Safer roads in Chad

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Recommendations for low-cost road safety measures in Chad

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Abstract

In the framework of the National Transport Support Project, SWOV provided local experts in Chad with technical assistance on road safety. The assistance focussed on the development of a comprehensive road safety strategy and physical road safety improvements on urban and inter-urban roads.

The problem identification was based on the analysis of incompatibilities in the function, shape and use of roads. Based on this analysis, the following measures were advised:

- Roads should be categorised to make their function self-explanatory.
- Network planning should be introduced and ring roads for transit traffic should be provided.
- Cross sections of roads should be improved. Low cost measures were provided for separation of motorised traffic and vulnerable road users.
- Safe intersection design needs attention. Standard intersection designs were given for common intersection types in Chad. Low cost improvements of unsafe intersection designs were provided.
- Traffic calming measures need to be taken to improve road safety.
- Since inter-urban roads run through a great deal of villages, the design of urban sections of inter-urban roads needs special attention. A different design of T-junctions, the splitting up of roads into two one-way roads and the introduction of speeds humps are effective measures.

Contents

1. Introduction

In the framework of the National Transport Program Support Project (PAProNat, ‘Projet d’Appui au Programme National des Transports’), SWOV, Institute for Road Safety Research was commissioned to provide technical assistance on road safety in Chad.

In Chad road safety issues have very recently been put on the agenda. In previous years the Chadian government and its partners implemented two projects in the transport sector, the sectoral adjustment programme for transport (PASET,1989-1993), and the second sectoral programme for transport (PTS2, 1994-1999). The road traffic components of these projects focussed mainly on the construction and maintenance of roads and on restructuring the governmental bodies responsible for this work.

The objective of SWOV’s technical assistance is twofold:

I To prepare, in co-operation with engineers of the local counterpart, concrete and realistic recommendations for appropriate low-cost road safety measures on inter-urban roads and urban streets to be built or upgraded in the near future,

II To strengthen the capacity of the local counterpart to include road safety audits in the design, construction and maintenance phases of future road infrastructure projects.

The SWOV consultant visited Chad twice: from August 2nd to 13th 2000, and from April 17th to 24th 2001. This report accounts for the work done during the two periods, and contains a number of proposals for solutions to problems on inter-urban roads and crossroads in the city of N'Djamena. *Appendix I* contains a list of the activities during both periods.

In the PAProNat project, which started in the second half of the year 2000, a road safety component was included. Although reliable data for Chad are not available, there are clear indications that traffic accidents create significant losses in terms of personal injury, death and material damage at significant economic and social costs. Major causes are the lack of safety awareness, age and poor technical condition of the vehicle fleet, design flaws and the poor condition of roads and urban streets, overloading of vehicles and insufficient enforcement of traffic regulations. The project focuses on (i) the development of a comprehensive road safety strategy and (ii) physical road safety improvements on roads and urban streets.

A first step to set up a comprehensive road safety strategy, particularly in urban traffic, is to categorise the roads within the urban network. In this report the road categories defined in the report *Productive and liveable cities* (SSATP, 2000) is used. This does not necessarily mean that this road categorisation should be adopted in Chad. The advantage of this categorisation, however, is that it is based on experience gained in other African countries, which are facing similar problems as Chad. In general however, the less road categories are used, the better one will be able to design roads which are functionally self-explanatory. This principle is known as ‘self-explanatory roads’.

2. Data

Chad is a landlocked country in Subsaharan Africa, covering 1,284,000 square km. Its population is estimated to be 7.1 million (Republic of Chad, 1999) The capital of Chad, N'Djamena, has an estimated number of inhabitants of 780,303 (Mairie de la Ville N'Djamena, 2000).

The northern two thirds of the country are sparsely populated. Economic activities are concentrated mostly in the southern third of the country. In this part of the country, the road network is denser than in the northern part of the country. The total road network in Chad comprises 40,000 kilometres. Under the PTS2 programme the government became responsible for 4,800 kilometres of the total network, of which 300 kilometres are surfaced, 3,100 kilometres are formed dirt road, 1,100 km are simple dirt road, and 300 kilometres pathway. Under the PAProNat programme the network under direct responsibility of the Ministère des Traveaux Publics, des Transports, de l'Habitat et de l'Urbanisme (MTPTHU) will consist of some 2,600 kilometres in the all-year road network and 3,600 kilometres in the dry-season-only network, totalling 6,200 kilometres of road.

The total vehicle fleet, estimated at 20,450, is distributed as shown in *Table 2.1* (Republic of Chad, 1999).

Passenger cars	Vehicles used for carriage of goods	Mini buses	Lorries	Tractors	Trailers, semi-trailers
6,140	7,380	590	3,130	1,140	2,070

Table 2.1. *Distribution of vehicle types*.

There is no indication which part of the number of vehicles is operated in and around N'Djamena. No data have been found concerning the numbers of mopeds, motorcycles, bicycles, carts, animals, and portage. As can be deducted from the low numbers in *Table 2.1*, non-motorised traffic (NMT) contributes largely to the Chadian transport production. Unfortunately the infrastructure has not been adapted to NMT at all.

Since 1993 the population of N'Djamena has grown significantly from 530,927 to 780,303. This development is expected to continue in the coming years resulting in 1,295,321 inhabitants in the year 2010. The majority of the new settlers will build their dwellings outside the Voie de Contournement (see map in *Figure A.1* of *Appendix II*) in unplanned areas. This development will have major drawbacks on the road safety of the roads inside the Voie de Contournement (See also the chapter on urban roads). Most economic activities in N'Djamena are concentrated within the Voie de Contournement, hence traffic on the roads in this area will grow exponentially.

Accidents are a negative effect of transport production. An accident database is an important source for road safety analysis. Not only to find dangerous locations or routes but also for monitoring reasons. The Direction de Transports de Surface (DTS) collects accident data from all over the country by gathering accident reports made by the police. For accidents which happen outside N'Djamena, DTS receives a carbon copy of the police report. These accident reports are then interpreted and coded according to the format of the digital accident database. For accidents which happen in N'Djamena, the police draw up a normal police report and fill out an additional accident form, which is in accordance with the format of the accident database. During the first SWOV visit the accident database could not be accessed, because of hardware problems of the computer on which the data had been stored, and a backup file had not been made. According to the database manager Monsieur Guérinebé Noubaodjoum the database contains information on about 8000 accidents that have occurred since 1987. It is known that, for a number of reasons, the registration of accidents is far from comprehensive. The most important reason is that the police are not informed of all accidents. People who are involved in an accident tend not to involve the police, because their vehicles are very often not insured, which is obligatory by law. In such a case, a settlement is arranged between those who are involved. Furthermore the police do not have the means to visit all reported accident locations.

Because of the unavailability of accident information, the SWOV consultant visited the emergency department of the Hôpital Général de Référence National (over 700 beds). This hospital is one of the three hospitals located in N'Djamena. According to the personnel addressed, most emergency cases are presented to this hospital, since they are the best- equipped hospital in N'Djamena to deal with accident victims. Information on every patient presented at the hospital, is recorded in a hand-written entry register. The data registered are: the name of the patient, date of birth, sex, type of injury and the cause of the injuries. On the basis of the latter data entry, one can determine if one is dealing with a traffic accident victim, since then the acronym ADV (accidente de voie) is included in the text. According to the employee in charge of the register, there is no single day without a serious injury caused by a traffic accident. This was confirmed by a quick scan of the register. The hospital is obliged to provide the Ministère de la Santé Publique with summary statistics every month. In these summary statistics however, injury causes are not included.

Clearly, this type of data does not provide sufficient information to perform a sound accident analysis, since information on location of the accident is not available. The entry register of the hospital may, however, be used for monitoring purposes. This would require a relatively small addition to the already required monthly summary statistics. Furthermore, comparing this type of information with the database at DTS could provide some additional information on the comprehensiveness of this database. When the observations made in the hospital were shared with the DTS database manager, it was learned that the DTS database does not contain at least one record per day of an accident in N'Djamena.

Basic information for traffic planning, and therefore also for traffic safety analysis, includes a map. The city plan, scale 1/15,000, of N'Djamena can be bought in the city. However, this map is not complete. Sections of the planned and unplanned areas in the east and north-east of the city, outside the Voie de Contournement, are not included. A more complete digital map is available at the Bureau des Services Techniques Municipeaux. This digital map was compiled with a Geographic Information System (GIS) in co-operation with the municipality of Toulouse in France. The bureau des Services Techniques Municipeaux is well-equipped, having a digitising tablet (A0 size) and a A0 colour printer. The map is available within two GIS programs, GEB concept and MAP-info. This data source/analysing tool has great potential, but is not used actively, at least not for traffic planning. A thematic map on road surface, the location of schools, markets and bus stations, was created by plotting the base map and colouring of the requested objects with markers by hand. This was done because the requested information was not available in the database. Some institutional issues concerning the application of the GIS will be discussed in the next chapter.

Another commonly used data type in traffic safety analysis in developed countries, is traffic volumes, origins/destinations of traffic and the numbers of trips on a certain network. At the moment this data is not available in Chad. In the current state of development of the country, traffic safety policies and measures can be developed without this data. In the long run, however, this data is important both for the urban and for the inter-urban network planning.

As mentioned in the Terms of Reference (TOR) of this technical assistance project, a number of black spots have been determined by the traffic police of N'Djamena. Regrettably, the SWOV consultant was only informed about the actual locations of these black spots on Wednesday August 9th, by brigadier Got T. Kralbaye during a sightseeing tour of N'Djamena. The black spots are all located on the surfaced road network. The locations are shown on the map in *Figure A.1* of *Appendix II*. In the early stages of his visit the SWOV consultant had asked the employees of the Direction des Transports de Surface to plot the locations of the black spots on the 1/15,000 city map. They were not able to do so, partly because of difficulties with using a map, partly because they had not been informed about the actual locations

During the second visit a table was received from brigadier Got T. Kralbaye, containing the monthly numbers of accidents over the year 2000 which were registered in N'Djamena by the Police de Circulation (See *Appendix V*). From the table it can be calculated that in N'Djamena in the year 2000 at least 53 accidents happened in which people were killed, 291 accidents resulted in seriously injured victims and 714 accidents resulted in slightly injured victims. Furthermore, brigadier Got T. Kralbaye gave a short analysis of the road safety problem in N'Djamena. According to him, the bad shape of the road infrastructure contributes largely to many accidents occurring in the city. Furthermore the growing number of inhabitants of N'Djamena is an important factor. He also observed that road users do not behave in accordance with the traffic code. The information concerning the locations of black spots confirms the information obtained during the first visit.

During the second visit, the SWOV consultant received information on the current design of five crossroads (See *Appendix VII*) when visiting the Bureau des Services Techniques Municipeaux. The designs however, do not represent the current state of the depicted crossroads. Particularly, the facilities for pedestrians and cyclists are not in place. Additionally, information was obtained about the pavement width of all paved roads in N'Djamena (See *Appendix VII*). A report about a new traffic plan, including measurements of traffic volumes, was available at the Bureau des Services Techniques Municipeaux . Regrettably, there was no spare copy available to be used by the SWOV consultant.

3. Institutional and other affairs

Black spot treatment is impossible without the knowledge and understanding of the triangle **function**, **use** and **shape** (See SSATP, 2000, chapter 6, and *Appendix IV*) of the road section or junction under study. Providing the Chadian technicians with sketch designs for the appointed black spots in N'Djamena or the signalized problems on inter-urban roads will probably increase the safety of these spots. But if the technicians don't understand why these infrastructural measures have effect, they may in future apply these designs on spots where they can have no effect or even a negative effect. The presentation given by the SWOV consultant to eight stakeholders, on the triangle **function**, **use** and **shape** (*Appendix III*), did not ring a bell at all. The total lack of knowledge on this subject means that any Chadian training on road safety should start at a very basic level and be very intensive. It was found impossible to arrange such a training within this Technical Assistance project. A French textbook is required, not only to be used during the training but also as a reference. Most appropriate would be a French translation of the report produced in the framework of the World-Bank Sub-Saharan Africa Transport Program (SSATP, 2000). Furthermore it is impossible to discuss road safety, or more particularly black spot treatment, with the Chadian partners, if a common conceptual framework does not exist.

The result is that it was impossible, in the given time schedule of the TOR, to train the Chadian technicians sufficiently to be able to supervise the engineering consultants who will be in charge of the designs within the PAProNat programme. The supervision of the design is very important, since the engineering consultants do not yet participate in the training programme.

As mentioned in the TOR, three governmental bodies, DTS, the Direction des Routes (DR), and the Municipality deal with the road network of N'Djamena. The consultant has some reservations concerning the level of co-operation between these three bodies. Both the GIS system and the preparation of a report containing a project proposal for the improvement of the drainage system (Mairie de la Ville N'Djamena, 2000) were not known to the DTS. The project proposal for the drainage system clearly bears a relation to road safety, since the position of the caniveaux largely determines the shape of a road section, and therefore its use and function. For the implementation of the PAProNat programme, as far as it concerns the network in N'Djamena, it should be clear where and by whom the decisions are taken, and who is responsible for the execution.

4. Urban roads (N’Djamena)

4.1. Observations

As is the case in most African (SSATP, 2000) countries, the urban road network in N’Djamena was mainly designed to facilitate motorised traffic (MT). Dedicated lanes for pedestrians, bicycles and mopeds are non-existent. The consequence is that surfaced roads, which offer the best circumstances for travelling, are used by all modes of transport. Therefore traffic on the paved roads is rather chaotic. These circumstances are even more pronounced in the rainy season, when the unpaved areas along the surfaced roads are hardly passable and pedestrians use the paved part of the road.

Another important aspect of the use of surfaced roads in N’Djamena is the fact that street trading, including so-called informal markets, is concentrated along these roads. The result is that, in certain areas, the space for pedestrians is very limited. Therefore pedestrians are forced to walk on the roadway. Another effect of street trading is that cars and minibuses stop in front of these stalls. In these circumstances the traffic situation becomes very dangerous, particularly because of sudden and unexpected stops. Pedestrians, bicycles, and mopeds move to the centre of the road, leaving limited space for approaching vehicles, which drive at relatively high speeds.

Parking is a general problem around the surfaced roads, since there are no formal parking lots. Drivers park anywhere, even close to junctions, obstructing sight lines of the other road users. The same goes for minibuses used for passenger transport by private operators. There are no spaces to be used as bus stops.

In general there are no markings on the roads in N’Djamena. The distance of vehicles to the “centre line” varies largely, and depends on the traffic situation. One can distinguish two situations: surfaced roads with a median, and surfaced roads without a median (See also *Appendix VII*). In the case of a road with a median, the pavement width is large enough to facilitate a 2x2 road. In practice the road is used as 2x1 road. Vehicles generally drive in the middle of the available space. The remaining space is used for parking, for cycling and as a sidewalk. In the case of a surfaced road without a median, drivers drive in the middle of the road, and swerve to the right when traffic approaches from the opposite direction.

In general, the footpaths (sidewalks) are in bad shape, forcing pedestrians to use the surfaced roadway. Most part of the road reserve, along surfaced roads, is not surfaced. Particular in the rainy season, these parts of the road are very soft, due to poor drainage of rain water. Vehicles parked on the soft surface cause holes, making the path inaccessible for pedestrians and carts. Crossing facilities for pedestrians and other vulnerable road users are non-existent. These road users cross the roadway at their conveniece.

The road safety situation on non-surfaced roads in N'Djamena is also poor. On those roads the lack of safety is not caused by high speed of the vehicles, but by the bad quality of the road. Any driver of any vehicle needs all her/his attention to find her/his path between holes and pools. This is particularly the case in the more eastern part of the city, where roads seem not to have been formed, levelled and compacted for a long period of time.

Clearly, at night the already poor road safety situation gets even worse, due to poor visibility. On a number of road stretches lighting poles have been installed, however only a few are fit for use. The poor visibility affects pedestrians in particular, but also bicycles without lights and other vehicles of which the electrical equipment is in a poor state of maintenance.

Another aspect of the lack of traffic safety is vehicle use. Overloading of vehicles is very common. Minibuses used for public transport are frequently carrying more people than they were designed for, causing instability. People are also transported by pickup trucks, sometimes on top of goods. This overloading is unsafe by itself, but also increases the number of victims in case of an accident, because the vehicle does not offer any protection to its occupants. This problem, however, can not be solved by means of infrastructural measures.

4.2. Road safety analysis and measures

In developed countries a black spot analysis is typically based on quite detailed accident data. Since this data is not available in Chad, another approach is required. A very suitable approach is to use the model **road function**, **road use** and **road shape** to analyse traffic safety. This model is strong enough to adequately describe the problems and to determine effective measures. It is questionable, considering the current state of development of Chad, if it is necessary to develop an accident database in the short term. Traffic safety can be analysed without accident data, and the gathering of accident data is time-consuming and expensive. Furthermore, knowledge on what measures have to be taken to solve the problems determined later in this section, is available from more developed countries. These countries have been through a similar phase of development. Accident data gathered in Chad would probably not add anything to this knowledge.

A short description of the **function**, **use** and **shape** model is given in *Appendix IV* and is a copy of the first two sections of chapter 6 of the SSATP (2000) report.

Section 4.1 mainly deals with the **use** of the road network in N'Djamena. Traffic is not streamlined (canalised) at all. Mopeds and cars mix continuously. Also pedestrians use the asphalt strip, particular during heavy rain fall, when sidewalks change into mud pools. Furthermore, cars may swerve to the right side of the road to park their car. The reported black spots (See map in *Figure A.1* of *Appendix II*) are all located on the paved network. The paved network generally has a collector or distributor function, meaning that the design speed is 50 km/h. On collector and distributor roads, traffic modes have to be separated from each other in order to ensure road safety. Basically, the width of the paved roads in N'Djamena is large enough to provide room for separated traffic flows, meaning that each traffic mode has its own lane. It is suggested to create a separate lane for cyclists by means of curb stones. Painted linings are not an option, because these require frequent maintenance, something that cannot be expected to happen in the near future in 'N Djamena. In the following figure some examples are shown. At least at the side of the bicycle lane, sharp edges have to be avoided.

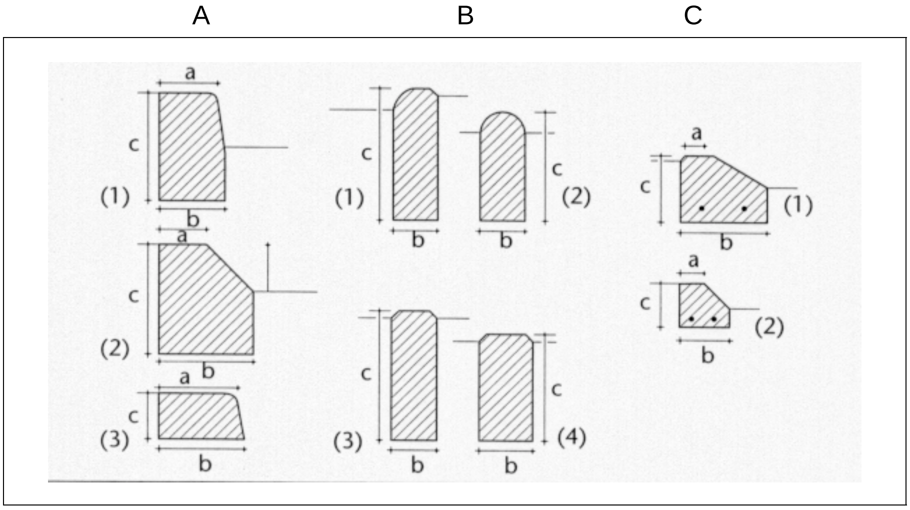

Figure 4.1. *Curb stones for separation of bicycle lanes.*

Measurements in Figure 4.1:

A: *a x b x c (cm.)*
(1): *13 x 15 x 16/20/25*
(2): *11 x 22 x 25, 18 x 20 x 16/20*
(3): *13 x 15 x 10/12/14*
18 x 20 x 10/12/14

B: *b x c (cm.)*
(1): *10 x 20/25/30, 12 x 25*
(2): *10 x 25*
(3, 4): *5 x 15, 6 x 15/20*
8 x 20, 10 x 20/30, 12 x 25

C: *a x b x c (cm.)*
(1): *7 x 20 x 15*
(2): *6 x 12 x 10*

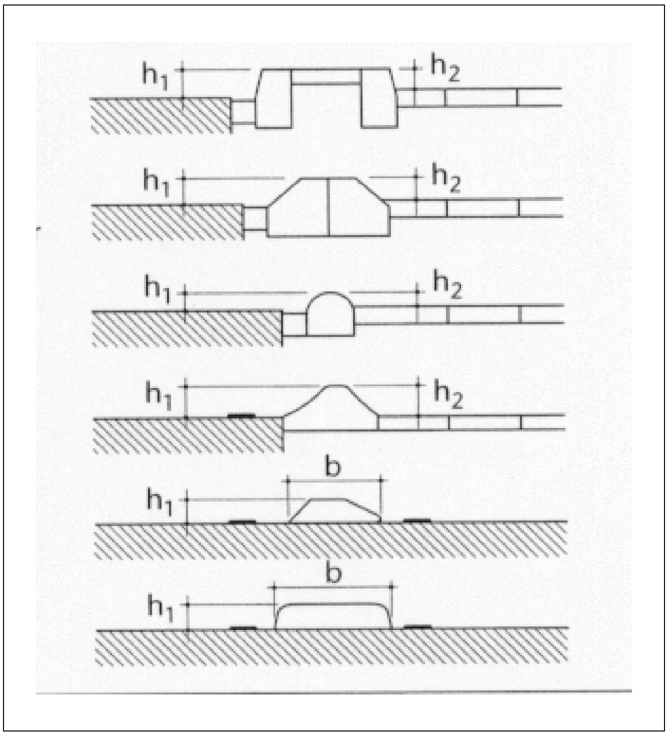

Figure 4.2. *Curb stones for separation of cycle lanes.*

Measurements in Figure 4.2.:
*b:	0.40 - 0.50 m.*
*h1:	< 0.10 - 0.12 m.*
*h2:	= 0.05 (0.07) m.*

Bicycle lanes should have sufficient width to facilitate the large proportion of road users using bicycles and push carts. In most cases one lane of 3 m width is sufficient for the current traffic volume of motorised vehicles.

All reported black spots except the one located in front of the Lyceé Eboué (number 6 on the map in *Appendix II*), are situated on cross roads. Also at cross roads the slow traffic has to be separated from the motorised traffic. Some of these crossroads are roundabouts. In the *Figure 4.3* a sketch is given of a roundabout with separated bicycle lanes, including some basic measurements.

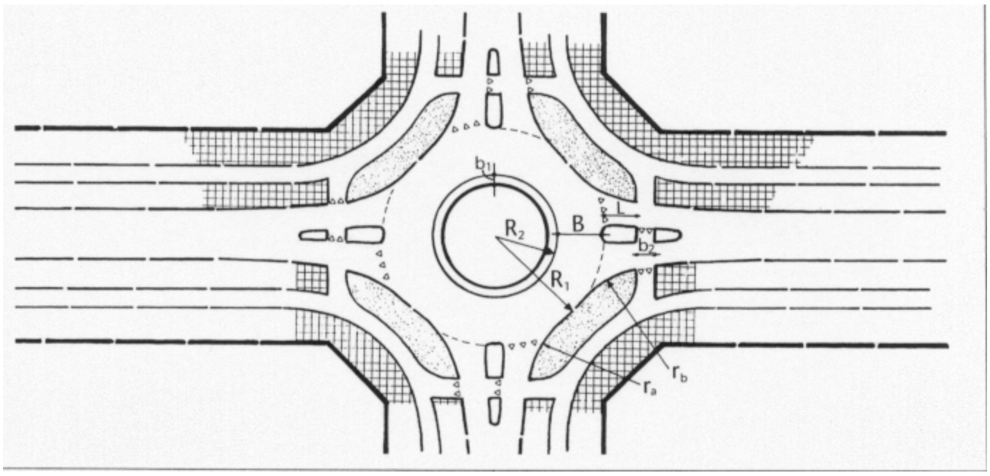

Figure 4.3. *Roundabout with separated bicycle lanes*

Measurements in Figure 4.3.:
R1: 12.50 - 20.00 m.
R2: 6.50 - 15.00 m.
ra: 12.00 m., with canalisation island
8.00 m.
rb: 15.00 m., with canalisation island
12.00 m., without canalisation island
B: 5.00 - 6.00 m.
b1: 1.50 (1.00) m.
b2: 2.00 m.
L: 5.00 m.

The design of a traditional crossroads, as obtained at the Bureau des Services Techniques Municipeaux for the crossroads of Avenue Colonel Moll and Avenue de Brazza is a correct and safe design and can be used as a safe standard design for comparable crossroads.

A specific problem is the black spot located in front of the Lyceé Eboué (number 6 on the map in *Appendix II*). It is a situation typical for the paved road network of N'Djamena. Pedestrians cross the road at mid block where high speeds of the motorised traffic occur. At such locations it is necessary to slow down the motorised traffic by means of a speed hump. A typical cross section of a speed hump applicable at a design speed of 50 km/h is given in *Figure 4.4*.

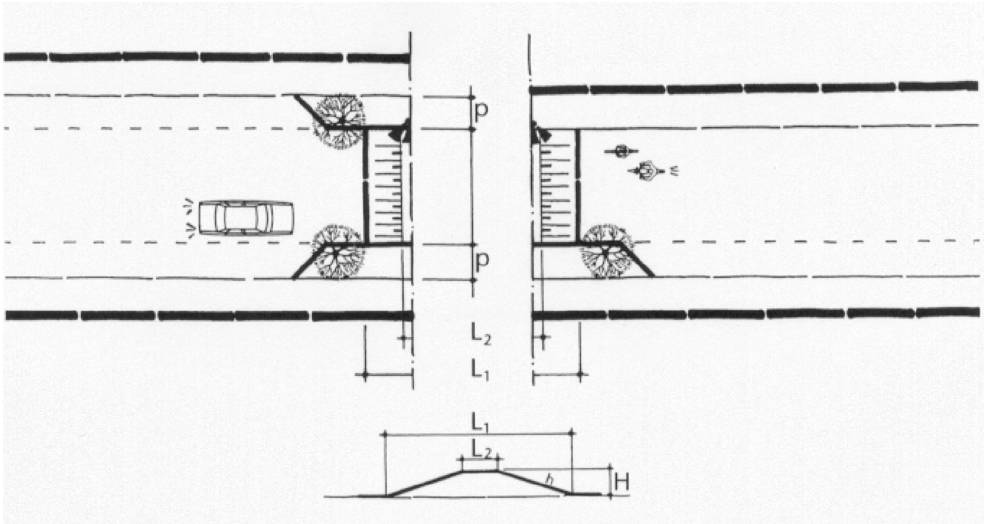

Figure 4.4. *Speed hump for use in streets with 50 km/h design speed*.

Measurements in Figure 4.4.:
p: width of parking lane
L1: 12 m.
L2: 2.40 m.
H: 0.12 m.
h: 1:40
spacing of speed humps 80 - 100 m.
distance to intersections > 8.00 m.

5. Inter urban roads

5.1. Observations

During his trip to visit the opening ceremony of the road to Massaguet, the SWOV consultant had the opportunity to observe the situation on inter-urban roads. Clearly the pavement quality of the new paved road section was excellent, allowing to drive comfortably at high speed. Maybe this observation doesn't apply to the inter-urban roads in the southern part of the country but it is clearly typical of newly paved road sections. Since the road surface allows high speeds, it is very likely high speeds will occur, since the police has no means to enforce speed limits. High speeds are very dangerous, because the road is also used by slowly moving traffic. Furthermore cattle and wild animals may cross the road at any time.

In general, it is very difficult to influence speed with infrastructural measures on stretches outside built-up areas without introducing dangerous situations, particularly at night. Two traffic safety problems, however, observed during the trip to Massaguet, can well be tackled by means of infrastructural measures. These concern junctions and urban sections of inter-urban (through-)roads.

One T-junction was designed as sketched in *Figure 5.1*. This design makes it possible for drivers to turn at high speeds. The large radius (R) applied doesn't force drivers to reduce speed during the turn.

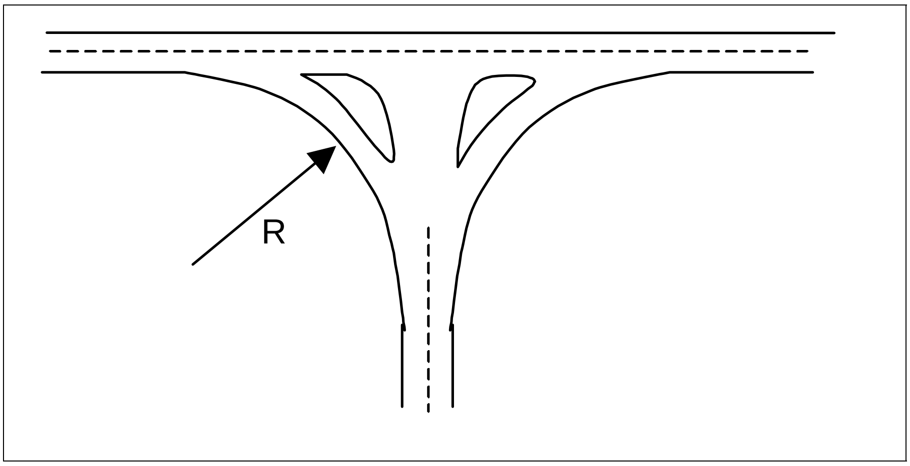

Figure 5.1. *Unsafe design of a T junction*.

A general design principle of junctions on inter-urban roads will be discussed in the next section.

The road to Massaguet passes through a number of small villages. Before entering such a village speed limits are signposted in two stages, starting with a speed limit of 80 km/h before the entrance, and 60 km/h at the entrance of the village. Within the village all sorts of activities are concentrated along the road, like loading and unloading of vehicles, trading, and the playing of children. In terms of function, the road changes from a transit road to an access road when the road enters the village. Despite the signposting of speed limits, high speeds were observed.

An obvious solution would be to divert the transit road around villages. However, in discussing such a solution with the Chadian engineers, it was learned that then new problems would occur. In the southern part of the country two diversion routes were built. In both cases, inhabitants rebuilt their houses along the diverted road. Probably the inhabitants had not been consulted in the planning process, neither had they been informed on the safety problems of a transit road running through their village. Furthermore, the Chadian government seems not to be able to plan and to enforce land use together with the local stakeholders. Clearly the latter is a condition which has to be fulfilled in order to make the diversion route to be used as such. On the basis of this observation it is concluded that a practical solution is to reduce speeds by means of infrastructural measures in built-up areas. This means the engineer has to adapt the shape of the road to its use and function being an access road. A design proposal will be discussed in the next section.

5.2. Measures

A basic design of a crossroad is sketched in *Figure 5.2*. The crossroad basically consists of two T-junctions. In case of right hand traffic, as is the case in Chad, a driver driving on the inter-urban road should first encounter the T-junction at his left hand side and then the T-junction on his right hand side. This order is important and should not be reversed. This design offers advantages as far as road safety is concerned. Road users on the rural road who want to cross the inter-urban road are forced to stop or at least to drive at low speeds. The T-junction should therefore be without traffic islands and the applied radius must be small. To avoid drivers to take a shortcut the T-junction should be marked with T-blocks or boulders.

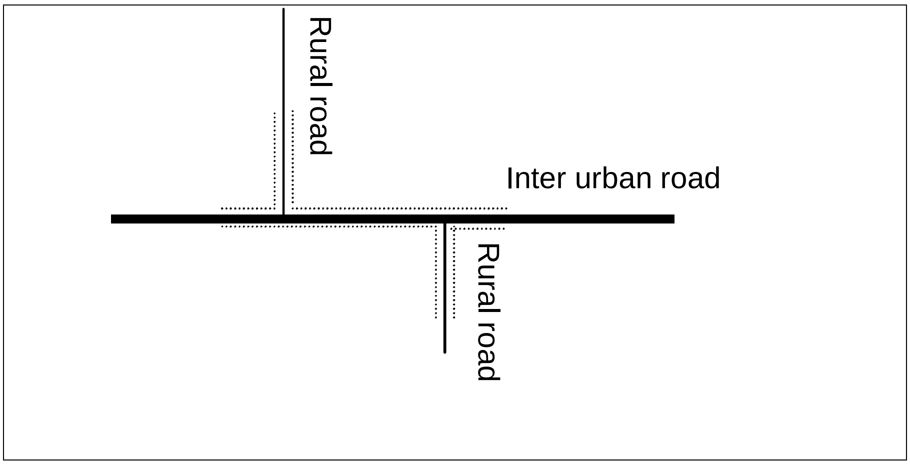

Figure 5.2. *Basic layout of a crossroad in an inter-urban road*.

As observed, the main problem of inter-urban roads passing through villages is speeding. High speeds cannot be combined with the observed use of the stretch of road within these built-up areas. To force drivers to drive at low speeds in built-up areas, the road should make a sharp bend, before it enters the village. In the sketch in *Figure 5.3*. the road has been split up in two one way roads with a wide median, which can be used for parking or even as a market place. To avoid drivers accelerating within the village a number of speed humps are required.

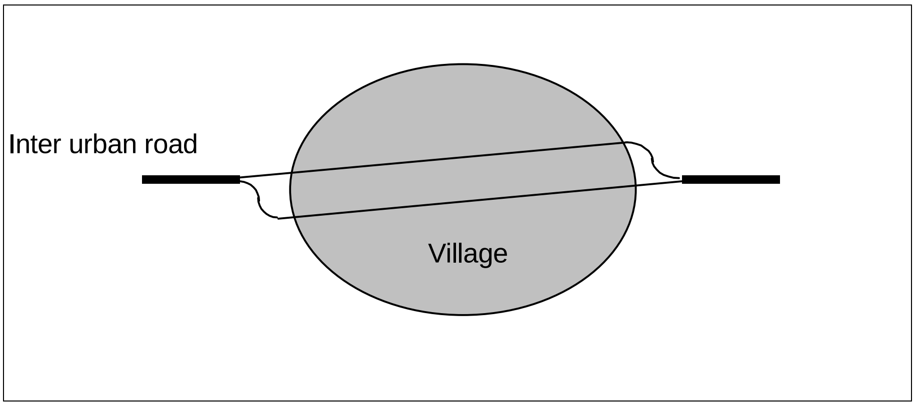

Figure 5.3. *Urban section of inter-urban road.*

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Appendix I Meetings and visits

Activities during the first visit 2-13 of August 2000

Wednesday 2nd of August:
- Introduction to the people of residential mission of the World Bank in Chad
- Meeting with Mr. Nene Tassy Directeur CISCP
- Meeting with Mr. Goukouny (Directeur des Transports de Surface)
- Meeting with Mr. Hassane Saline (Directeur des Routes)

Thursday 3rd of August
- Visit of the opening ceremony of the newly paved road to Massaguet

Friday 4th of August
- Meeting with Mr. Ahmet Abakar Adjid (Directeur des Services Techniques Municipeaux)
- Meeting with Mr. Goukouny and Mr. Hassane Saline to arrange a session with technicians from both the Ministry of Public Works, Transport Housing and Urbanisation (MTPTHU) and the bureau des Services Techniques Municipeaux on Tuesday 8 August
- Trip around the city of N'Djamena together with taxidriver Ali Muhamat and translator Mr. N'Garadoum Nahongar.

Monday 7th of August
- Visit to the emergency department of the hospital with translator Mrs. Haoua Kolmagne.

Tuesday 8th of August
- Technical meeting on Road Safety with the persons listed in the table below. Copies of the sheets used during the presentation are presented in *Appendix III*.

Guérinebé Noubaodjoum	Chargé de la sécurité routière	Direction des Transport de Surface
Ndeiby Nadero	Chef DESR	Direction des Transports
Ngakouton Adjari	Chef de la subdivision de la programmation	Direction des Routes
Nangadoumngar	CSECT/DSTM	Mairie N'Djamena
Dawala Dabou	Chef de Section Regulation circulation	Mairie N'Djamena
Bessanan Dyndo	Chef de Division de Travaux Entretien	Direction des Routes
Djiramadji Ngdnsdbe	Chef Cellule Ouvrages d'art	Direction des Routes
Najenapzem Ruben	Service Routes /SO	Délégation Sud Occidentale

Wednesday 9th of August
- Trip along de black spots in N'Djamena identified by the traffic police with Mr. Goukouny, Guérinebé Noubaodjoum, and brigadier Got T. Kralbaye ('Commissariat Central Police de Circulation') and the translator Ngaradoum Nahongar.

Thursday 10th of August
- Short meeting with Mr. Ahmet Abakar Adjid
- Visit to the bureau des Services Techniques Municipeaux to collect information on the locations of schools, markets, asphalt roads, bus stations, bus routes, the central Business District and other important public spots in the city of N'Djamena. Meeting with Mr. Dawala Dabou and Mr. Hanza, who is in charge of a Geographic Information System containing information on the city of N'Djamena.

Activities during the second visit 17-24 of April 2001

Wednesday 18th of April
- Trip around the city of N'Djamena together with taxidriver Ali Muhamat

Thursday 19th of April
- Early trip around the city of N'Djamena together with taxidriver Ali Muhamat and translator Mr. N'Garadoum Nahongar to get an impression of the traffic in N'Djamena during rush hour.
- Visit to the Commissariat Central to collect some accident data (See *Appendix V*)

Friday 20th of April
- Visit to the bureau des Services Techniques Municipeaux to collect information on crossroads designs in the city of N'Djamena (See *Appendix VI*) and pavement width applied in N'Djamena (See *Appendix VII*).

Monday 21rst of April
- Presentation of preliminary results of the Technical Assistance
- Meeting with Mr. Goukouny

Tuesday 22nd of April
- Short meeting with Mr. Nene Tassy, Directeur CISCP.

Appendix II Map of N'Djamena

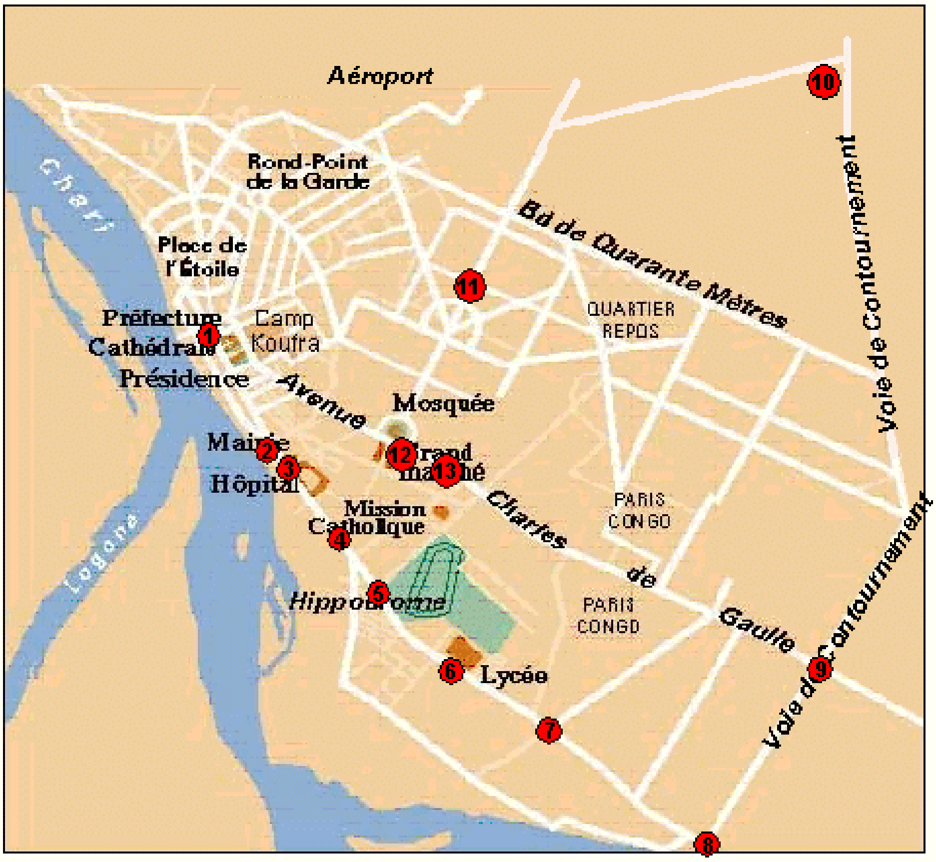
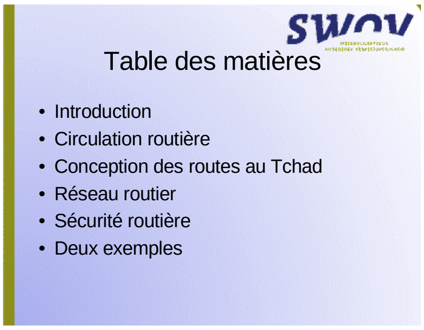
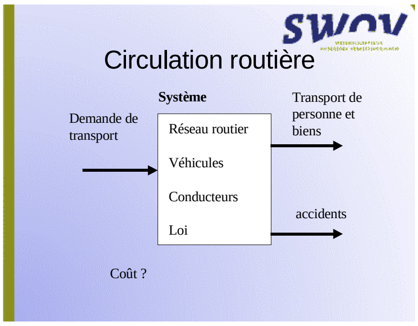


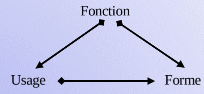
Figure A.1. *Map of N' Djamena with black spots*.

Appendix III Sheets of the meeting of August 8th





Réseau routier



Fonction

- Deserte
- Transit
- Hierarchy

Forme

- Forme actuelle
- Plan de situation
  - nombre de voies
  - géometrie
  - couche de surface
- forme <---> Projet

Usage

- La mesure
  - la circulation
  - accident
  - retard des vehicules
  - les temps d'attente
  - le nombre des vehicules garés
  - l'espace occupé par les kiosques

Appendix IV Function, use and shape from *Productive and liveable cities* (SSATP, 2000)

There is a strong relationship between the function, the shape and the use of a road or intersection. This interdependence can be visualized by showing them as a triangle (*Figure A.2*).

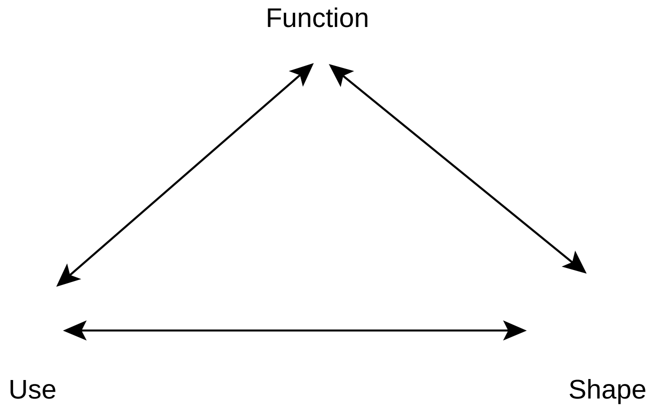


Figure A.2. *The triangle of function, shape and use*.

Planners and engineers are continuously challenged to (re-)establish the balance between the three.

Function
The *FUNCTION* of a road is defined as the purpose for which it has been provided. In other words, its function is what it is intended to be used for.
A road can simultaneously have several functions. For example, access to houses, or primary arterial transit traffic of motor vehicles. As is clear from the example, different functions can be difficult to combine. To minimize the conflict between different functions on the same road, and to maximize the efficiency and the safety of the traffic flow, urban road network planners adopt a functional classification of roads in distinct types, and a road hierarchy (see **road categories and hierarchy**).

The road function is a planner's concept, which is reflected in the design of the road, its traffic management and the traffic regulations. For example, heavy truck traffic can be forbidden on a certain road, because that road does not have that function. In reality, the planner's concept and the regulations may not always be recognized or respected by the road users, and a road may be used differently from the use intended by its provider.

The two most important functions that a road can have are *transit* (through-traffic) and *access* to the plots, buildings, houses, etc. along the road. In addition a number of other functions or sub-functions can be distinguished: (i) role as public transport route; (ii) role as bicycle traffic route; (iii) role as walking route; (iv) shopping function; (v) parking; (vi) provision of direct plot access for MT, etc.

Shape
The SHAPE of a road is defined as its actual physical form. This is the product of its geometric design and pavement design, its actual construction, and the later wear and tear, damage and maintenance. How much road space is available to each transport mode, and of what quality is it? This includes possible traffic signal controls. Designing and supervising the construction and maintenance of the shape of roads is mainly the task of the traffic and road engineers.
The actual shape of a road can be different from its design, for example because pavement maintenance has been neglected, or because driver behaviour has changed a walkway into a parking area, etc.
The shape of a road (or intersection) can be observed and measured. The relevant variables are: lane width, corner radius, type of pavements, pavement defects, road base strength, dimensions and current status of drainage structures, median islands, kerbstone and other lane delineation elements, etc.

Use
The USE of a road is defined as the actual traffic composition and behaviour plus all other activities that are carried out within the road reserve. Usually it is a reflection of the function of the road, but the actual use of a road can also be different from its intended function.
The use of a road (or intersection) can be observed and measured. The variables to be measured are: traffic volumes, speeds, driver behaviour, accidents, vehicle delays, waiting times for pedestrian crossing, waiting times for left and right turns, number of parked vehicles, space occupied by kiosks and/or street traders, etc. The use of a road can change over time, due to changes in land use (activities) along the road, or due to changes in other roads in the road network. Such changes are often sudden or temporary , so observations of road use must be made with care.

Problem analysis
In observing and analysing traffic problems, it is extremely useful to distinguish between the function, the shape and the use of a road. Most traffic problems can be described as the lack of balance between the shape, the function and the use of roads. For example: if an intersection is inefficient, and creates frequent delays and congestion, or if it is dangerous and the scene of many accidents, the causes can be analysed by observing at what points and at what times of the day its use (traffic volume, composition and behaviour) is not compatible with its shape. For example: wide corners that invite minibus parking at the corner and contribute to intersection blocking, or high speed on one of the intersecting roads, creating long delays for vehicle turns in/out of the other road, or long crossing distances in the absence of a median pedestrian crossing island. This in turn creates long waiting times for pedestrians that have to cross, and serious accident hazards, or driver behaviour that is incompatible with the function of the road, for example speeds far above the speed limit in shopping streets or residential streets.

In practice, function, shape and use often become imbalanced, as usage expands. A road constructed twenty or even only ten years ago is likely to have a different usage now than what it was originally designed for. The actual shape may also no longer be according to the design, because maintenance may have been inadequate. The function of a road can also change over time, because other roads change or are added to the network, which will influence the traffic's preferred routing.

Often, imbalance between function, use and shape results in unsafe and inefficient traffic situations. There are three categories of intervention to restore the balance.

Intervention type	Examples of interventions
Adjust the shape	Build traffic calming structures Construct walkways (Re-) construct the carriageways
Influence the use	Establish and enforce parking restrictions Relocate kiosks and street traders Ban truck traffic
Change the function	Provide (or convert) other routes for transit traffic Pedestrianise (convert to pedestrian route or market or shopping area)

Table A.1. *Types of intervention.*

The reason for showing these three intervention categories is to underline that road reconstruction may not be necessary. Reconstructing a pavement or changing the geometric design is expensive, and not the only type of intervention that is possible. In many cases other responses, such as changing the function of a number of roads in the urban road network, may be more sensible.
For example: if not enough road space is available to realize a design (shape) that can properly accommodate the current use of the road, solutions can be found by either influencing the use or reconsidering the road's functions, or by changing its shape, or a combination. Shifting parking from along the road to new off-road parking lots may make space available for a proper walkway or for a cycle lane. Traffic calming interventions that adjust the shape (e.g raised zebra crossings) can influence driver behaviour (speed) and thus restore traffic safety for local residents and school children. By changing the road function transit traffic can be eliminated from the road by creating a traffic circulation (e.g. with short one-way sections) that makes the route unattractive for non-local traffic. Etc.
To find a good balance, alterations to all three corners of the triangle should be considered. In the plan preparation protocols annex, an intervention report format is provided that applies the concept of Function, Shape and Use to facilitate problem analysis and the formulation of intervention objectives.

Road categories and hierarchy
All roads in an urban area together form the road network. Not all roads have the same importance or have the same function for the movement of traffic. For proper planning of the road network, it is important to classify roads into a number of types, according to their main function. The functional classifications used in different countries are quite similar, although there are some differences in the vocabulary used. The classification in these guidelines is in accordance with the terminology that is currently used in Kenya and Tanzania, based on the UK tradition. An overview is given in *Table A.2*.

Four main types of urban roads are distinguished. Each type will be briefly described below, as well as some aspects of the road functions. Part Ill of the guidelines provides a more detailed classification (*Table A.2*) and design recommendations per type of road.

Use	Function		
	Access	**Transit**	**Public Transport**
Access road (grid distance 100-500 m)	Access to buildings and plots	No MT transit, important for NMT transit (direct routes)	Not allowed
Local Collector (500-2,000 m)	Access to buildings and plots, connection to access streets.	MT transit to be discouraged strongly	Sometimes allowed, depends on road network
Collector/distributor (1,000-5,000 m)	Access to buildings and plots, connection to access streets	Transit to, from and within city districts	Carries the main bus routes
Urban Corridor (4,000-10,000 m)		City-wide transit, link to national highways	
main carriageway	No plot access	No NMT	Carries the main bus routes
service road	Access to plots, link to access streets	No MT transit, main NMT transit route	Not allowed

Table A.2. *Functional classification of urban roads.*

Access road

Access roads (streets) provide access to houses, shops, offices and plots. Final access to buildings is always on foot, irrespective of the mode of transport for an earlier part of the trip. Urban access streets are first and foremost pedestrian territory .Access streets can also be completely pedestrianised, providing no access to motor vehicles at all, or only for service vehicles or freight at certain hours. Access streets form a large part of the public open space in a city, and also have to provide a playing area for children. The road reserve should provide space for this function as well as for walk/carriageways and drainage. Bus routes on access roads should be prohibited, because they jeopardize safe and comfortable movement of pedestrians and cyclists on the access streets, as well as a safe residential environment for children. Apart from some, in CBD's or high-income neighbourhoods, access streets at present usually have a compacted earth or gravel pavement.

For access streets, a good instrument to eliminate transit traffic is to impose an MT traffic circulation in loops, without straight-through connections. The connections between these loops can be provided as NMT -only routes, to enable pedestrians and cyclists to follow a straight route. Sometimes such NMT-only direct connections can effectively be created by constructing NMT-only bridges. This also saves a lot of money, because these are cheap. Bridges for MT can be limited to collector roads and corridors, and sometimes a local collector.

Local collector road
The most important function of a local collector is to provide access to economic activities along the road. For shops, small businesses and workshops visibility of their location is very important, so many of them like to locate along this type of road, in particular if it is also an important pedestrian route. This gives extra importance to the provision of good walkways along local collector roads, as a good instrument for economic stimulation of the local economy by increasing the amount of small business locations with good accessibility .

This type of road also provides the link (i.e.transit) between access streets and collectors and corridors, but this is only meant for traffic with its origin or destination in the neighbourhood concerned. Longer distance transit traffic of motor vehicles should be minimized.
Local collector roads are important as cycling routes. They have an MT traffic volume that leaves plenty of space for cyclists, and with simple traffic calming measures can be made safe and attractive enough for cyclists. If a good network of local collector roads exists, cyclists can often select routes that avoid more busy and dangerous collector roads or corridors without proper bicycle facilities.

Bus routes are in general not desirable on local collector roads, but in some cases, where the distance to the nearest larger type of road (collector/distributor) is long (more than two km), allowing a bus route may be desirable. Special attention for traffic safety is then required. In many cities, local collector roads are the lowest class of road expected to have a bitumen carriageway pavement. Walkways along local collectors are in general absent or undefined and unpaved.

Collector road
Collector roads connect local collectors and access streets to corridors, as well as to other local collectors and access streets. For many trips within a city district, whether entirely as a pedestrian or by bicycle, bus or car, a collector road will be the highest class of road used. The desirable distance between collector roads depends on the land use density and the MT volume. Usually 1-3 km. Typically, a collector road is a bus route.

Collector roads also have an important access function for the activities along the road. Many shops and offices are located along them. The structure of African cities (in particular the scarcity of road- frontage locations) does not allow an urban road network concept of collector roads with a transit function only and no direct plot access, as is now dominant for new urban roads in Europe.

Because of the variety of functions that they combine, and the diversity of the traffic flow, collector roads are often the most difficult urban roads to design and to provide proper traffic management for, i.e. safe movement of all modes of traffic, a high capacity utilization and a smooth traffic flow.

Urban corridor
The most important function of urban corridor roads is to provide for efficient transit traffic from one part of the city to another .
Traditionally the corridor network is radial towards the central business district (CBD), but increasingly, the demand for efficient traffic movement

between other parts of the expanding city, outside the CBD, necessitates corridors that have no relation to the CBD.
The second, and almost equally important function of urban corridor roads is that, because of the optimal accessibility that they give, they are a prime location for important urban activities, such as office buildings, shopping centres, large markets, and large businesses. Urban corridor sections outside the CBD have a significant potential to develop as important activity concentrations and reduce the need for longer trips to the CBD.
To allow these two functions to be combined in a positive manner, the transit and the access traffic in the corridor have to be separated by providing separate service roads and the elimination of direct plot access to the transit carriageway section, and by the elimination of intersections between access streets and the transit carriageway of the corridors. Failure to construct and manage the corridors in such a way that their two functions can be combined effectively, tends to create traffic chaos and safety hazards, as well as a reduction of their attractiveness as a business location.
The preferred distance between parallel corridors is usually quite high, in a square road grid, it varies between around 3 km in the central parts and 6-10 km towards the urban periphery .

Road network hierarchy
While planning an urban road network it is important to adopt a road hierarchy. An urban road network is characterized by a high density of road links, and a large number of intersections between different roads. Usually it is possible to make a choice between a variety of routes to go from one point to another. The efficiency of the intersections largely determines the efficiency, i.e. the average flow speed of the traffic movement. The way the route choice of the road users determines the intensity of conflicting traffic flows at intersections has a strong effect on the occurrence of delays and congestion.
Creating a clear road hierarchy is one of the most powerful instruments that a traffic engineer has, to enhance an efficient traffic flow in the network, and simultaneously limit the negative side-effects of the traffic as much as possible (accidents, foul air, noise).

The principle is to (1) concentrate the longer distance motor vehicle trips within the city on urban corridor roads for the biggest possible part of their trip, and (2) assure a smooth flow of traffic on those corridors.

This requires priority for transit traffic on the corridors, provision of access to activities along the corridor by means of separate service roads, a limited number of intersections (no intersections between access roads and the transit lanes of the corridor), and lot of attention to efficient intersection design and management. By concentrating MT trips on the corridors, the trip distance usually increases a bit, but this is more than compensated by a higher average travel speed and less fuel consuming acceleration/ deceleration.
The complementary principle to (1) is to eliminate MT transit traffic completely from access roads and local collector roads. Doing this is beneficial for MT flow efficiency, because the number of intersections encountered per MT trip decreases and thereby the total intersection delay. It is also beneficial for local residents and local traffic in access streets and

on local collectors, because the MT traffic is reduced, resulting in a more pleasant and safer urban environment.
Keeping access streets and local collectors free from transit traffic is also a vital instrument to enhance cycling. Access streets and local collectors that are safe to cycle on, provide the possibility to cycle on around 75-80% of the total length of urban road network.
Complementary bicycle facilities on the main collector roads and corridors (including the ability to cross them safely) are of course still needed to enable cycling throughout a city , but those facilities are really complementary to the basic provision, which is access streets and local collector roads where one can safely and comfortably cycle.
Failure to create a well-understood and accepted road hierarchy in an urban network leads to a situation where large numbers of MT drivers attempt to find all kinds of ‘shortcut’ routes. This results in many more inefficient intersections, longer average travel times, extensive damage to the shortcut routes that were not constructed to carry heavy traffic, and a spread of traffic hazards and pollution throughout all neighbourhoods. In other words: lack of network hierarchy creates negative side-effects: the losses are much bigger than the gains individual drivers may sometimes think they can achieve.
In many African countries, there is no officially established classification of urban roads based on a clear definition of road functions with corresponding design standards. Usually, only a general national classification and design standards exist, based on highways and rural roads. This practice has had a negative impact on road networks in urban areas, because of the differences between urban and other roads.
On urban roads: (i) design standards must prominently include pedestrian and bicycle traffic facilities and (ii) special attention must be given to intersection design. The design of the intersections is in fact more important than that of the sections, and has a big effect on the total cost. The use of designs that were essentially trunk road designs has contributed significantly to the creation of unsafe and inefficient urban road networks.

Traffic conflicts related to the road function

Two conflicts between the access and the transit function are typical: The first is motor vehicles that make a left turn into a plot entrance across the opposing traffic (in right-hand traffic). If the vehicle has to wait in the middle of the road it creates delays and the vehicles behind it will try to bypass it via the road shoulder. While moving into the entrance it has to cross the walkway, often without much attention for the pedestrians because using a small gap in the vehicle stream requires all the driver's concentration. A median is a good instrument to make this manoeuvre impossible, and in that way resolve the conflict.
The second is a high number of plot entrances across the walkway (and bicycle lane or track), which create serious problems for efficient and safe pedestrian and cycle movement. The detailed design of plot entrances across a walkway or cycle track must fulfill a number of requirements: (i) have a continuous flat walkway bicycle track pavement without kerbs or slopes; (ii) have a slope or hump at the entry point from the carriageway to eliminate high vehicle speed; (iii) have a minimal radius of the entrance; (iv) include blockage of MT entry on the walkway bicycle track, with bollards etc.; (v) have a minimal width and provide no place to park without blocking the entrance; (vi) allow no entrance if in practice vehicles cannot park

inside. Special difficult cases are entrances to parking areas and fuel stations.
The presence of public transport vehicles on a road has a significant effect on the traffic pattern and the road user behaviour. This is particularly true for "informal" public transport in minibuses, shared taxis, etc. The driving behaviour of these vehicles is dictated by (i) the commercial need to attract as many passengers per day as possible and (ii) the fatigue of the driver, caused by long working hours. In the absence of public transport vehicles, roads are safer and more attractive for cyclists. For the design of an attractive network of cycling routes it is therefore important to attempt to concentrate the bus routes on the urban corridors and the collector roads. This results in safer traffic, and thus a better chance for cycling. At the same time it results in more efficient public transport (PT): routes can be shorter and stops for passengers fewer.
It is interesting to note that in most African cities, unlike in Asia, informal 'door-to-door' public transport in small motor vehicles (in Asia mostly three-wheelers) does not exist. The combination of (i) PT on concentrated main routes, and (ii) a proper walkway infrastructure creates a more attractive urban transport system in terms of total costs, safety and pollution than the Asian model, which in contrast is characterized by polluting door-to-door informal motorized public transport and a higher percentage of private motor vehicles, most of them motorized two-wheelers. The African experience in cities with significant door-to-door informal public transport appears to confirm this (for example motorcycles in Nigeria).

In urban traffic, a good average speed of travel depends on creating a fluid flow, at modest speed, and with small speed differences between different vehicles. The average speed indications given in Table 14.1, which is an extension of Table 6.2, seem to be low at first sight, compared to the top speed that a car can reach. However, they are in fact significantly higher than the average speeds of MT that are achieved in reality in most large cities around the world for most of the day. In many cities, the average speeds during daytime are below 20 km/h, and lower values have been reported as well. Average speed means: total travel time from trip origin to trip destination, divided by the total distance travelled. The maximum speed that a vehicle can reach at isolated points in the urban network is quite irrelevant for the total travel time, but creates severe traffic accident hazards.
Therefore, the maximum design speed of a road is an important variable in urban road design, but it plays a role which is quite opposite to that in highway design. In highway design, the task is to make the vehicle driver remain safe at the highest speed that can be expected. In urban road design, the task is to force the driver to slow down to or below the maximum safe (=design) speed, by making it clear that above that speed the driver would risk danger and significant discomfort to himself. In urban traffic, the vulnerability of pedestrians and cyclists is much higher than that of motor vehicle passengers. Obstacles that, if hit by a car, create damage are an essential ingredient of urban traffic safety policies. Their role is threefold: (i) they constrain MT to the carriageway, (ii) they warn drivers against too high speeds, and (iii) in case of a driver mistake they stop a vehicle by means of a collision, thus protecting pedestrians.

Appendix V Accident data from the ‘Commissariat Central Police de Circulation’

Data received in handwriting from brigadier Got T. Kralbaye.

Relevé des accidents de circulation toute catégorie confondus pour les périodes allacif du 1er Janvier au 31 Décembre 2000.

Mois	Mortels	Blessés Grave	Blessés légers	Dégats matérial	Delits de fuite	Non transmis	Total
Janvier	4	15	84	27	6	31 CA8	167
Février	3	17	53	25	3	27 CA3	128
Mars	1	16	54	34	3	39 CA7	148
Avril	3	9	51	22	5	18 CC	111
Mai	3	14	50	40	4		108
Juin	1	13	49	34	3		100
Juillet	0	18	63	20	6		107
Août	3	15	51	25	3		100
Septembre	4	18	53	24	5		99
Octobre	3	19	57	22	3		106
Novembre	2	17	58	37	2		117
Décembre	3	22	59	37	4		124
Rajour	23	98	32	347	13		

Total Gèneral: 1580

<u>Nota</u>: Tous ces accidents sont dues pour la plupart a défaut d'infrastructures routières adéquates et au manque d'entretien de celles déjà existantes. Vient ensuite le surpeuplement de la ville ces dernières années et le nombre sans cesse croissant des véhicules en circulation. Il faut ajouter à tout cela l'incivisme et l'inobservation délibérée des règles du code de la route au mépris des agents, sans oublier les véhicules eux-mêmes dont les états techniques laissent à désirer et enfin l'ignorance et la négligence des piétons sont aussi déterminants.

Abordant le volet des points noirs et des zones sensibles, nous citeront entre- autre l'axe routier N'guéli - N'Djamena et la voix de contournement Chagoua - Dembé où on enregistre en moyenne 6 à 8 cas chaque jour.

N'guéli - N'Djamena, en raison de son éloignement et du bon état de la route, incite à faire de la vitesse; Quant à Chagoua - Dembé, à cause de la densité de la circulation, les accidents qui s'y produisent sont toujours les plus meurtriers.
Les usagers les plus impliqués sont évidemment les piétons, les véhicules à bras, les engins à deux roues, les véhicules particuliers mais aussi et surtout les minibus et les taxis ordinaires.

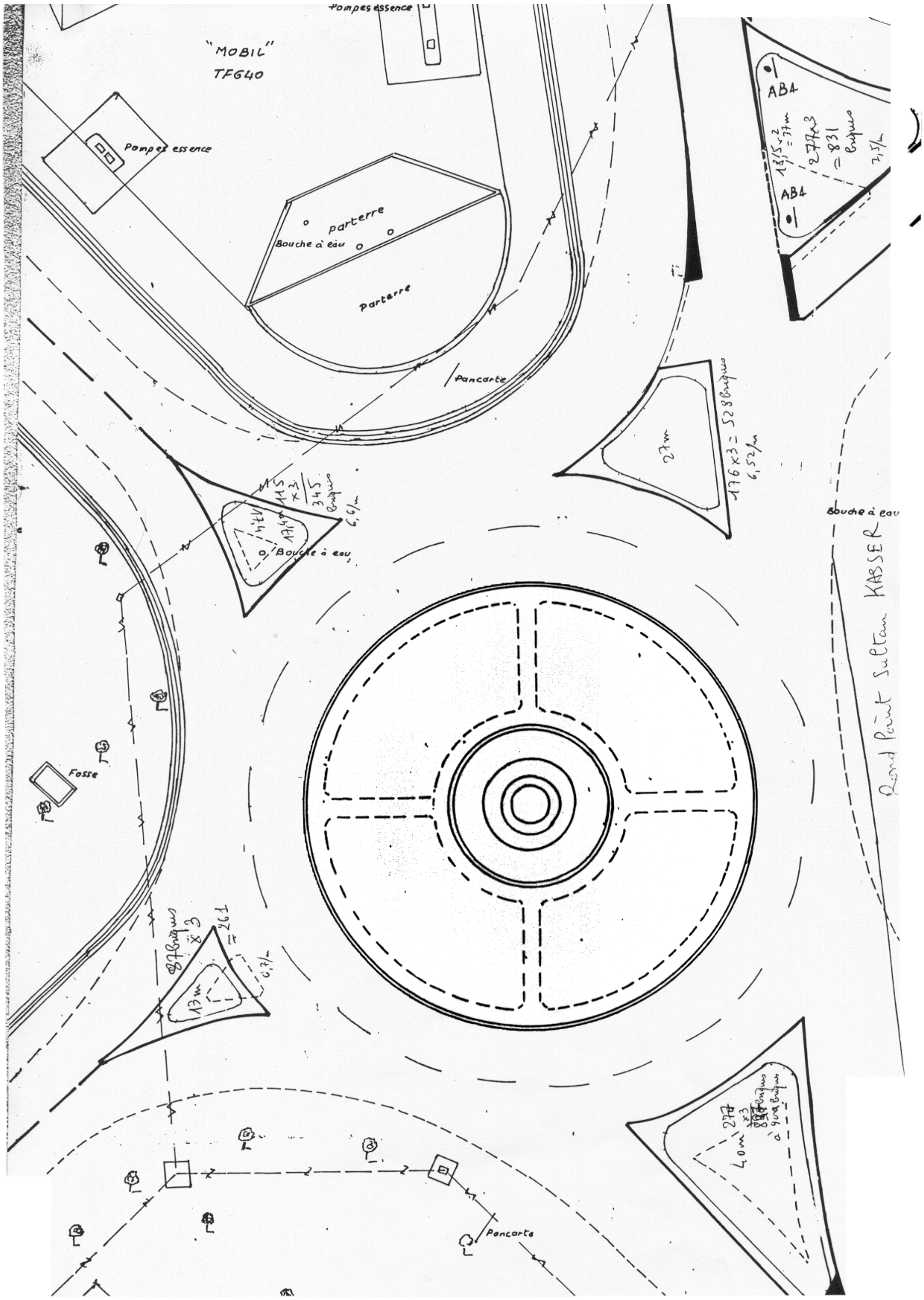
Les points sensibles qui connaissent les plus grandes densités sont par exemple les marchés et les établissements scolaires.

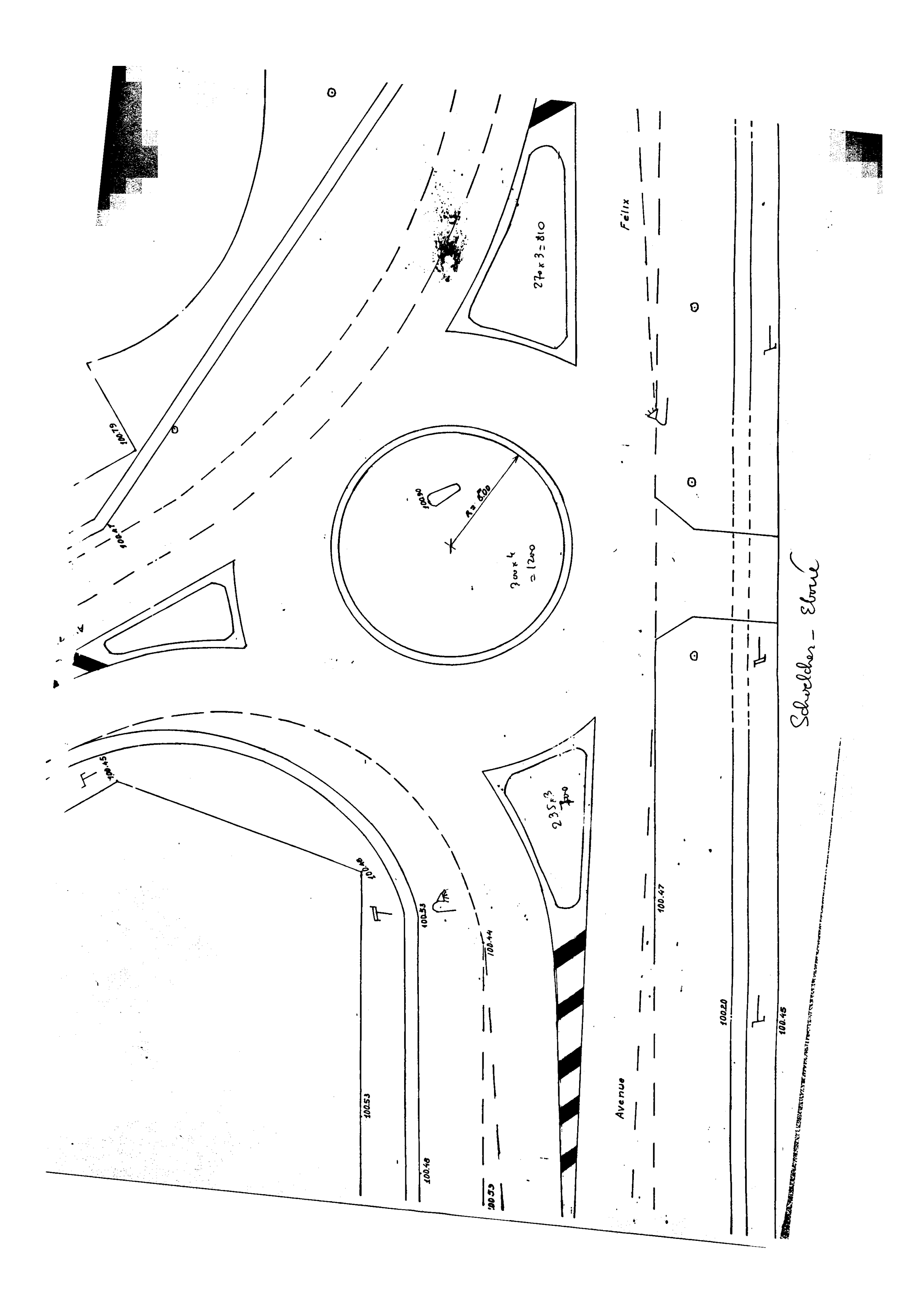
Ainsi, les marchés de Dembé et le marché central sont des cas particuliers où on enregistre quotidiennement et en moyenne 5 à 10 cas. Ces marchés, reliés entre eux par une partie de l'avenue Charles de Gaulle, connaissent de grands mouvements des commerçants aux heures de pointe et à cela s'ajoute l'état de dégradation quasi permanente de cette route.

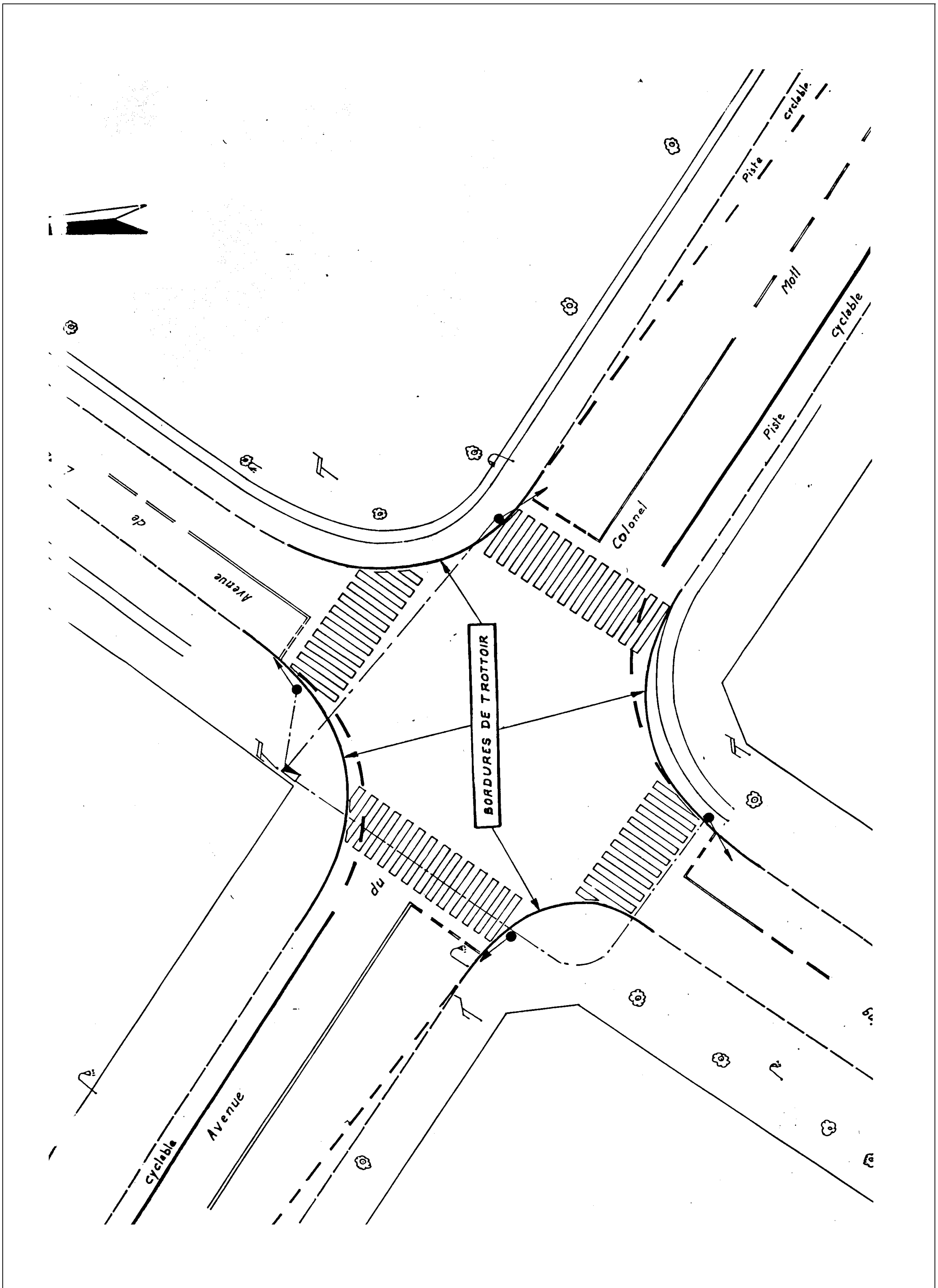
Quant aux avenues Mobutu, Bokassa, Nimeiry, et du Boulevard Georges Pompidou, la circulation serait plus calme à l'instar des avenues Gaourang et celle du 11 Août n'eut été la proximité des établissements scolaires tels que l'école des soeurs de chagoua, les lycées sacré-coeur, technique, et Eboué, les écoles de la mosqué Harazaï, chouada, du Centre culturel soudanais, etc. A ces points on enregistre 8 à 10 cas en moyenne. A noter également les avenues Eboué et Schoelcher qui connaissent des grandes activités à cause de la proximité des écoles des filles, du centre, du débouché sur le fleuve Chari, et de la place Félix Eboué avec le parking de l'hôpital Général de Référence Nationale.

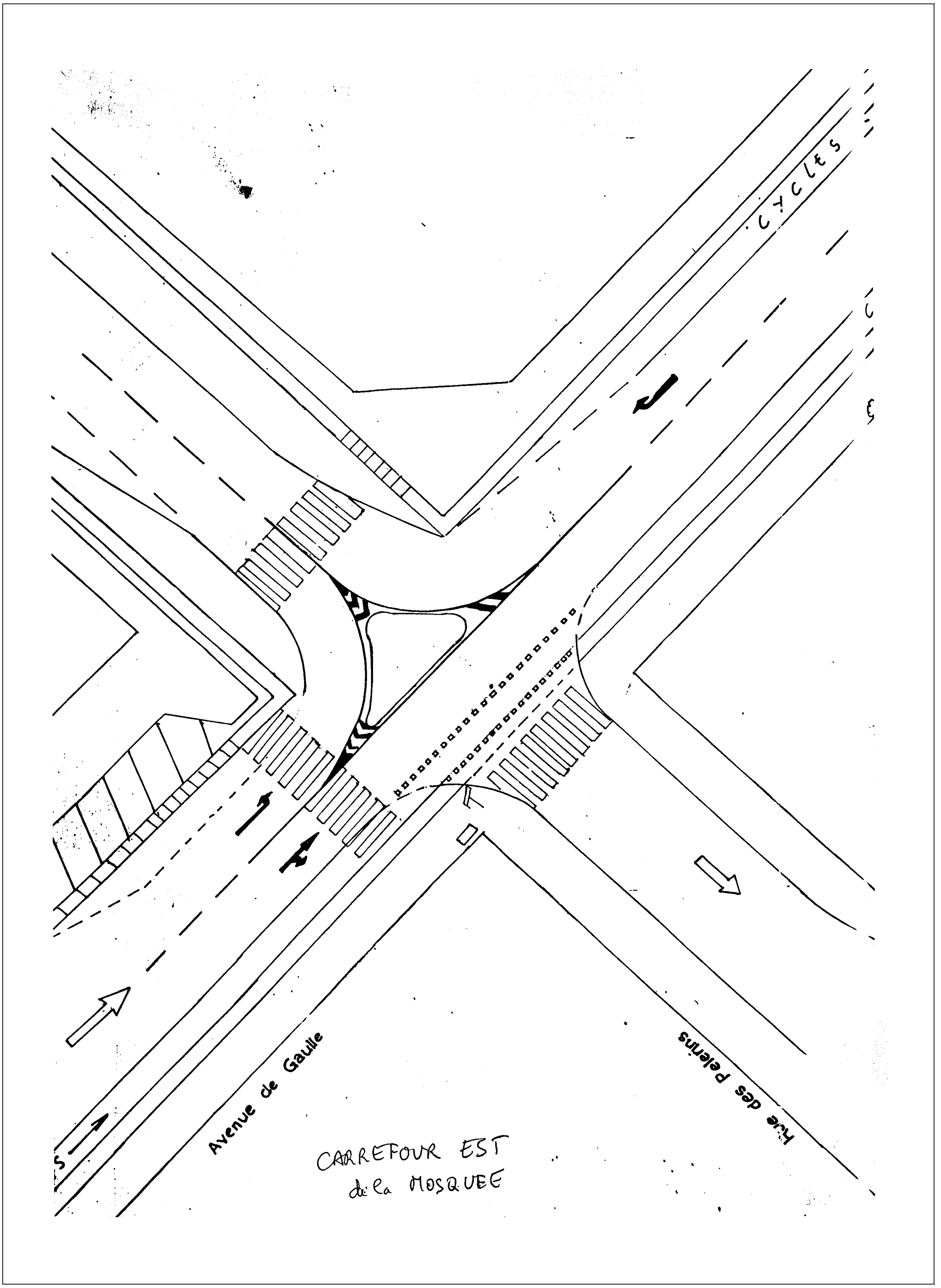
Signalons aussi qu'aux points où sont implantés les feux tricolores, nous constatons chaque jour 3 à 5 cas qui sont souvent dûs au non- respect des règlements par les automobilistes.

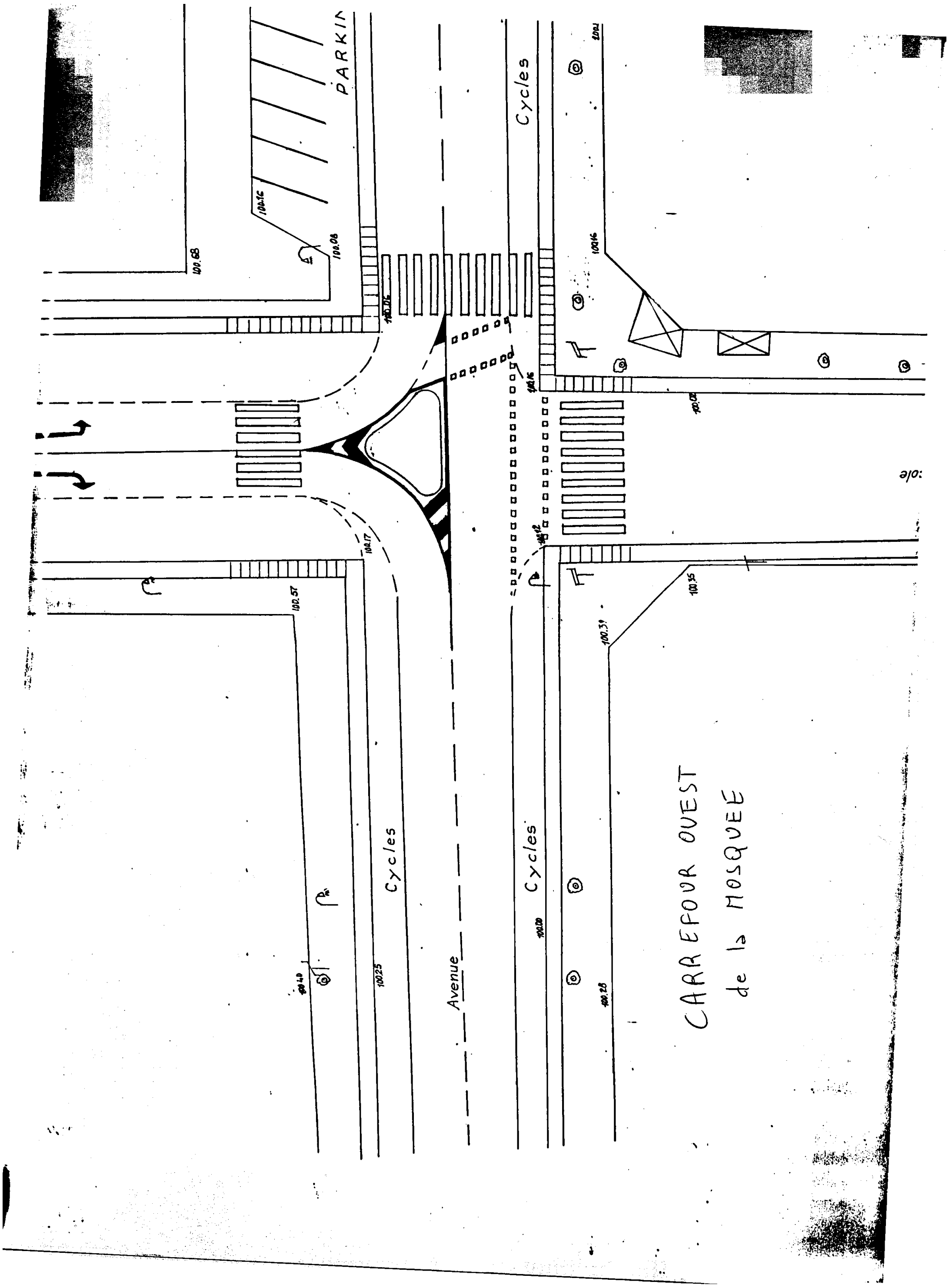
Appendix VI Designs of five crossroads in N'Djamena


Pompes essence
"MOBIL"
TFG40
Pompes essence
parterre
Bouche à eau
Parterre
Pancarte
AB4
AB4
27m
176x3 = 528 Briques
6,52/m
Bouche à eau
KASSER
Bouche à eau
Fosse
Pancarte


Félix
Avenue
100.47
100.20
100.45
100.53
100.48
100.44


BORDURES DE TROTTOIR
Piste cyclable
Moll
Piste cyclable
Colonel
Avenue
de
du
Avenue
cyclable


CYCLES
Avenue de Gaulle
Rue des Pelerins
CARREFOUR EST
de la MOSQUEE



CARREFOUR OUEST
de la MOSQUEE
Cycles
Cycles
Cycles
Avenue
PARKI

Appendix VII Pavement width of paved roads in N'Djamena

Voie Bitume dans la Commune de N'Djamena

Nom de la Rue	**Largeur**	**Longueur**	**Longueur Developpe**
BVD George Pompidou	6 m x 2	3,700 m	7,400 m
Avenue Nimeiry I	6 m x 2	2,350 m	4,700 m
Avenue Nimeiry II	6 m x 2	1,400 m	2,800 m
Avenue Mobutu	6 m x 2	3,600 m	7,200 m
Avenue Bokassa	6 m x 2	1,000 m	2,000 m
Avenue Gaourang	6 m x 2	1,075 m	2,150 m
BD du 11 Aout	6 m x 2	260 m	520 m
Avenue Ch. De Gaulle	9 m	6,200 m	6,200 m
Avenue Felix Eboue Moll	10 m	2,800 m	2,800 m
Route de Farcha	6 m	4,500 m	4,500 m
Rue de General Thilo	6 m	400 m	400 m
Rue Bayonne	6 m	505 m	505 m
Rue Cherif Idjile	7 m	660 m	660 m
Rue Robert Levy	6 m	150 m	150 m
Rue Paul Tripier	6 m	200 m	200 m
Rue Suberville	6 m	214 m	214 m
Avenue Saint Martin	7 m	480 m	480 m
Rue Behagle	6 m	400 m	40 m
Rue Charles de Gaulle	6 m	407 m	407 m
Rue Cointil	6 m	200 m	200 m
Rue de Paris	6 m	275 m	275 m
Rue Scholcher	9 m	900 m	900 m
Hemicycle	7 m	550 m	550 m
Place de L'Indepance	34 m	176 m	176 m
Rue Cite de L'Afrique	6 m	350 m	350 m
Rue de Brazza	6 m	175 m	75 m
Rue Beck Ceccaldi	6 m	450 m	450 m
Rue 2083	6 m	300 m	300 m
Bld 26 Aout	6 m	1,490 m	1,490 m
Bld des Sao	7 m	1,500 m	1,500 m
Rond-Point Renaissance	6 m	190 m	190 m
Rond-Point Etoile	6 m	163 m	163 m
Rond-Point Nouakchott	6 m	144 m	144 m
Rond-Union	6 m	116 m	116 m
Rond-Point Chagoua	6 m	150 m	150 m
Rue de General Brosset	7 m	550 m	550 m
Rue de Strasbourg	7 m	447 m	447 m

Longueur des voies bitumée dans la Ville de N'Djamena: 38,427 km
Voie de Contournement: 22 km

Total: 60,427 km