the field with regard to roads (related with this object by Id, see Logical Data Model section):

Domains and related tables mentioned in Domain column are displayed in the logical data model and explained in the data dictionary section.

- ***TB\_Restriction***: in which information related with possible traffic restrictions in the road will be collected.
- ***TB\_Com\_Coverage***: in which information about the existence of accessible communication networks will be collected.
- ***TB\_Structural***: in which information about the structural characteristics of the road will be given.

### **Infrastructure and bottle necks:**

Infrastructure and limiting events represent point nature entities but still interesting enough to be collected because of their influence in the traffic circulation (passing areas, bridges, etc.) or in emergency situations (fire forest fighting – water points).

The following tables contain the attributes considered for each point entity:

**Water point**

Field Name	Field Description	Definition	Domain
Id	Entity code	Integer	-
Water_Capacity	Water storage capacity of the equipment	Decimal	-
Date	Inventory date	Date	-

**Hydrant**

Field Name	Field Description	Definition	Domain
Id	Entity code	Integer	-
Date	Inventory date	Date	-

**Passing place**

Field Name	Field Description	Definition	Domain
Id	Entity code	Integer	-
Date	Inventory date	Date	-

**U\_Turn place**

Field Name	Field Description	Definition	Domain
Id	Entity code	Integer	-
Vehicle	Type of vehicle capable to turn back	Text	-
Date	Inventory date	Date	-

**Crossroad**

Field Name	Field Description	Definition	Domain
Id	Entity code	Integer	-
Date	Inventory date	Date	-

**Bottle neck**

Field Name	Field Description	Definition	Domain
Id	Entity code	Integer	-

Type	Type of limiting event	Text	Bottle Neck_Type
Date	Inventory date	Date	-

The image below represents the **Spatial Database Repository** and the elements that make it up:

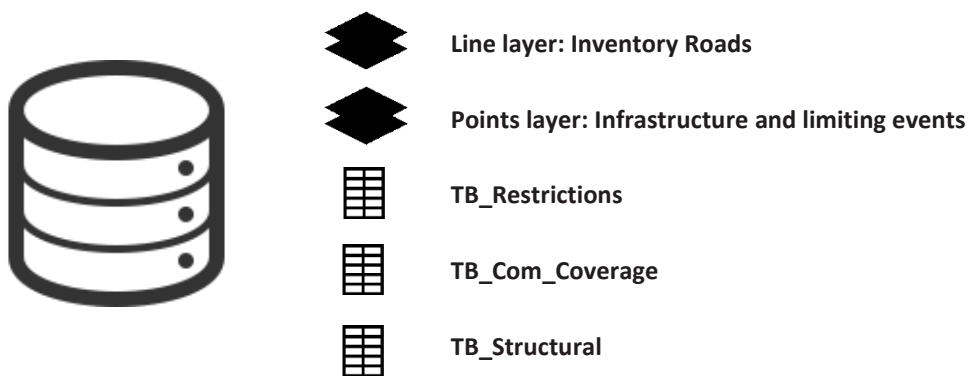


Figure 2: Spatial Database Repository

### 3.2. Logical data model

The relational model separates the logical design from the physical design. With the objective of minimizing data redundancy we follow the database normalization standards. Normalization involves decomposing a table into less redundant tables without losing of information.

**Note:** The objectives of normalization beyond 1NF (First Normal Form) were stated as follows by Codd:

1. To free the collection of relations from undesirable insertion, update and deletion dependencies;
2. To reduce the need for restructuring the collection of relations, as new types of data introduced, and thus increase the life span of application programs;
3. To make the relational model more informative to users;

The following figure shows the logical model schema:

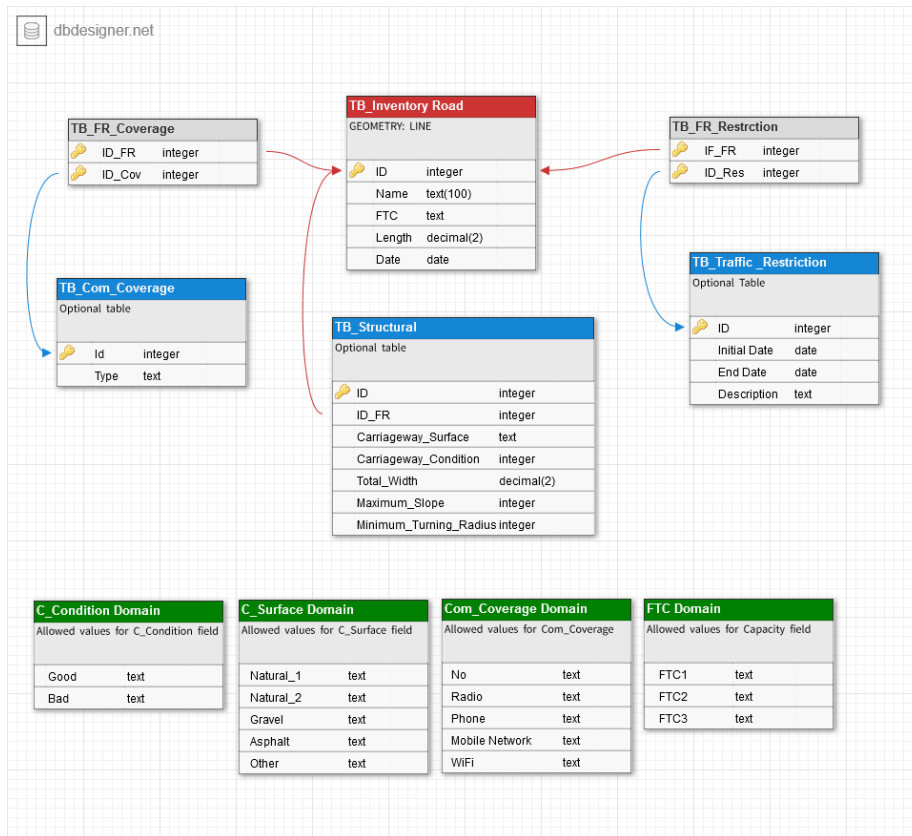


Figure 3: Logical Model – inventory roads

The above figure contains the logical data model related to the inventory roads and to the different information that can be included.

The next figure reflects the point nature objects. The link with the inventory roads will be just spatial, in other words, the relationship between roads and their infrastructure or limiting events will be reflected by their spatial positioning, avoiding alphanumeric links.

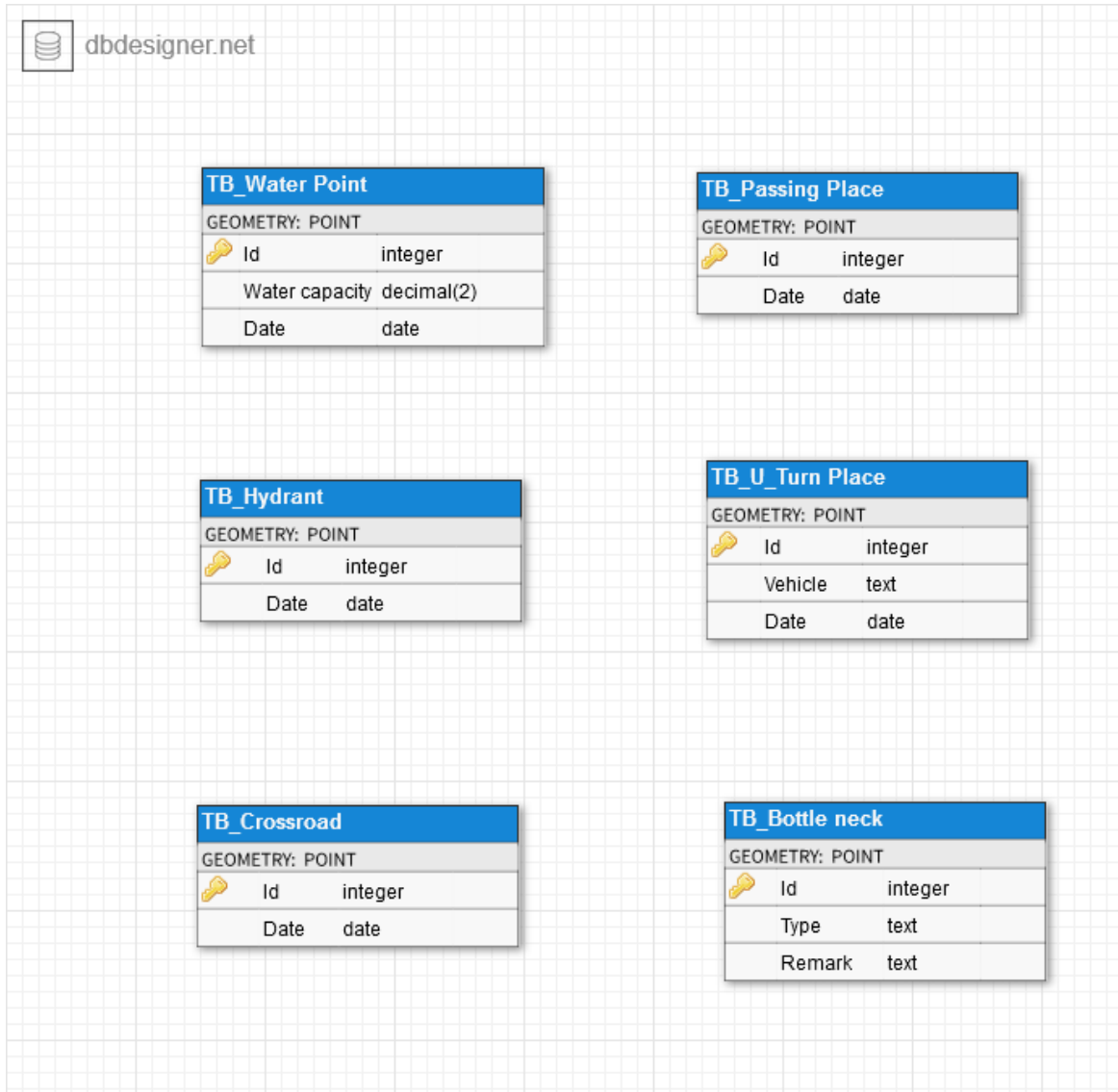


Figure 4 Logical model - infrastructures

#### 4. DATA DICTIONARY

The data dictionary comprises the description and explanation of the elements from the data model (linear and point elements and its fields). It can be considered as justification of their selection.

<b>Element</b>	<b>Segment road object</b>
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<b>Definition</b>	Lineal element which is the minimum functional unit of the network. In general terms, a segment is an entity located between two nodes. These nodes will be determined by the FTC attributes or dead ends.
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<b>Geometry</b>	Line
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<b>Attributes</b>	Id, Name, Type, FTC, Length, Date
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<b>Element</b>	<b>Point object</b>
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<b>Geometry</b>	Point: Water point, hydrant, passing place, U_Turn place, crossroad, bottle neck
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#### TB\_Inventory Roads attributes

**Id**

Definition:	Record Id. It is automatically given by the system. It is unique.
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Type of information:	Numeric
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**Name**

Definition:	Traditional road name. In case we can assign a name, it could be interesting from the point of view of their use for communications purposes to external personnel.
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Type of information:	Text
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<b>FTC</b>	<b>Firefighting traffic capacity</b>
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Definition	It refers to the capacity of the road to support different kinds of traffic. In conventional roads it is presumed that all types of vehicle can use them, but due to the specific characteristics of this network it is easy to find roads where only
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certain ground means are capable to go through them. This classification addresses this issue.

Type of information	Text	
Domain	FTC1 – high	Those which meet the FTC1 requirements
	FTC2 – medium	Those which meet the FTC2 requirements
	FTC3 – low	Those which meet the FTC3 requirements

In order to get the different values for the FTC attribute a definition was established for each level of traffic capacity .The following table contains the definition for each one:

	Structural parameters	Infrastructure associated parameters	
Vehicle capacity		Passing areas	U_Turn Place
FTC1	Forest roads which allow all kinds of firefighting vehicles (gondola included) to drive along them.	When needed	At the road/segment end (dimensioned to all types of vehicles)
FTC2	Forest roads which allow suppression trucks (loaded with water) to drive along them. These include vehicle classes V2 and V3 (see below).	When needed	At the road/segment end (dimensioned to suppression trucks of 6-7 m length)
FTC3	Other characteristics allowing at least a light firefighting vehicle to drive on it. Only vehicles of V3 class can drive along them.		

**NOTE:** The presence of bottle necks (limitation of weight, height, width, difficulties to access) will make the road (or stretch) drop in the classification until the level of vehicles involved can use it.

Once we had information about different forest firefighting vehicles from each partner we established the vehicles classification (the vehicle classification is addressed in the deliverable D.2.2: Analysis of fire forest emergencies requirements, annex 1 and in task C1: Good practice report: Building and maintenance). Therefore we get the connection between vehicles and the roads they can access.



Taking into account the 5 vehicles levels (annex 1, D.2.2) it is possible to sum up the following categories:

- V1 – 1<sup>st</sup> order: include vehicle level 4 and 5
- V2 – 2<sup>nd</sup> order: include vehicle level 2 and 3
- V3 – 3<sup>rd</sup> order: include vehicle level 1

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### Length

Definition	Segment length
Type of information	Numeric

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### Date

Definition	Inventory date. It is an essential requirement to know the date of the information, especially for future updates.
Type of information	Date

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The rest of information gathered in the field and related with inventory roads it is presented in the next tables: TB\_Restrictions, TB\_Com\_Coverage and TB\_Structural. This information is optional and it is linked to the main table (TB\_Inventory roads) with the Id attribute. They don't have geometric attribute.

**TB\_Restrictions:** Possible restrictions can be found in rural roads due to different causes. Since it is possible that a specific segment has more than one restriction a related table which contains fields to state dates and comments has been considered.

**TB\_Com\_Coverage:** Since it is possible that a specific segment has more than one type of communication mode a related table which contains fields to state the different types we can find in a segment has been considered.

**TB\_Structural:** It contains the information related with the structural parameters of the road. The relationship will be 1:1 since this data will be referred to each segment created with the basis of the segmentation.

## TB\_Restictions Attributes

### Id

Definition	Record Id. It is automatically given by the system. It is unique.
Type of information	Numeric

### Initial Date

Definition	Initial date of the restriction
Type of information	Date

### Final Date

Definition	Final date of the restriction
Type of information	Date

### Description

Definition	Description of the cause.
Type of information	Text

## TB\_Com\_Coverage Attributes

### Id

Definition	Record Id. It is automatically given by the system. It is unique.
Type	Numeric

### Type

#### Communication coverage network

Definition	Type of communication coverage. This information can be used to set waiting areas for firefighting vehicles or in other network analysis.	
Type	Text	
Domain	No	No possibility of communication
	Radio	Possibility of communication via radio
	Phone	Possibility of communication via phone
	Mobile Network	Possibility of communication via Internet (mobile network)
	WiFi	Possibility of communication via Internet (WiFi)

## TB\_Structural Attributes

### Id

Definition	Record Id. It is automatically given by the system. It is unique.
Type of information	Numeric

### ID\_FR

Definition	Related with Inventory Road object (Id)
Type of information	Numeric

### C\_Surface

#### Carriageway surface

Definition	This attribute describes the structural material of the carriageway. It is useful to give an overall idea of the road. It adds extra information.	
Type of information	Text	
Domain	Natural_1	Silty clay
	Natural_2	Rocky ground
	Gravel	Gravel or similar
	Asphalt	Bitumen-based material
	Other	Other type of material

### C\_Condition

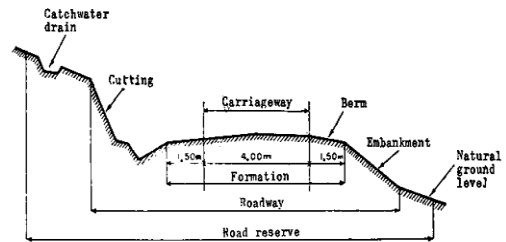
#### Carriageway condition

Definition	This attribute expands the C_Surface information. It is an assessment of the overall conservation status. It is useful to know where it is foreseen future accessibility problems.	
Type of information	Text	
Domain	Good	No problems for vehicles circulation in the near future
	Bad	Problem for vehicles circulation

**Total Width**

Definition Segment width. Including berms.

Type of information Numeric



**Maximum slope**

Definition Maximum slope of the segment. In percentage. Closely related to the vehicle characteristics. It can be a limiting event to traffic.

Type of information Numeric

**Minimum turning radius**

Definition Minimum turning radius. Its knowledge is important when vehicles must pass through sections with tight curves.

Type of information Numeric

**Point objects:**

**TB\_Water point**

**Id**

Definition	Record Id. It is automatically given by the system. It is unique.
Type of information	Numeric

**Water capacity**

Definition	The capacity in liters of the infrastructure.
Type of information	Numeric

**Date**

Definition	Inventory date. It is an essential requirement to know the date of the information, especially for future updates.
Type of information	Date

## TB\_Hydrant

### Id

Definition Record Id. It is automatically given by the system. It is unique.

Type of information Numeric

### Date

Definition Inventory date. It is an essential requirement to know the date of the information, especially for future updates.

Type of information Date

## TB\_Passing Place

### Id

Definition Record Id. It is automatically given by the system. It is unique.

Type of information Numeric

### Date

Definition Inventory date. It is an essential requirement to know the date of the information, especially for future updates.

Type of information Date

## TB\_Crossroad

### Id

Definition	Record Id. It is automatically given by the system. It is unique.
Type of information	Numeric

### Date

Definition	Inventory date. It is an essential requirement to know the date of the information, especially for future updates.
Type of information	Date

## TB\_U\_Turn Place

### Id

Definition	Record Id. It is automatically given by the system. It is unique.
Type of information	Numeric

### Vehicle

Definition	Vehicle that is able to turn back in this U_turn place.
Type of information	Numeric

### Date

Definition	Inventory date. It is an essential requirement to know the date of the information, especially for future updates.
Type of information	Date



**TB\_Bottle Neck**

**Id**

Definition	Record Id. It is automatically given by the system. It is unique.
Type of information	Numeric

**Type**

**Limiting event**

Definition	Type of limiting event. These events can affect the regular circulation of the road. They can be infrastructure or other.	
Type	Text	
Domain	Bridge	Narrowing, weight limitation
	Tunnel	Narrowing, height limitation
	Barrier	Blocking the path
	Other	Other limitation not considered above

**Date**

Definition	Inventory date. It is an essential requirement to know the date of the information, especially for future updates.
Type of information	Date



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Codd, E. F. (1970). A relational model of data for large shared data banks. Communications of the ACM, 13(6), 377-387