Qatar 2050 قطر
الخطة الشاملة للنقل
Transportation Master Plan

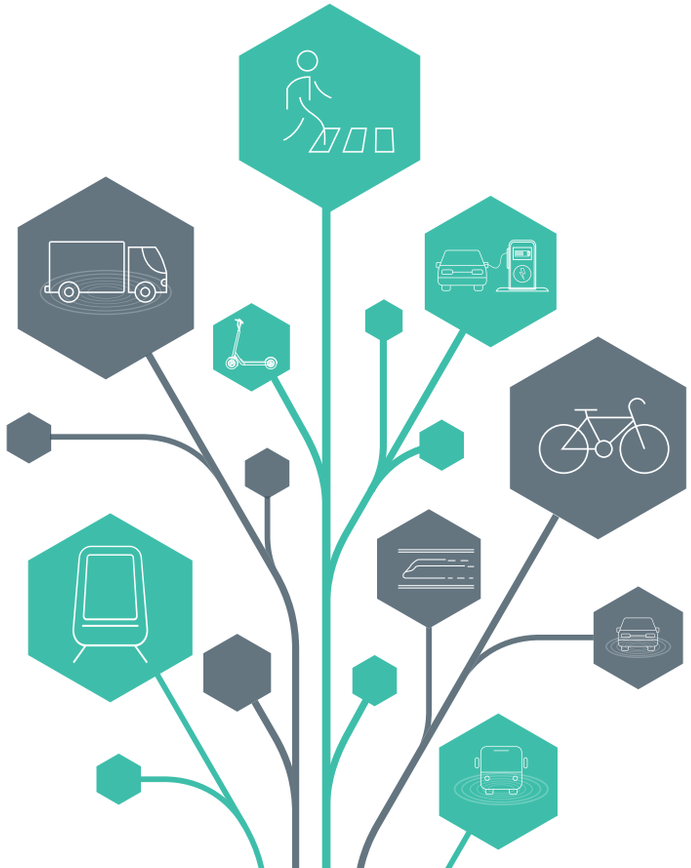
وزارة المواصلات
MINISTRY OF TRANSPORT

2050

Updating Transportation
Master Plan For Qatar
TMPQ

Road Network Hierarchy

نقل متكامل ومستدام للجميع
INTEGRATED & SUSTAINABLE TRANSPORT FOR ALL



2050

نقـل متكامـل ومسـتدام للجميـع

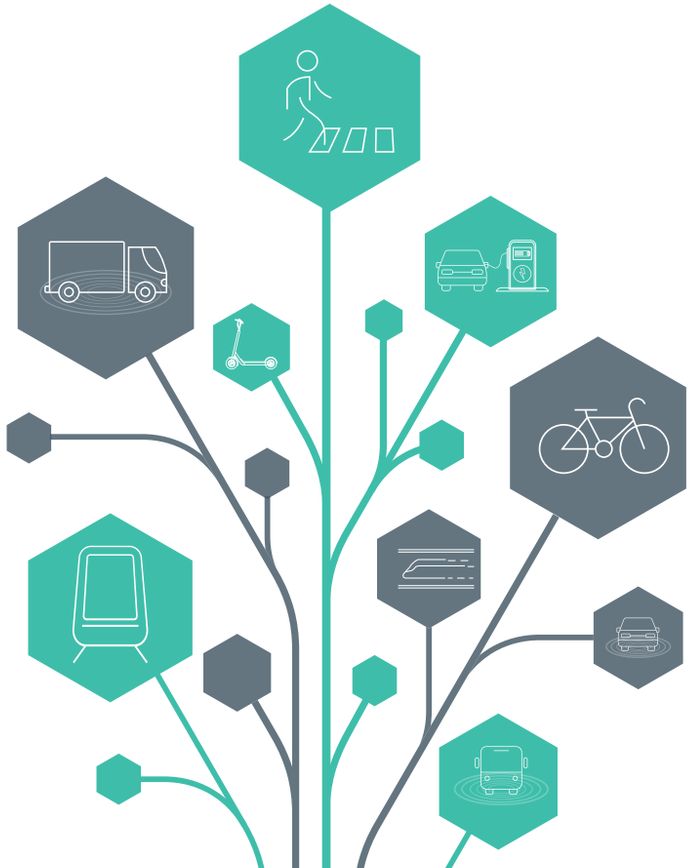
INTEGRATED & SUSTAINABLE TRANSPORT FOR ALL

ملاحظة:

يرجى العلم أن أي إشارة أو ذكر لـ "وزارة المواصلات والاتصالات" واختصارها "MOTC" في هذا التقرير، أصبحت تشير حالياً إلى "وزارة المواصلات" و اختصارها "MOT".

Note:

Please note that any reference or mention of the "Ministry of Transport and Communications" and its abbreviation "MOTC" in this report, now refers to the "Ministry of Transport" and its abbreviation "MOT".



2050

نقـل متكامـل ومسـتدام للجميـع

INTEGRATED & SUSTAINABLE TRANSPORT FOR ALL

مقدمة

يعتبر قطاع النقل البري أحد القطاعات الرئيسية في تطوير مختلف جوانب الحياة وضمان لنقل السلع والخدمات للأفراد والمجتمعات، كما يدعم نمو القطاعات الأخرى، مثل الزراعة والصناعة والتعدين والتجارة ويدفع التنمية المستدامة للمدن والمجتمعات والاقتصاد لتحقيق أهداف رؤية قطر الوطنية 2030.

ومن هذا المنطلق والتزاماً بمسؤولياتها قامت وزارة المواصلات والاتصالات بإعداد خطة النقل الشاملة لدولة قطر حتى عام 2050م بمشاركة ومساهمة العديد من الجهات الحكومية والخاصة والمختصين بهذا المجال.

توفر خطة النقل الشاملة لدولة قطر إطارًا شاملاً لمستقبل النقل البري فضلاً عن مجموعة متكاملة من المبادرات والمشاريع لخدمة جميع مستخدمي أنظمة وشبكات النقل البري، وذلك لتطوير مستوى خدمات النقل بما يتواكب مع النمو السكاني المتزايد في جميع أنحاء دولة قطر والتنمية الاقتصادية على مدار الثلاثين عامًا القادمة حتى عام 2050م. وهذه الخطة بعيدة المدى ستضع دولة قطر في المقدمة كأحد أكثر دول العالم استدامة من خلال توفير حلول نقل مبتكرة ومستدامة لدعم الاقتصاد، وتحسين جودة الحياة للمواطنين والمقيمين في دولة قطر مع الحفاظ على هويتها الوطنية.

واستمدت هذه الخطة مبادراتها وسياساتها وأدلتها من ركائز رؤية قطر الوطنية 2030، والتي تطمح إلى أن تكون دولة قطر في طليعة الدول المتقدمة، في ظل القيادة الرشيدة لحضرة صاحب السمو الشيخ تميم بن حمد آل ثاني أمير البلاد المفدى.

كما قدمت العديد من الجهات مساهمات وتعاوناً كبيراً في إعداد هذه الخطة الطموحة. ولمواصلة تطوير هذه الخطة وضمان تنفيذها بنجاح تحث وزارة المواصلات والاتصالات جميع الجهات الأخرى للاطلاع على هذه الخطة، والعمل معًا مسترشدين بها لتطوير أنظمة نقل بري متكاملة تلتزم بالأهداف الوطنية لمستقبل مزدهر ومستدام.

كما تؤكد وزارة المواصلات والاتصالات على التزامها بالعمل الجاد والدؤوب من خلال المشاريع والبرامج المستقبلية التي تهدف إلى بناء نظام نقل بري قائم على أحدث التقنيات وأفضل الممارسات في هذا القطاع.

Foreword

Land transportation is one of the key sectors that tremendously helps improve all aspects of life and ensures the delivery of goods and services to individuals and communities. It also underpins the growth of other sectors, such as agriculture, industry, mining and trade and drives the sustainable development of cities, societies and the economy in step with the objectives of the Qatar National Vision 2030.

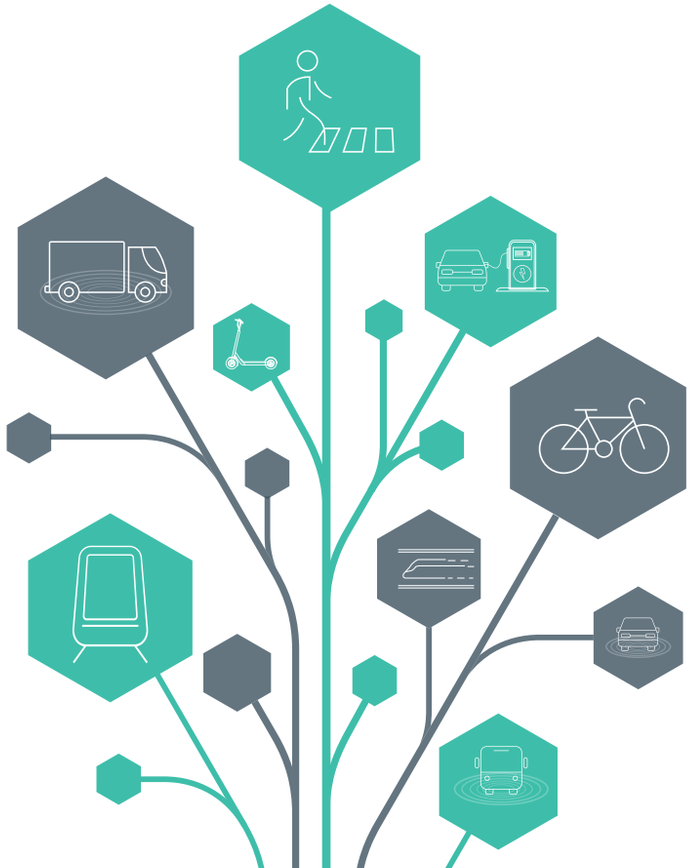
It is with this understanding that the Ministry of Transport and Communications (MOTC), in compliance with its responsibilities, has developed the Transportation Master Plan for the State of Qatar (TMPQ) with collaboration and input from multiple government and private entities and other relevant stakeholders and organizations.

The TMPQ provides an overarching framework for the future of land transportation that recommends an integrated set of transportation initiatives and projects for all users of land transportation systems, which will accommodate the population growth and a growing development momentum across Qatar over the next 30 years until 2050. This far-reaching masterplan can eventually bring Qatar to the forefront of world's most sustainable nations by providing innovative and sustainable transportation solutions that further boost the economy, improve the quality of life for citizens and residents, while preserving the national identity of Qatar.

The transportation schemes, initiatives, policies and manuals within TMPQ have been derived from the pillars of the Qatar National Vision 2030, which strive to place Qatar in forefront and the most advanced nations under the leadership of the Emir of Qatar, His Highness Sheikh Tamim Bin Hamad Al Thani.

A multitude of stakeholders played key roles and made very significant contributions to this ambitious plan. To continue that development and for successful implementation, MOTC encourages all other entities to familiarize themselves with the TMPQ and work together guided by this plan to develop integrated transportation systems that zoom on in the national objectives for a prosperous and sustainable future.

MOTC further stresses its commitment to working relentlessly on many future projects and programs and which aim to deliver a land transportation system that is based on latest technologies and best practices in the transportation field.



2050

نقـل متكامـل ومسـتدام للجميـع

INTEGRATED & SUSTAINABLE TRANSPORT FOR ALL

تنويه

قامت وزارة المواصلات والاتصالات بإعداد هذا التقرير ضمن اختصاصاتها وصلاحياتها وفقاً لأحدث الممارسات العالمية في هذا المجال وبناءً على المعلومات، والإحصائيات والبيانات المتوفرة عند إعداد هذا التقرير. لذا إن استخدام هذا التقرير لأي عمل، لا يعفي المستخدمين من استخدام أحدث الممارسات العالمية، واتباع الأساليب الهندسية الصحيحة وفقاً لأحدث التقنيات العالمية المتبعة.

وعليه وجب التأكيد على أن وزارة المواصلات والاتصالات لا تتحمل أي مسؤولية مالية أو قانونية يمكن أن تُعزى إلى هذا الاستخدام، كما أنه لا يحق للمستخدمين المطالبة أو استلام أي نوع من التعويض عن أية أضرار أو خسائر.

وللحصول على نسخة من هذا التقرير، يجب التقدم بطلب رسمي إلى وزارة المواصلات والاتصالات في دولة قطر والذي يعد موافقة على ماورد في هذا التنويه. ويجوز للمستخدمين عرض محتويات التقرير ونسخها وطباعتها للاستخدام الخاص فقط، شريطة أن تحمل جميع النسخ والمطبوعات الخاصة بالمحتويات حقوق النشر وإشعارات الملكية وإخلاء المسؤولية الأخرى المعروضة على التقرير. كما لا يجوز للمستخدمين الإعلان أو النشر أو الإفصاح عن البيانات و / أو الكشف عن أي معلومات مدرجة في هذا التقرير على الإطلاق دون موافقة كتابية مسبقة من قبل وزارة المواصلات والاتصالات.

وفيما يخص التغييرات أو الإصدارات المستقبلية، ستقوم الوزارة بتوفيرها ويمكن الحصول عليها من خلال الاتصال بالإدارة المخولة في الوزارة، وعليه يتوجب على المستخدمين التحقق بشكل متواصل بأن لديهم أحدث إصدار من هذا التقرير.

ملاحظة: ستقوم وزارة المواصلات والاتصالات بمواصلة تحديث وتعديل هذا التقرير مع الأخذ بعين الاعتبار النظريات الجديدة وأحدث الأساليب التكنولوجية والمواضيع المُستجدة التي تتعلق بتخطيط وتحليل وتصميم أنظمة النقل والمرور.

إن وزارة المواصلات والاتصالات تشجع المستخدمين على تقديم الملاحظات والاقتراحات والتعليقات وردود الأفعال وذلك من خلال قنوات الاتصال الخاصة بالوزارة، وسيتم مراجعة هذه الملاحظات والاقتراحات ومن ثم تقييمها للنظر في إمكانية إدراجها ضمن الإصدار القادم من التقرير.

Disclaimer

The Ministry of Transport and Communications (MOTC) of Qatar has developed this document with upmost due diligence, using information, statistics and survey data available at the time of writing and following international best practices.

Without any liability to MOTC, the using of content contained herein and its supplementary data for any work purpose, does not relieve the user from exercising due diligence and sound engineering practices as per international best practices, nor does it entitle the user to claim or receive any kind of compensation for damages or loss that might be attributed to such use.

Access to this document shall be officially requested from MOTC Which means your acceptance to what is stated in this notice. Except where otherwise specified, users may view, copy and print the Document Contents only for their own use, provided that all copies and printouts of the Contents bear the copyright and other proprietary notices and disclaimers displayed on the Document. Users shall not advertise, publicize, release statements and/or disclose any information included in this Document whatsoever without the prior written consent from MOTC.

Future changes, amendments and versions of this Document will be made available by MOTC and can be obtained by contacting the department authorized by the Ministry. Users are therefore advised to investigate and verify that the version they have is the latest and up-to-date one.

Note: New findings, technologies, and topics related to the planning, designing, operating, and maintaining of transportation and traffic systems will regularly be used by MOTC to keep this report up to date. Users are encouraged to provide feedback through MOTC communication channels. Feedback will be reviewed, assessed, and possibly included in the next version.

Qatar 2050 قطر
الخطة الشاملة للنقل
Transportation Master Plan

Table of Contents

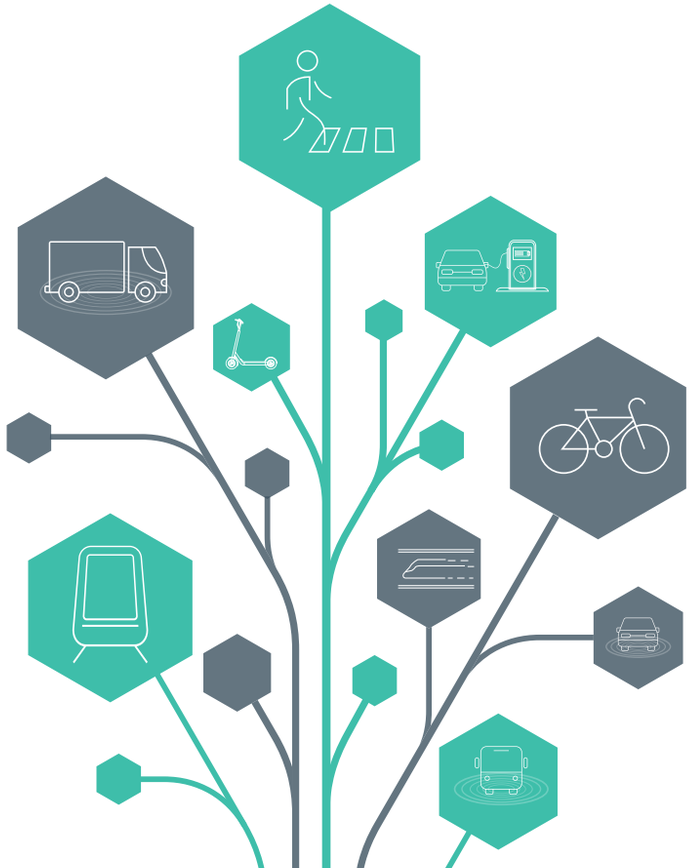
Qatar 2050 قطر
الخطة الشاملة للنقل
Transportation Master Plan

List of Tables

List of Figures

Qatar 2050 قطر
الخطة الشاملة للنقل
Transportation Master Plan

List of Appendices



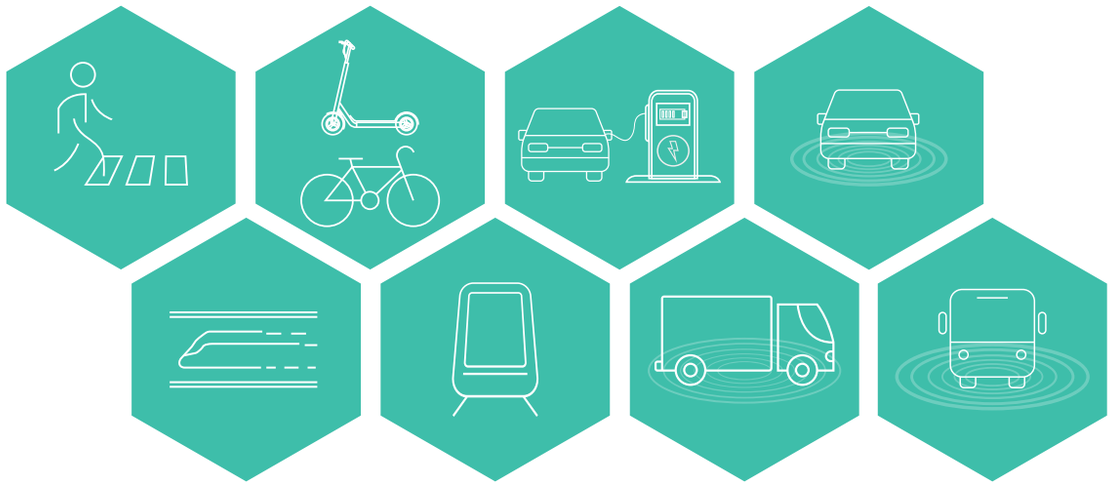
2050

نقـل متكامـل ومسـتدام للجميـع

INTEGRATED & SUSTAINABLE TRANSPORT FOR ALL

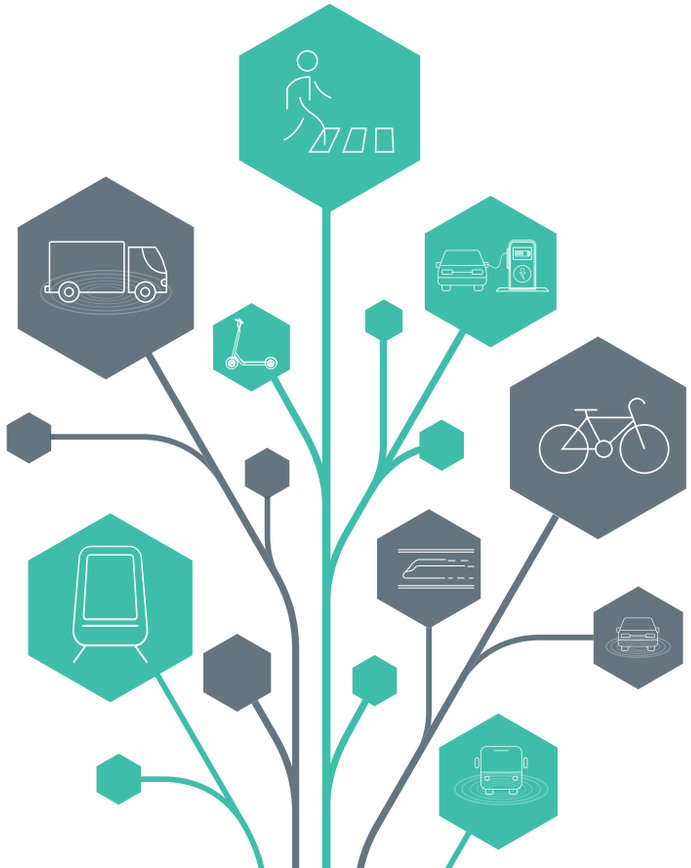
2050

ABBREVIATIONS



ABBREVIATIONS

AADT	Annual Average Daily Traffic
ADRDM	Abu Dhabi Road Design Manual
AI	Artificial Intelligence
BRT	Bus Rapid Transit
CBD	Central Business District
CCD	Context Sensitive Design
CD	Collector-Distributor
CGIS	Center of Geographic Information System
FCS	Functional Classification System
FHWA	United States Federal Highway Administration
GIS	Geographic Information System
HV	Heavy Vehicle
LRT	Light Rail Transit
LV	Light Vehicle
LOS	Level of Service
MaaS	Mobility As a Service
MOTC	Ministry of Transportation and Communications
O-D	Origin-Destination
PMD	Personal Mobility Device
PWA	Public Works Authority
QHDM	Qatar Highway Design Manual
QNDFH	Qatar National Development Framework Hierarchy
QSTM	Qatar Strategic Transportation Model
ROW	Right of Way
TCD	Traffic Control Device
TCM	Traffic Calming Measures
TMPQ	Transportation Master Plan for Qatar
TOR	Terms of Reference
USDM	Abu Dhabi Urban Streets Design Manual



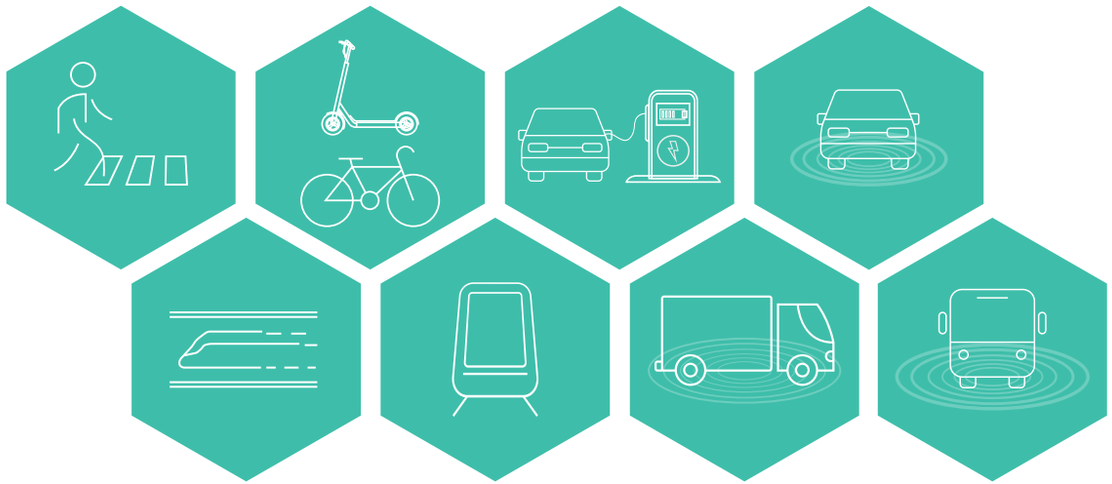
2050

نقـل متكامـل ومسـتدام للجميـع

INTEGRATED & SUSTAINABLE TRANSPORT FOR ALL

2050

GLOSSARY



GLOSSARY

Access Function

The extent to which a road functions to enable access to roadside land use.

Annual Average Daily Traffic (AADT)

The average 24-hour traffic count collected daily over one year.

Context Sensitive Design

A process and practice that considers the both the immediate environment of the roadway and the transportation needs of the communities it serves.

Functional Classification System

The framework for classifying roads based on the function they serve within a network. It includes the list of classes, the properties and descriptions associated with them and how they affect the planning and design process.

Mobility Function

The extent to which a road functions to enable free flow of through traffic.

Roadway

All the elements of a road including travelled way, median, shoulder, sidewalk and any other element within the right of way.

Roadway Context

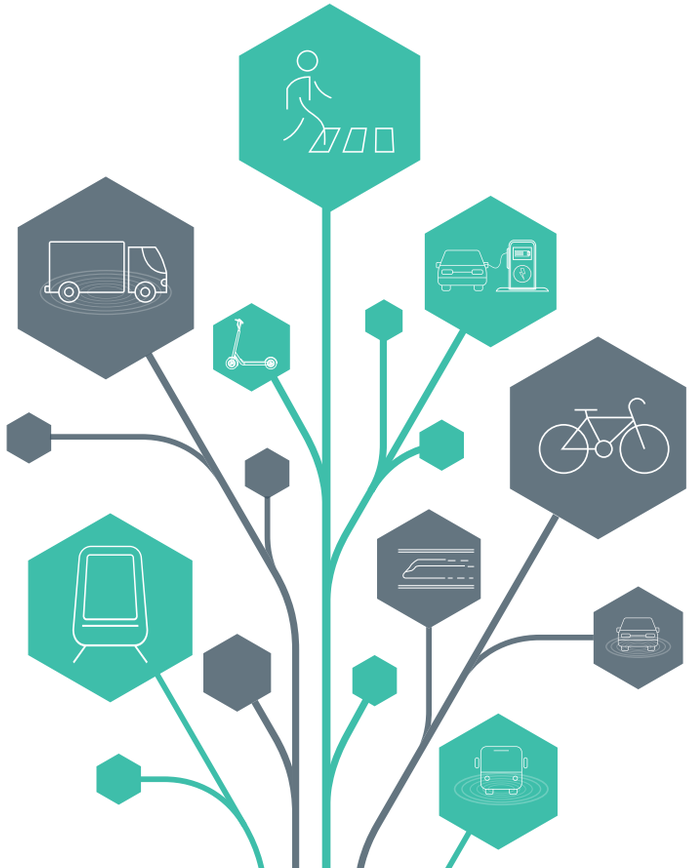
The nature of land surrounding a road whether it is considered rural or urban.

Survivability speed

The highest speed of collision between motor vehicles and pedestrians or cyclists whereby they have a high chance of survival

Travelled Way

The continuous portion of the roadway for the movement of motor vehicles, excluding shoulders or parking.



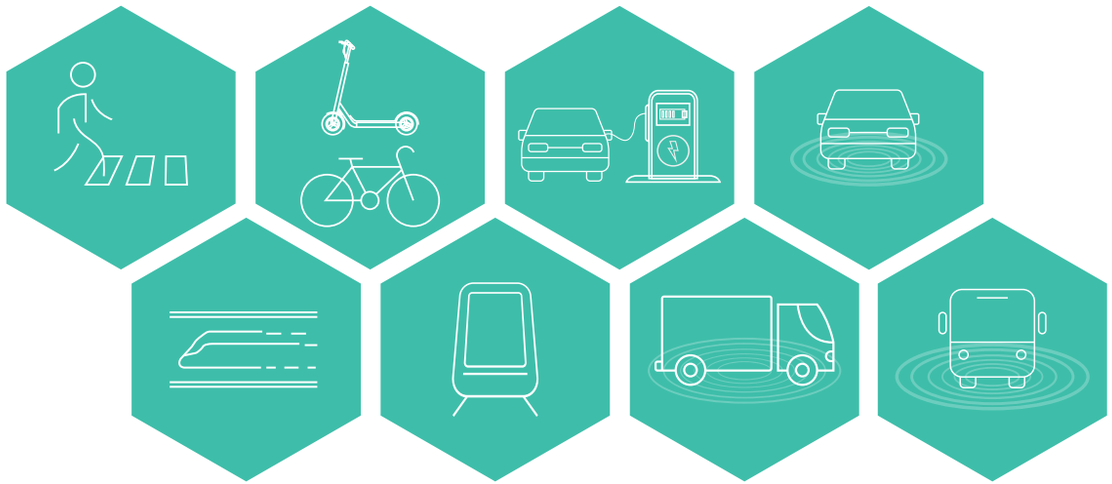
2050

نقـل متكامـل ومسـتدام للجميـع

INTEGRATED & SUSTAINABLE TRANSPORT FOR ALL

2050

REFERENCES



REFERENCES

1. **Highway Functional Classification: Concepts, Criteria and Procedures, 2013 (FHWA)**

   https://www.fhwa.dot.gov/planning/processes/statewide/related/highway_functional_classifications/fcauab.pdf

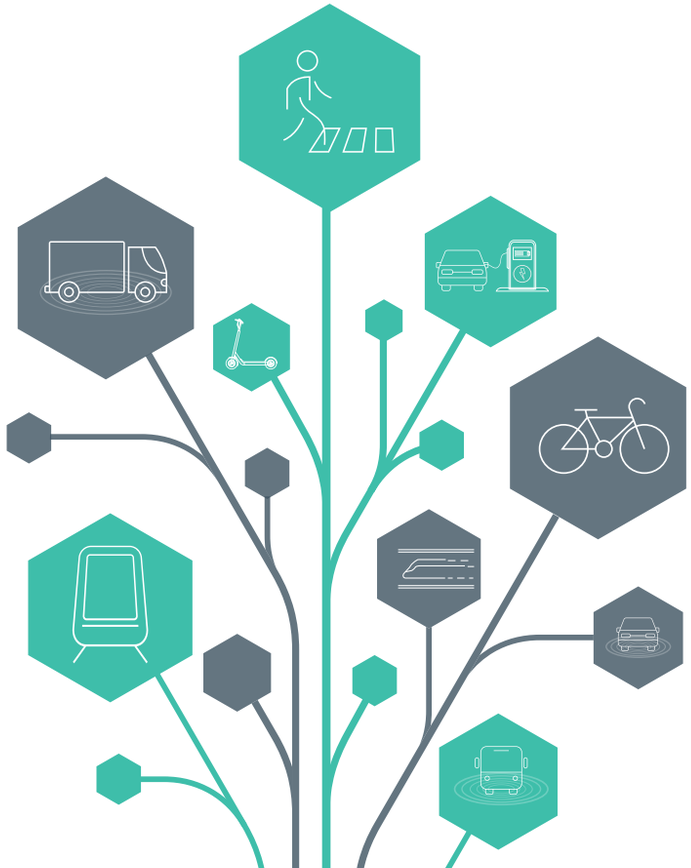
2. **An Expanded Functional Classification System for Highways and Streets (NCHRP, Research Report 855, 2018)**

   https://www.nap.edu/read/24775/chapter/2

3. **Urban Street Design Manual, Abu Dhabi**

   https://nelsonnygaard.com/wp-content/uploads/2014/04/Abu-Dhabi-StreetDesignManual.pdf

4. **Qatar Highway Design Manual, 2020**



2050

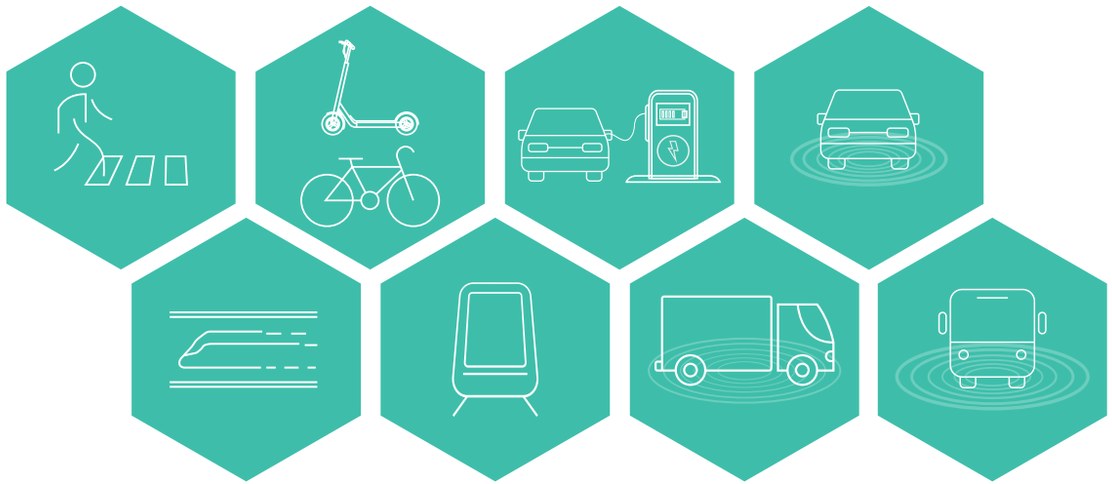
نقـل متكامـل ومسـتدام للجميـع

INTEGRATED & SUSTAINABLE TRANSPORT FOR ALL

2070

SECTION - 01

INTRODUCTION



1 INTRODUCTION

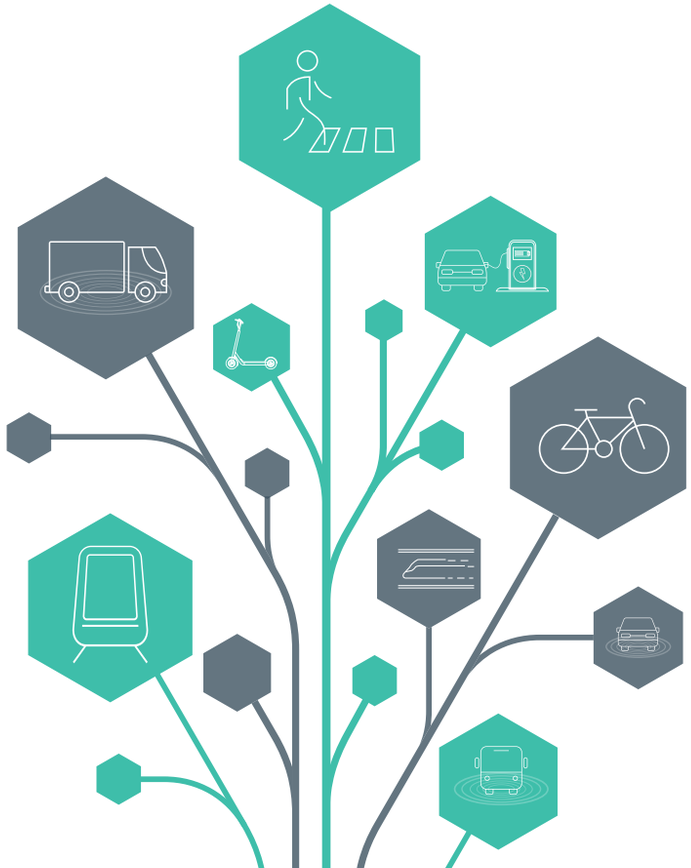
1.1 CONTEXT OF THIS DOCUMENT AND BACKGROUND OF THE TMPQ

This document of the updated Transportation Master Plan for Qatar discusses the concept and framework underlying the functional classification of roads in the State of Qatar. It includes an overview of the existing functional classification system, a review of the existing road network classification, a review of international best practices and an updated road classification system to guide planners and designers. The purpose of this updated road functional hierarchy system is to bridge the gaps and clarify the ambiguities identified during the review of the existing system.

1.2 STRUCTURE OF THIS REPORT

The structure of this document comprises of the following sections:

- Section 2. Review of existing road hierarchy system (base year 2018);
- Section 3. Review of international best practices;
- Section 4. Development of proposed functional hierarchy framework; and
- Section 5. Application of the updated functional classification system.



2050

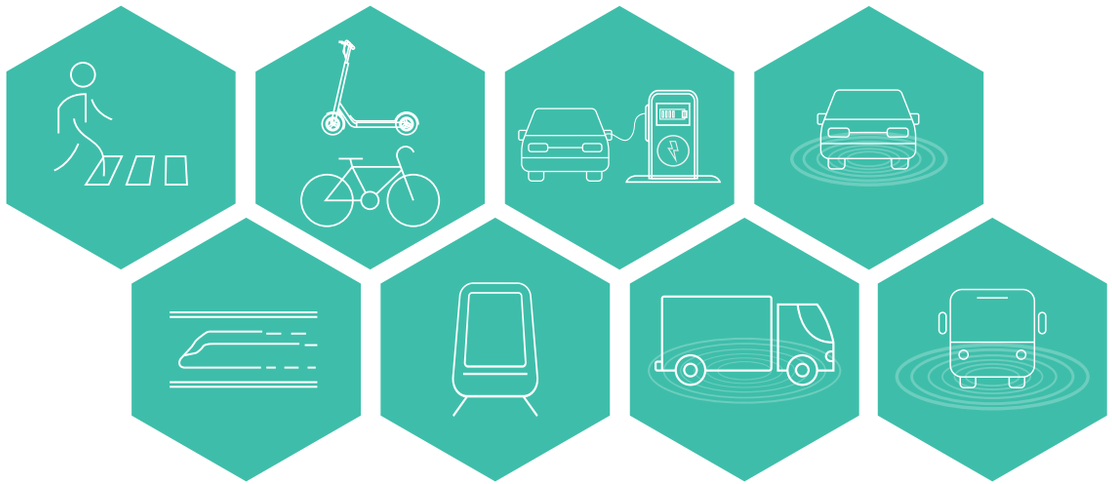
نقـل متكامـل ومسـتدام للجميـع

INTEGRATED & SUSTAINABLE TRANSPORT FOR ALL

02

SECTION - 02

EXISTING ROAD HIERARCHY



2 EXISTING ROAD HIERARCHY

The review of the existing road hierarchy in Qatar comprises of the reviews of existing functional classification system (Section 2.1) and the existing road network classification (Section 2.2).

It is endeavored to focus on road network hierarchy from the transport planning perspective and therefore have conducted meetings with MOTC-LTPD team to take into account their main objectives from this exercise.

2.1 EXISTING FUNCTIONAL CLASSIFICATION SYSTEM

The existing Functional Classification System (FCS) in Qatar was first outlined in the TMPQ 2008 and adopted with modification in the QHDM (2020). In both documents, the functional classes are divided into rural and urban contexts and, within the urban context, four land-use-related sub-contexts are used: Industrial, Commercial, Residential and Recreational. This section provides a review of the existing system for functional classification as well as the database containing the classification of existing roads based on the current system.

2.1.1 TRANSPORT MASTER PLAN FOR QATAR 2008

TMPQ 2008 conducted a review of the then existing FCS in Qatar contained within the Qatar Highway Design Manual 1997 and proposed a new FCS.

2.1.1.1 Context Definition

The classification contexts in the TMPQ are used without changes in the QHDM 2020. This context definition is clear and descriptive. It is also designed to be suitable for local conditions. The main urban and rural classification contexts used are defined as follows:

- Urban roads – lie adjacent to areas which contain, or are zoned to contain, built land use development.
- Rural roads – lie adjacent to areas which are predominantly natural, with little or no adjacent built land use development.

Within the urban area, the land use frontage of a given road is used as a major criterion for the functional classification, due to its effect on the functional requirements from the roadway (mobility, access, parking, etc.). The TMPQ defines the following roadway contexts related to adjacent land uses:

- Industrial: this land use context encompasses the following land use categories: light manufacturing, heavy manufacturing, military facilities, storage/logistics and shipment land uses (airports and ports).
- Commercial: this land use context is defined as involving in the trade of goods and services and encompasses the following land use categories: business districts, offices, shopping malls, strip malls, restaurants, hotels and retail outlets. It may also encompass institutional land use categories such as: schools, mosques and health centers.

- Residential: this land use context encompasses residential land use ranging from low density villas to high density apartment housing.
- Recreational/Leisure/Park: this land use context encompasses the following land use categories: sports facilities, such as leisure centers or gyms, sports stadiums, open spaces and public parks.
- Mixed Land Uses: recognizing that, in practice, the same roadway may be surrounded with different land use categories and that the same building adjacent to the road may include both commercial and residential uses, the TMPQ prescribes that all surrounding land use types be taken in consideration and that the roadway is classified based on the most predominant of them.

2.1.1.2 FUNCTIONAL CLASSIFICATION SYSTEM SUMMARY

The Functional Classification System proposed in the TMPQ 2008 is summarized in Table 2.1 for urban areas and Table 2.2 for rural areas, giving a brief description of its function. The urban sub-contexts described above don't affect the function of the road, they change certain parameters used in planning and design, and these are discussed in Section 2.1.1.3 below.

An example of the urban network classification is presented in Figure 2.1:

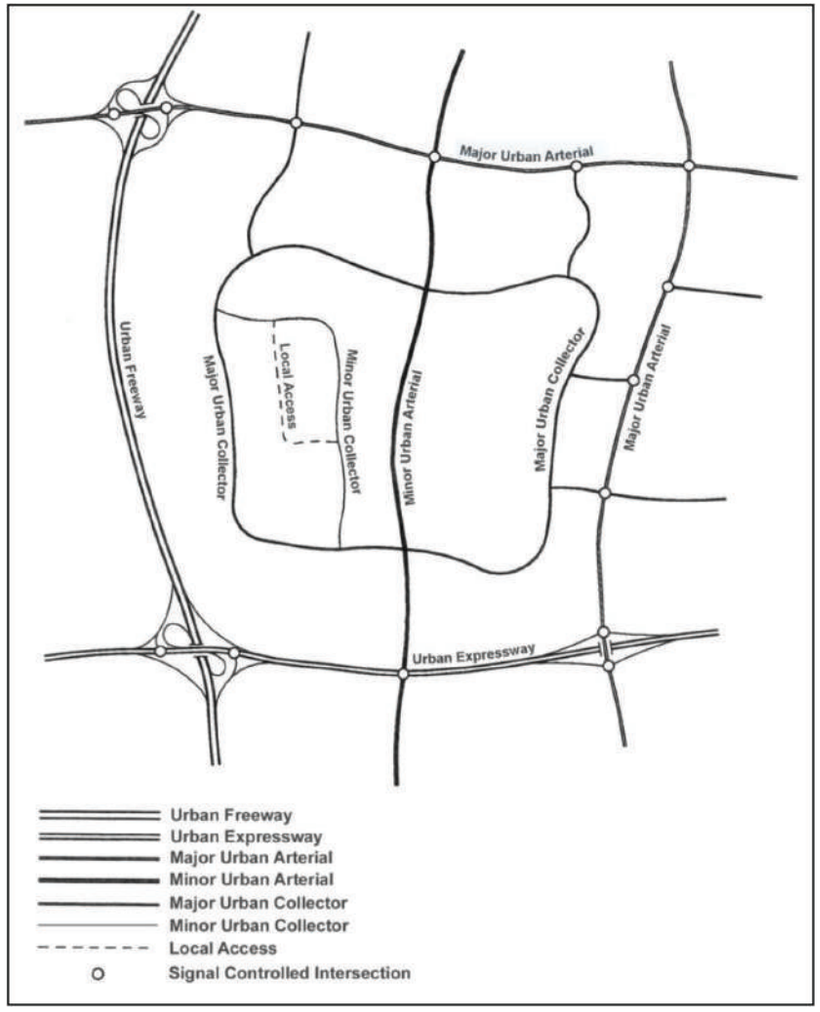
Table 2.1 - TMPQ 2008 Urban System Functional Classifications Description

Functional Class	Description
Urban Freeway	– Carry high volumes of free-flowing through traffic between major traffic generating land uses. – Act as an urban extension of rural freeways. – Mobility is the primary function and land use access is prohibited.
Urban Expressway	– Carry medium to high traffic volumes, mainly at free-flow conditions, between major land uses across a wide urban area. – Traffic mobility is the primary function and land use access is not permitted.
Major Urban Arterial	– Carry medium volumes of traffic under free-flow conditions where possible between urban districts containing major land uses. – Traffic mobility is the primary function and limited land use access is permitted.
Minor Urban Arterial	– Carry medium to low volumes of traffic between urban districts containing specific land uses. – Traffic mobility is the major function and some land use access is permitted.
Major Urban Collector	– Collect/distribute medium to low volumes of traffic to and from arterial roads within districts. – Traffic mobility and land use access are of equal importance.
Minor Urban Collector	– Collect/distribute low volumes of traffic to and from arterial roads within local areas. – Land use access is the primary function and traffic mobility is the secondary function.
Local Access Road	– Provide access only to adjacent property/land. – Land use access is the primary function and only minor volumes of traffic mobility are permitted.

Table 2.2 - TMPQ 2008 Rural System Functional Classifications Description

Functional Class	Description
Rural Freeway	– Carry high volumes of free-flowing through rural traffic between major city clusters at a national/international scale. – Traffic mobility is the primary function and land use access is prohibited.
Rural Expressway	– Carry medium to high rural traffic volumes, mainly at free-flow conditions, between major land uses within a large area. – Traffic mobility is the primary function and land use access is prohibited.
Rural Arterial	– Carry medium to high rural traffic volumes between major land uses within a smaller area. – Traffic mobility is the primary function and land use access is prohibited.
Rural Collector	– Collect/distribute medium volumes of rural traffic serving adjacent rural land use and rural arterials and expressways. – Traffic mobility and land use access are of equal importance.
Local Access (Rural)	– Provide access only to adjacent rural property/land. – Land use access is the primary function traffic mobility is a secondary function.

Figure 2.1 - Example of Urban Road Network Classification in the TMPQ 2008



2.1.1.3 KEY DESIGN PARAMETERS

The details of key parameters used in design are provided as part of the functional classification system in the TMPQ 2008. These parameters for functional classification are listed in Table 2.3 for urban roads and Table 2.4 for rural roads. The sections below provide a summary description of these parameters.

Table 2.3 - TMPQ 2008 Functional Hierarchy Key Design Parameters for Urban Roads

Roadway Classification	Land Use Frontage	Function	Posted Speed (km/h)	Daily Traffic Volume	ROW Width (m)	Carriageway width (m)	Min. Median Width (m)	Urban Aesthetics	Parking Provision	Minimum TCD Spacing (m)
Urban Freeway	Not residential or recreational	Maximum Mobility – No Access	LV: 100-120 HV: 80-100	> 80,000	> 54	> 22	9.4	Required	Prohibited	1800
Urban Expressway	Not residential or recreational	Mobility is the Primary Function - No Access	LV: 80-120 HV: 80	60,000 to 80,000	> 54	> 22	9.4	Required	Prohibited	500
Urban Major Arterial	Commercial or Industrial Preferred	Mobility is the Primary Function - Limited Access	LV: 60-80 HV: 60	30,000 to 60,000	46 - 64	14.6 - 29.2	9.4	Required	Restricted	300
Urban Minor Arterial	Commercial or Industrial Preferred	Mobility is the Major Function - Some Access	LV: 40-60 HV: 40	20,000 to 40,000	46 - 58	14.6 - 21.9	9.4	Required	Some Restrictions	150
Urban Major Collector	Industrial	Mobility and Access of Equal Importance	LV: 60-80 HV: 60	20,000 to 50,000	43 - 55	14.6	7.4	Required	Some Restrictions	100
	Commercial	Mobility and Access of Equal Importance	LV: 60-80 HV: 40-60	20,000 to 50,000	43 - 55	14.6	7.4	Required	Restricted	100
	Residential	Mobility and Access of Equal Importance	LV: 40-60 HV: 40	20,000 to 30,000	43 - 55	14.6	7.4	Required	Restricted	100
	Recreational	Mobility and Access of Equal Importance	LV: 40-60 HV: N/A	10,000 to 20,000	43 - 55	14.6	7.4	Required	Restricted	100

Table 2.3 - TMPQ 2008 Functional Hierarchy Key Design Parameters for Urban Roads

Roadway Classification	Land Use Frontage	Function	Posted Speed (km/h)	Daily Traffic Volume	ROW Width (m)	Carriageway width (m)	Min. Median Width (m)	Urban Aesthetics	Parking Provision	Minimum TCD Spacing (m)
Urban Minor Collector	Industrial	Mobility is Secondary Function Access is Primary Function	LV: 40-60 HV: 40	5,000 to 30,000	24 - 32	7.3	-	Required	Some Restrictions	50
	Commercial	Mobility is Secondary Function Access is Primary Function	LV: 40-60 HV: 40	5,000 to 30,000	24 - 32	7.3	-	Required	Restricted	50
	Residential	Mobility is Secondary Function Access is Primary Function	LV: 40 HV: 40	5,000 to 20,000	24 - 32	7.3	-	Required	Restricted	50
	Recreational	Mobility is Secondary Function Access is Primary Function	LV: 40 HV: N/A	5,000 to 10,000	24 - 32	7.3	-	Required	Restricted	50
Urban Local Access Road	Industrial	Mobility is Minor Function Access is Primary Function	LV: 40 HV: 40	< 5000	19 - 21	6.6 - 7.3	-	Required	Some Restrictions	50
	Commercial	Mobility is Minor Function Access is Primary Function	LV: 40 HV: 40	< 5000	19 - 21	6.6 - 7.3	-	Required	Some Restrictions	50
	Residential	Mobility is Minor Function Access is Primary Function	LV: < 40 HV: N/A	< 5000	19 - 21	6.6 - 7.3	-	Required	Some Restrictions	< 50 where required
	Recreational	Mobility and Access are Minimal	LV: < 40 HV: N/A	< 5000	19 - 21	6.6 - 7.3	-	Required	Restricted	< 50 where required

Table 2.4 - TMPQ 2008 Functional Hierarchy Key Design Parameters for Rural Roads

Roadway Classification	Land Use Frontage	Function	Posted Speed (km/h)	Daily Traffic Volume	ROW Width (m)	Carriageway width (m)	Min. Median Width (m)	Parking Provision	Minimum TCD Spacing (m)
Rural Freeway	Not Applicable	Maximum Mobility – No Access	LV: 100-120 HV: 80-100	> 80,000	> 33	> 14.6	> 8	Prohibited	2000
Rural Expressway	Not Applicable	Mobility is the Primary Function - No Access	LV: 80-120 HV: 80	5,000 to 8,000	> 33	> 14.6	> 8	Prohibited	800
Rural Arterial	Not Applicable	Mobility is the Primary Function - Limited Access	LV: 60-80 HV: 60	2,000 to 5,000	29 - 34	14.6 - 21.9	> 8	Prohibited	400
Rural Collector	Not Applicable	Mobility and Access of Equal Importance	LV: 40-60 HV: 40	1,000 to 2,000	19 - 33	7.3 - 14.6	0 - 8	Restricted	100
Rural Local Access Road	Not Applicable	Mobility is Secondary Function Access is Primary Function	LV: 20-40 HV: 20	< 1,000	19 - 23	> 6.5	0	Some Restrictions	As required

Source: TMPQ 2008

Notes:

1. Cross Section dimensions are indicative only and should not be considered to replace detailed engineering and design standards in the Qatar Highway Design Manual.
2. Cross Section dimensions do not include additional right of way width that may be required for utilities. This element will be subject to detailed design based on site specific requirements.
3. Cross Section dimensions do not include additional right of way width that may be required for public transport corridors.

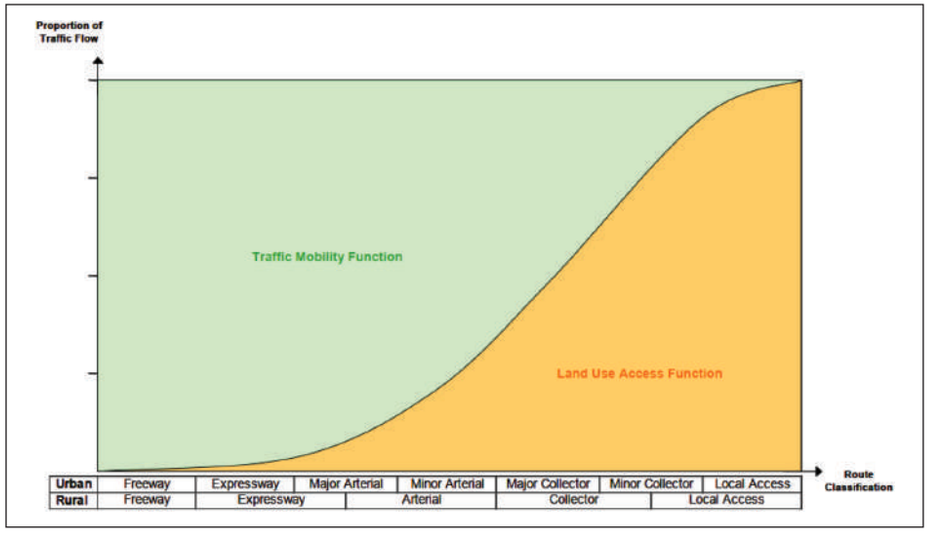
Total carriageway width and the required number of running lanes should be based on detailed design related to expected demand and required highway level of services.

2.1.1.3.1 Land Use Frontage

This parameter applies only to urban roads, it describes the preferred land use sub-context classification in Section 2.1.1.1 for urban sub-contexts. Most urban roads can be used within all sub-contexts with different design parameters. However, expressways and freeways are not to be used in residential or recreational areas; arterials can be used in these areas, but are not recommended.

2.1.1.3.2 Mobility versus Access

The mobility versus access criterion, as the main function of the road, indicates the extent to which a road should accommodate 'through' traffic (Traffic Mobility Function) or traffic wishing to access adjacent land uses and frontages (Land Use Access Function). Figure below depicts the balance between mobility and access to conceptualize this tradeoff relationship.



This is the main criterion which defines the role of the road and informs the transport demand management and planning processes. The aim is to provide an efficient traffic mobility function where required without being impeded by traffic movements associated with land use access, and vice versa, so that sufficient land use access can be provided where required.

2.1.1.3.3 Posted Speed

The posted traffic speed criterion indicates the traffic speed limits (in kilometers per hour) that should be applied to each of the route classifications. The TMPQ is careful to note that posted speed is not a strict functional classification criterion, since roads with the same speed limits can perform different functions. However, it is related to functional classification since it will have influence on the planning and design

solutions; it can be one quantitative indicator of the mobility function of the road. Posted speed may also be used to enforce the role of a roadway link in the hierarchy and has an impact upon the types of vehicles that can safely share the road.

The link between functional classification and posted traffic speeds becomes clear when looking at posted speeds in the highest and lowest class roads. Posted speed on freeways and expressways may be as high as 120 km/h for light vehicles enabling efficient traffic mobility under free-flowing conditions (heavy vehicle speeds are limited to 100 km/h on freeways and 80 km/h on expressways for safety reasons). Conversely, on urban local access roads traffic speeds are limited to 40 km/h to encourage safe and efficient access to adjacent land uses where traffic mobility is a minor function.

2.1.1.3.4 Traffic Volumes

The traffic volume criterion indicates the total daily volume of traffic that each route classification is expected to accommodate. Traffic volumes are also related to the Access\Mobility function of the roadway.

2.1.1.3.5 Cross-Section Elements

The Road Cross-Section criterion provides recommendations for the dimensions of the various cross-section elements. These dimensions are shown in Table 2.3 and Table 2.4. The TMPQ considers these dimensions to be indicative only and not be considered to replace detailed engineering design and standards. The cross-sectional elements given in the FSC are:

- Right of Way Width – The total width of the area of land in which the route corridor is accommodated. Land uses within the right of way width may include traffic lanes, medians between carriageways, the hard shoulders, footways, cycleways, buffer areas and frontage set back areas. The full extent of the right of way width is defined by land use frontage or the boundary of an adjacent land use. The right of way width does not include specific provision for utilities where required. Additional right of way width requirements will be subject to detailed design and consultation with utilities providers;
- Carriageway Width – The total width of all areas within the cross-section exclusively for travel use by motorized vehicles. This does not include the width of median between carriageways, shoulders, parking or hard strip areas;
- Median Width – The total width of the median between carriageways. The median may accommodate street lighting and vehicle restraint systems, as well as utilities where appropriate;
- Urban Aesthetics – This refers to the arrangement, visual appearance and aesthetic quality of the route. It refers to the shaping and landscape design of public spaces to improve the way they are experienced and used.

2.1.1.3.6 Provision for Parking/Loading

This criterion states the extent to which roadside parking and loading provision is permissible on each of the route classifications. Levels of provision for parking used in Table 2.3 and Table 2.4 are defined as follows:

- Prohibited – No parking or loading provision is allowed directly adjacent to the road.

- Restricted – Limited parking and/or loading provision may be permitted adjacent to the route where and/or when necessary. The provision of spaces for parking and/or loading should be limited to clearly marked bays and strictly enforced. Access to those parking and loading areas should also be limited by time of day and/or day of the week to ensure minimum impact upon traffic mobility on the adjacent road;
- Some Restrictions – Parking and/or loading provision is generally permitted adjacent to the route, although there may be some restrictions in certain locations to maintain traffic movement, access and safety. The amount of parking and loading should be considered according to local conditions, including the requirements of land uses and the traffic mobility function of the route.

2.1.1.3.7 Permitted Network Connections

This criterion states the permitted network connections between different functional classifications that should be adopted when planning new roads. This is directly related to the connectivity of the network. Table 2.5 and Table 2.6 summarize the permitted network connections on different roadway classes (for urban and rural roads respectively).

2.1.1.3.8 Permitted Junction Types

This criterion states the permitted junction types along the roadway. This is an important indicator of the functional class of the roadway and is also related to network connectivity.

Table 2.5 - TMPQ 2008 Permitted Network Connections and Permitted Junction Types for Urban Roads

Functional Class	Land Use Frontage	Permitted Network Connections	Permitted Junction Types
Urban Freeway	-	Expressway, Major Arterial (Limited)	Grade Separated Interchange
Urban Expressway	-	Freeway, Major Arterial, Minor Arterial	Grade Separated Interchange Signal Controlled (limited)
Major Urban Arterial	-	Freeway (Limited), Expressway, Major Collector, Minor Collector, Local Access (Limited)	Signal Controlled Priority Junction
Minor Urban Arterial	-	Expressway, Major Arterial, Major Collector, Minor Collector, Local Access	Signal Controlled, Priority Junction, Pedestrian Crossing
Major Urban Collector	Industrial	Major Arterial, Minor Arterial, Minor Collector, Local Access	Signal Controlled, Priority Junction, Pedestrian Crossing (limited)
	Commercial	Major Arterial, Minor Arterial, Minor Collector, Local Access	Signal Controlled, Priority Junction, Pedestrian Crossing
	Residential	Minor Arterial, Minor Collector, Local Access	Signal Controlled, Priority Junction, Pedestrian Crossing
	Recreational	Major Arterial, Minor Arterial, Minor Collector, Local Access	Signal Controlled, Priority Junction, Pedestrian Crossing

Table 2.5 - TMPQ 2008 Permitted Network Connections and Permitted Junction Types for Urban Roads

Functional Class	Land Use Frontage	Permitted Network Connections	Permitted Junction Types
Minor Urban Collector	Industrial	Major Arterial, Minor Arterial, Major Collector, Local Access	Roundabout, Signal Controlled, Priority Junction, Pedestrian Crossing
	Commercial	Major Arterial, Minor Arterial, Major Collector, Local Access	Roundabout, Signal Controlled, Priority Junction, Pedestrian Crossing
	Residential	Minor Arterial, Major Collector, Local Access	Roundabout, Signal Controlled, Priority Junction, Pedestrian Crossing
	Recreational	Major Arterial, Major Arterial, Minor Collector, Local Access	Roundabout, Signal Controlled, Priority Junction, Pedestrian Crossing
Local Access Road	Industrial	Major Arterial (limited), Major Collector, Minor Collector	Roundabout, Signal Controlled, Priority Junction, Pedestrian Crossing
	Commercial	Major Arterial (limited), Major Collector, Minor Collector	Roundabout, Signal Controlled, Priority Junction, Pedestrian Crossing
	Residential	Minor Collector	Roundabout, Signal Controlled, Priority Junction, Pedestrian Crossing
	Recreational	Major Arterial (limited), Major Collector, Minor Collector	Roundabout, Signal Controlled, Priority Junction, Pedestrian Crossing

Table 2.6 - TMPQ 2008 Permitted Network Connections and Permitted Junction Types for Rural Roads

Functional Class	Permitted Network Connections	Permitted Junction Types
Rural Freeway	Expressway	Grade Separated Interchange
Rural Expressway	Freeway Arterial	Grade Separated Interchange Signal Controlled (limited)
Rural Arterial	Collector Expressway	Roundabout Signal Controlled Priority Junction
Rural Collector	Arterial Local Access	Roundabout Signal Controlled Priority Junction Pedestrian Crossing
Local Access (Rural)	Collector	Roundabout Priority Junction Pedestrian Crossing

2.1.1.3.9 Minimum Spacing Between Traffic Control Devices

The TMPQ 2008 sets standards for the minimum spacing between any type of traffic control device as a criterion in functional classification. A traffic control device is defined as any of the following:

- A highway junction or access;
- Median gap;

- Pedestrian crossing;
- Traffic calming device.

The use of all traffic control devices (over and above intersections) is based on the need to maintain consistency in highway design, with safety forming the primary objective. Because all traffic control devices influence traffic flow speed, they have a direct influence on the Access/Mobility functions of the roadway.

This criterion specifies the minimum permitted distance between traffic control devices for each of the route classifications.

2.1.1.3.10 Transport Mode Provision

This criterion describes the extent to which transport modes (other than motorized vehicles) are accommodated on each route classification. This acknowledges that some roads within the hierarchy are not suitable to accommodate certain types of vehicles on the main roadway itself. For example, bicycles should not be permitted to use the main roadway forming a freeway. However, bicycles could be permitted to use a separate cycleway running adjacent to the freeway in the same corridor right of way.

The following tables show the provisions for different transport modes for each road functional class, considering the urban and rural cases, respectively.

Table 2.7 - TMPQ 2008 Provision for Multimodal Transport in Urban Roads

Functional Class	Land Use Frontage	Pedestrians	Cyclists	Road Based Public Transport	Light Rail Based Public Transport	Trucks
Urban Freeway	-	Footways (segregated from road)	Cycleways (segregated from road)	Express Services Only	Light Rail (segregated from road)	No Restrictions
Urban Expressway	-	Footways (segregated from road)	Cycleways (segregated from road)	Express Services Only	Light Rail (segregated from road)	No Restrictions
Major Urban Arterial	-	Footways (segregated from road)	Cycleways (segregated from road)	Local Services (with priority where required)	Light Rail (segregated from road)	Some Restrictions
Minor Urban Arterial	-	Footways on Both Sides of Road	Cycleways (segregated from road)	Local Services (with priority where required)	Light Rail Shared (with priority where required)	Restricted

Table 2.7 - TMPQ 2008 Provision for Multimodal Transport in Urban Roads

Functional Class	Land Use Frontage	Pedestrians	Cyclists	Road Based Public Transport	Light Rail Based Public Transport	Trucks
Major Urban Collector	Industrial	Footways on Both Sides of Road	Cycle Lanes Desirable	Local Services (with priority where required)	Light Rail Shared (with priority where required)	No Restrictions
	Commercial	Footways on Both Sides of Road	Cycle Lanes Desirable	Local Services (with priority where required)	Light Rail Shared (with priority where required)	Some Restrictions
	Residential	Footways on Both Sides of Road	Cycle Lanes Desirable	Local Services (with priority where required)	Light Rail Shared (with priority where required)	Local Access Only
	Recreational	Footways (segregated from road)	Cycleways (segregated from road)	Local Services (with priority where required)	Light Rail Shared (with priority where required)	Prohibited
Minor Urban Collector	Industrial	Footways on Both Sides of Road	Cycle Lanes Desirable	Local Services	Light Rail Shared (with priority where required)	Some Restrictions
	Commercial	Footways on Both Sides of Road	Cycle Lanes Desirable	Local Services	Light Rail Shared (with priority where required)	Local Access Only
	Residential	Footways on Both Sides of Road	Cycle Lanes Desirable	Local Services	Light Rail Shared (with priority where required)	Local Access Only
	Recreational	Footways (segregated from road)	Cycleways (segregated from road)	Local Services	Light Rail Shared (with priority where required)	Prohibited
Local Access Road	Industrial	Footways on Both Sides of Road	Cycle Lanes Desirable	Local Services	Not Recommended	Some Restrictions
	Commercial	Footways on Both Sides of Road	Cycle Lanes Desirable	Local Services	Not Recommended	Local Access Only
	Residential	Footways on Both Sides of Road	Cycle Lanes Desirable	Local Services	Not Recommended	Local Access Only
	Recreational	Footways on Both Sides of Road	Cycle Lanes Desirable	Local Services	Not Recommended	Prohibited

Table 2.8 - TMPQ 2008 Provision for Multimodal Transport in Rural Roads

Functional Class	Pedestrians	Cyclists	Road Based Public Transport	Light Rail Based Public Transport	Trucks
Rural Freeway	Prohibited	Prohibited	Express Services Only	Light Rail (segregated from road)	No Restrictions
Rural Expressway	Prohibited	Prohibited	Express Services Only	Light Rail (segregated from road)	No Restrictions
Rural Arterial	Footways Where Required (segregated from road)	Cycleways (segregated from road)	Local Services (with priority where required)	Light Rail Shared (with priority where required)	Some Restrictions
Rural Collector	Footways Where Required	Cycle Lanes Where Required	Local Services (with priority where required)	Not Recommended	Local Access Only
Local Access (Rural)	Footways Where Required	Footways Where Required	Generally, Not Provided	Not Recommended	Local Access Only

Source: TMPQ 2008

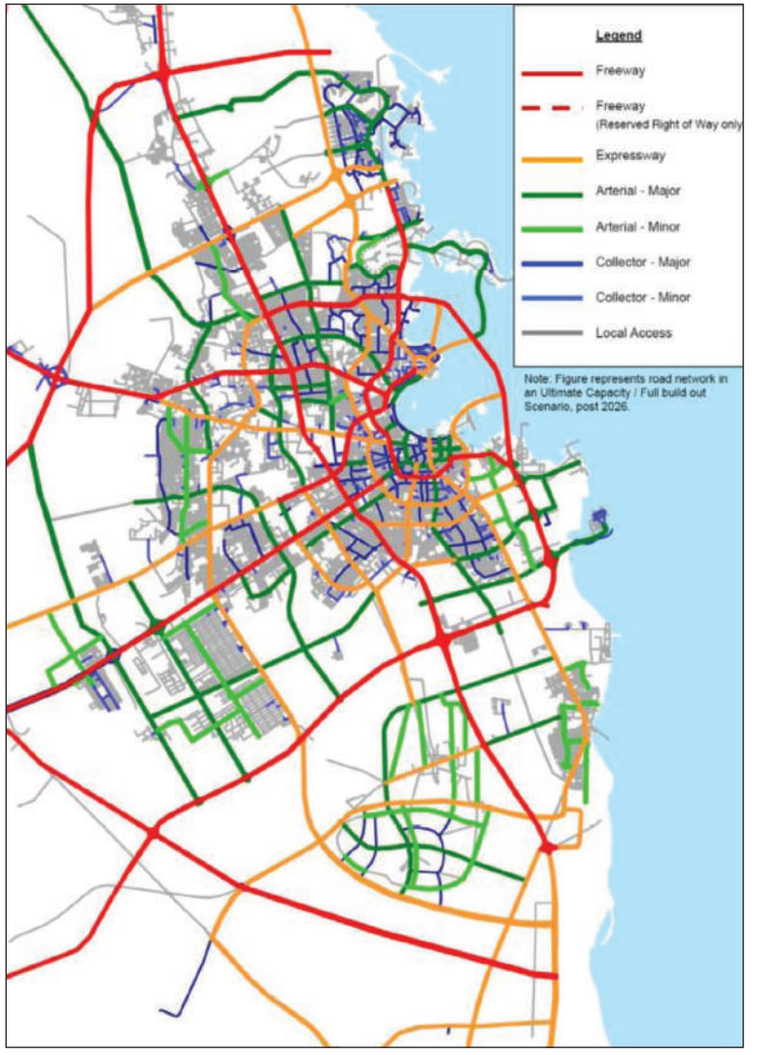
2.1.1.4 Network Map

Using the proposed Functional Classification System, the TMPQ 2008 provides a map of the future road network in 2026 (Figure 2.2) with the roads classified based on the proposed system. The network was created based on the output of the Strategic Transport Model for 2026 (using the VISUM software). Functional classification was applied automatically using scripts to look up specific characteristics of roads in the model and compare them to the quantities in the proposed Functional Classification System. The model outputs used in this exercise are:

- Daily traffic volumes on links (2-way, 24-hour flow);
- Posted traffic speeds on links;
- Number of lanes (related to 'Road in Cross Section' criteria);
- Permitted transport modes.

This approach to determining the functional classification of a road network is only good as a first step, it results in a rough estimate of the functional classification of the network. It will not, however, produce a proper final database of functional classification that is free of misclassification, errors, gaps and continuity problems. An approach for determining the functional classification of Qatar's existing road network is presented and applied in Section 2.2.1. Additionally, a formal procedure for determining the classification of future roads or changing the classification of existing roads as their conditions change, is proposed in Section 5.1.

Figure 2.2 - TMPQ 2008 Functional Hierarchy Map of Doha (2026 horizon year)



2.1.2 QATAR HIGHWAY DESIGN MANUAL 2020

2.1.2.1 Functional Classification System Summary

The classification in the QHDM is summarized, in Table 2.9 and Table 2.10 below for urban and rural systems, respectively, highlighting the characteristics of each road class.

Table 2.9 - QHDM Urban System Functional Classification Description

Functional Class	Description
Expressway	– Traffic moves at high speeds and over long distances. – Freight traffic and intercity bus routes can travel along expressways. – Through movement typically grade separated from cross street movements. – Primary function is mobility. No access.
Major Arterial	– Accommodates through traffic at high operating speeds. – Typically intersect at grade with cross streets. – Primary function is mobility. Limited access.
Minor Arterial	– Mostly accommodates through traffic at medium to high operating speeds. – Intersections always at grade. – Important for pedestrians and cyclists. – Primary function is mobility. Access is secondary function.
Boulevard	– Special class of arterials, located in areas with a high level of retail or recreational frontage. They have wide sidewalks to accommodate high levels of pedestrian activity. – Traffic volumes like those along arterials, but with slower travel speeds. – More frequent pedestrian crossings. – Primary function is access. Mobility is secondary function.
Collector Distributor	– Part of a controlled access facility such as an expressway, designed to operate as freeway facilities. – One directional roads, on-street parking and direct access to adjacent land uses is prohibited. – Located between adjacent intersections or interchanges. – Primary function is mobility. Access is secondary function.
Major Collector	– Distribute trips from arterials into nearby land uses and collect traffic from local roads to feed to arterials. – Equal emphasis is placed on mobility and accessibility.
Minor Collector	– Collect traffic from service roads and local roads and distribute to arterials. Low traffic volumes. – Primary function is access. Mobility is secondary function.
Service Road	– Provide direct access to adjacent land uses while also distributing traffic on to higher-grade roads. – Run parallel to collector-distributors or arterials. – On-street parking on service roads is common.
Local Road	– Provide access to adjacent land uses while feeding collector roads. Minimal mobility. – No formal access control. – Through traffic is actively discouraged from using local roads by traffic-calming measures.

Source: QHDM 2020

SECTION 2

Table 2.10 - QHDM Rural System Functional Classification Description

Functional Class	Description
Rural Freeway	– Connect inter-urban centers. High speeds, volumes and LOS. – Grade-separated interchanges exclusively. – Maximum mobility. Little access.
Rural Arterial	– Connect major land uses within a smaller region. – Little access. They have medium to high traffic volumes.
Rural Collector	– Distribute traffic from arterials into local roads and collect traffic from local roads to arterials. – Direct access from collectors to adjacent land uses is possible.
Rural Local Road	– Feed traffic from adjacent land uses and distribute it to collectors.

Source: QHDM 2020

2.1.2.2 Special Roads

Some special corridors mentioned within the QHDM do not strictly fit into the categories described above because they have their own unique characteristics. They include:

- Pedestrian only streets that are closed to motorized traffic except for periodic access by service and maintenance vehicles;
- Bike corridors that could either be part of the right-of-way of a roadway, but are segregated from the travelled way, or be separate from any motor vehicle roadway;
- Dedicated public transport corridors which are segregated from the roadway and only accommodate public transport modes. Some examples include bus rapid transit lanes and rail lines;
- Some other special roads that are not meant to fall within this classification include roads providing access to critical infrastructure, Emiri roads, roads within military sites, Sikkas (alleyways or pedestrian-only routes) and roads for emergency services.

2.1.2.3 Key Design Parameters

QHDM provides quantitative values and ranges for specific design parameters based on the road functional classification. These key parameters are shown in Table 2.11 and Table 2.12 for urban and rural contexts respectively. The manual states that these design parameters are to be used in the preliminary design stage and that their values are not absolute and should be used for guidance only; minimum design requirement for specific cases are set out in the rest of the QHDM. The key parameters shown in Table 2.11 and Table 2.12 will be updated in next revision of the QHDM to ensure it is aligned with the guidance in Road Planning Guide for Qatar.

The subsequent sections provide a summary description of these parameters.

Table 2.11 - QHDM Key Design Parameters of Urban Roads

Through Roadway	Land Use Frontage	Function	AADT Range[a]	Roadway Type	Mobility vs. Access	Intersection Type	Minimum Intersection Spacing[b] (m)	Posted Speed[c] (km/h)	ROW[d] (m)	Parking Provision	Min. LOS
Expressway	Not residential or recreational	Mainly free-flow traffic connecting major land uses across wide urban area. Medium to high traffic volumes.	50,000–80,000	8- to 10-lane divided highway	Primary function is mobility. No access.	Grade-separated interchange	1,500	80/100	64–264	Prohibited	C
Major Arterial	Commercial Industrial preferred	Connect urban districts. Medium to high traffic volumes.	30,000–60,000	4- to 8-lane divided highway	Primary function is mobility. Limited access.	Signalized or priority right-in/right-out (exceptionally grade-separated interchange)	600[e]	50/80	64	Prohibited	C
Minor Arterial	Commercial industrial preferred	Connect urban districts. Medium to low traffic volumes.	20,000-50,000	4- to 8-lane divided highway	Primary function is mobility. Access is secondary function.	Signalized or priority right in/right-out	150	50/80	40–64	Restricted	C
Boulevard	Retail or commercial or recreational	Special[f] arterial. Medium to high traffic volumes.	30,000–60,000	4- to 8-lane divided highway	Primary function is access. Mobility is secondary function.	Signalized, roundabout, or priority right-in/right-out	300	50/80	64	Restricted	D
Collector Distributor	Not residential or recreational	Distribute traffic between expressway interchanges. Medium to low traffic.	5,000–50,000	One directional	Primary function is mobility. Access is secondary function.	Grade separated and priority right-in/right-out	NA	50/80 or 100	Not applicable[g]	Prohibited	D
Major Collector	Industrial	Collect traffic from service roads and local roads and distribute to arterials. Medium to low traffic volumes.	20,000–50,000	4- to 6-lane divided highway	Mobility and access given equal importance.	Signalized, roundabout, or priority	100	50	32–40	Some restrictions	D
	Commercial		20,000–50,000			Signalized, roundabout, priority, or pedestrian crossing	100	50		Restricted	D
	Residential		20,000–30,000				100	50		Restricted	D
	Recreational		10,000–20,000				50	50		Restricted	D

Table 2.11 - QHDM Key Design Parameters of Urban Roads

Through Roadway	Land Use Frontage	Function	AADT Range[a]	Roadway Type	Mobility vs. Access	Intersection Type	Minimum Intersection Spacing[b] (m)	Posted Speed[c] (km/h)	ROW[d] (m)	Parking Provision	Min. LOS
Minor Collector	Industrial	Collect traffic from service roads and local roads and distribute to arterials. Low traffic volumes.	5,000–20,000	4-lane divided highway or 2-lane undivided highway	Primary function is access. Mobility is Secondary function.	Signalized, roundabout, or priority	50	50	20–32	Some restrictions	D
	Commercial		5,000–20,000			Signalized, roundabout, priority, or pedestrian crossing	50	50		Restricted	D
	Residential		5,000–20,000				50	50		Restricted	D
	Recreational		5,000–10,000				50	50		Restricted	D
Service Road	Any	Provide access to adjacent land. Distribute traffic to collectors and boulevards.	<5,000	2-lane undivided highway	Primary function is access. Mobility is secondary function.	Signalized, roundabout, or priority	50	50	Not applicable[g]	Permitted with conditions	D
Local Road	Industrial	Provide access to adjacent land.	<5,000	2-lane undivided highway	Primary function is access. Minor mobility function. Through traffic is discouraged with traffic-calming.	Signalized, roundabout, priority, or pedestrian crossing	As required	50	20-24	Permitted with conditions	D
	Commercial						As required	30/50[h]			D
	Residential						As required	30/50[h]	10-24[d]		D
	Recreational				Minimal mobility and access functions.		As required	30/50[h]		Restricted	D

[a] Indicative values, neither minima nor maxima.

[b] Taken from intersecting road centerlines.

[c] Expected posted speed values; other posted speeds may be appropriate and should be agreed upon with the overseeing organization before use.

[d] New roads shall have minimum 20 meters ROW. The stated ROW values include allowances for utility reserves. However, these values are not absolute and are provided for guidance only.

[e] One access to development between intersecting roads permitted at mid-point.

[f] Adjacent to high-quality development where lower vehicle speeds and greater integration of non-motorized users is required or demanded.

[g] Collector-distributor and service roads are included within the right-of-way of other road types.

[h] An exception would be 30 km/h with traffic calming, signage, and markings where categorized as "urban streets." For example, in the vicinity of schools.

Table 2.12 - QHDM Key Design Parameters of Rural Roads

Through Roadway	Function	AADT Flow	Roadway Type	Mobility vs. Access	Intersection Type	Minimum Intersection Spacing	Posted Speed	ROW (m)	Parking Provision	Minimum LOS
Rural Freeway	Connect regions and major cities on national and international scale. Free-flowing traffic. Capable of accommodating high traffic volumes.	> 8,000	6-lane divided highway, or more	Maximum mobility. No access[a]	Grade-separated interchange	3000	100/120	264	Prohibited	B
Rural Collector Distributor	Distribute traffic between freeway interchanges. Low to medium traffic.	5,000 – 50,000	One directional	Primary function is mobility. Access is secondary function.	Grade separated and priority right-in/right-out	NA	80 /100 or 120	Not applicable	Prohibited	C
Rural Arterial	Connect major land uses within a smaller region. Medium to high traffic volumes.	2,000–8,000	4-or 6-lane divided highway	Mobility is primary function. Limited access possible.	Grade-separated interchange, roundabout, or priority right-in/ right-out	1000	80/100	64	Prohibited	C
Rural Collector	Collect and distribute traffic to adjacent rural land uses. Medium traffic volumes.	1,000–2,000	4-lane divided highway	Equal mobility and access functions.	Roundabout, priority right in/ right out, or pedestrian crossing	500	50/80	24–40	Permissible with conditions	D
Rural Local Road	Provide access to adjacent rural property and land.	< 1,000	2-lane undivided highway	Primary function is access. Mobility is secondary function.	Roundabout, priority, or pedestrian crossing	As required	50	20 or less	Permissible with conditions	D

Source: QHDM 2020

[a] Conditional access to petrol stations and rest areas permitted.

2.1.2.3.1 Land Use Frontage (Urban Roads Only)

In the QHDM, four land use contexts for urban roads are defined. They affect the level of access and on-street parking requirements from a roadway. The four contexts are:

- Industrial: Includes activities associated with manufacturing, storage (warehouses), logistics and military facilities;
- Commercial: Includes offices, shopping malls, retail outlets, strip malls, restaurants, banks, hotels and business districts such as West Bay;
- Residential: Includes villas, townhouses and apartments. Buildings that comprise apartments but have significant retail facilities on the ground floor should be regarded as commercial;
- Recreational: Includes sports facilities (for example, leisure centers, gymnasiums and stadiums), open spaces and public parks.

This frontage land use context for urban roads creates four different subclasses of major collectors, minor collectors and local roads.

2.1.2.3.2 Function

The QHDM provides a general description of the function of each roadway class to guide the planner or designer in understanding the main role of the roadway.

2.1.2.3.3 Annual Average Daily Traffic Flow

The Annual Average Daily Traffic (AADT) that each road is designed to accommodate by the design year given the functional classification. This is a measure of traffic volume capacity. The design period for roadways in Qatar is 20 years.

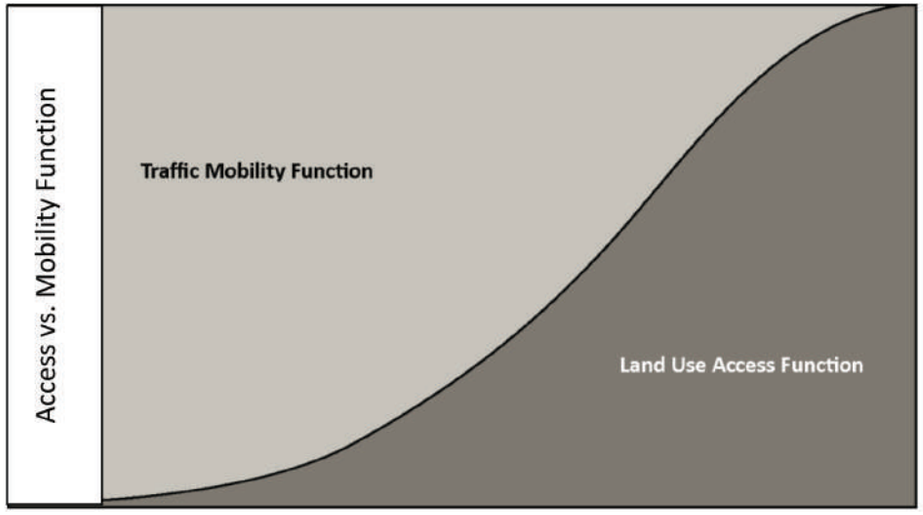
2.1.2.3.4 Mobility versus Accessibility

This characteristic describes the two main functions of roads (for motor vehicles) in terms of functional classification. The qualitative definitions of mobility and access within the QHDM show these two functions in opposition to each other, highlighting the tradeoff between them:

- Mobility: provision for through traffic that has no direct business in or relationship with the land uses it is passing through;
- Access: provision for traffic with direct business in or having a direct relationship with the area it passes through.

Figure 2.3 depicts the balance between mobility and access to conceptualize this tradeoff relationship.

Figure 2.3 - QHDM Access/Mobility Functions of Roadways



Urban	Expressway	Major Arterial/ Boulevard	Minor Arterial/ Boulevard	Major Collector	Minor Collector	Local Road
Rural	Freeway	Rural Arterial		Rural Collector		Local Road

Source: Qatar Highway Design Manual (2020)

2.1.2.3.5 Permitted Intersection Types

This characteristic refers to the types of intersections that are permitted along each road class. For the road to serve its functional need, the type of intersections must be appropriate. If through circulation is the primary function, for example, then grade separation might be required to serve it. This is not directly related to network connectivity, which is discussed in Section 2.1.2.3.11 separately.

2.1.2.3.6 Minimum Intersection Spacing

Intersections enhance accessibility but reduce mobility by interrupting traffic flow. This criterion refers to the minimum distance allowed between intersections along the roadway based on road class. The distance is measured between the intersecting centerlines.

2.1.2.3.7 Posted Speed

This characteristic represents the posted speed limit for each functional road category. While posted speeds may vary for different vehicle types, the speed limits identified in the manual are related passenger vehicles and, therefore, is the highest posted speed on each road classification.

2.1.2.3.8 Right-of-Way (ROW) Width

This criterion is the width of the area of land in which the roadway is constructed based on typical design dimensions, conditions and terrain. ROW width is related to the functional classification. The ROW values stated in the Table 2.11 and Table 2.12 include allowances for utility reserves. However, these values are not absolute and are provided for the guidance only.

2.1.2.3.9 Parking Provisions

This criterion describes the extent to which parking and loading provision is allowed on roadways based on functional classes. The manual presents three types of parking provision:

- Prohibited: No parking or loading provision is allowed directly adjacent to the road. Applicable to freeways, expressways and major arterials;
- Restricted: Parking is restricted to areas where it is safe and practicable. Parking areas shall be clearly defined and strictly enforced;
- Permitted with conditions: Parking is permitted alongside the road, although time-of-day or location-specific restrictions may be implemented to eliminate potential operational problems.

2.1.2.3.10 Minimum Level of Service for Design Year

This criterion represents the minimum LOS at which the road should operate at the design year, considering the prevailing levels of demand. The LOS describes the travel experience in terms of operating speed, delays, the ability to safely overtake vehicles, traffic congestion, overall safety, and driver and passenger comfort. This characteristic is related to the context and functional class of the roadway.

2.1.2.3.11 Network Connectivity

The matrix of connections allowed between different classes of roadways in the QHDM is presented in Table 2.13 for urban roads and Table 2.14 for rural roads. The rows represent the through route (the main route that vehicles take to access or egress an area) and columns represent the connecting route (the type of roads that can intersect with the through route). Given two intersecting roads, the one that is higher in the hierarchy is the through route.

Undesirable connectivity, providing a connection between two roads with incompatible functions, is likely to lead to conflict and congestion. QHDM gives two examples of such inappropriate practice:

- Several residential compounds alongside a major arterial seek their own direct access on to the arterial. In this case, the traffic from the residential compounds should be combined on to a service road that then connects to the major arterial at a single point;
- In the case of access to a car park directly from a relatively high-speed arterial road, an intermediate collector road is recommended to serve as a transition between the arterial and the car park.

Table 2.13 - QHDM Permitted Network Connections for Urban Roads

Expressway		Connecting Route																	
		Major Arterial Minor Arterial		Boulevard Collector Distributor		Major Collector				Minor Collector				Service Road	Local Roads				
Through Route	Land Use Frontage	Not Residential or Recreational	Commercial/ Industrial Preferred	Commercial/ Industrial Preferred	Retail/ Commercial/ Recreational	Any	Industrial	Commercial	Recreational	Residential	Industrial	Commercial	Recreational	Residential	Any	Industrial	Commercial	Recreational	Residential
Expressway	Not Residential or Recreational	✓	✓	O	O	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Major Arterial	Commercial/Industrial Preferred	✓	✓	✓	✓	✓	✓	✓	✓	O	O	O	O	O	✓	X	X	X	X
Minor Arterial	Commercial/Industrial Preferred	O	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X
Boulevard	Commercial/ Recreational	O	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Collector Distributor	Any	✓	✓	O	O	✓	O	O	O	O	O	O	O	O	X	X	X	X	X
Major Collector	Industrial	X	✓	✓	✓	O	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Commercial	X	✓	✓	✓	O	✓	✓	✓	✓	O	✓	✓	✓	✓	X	✓	✓	✓
	Recreational	X	✓	✓	✓	O	✓	✓	✓	✓	O	✓	✓	✓	✓	X	✓	✓	✓
	Residential	X	O	✓	✓	O	O	✓	✓	✓	O	✓	✓	✓	✓	X	✓	✓	✓
Minor Collector	Industrial	X	O	✓	✓	O	✓	O	O	O	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Commercial	X	O	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	✓	✓	✓
	Recreational	X	O	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	O	✓	✓
	Residential	X	O	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	O	O	✓
Service Road	Any	X	✓	✓	✓	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	O	O	O	O
Local Roads	Industrial	X	X	X	✓	X	✓	X	X	X	✓	X	X	X	O	✓	✓	✓	✓
	Commercial	X	X	X	✓	X	✓	✓	✓	✓	✓	✓	O	O	O	✓	✓	✓	✓
	Recreational	X	X	X	✓	X	✓	✓	✓	✓	✓	✓	✓	O	O	✓	✓	✓	✓
	Residential	X	X	X	✓	X	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓

Key: ✓ Recommended **O** Permitted, but not recommended **X** Not recommended

Source: Qatar Highway Design Manual (2020)

Table 2.14 - QHDM Permitted Network Connections for Rural Roads

Through Route	Connecting Route			
	Rural Freeway	Rural Arterial	Rural Collector	Rural Local Road
Rural Freeway	✓	✓	X	X
Rural Arterial	X	✓	✓	O
Rural Collector	X	X	✓	✓
Rural Local Road	X	X	X	✓

Key: ✓ Recommended **O** Permitted, but not recommended
X Not recommended

Source: Qatar Highway Design Manual (2020)

Regarding grade separated intersections, the appropriate connections for different situations are:

- **Urban Expressway to Urban Expressway Connection**: All movements, both through and turning between two expressways, should be free flowing, unstopped;
- **Rural Freeway to Rural Freeway Connection**: All through movements and all turning movements, are free-flow movements;
- **Expressway to Urban Arterial Connection**: The through movement on the expressway is free flow. Both the through and turning movements on the arterial are signalized;
- **Rural Freeway to Rural Arterial Connection**: The through movement on the freeway is free flow, but the movement to the freeway and to the arterial is by a signalized intersection or a roundabout.

2.1.2.3.12 Multimodal Provision

Table 2.15 and Table 2.16 show the provisions or prohibitions for non-motorized and multimodal users for rural and urban roadways respectively. Modes studied include pedestrians, cyclists, transit buses, light rail service and freight transport.

Table 2.15 - QHDM Provision for Multimodal Transport in Urban Areas

Through Route	Land Use Frontage	Pedestrians	Cyclists (bike lane and path)	Road-Based Public Transport Services	Light Rail-Based Public Transport	Heavy Trucks
Expressway	Not residential or recreational	Segregated sidewalks	Segregated bike paths	Express services only	Light rail (segregated from road)	No restrictions
Major Arterial	Commercial or Industrial preferred	Segregated sidewalks	Segregated bike paths	Local services (with priority lane where required)	Light rail (segregated from road)	Some restrictions
Minor Arterial	Commercial or industrial preferred	Segregated sidewalks	Segregated bike paths	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Restricted
Boulevard	Retail, commercial or recreational	Sidewalks on both sides of road and sitting areas	Segregated bike paths	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Restricted
Collector Distributor	Not residential or recreational	Segregated sidewalks	Segregated bike paths	Local services (with priority lane where required)	None	Some restrictions
Major Collector	Industrial	Sidewalks on both sides of road	Segregated bike paths	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	No restrictions
	Commercial	Sidewalks on both sides of road	Segregated bike paths	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Some restrictions
	Residential	Sidewalks on both sides of road	Segregated bike paths	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Local access only
	Recreational	Sidewalks on both sides (segregated from road)	Segregated bike paths	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Prohibited
Minor Collector	Industrial	Sidewalks on both sides of road	Segregated bike paths or shared road use	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Some restrictions
	Commercial	Sidewalks on both sides of road	Partial integration within roadway	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Local access only
	Residential	Sidewalks on both sides of road	Partial integration within roadway	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Local access only
	Recreational	Sidewalks on both sides (segregated from road)	Partial integration within roadway (separate bike path or shared road use)	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Prohibited
Service Road	Any	Segregated sidewalks	Segregated bike paths	Local services	None	Some restrictions
Local Road	Industrial	Sidewalks on both sides of road	Cyclists may use roadway	Local services	Not recommended	Some restrictions
	Commercial					Local access only
	Residential					Local access only
	Recreational					Prohibited

Table 2.16 - QHDM Provision of Multimodal Transport in Rural Areas

Through Route	Transport Provision				
	Pedestrians	Cyclists	Road-Based Public Transport Services	Light Rail-Based Public Transport	Heavy Trucks
Rural Freeway	Segregated sidewalks where required	Segregated bike paths where required	Express services only	Light rail (segregated from road)	No restrictions
Rural Arterial	Segregated sidewalks where required	Segregated bike paths	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Some restrictions
Rural Collector	Sidewalks where required	Segregated bike paths	Local services (with priority lane where required)	Not recommended	Local access only
Rural Local Road	Sidewalks where required	Cyclists may use roadway	Generally, not provided	Not recommended	Access only

Source: Qatar Highway Design Manual (2020)

2.1.3 IDENTIFICATION OF ISSUES IN THE EXISTING FRAMEWORK

This section lists the issues identified as part of the assessment of the existing functional classification framework. Overall, the current system is very good and robust, with only a few ambiguities and issues which require some relatively minor tweaks.

1- Definition of Boulevards

Boulevards are defined as a special class of arterial which is located at areas with high level recreational or commercial frontage. They are designed to accommodate high levels of pedestrian demand using features such as sidewalks and frequent pedestrian crossing. The issues with the exiting definition are:

- Boulevards serve a high access function for cars compared to arterials. They should not be considered on the hierarchical level of arterial in all cases;
- Boulevards can be used in high density land use (such as CBDs and high-rise areas) regardless of the frontage activity due to the potential for high pedestrian volumes.

2- Definition of Service Roads

The existing description of service roads as two-way roads running parallel to collector distributers and arterials is too narrow and applies only to very few roads in Qatar. It should be expanded to include one-way service lanes on arterials which share all the characteristics of service road, providing high levels of access and parking to adjacent developments. These may be confused for collector distributers, which serve completely different functions and have very different characteristics.

3- Definition of Collector Distributors

The collector distributers should be amended to clarify that they may be used only as part of the ROW of an expressway or a freeway. And that despite being classed as urban roads, their use on freeways is acceptable.

4- Lack of Consideration for Density of Land Use

The level of development and the density of population is not given proper consideration as a functional hierarchy parameter. In practice, patterns of demand and travel characteristics differ considerably between high density towers land use and low-density suburban land use. This issue is partially addressed by the suggested amendment to the definition of boulevards. Density of development has impacts on planning and design decisions.

5- AADT Ranges

The data provided for daily AADT ranges of different functional categories is not consistent with real conditions and need to be reviewed and amended. Traffic count data, best international practices, and other sources can be used to arrive at better values.

6- ROW Width Ranges

ROW data provided are not consistent with real conditions.

7- Allowable Network Connections

Guidelines for permitted network connection between functional categories are not consistent with real conditions. They are also too restrictive and inflexible for designers in some cases, for example, minor arterials should be very versatile and connectable to nearly all other classes of roads.

8- Pedestrian Crossings

No guidance is provided in the pedestrian provision section for the requirements and type of crossings for pedestrians. This consideration is added in the updated framework.

2.2 EXISTING ROAD NETWORK CLASSIFICATION

This section reviews existing databases available for Qatar road network with functional classification information. It identifies any misclassification or gaps and assesses whether this classification is fit for the purposes of transport planning and design.

2.2.1 EXISTING NETWORK CLASSIFICATION DATABASES

Three GIS format databases of the road network have been reviewed. The only criterion for the review in this report is the functional classification attribute of each dataset.

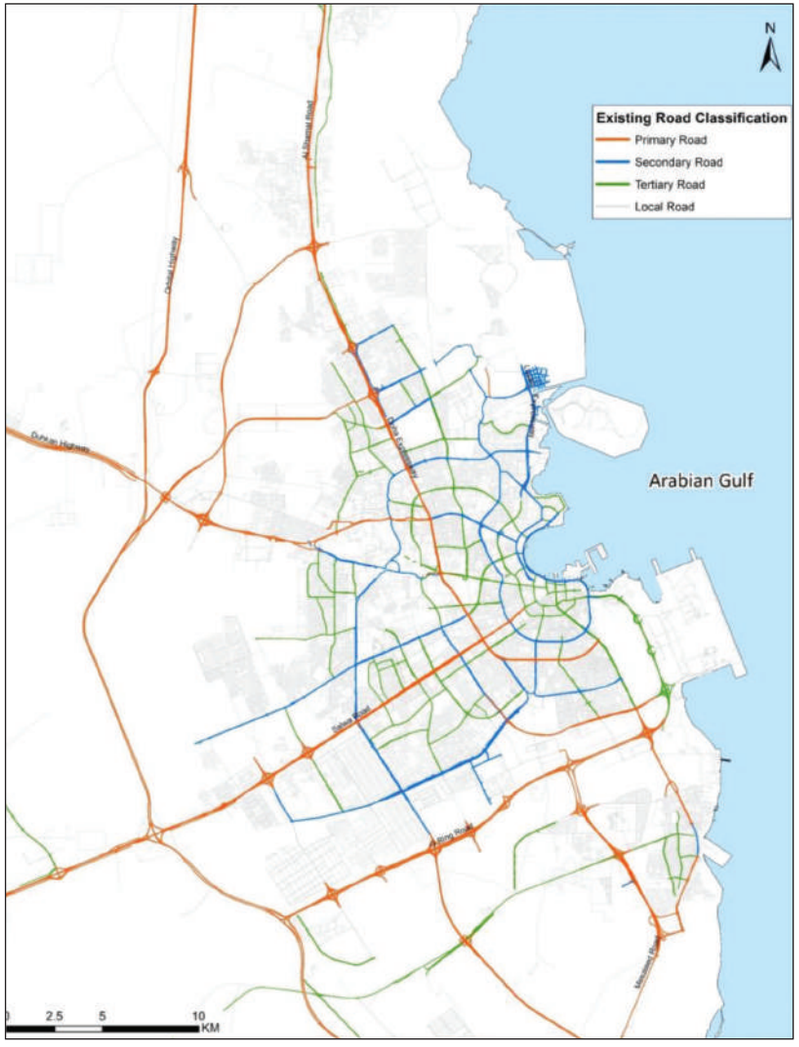
2.2.1.1 Ashghal GIS Database

Received in April 2017, this database from the Public Works Authority (PWA) includes the functional classification of roads based on the now superseded framework in the QHDM 1997. It shows four classes of roads:

- Primary roads;
- Secondary roads;
- Tertiary roads;
- Local roads.

Figure 2.4 shows the network within the greater Doha area. The system of classification in this database is obsolete and no longer in effective use for the planning or design of roadways in Qatar. Therefore, this database is not suitable for the purpose of functional classification in its current form, hence no further review will be undertaken.

Figure 2.4 - Ashghal GIS database



QSTM 2.0

2.2.1.2 QSTM 2.0

The Qatar Strategic Transport Model 2.0 (QSTM 2.0) is a model of the road network in Qatar representing the base year of 2018 and the future years of 2021 and 2031. It is a comprehensive demand generation and simulation model that is used as the primary tool for updating the Transport Master Plan for Qatar. This report has reviewed the 2018 network database by assessing the functional classification attributes of the roads.

Figure 2.5 shows the functional classification of the greater Doha area network in the QSTM.2.0. The network classification does not use the QHDM 2020 framework. Only five functional classes are used in the database, as follows:

- Expressway;
- Freeway;
- Arterial;
- Major Collector;
- Local Street.

These functional categories are included within the QHDM 2020, but many discrepancies with regards to the framework exist in the dataset, including:

- No differentiation between urban and rural roads (except freeway vs. expressway);
- No consideration of boulevards, collector-distributors or service roads;
- No differentiation between major and minor arterials, and major and minor collectors.

The functional classification system used in the QSTM 2.0 is sufficient for purposes of transport modelling, such as trip assignment to roads, calculation of capacity of roads and so on. However, it is insufficient for enabling and guiding the planning and design of roads. Therefore, this network will not be considered further.

Figure 2.5 - Functional Classification in the QSTM 2.0 Database

2.2.1.3 MOTC GIS Database

This is a database in GIS format from MOTC (received in July 2018) that is similar to Ashghal's database of the road network, updated to use the current standard of functional classification. The database is in a preliminary stage and is being updated. A map of greater Doha's road network with the functional classification from this database is shown in Figure 2.6 below.

This database uses the official QHDM standards in its functional classification with the following functional classification categories:

- Expressway;
- Major Arterial;
- Boulevard;
- Minor Arterial;
- Major Collector;
- Minor Collector;
- Collector Distributor;
- Local Road;
- Rural Freeway;
- Rural Arterial;
- Rural Collector.

This is the best available database of the existing road network's functional classification. It is based on the currently applicable standards, however, it

does suffer from some misclassification errors. It is also missing rural local roads (considered in the same category as urban local roads) and service roads.

Examples of misclassification errors include:

- C-Ring Road: Classified as an expressway, but the use of at grade intersections disqualifies the road from expressway classification, which exclusively use grade separated interchanges. Major arterial is the most appropriate classification;
- Ras Abu Abboud Expressway: Classified as a major arterial, but it's a very high speed, access-controlled road with grade separated junctions, therefore it should be classified as an expressway;
- Doha Expressway: A long section along this expressway, starting from Al Duhail and moving southward, is classified as a major arterial. The entire road should be classified as an expressway;
- Majlis Al Taawon Street: A large section in the north of this road is classified as an expressway, it is not an appropriate classification. The short section includes at grade junctions and short spacing between them. The classification of this section was changed to minor arterial;
- Furousiya Street: A section of this road is classified as a freeway. This is unambiguously an urban road, and the classification was corrected to a major arterial;
- Najma Street: This long road is classified as a minor arterial throughout its run. Due to the large ROW and long spacing between junctions, the classification was changed to major arterial, in addition, the long run connecting major urban sections implies a major arterial function of the road;
- G-Ring Road: Classified as a freeway, this road runs on southern edge of the Doha urban area, but most of the land use on both sides of the road is either developed or planned to be developed. The road, therefore, should be classified as an urban expressway.

This network database also suffers from many issues of discontinuity, where small sections of a continuous roadway are given a different (often incorrect) classification. These segments can be as short as a few hundred meters. Examples of these segments include:

- Markhiya Street;
- D-Ring Road;
- Salwa Road;
- Al Matar Street;
- Al Waab Street;
- Lusail Expressway;
- Al Corniche Road.

This issue is likely to be a result from the automated script that was used to assign classification in the database, but the resulting discontinuity is highly undesirable.

An exercise of manual update to this database was carried out as described in the next Section 2.2.2 with the aim of correcting all these issues and arriving at a final database that is up to date with the standards and fit for the purposes of road planning and design. The result of this process is showcased in Section 2.2.3.

Figure 2.6 - Map of MOTC Database of Existing Functional Classification

2.2.2 CRITERIA FOR CLASSIFICATION

This section describes the process and criteria used in selecting the updated functional classification of roads in the database discussed in Section 2.2.1. It addresses the errors identified and arrives at an updated database of the base year 2018 road network that is fit for the purposes of assisting in transport planning and design.

The process for updating is performed manually using a graphical interface which shows the road network and looking up from other sources any other relevant information on the road in question. The sequence of steps is presented in Figure 2.7 below, and a detailed explanation of each step follows.

Figure 2.7 - Procedure for Selecting Functional Classification

Step 1 **Define the Function of the Road**

- Define the road's place on the spectrum of access/mobility
- Review indicators of mobility function of the road
- Review indicators of the access function of the road

Step 2 **Review the Primary Characteristics**

- Review the right of way and cross-sectional elements
- Review the spacing of junctions

Step 3 **Review the Secondary Characteristics**

- Review the traffic volume
- Review any other available information

Step 4 **Review Any Disqualifying Characteristics**

- Review the charactarisics of the selected classification
- Check if the road cannot be of the selected classification

2.2.2.1 Step 1: Define the Function of the Road

The main characteristic for functional classifications is the function of the road. As per the existing standards, most functional classes are defined based on the function of the road on the spectrum between access and mobility as shown in Figure 2.3. This step involves looking at the road in question and pinpointing the location it occupies on that spectrum. The first thing to determine is whether the road is urban or rural based on whether the surrounding area is developed (or planned to be developed) or not.

The characteristics of the road which are indicative of a mobility function of the road include:

- High posted speed;
- Long continuous run;
- Large number of lanes that are divided;
- Wide right of way;
- Long spacing between intersections;
- Long spacing of access points;
- Lack of traffic control devices and on street pedestrian crossings;
- No provision of on-street parking.

Since the level of mobility is inversely proportional to the level of access function, the characteristics indicative of an access function of a road are the opposite of its mobility characteristics, they include:

- Low posted speed;
- Shorter continuous run;
- Smaller number of lanes that are undivided;
- Short right of way;
- Short spacing between intersections;
- Shor spacing of access points;
- Presence of traffic control devices and on street pedestrian crossings;
- Presence of direct on-street parking.

Looking at these characteristics (in a qualitative way, without necessarily detailing the exact numbers in each section of the road), this step places the road in one or at most between two functional classes, based on the characteristics described in the QHDM.

2.2.2.2 Step 2: Review the Primary Characteristics

The second step involves a more detailed look at the most important characteristics of the road, such as:

- Cross-sectional elements: the total right of way, of the road as well as the layout and elements in the cross-section of the road. The main elements to look at are the number of lanes and whether the road is divided with a median. As per the standards, a divided road is likely to be a major collector or higher on the hierarchy, and an undivided road is a minor collector or lower, although minor collectors can have divided or undivided roadways;
- Spacing of junctions: this is a measure of the shortest spacing between junctions along the length of the road (measured at the centerline). This spacing can be compared to the minimum spacing requirements of the standards.

At the end of this step, a single classification must be chosen for the road.

2.2.2.3 Step 3: Review the Secondary Characteristics

This next step is to look at a secondary set of characteristics that are indicative of the function of the road. These characteristics are:

- Traffic volume: The volume carried by a roadway is related to its functional classification due to the principle of hierarchy of movement. In general, the higher a road is on the mobility hierarchy, the bigger traffic volume it is expected to accommodate;
- Other characteristics: The functional class of other roads near the road in question and connected to it. The level and type of provision the road offers to multimodal users such as pedestrians, cyclists, public transport buses and trucks.

This check aims to confirm the functional class chosen in the previous step.

2.2.2.4 Step 4: Review Any Disqualifying Characteristics

This final step involves a negative testing of the chosen functional classification to ensure the road does not have characteristics that means it cannot belong to the selected classification. This step is just a final check to ensure consistency with the requirements of the standards.

If there is a reason the road's classification cannot be correct, an alternative classification is chosen and tested as per the same procedure.

2.2.3 FUNCTIONAL CLASSIFICATION OF THE EXISTING ROAD NETWORK

This section presents the functional classification of the base year 2018 network. This is the result of updating the existing functional classification database using the process and criteria described in Section 2.2.2.

This functional classification is available in GIS and is compatible with other GIS databases. The main features of this database are:

- Reviewed extensively to ensure its compliance with the standards of the QHDM 2020;
- All functional classes in the QHDM standards are utilized;
- Reviewed by the technical team at MOTC and subsequent comments addressed;
- The boundary of urban areas was defined based on the boundary within the QNDF and the classification is consistent with the defined boundary.

Table 2.17 below shows the proposed functional classification of the major roads in Qatar along with the value of specific classification criteria. Roads marked in red have been changed in the proposed functional classification. The map in Figure 2.8 shows the functional road classification in the greater Doha area. The GIS database which contain all information related to the proposed road classification of existing road network in Qatar is included in Appendix 1.

Table 2.17 - Proposed Functional Classification of Existing Major Roads

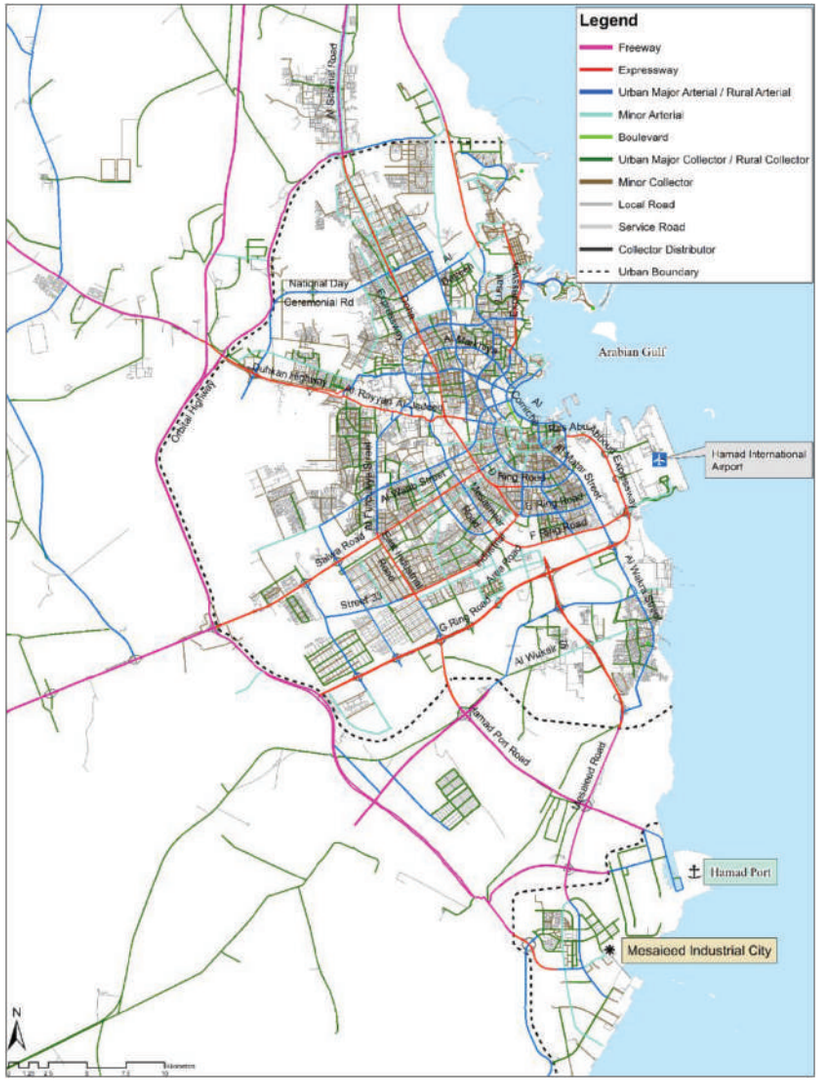
Road Name	Existing Road Characteristics						Road Classification				
	ADT[a]	Function	Number of lanes	ROW Width (m)	Signalized Intersection Spacing (m)	Posted Speed (km/h)	TMPQ 2008, (Full Build Out Scenario, 2026)	Ashghal 2015 database	MOTC 2018 database	Proposed Classification 2018 based on QHDM 2015	Commentary
Ring Roads											
Corniche Road	123,750	Mobility	6	60-82	445-1480	80	Major Arterial / Major Collector	Secondary	Major Arterial	Major Arterial	
A-Ring	No data	Mobility / Access	4	64-80	285-755	60	Major Arterial / Major Collector	Tertiary	Major Collector	**Minor Arterial**	Provides mobility, connects to Ras Abu Abboud Expressway
B-Ring	47,944	Access	4	30	307-972	80	Freeway	Tertiary	Minor Arterial	**Major Collector**	High frontage activity, on-street parking, direct access to plots
C-Ring	80,284	Mobility / Access	6-8	50-60	595-1430	80	Expressway	Secondary	Expressway	**Major Arterial**	No provision for free-flowing traffic
D-Ring	82,885	Mobility	6	100-120	1000-1400	80	Expressway	Primary	Major Arterial	Major Arterial	
Doha Expressway	187,512	Mobility	6-8	100-120	-	80	Expressway	Primary	Major Arterial	**Expressway**	Free flowing traffic
E-Ring	No data	Mobility	6	60-80	2282-2445	80	Freeway	Secondary	Minor Arterial	**Major Arterial**	Provides mobility, connects to Doha Expressway
F-Ring	No data	Mobility	8	100-120	-	100	Major Arterial	Primary	Major Arterial	**Expressway**	Free flowing traffic, connects major land uses
Orbital Highway	No data	Mobility	8-10	250-600	-	120	Freeway	Primary	Major Arterial	**Freeway**	Free flowing traffic, connects major land uses
Wholesale Market Street	66,630	Mobility / Access	6	50-70	682-2160	100	Expressway	Tertiary	Minor Arterial	Minor Arterial	
Al Bustan Street	51,630	Mobility	6	42-47	655-1044	80	Major Arterial	Secondary	Minor Arterial	**Major Arterial**	Connects urban districts, mobility for through traffic, adequate intersection spacing
Furousya Street	78,571	Mobility	6	65-150	1510-1932	100	Expressway	Secondary	Major Arterial	Major Arterial	
E-Industrial Street	102,615	Mobility	6	60-80	-	100	Expressway	Secondary	Major Arterial	**Expressway**	Free flowing traffic
Majlis Al Tawoon Street	57,539	Mobility	6	47-67	490-1300	80	Freeway	Secondary	Expressway	**Major Arterial**	Mobility for through traffic, existence of signalized intersections

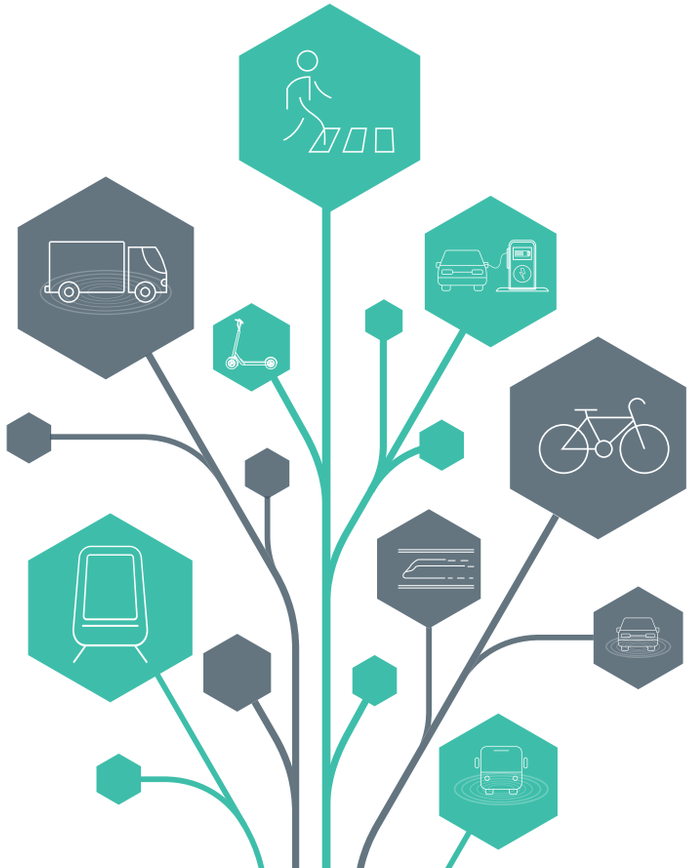
Table 2.17 - Proposed Functional Classification of Existing Major Roads

Road Name	Existing Road Characteristics						Road Classification				
	ADT[a]	Function	Number of lanes	ROW Width (m)	Signalized Intersection Spacing (m)	Posted Speed (km/h)	TMPQ 2008, (Full Build Out Scenario, 2026)	Ashghal 2015 database	MOTC 2018 database	Proposed Classification 2018 based on QHDM 2015	Commentary
Radial Roads											
Salwa Road (Urban)	76,307	Mobility	6-8	145	-	100	Freeway	Primary	Expressway	Expressway	
Al Haloul Street	44,298	Mobility / Access	4	50-60	275-1181	80	Major Arterial	Tertiary	Minor Arterial	Minor Arterial	
Rawdat Al Khail Street	54,378	Mobility	4-6	64-70	90-975	100	Major Arterial	Secondary	Major Arterial	Major Arterial	
Industrial Road	52,206	Mobility	8	190	-	100	Major Arterial	Secondary	Expressway	Expressway	
Al Matar Street	77,377	Mobility	6	60-80	585-1757	80	Expressway	Tertiary	Major Arterial	Major Arterial	
Najma Street	63,242	Mobility	4-6	60-80	240-2010	50	Major Arterial	Tertiary	Minor Arterial	**Major Arterial**	Connects urban districts, mobility for through traffic
Ras Abu Abboud	69,720	Mobility	8	100-120	-	100	Freeway	Tertiary	Major Arterial	**Expressway**	Free flowing traffic
Al Waab Street	77,237	Mobility	6	50-80	615-1531	80	Freeway / Expressway	Secondary	Major Arterial	Major Arterial	
Al Rayann Al Jadeed Street	52,507	Mobility	4-10	60-120	-	80	Expressway	Tertiary / Secondary	Major Arterial	**Expressway**	Free flowing traffic
Khalifa Street / Luqta Street	75,566	Mobility	6	60-120	1063-3842	80 / 100	Freeway	Tertiary / Secondary	Major Arterial / Expressway	**Major Arterial**	Connects urban districts, mobility for through traffic, existence of signalized intersections
Al Markiyah Street	67,674	Mobility	6	60-80	396-2505	100 / 80	Major Arterial	Tertiary	Major Arterial	Major Arterial	

[a] Average Daily Traffic (ADT) over one-week period in normal conditions. Source: Traffic Count by Crown Consult.

Figure 2.8 - Proposed Functional Classification of the Existing Road Network - Greater Doha





2050

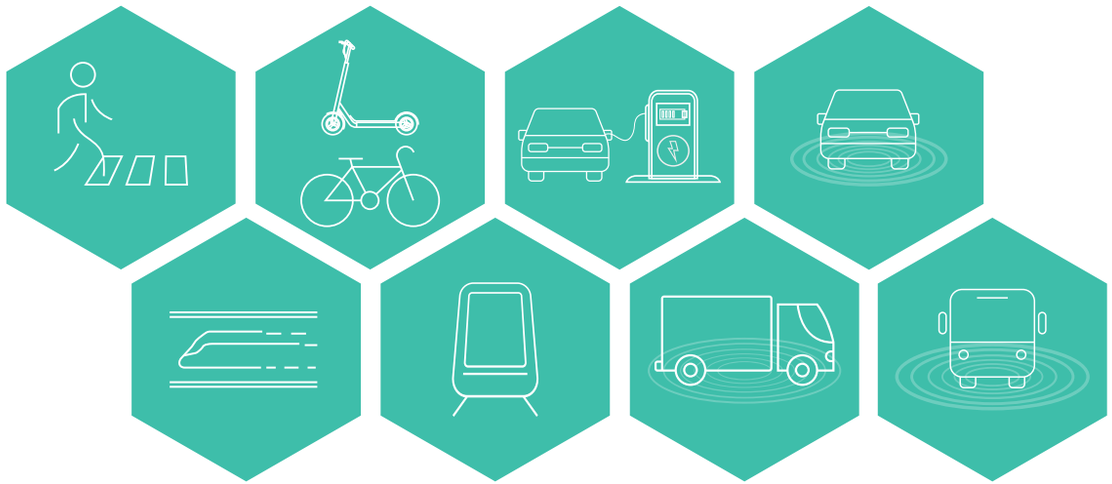
نقـل متكامـل ومسـتدام للجميـع

INTEGRATED & SUSTAINABLE TRANSPORT FOR ALL

2070

SECTION - 03

REVIEW OF INTERNATIONAL BEST PRACTICES



3 REVIEW OF INTERNATIONAL BEST PRACTICES

This section presents a detailed review of three cases of international systems of functional classification.

3.1 CASE 1: THE UNITED STATES

The Federal Highway Administration (FHWA) of U.S. Department of Transportation has developed a guideline "*Highway Functional Classification: Concepts, Criteria and Procedures, 2013 Edition*" to preserve the consistency between all states.

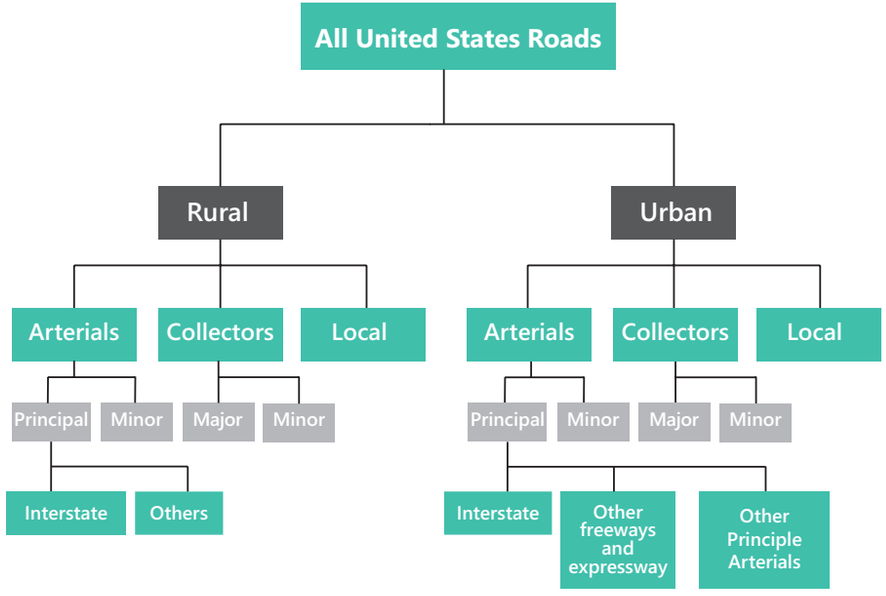
3.1.1 FUNCTIONAL CLASSIFICATION CATEGORIES

The FHWA's "*Highway Functional Classification: Concepts, Criteria and Procedures, 2013 Edition*" describes the procedures and processes for assigning functional classifications to roadways and adjusting urban area boundaries. There are seven functional classification categories which are used currently in United States:

- Principal Arterial
  - Interstate
  - Other freeways & expressways (OF&E)
  - Other principal arterials (OPA)
- Minor Arterial
- Collector
  - Major Collector
  - Minor Collector
- Local

Figure 3.1 shows the basic hierarchy of the Highway Functional Classification System on both urban and rural contexts. The classes are defined by certain characteristics as well as the level of access and the type of travel mobility the roads provide. The three roadway classes are arterials, collectors and local.

Figure 3.1 - United States Highway Functional Classification System (FHWA)



Source: Highway Functional Classification: Concepts, Criteria and Procedures, 2013 (FHWA)

Urban and rural areas have different characteristics as to density and types of land use, nature of travel patterns, density of street and highway networks, and the way in which all these elements are related to highway function.

Each classification is based on the roadway's function within the roadway system. FHWA sets out requirements for the functional classifications and provides descriptions of typical features of each functional classification.

The FHWA's guideline bases functional class primarily on the function of the road, not the road's location with regards to the urban and rural boundary. Urban and rural boundaries are a secondary category.

3.1.2 FUNCTIONAL CLASSIFICATION CONCEPTS

Most travel occurs through a network of interdependent roadways, with each roadway segment moving traffic through the system towards destinations. The concept of functional classification defines the role that a particular roadway segment plays in serving this flow of traffic through the network. Roadways are assigned to one of several possible functional classifications within a hierarchy according to the character of travel service each roadway provides. Planners and engineers use this hierarchy of roadways to efficiently channel transportation movements through a highway network.

3.1.3 ACCESS VERSUS MOBILITY

Roadways serve two primary travel needs: access to/egress from specific locations and travel mobility. While these two functions lie at opposite ends of the continuum of roadway function, most roads provide some combination of each.

- Roadway mobility function: Provides few opportunities for entry and exit and therefore low travel friction from vehicle access/egress
- Roadway accessibility function: Provides many opportunities for entry and exit, which creates potentially higher friction from vehicle access/egress

Roadways that provide a high level of mobility are called "Arterials"; those that provide a high level of accessibility are called "Locals"; and those that provide a more balanced blend of mobility and access are called "Collectors." While most roadways offer both "access to property" and "travel mobility" services, it is the roadway's primary purpose that defines the classification category to which a given roadway belongs.

3.14 DEFINITIONS AND CHARACTERISTICS OF EACH FUNCTIONAL CLASSIFICATION CATEGORY

3.1.4.1 Interstates

Interstates are the highest classification of Arterials and were designed and constructed with mobility and long-distance travel in mind. Since their inception in the 1950's, the Interstate System has provided a superior network of limited access, divided highways offering high levels of mobility while linking the major urban areas of the United States.

3.1.4.2 Other Freeways & Expressways

Roadways in this functional classification category look very similar to Interstates. While there can be regional differences in the use of the terms 'freeway' and 'expressway', for the purpose of functional classification the roads in this classification have directional travel lanes, are usually separated by some type of physical barrier, and their access and egress points are limited to on- and off-ramp locations or a very limited number of at-grade intersections. Like Interstates, these roadways are designed and constructed to maximize their mobility function, and abutting land uses are not directly served by them.

3.1.4.3 Other Principal Arterials

These roadways serve major centers of metropolitan areas, provide a high degree of mobility and can also provide mobility through rural areas. Unlike their access-controlled counterparts, abutting land uses can be served directly. Forms of access for Other Principal Arterial roadways include driveways to specific parcels and at-grade intersections with other roadways. For the most part, roadways that fall into the top three functional classification categories (Interstate, Other Freeways & Expressways and Other Principal Arterials) provide similar service in both urban and rural areas. The primary difference is that there are usually multiple Arterial routes serving a particular urban area, radiating out from the urban center to serve the surrounding region. In contrast, an expanse of a rural area of equal size would be served by a single arterial route.

Table 3.1 presents a few key differences between the character of service that urban and rural Arterials provide.

Table 3.1 - Characteristics of Urban and Rural Major Arterials (FHWA)

Urban	Rural
▸ Serve major activity centers, highest traffic volume corridors and longest trip demands. ▸ Carry high proportion of total urban travel on minimum of mileage. ▸ Interconnect and provide continuity for major rural corridors to accommodate trips entering and leaving urban area and movements through the urban area. ▸ Serve demand for intra-area travel between the central business district and outlying residential areas.	▸ Serve corridor movements having trip length and travel density characteristics indicative of substantial statewide or interstate travel. ▸ Connect all or nearly all Urbanized Areas and a large majority of Urban Clusters with 25,000 and over population. ▸ Provide an integrated network of continuous routes without stub connections (dead ends).

Source: FHWA

3.1.4.4 Minor Arterials

Minor Arterials provide service for trips of moderate length, serve geographic areas that are smaller than their higher Arterial counterparts and offer connectivity to the higher Arterial system. In an urban context, they interconnect and augment the higher Arterial system, provide intra-community continuity and may carry local bus routes. In rural settings, Minor Arterials should be identified and spaced at intervals consistent with population density, so that all developed areas are within a reasonable distance of a higher-level Arterial. Additionally, Minor Arterials in rural areas are typically designed to provide relatively high overall travel speeds, with minimum interference to through movement. Table 3.2 presents a few key characteristics of Urban and Rural Minor Arterials.

Table 3.2 - Characteristics of Urban and Rural Minor Arterials (FHWA)

Urban	Rural
▸ Interconnect and provide continuity for major rural. ▸ Interconnect and augment the higher-level Arterials; ▸ Serve trips of moderate length at a somewhat lower level of travel mobility than Principal Arterials; ▸ Distribute traffic to smaller geographic areas than those served by higher-level Arterials; ▸ Provide more land access than Principal Arterials without penetrating identifiable neighborhoods; ▸ Provide urban connections for Rural Collectors.	▸ Link cities and larger towns (and other major destinations such as resorts capable of attracting travel over long distances) and form an integrated network providing interstate and inter-county service; ▸ Be spaced at intervals, consistent with population density, so that all developed areas within the State are within a reasonable distance of an Arterial roadway; ▸ Provide service to corridors with trip lengths and travel density greater than those served by Rural Collectors and Local Roads and with relatively high travel speeds and minimum interference to through movement.

Source: FHWA

3.1.4.5 Major and Minor Collectors

Collectors serve a critical role in the roadway network by gathering traffic from Local Roads and funneling them to the Arterial network. Within the context of functional classification, Collectors are broken down into two categories: Major Collectors and Minor Collectors. The determination of whether a given Collector is a Major or a Minor Collector is frequently one of the biggest challenges in functionally classifying a roadway network. In the rural environment, Collectors generally serve primarily intra-county travel (rather than statewide) and constitute those routes on which (independent of traffic volume) predominant travel distances are shorter than on Arterial routes. Consequently, more moderate speeds may be posted.

Generally, Major Collector routes are longer in length; have lower connecting driveway densities; have higher speed limits; are spaced at greater intervals; have higher annual average traffic volumes; and may have more travel lanes than their Minor Collector counterparts. Major Collectors offer more mobility and Minor Collectors offer more access. In rural areas, AADT and spacing may be the most significant designation factors. The following table describes the main characteristics of Major and Minor Collectors.

Table 3.3 - Characteristics of Urban and Rural Major Collectors (FHWA)

Major Collectors	
Urban	**Rural**
▸ Serve both land access and traffic circulation in higher density residential, and commercial/ industrial areas; ▸ Penetrate residential neighborhoods, often for significant distances; ▸ Distribute and channel trips between Local Roads and Arterials, usually over a distance of greater than three-quarters of a mile; ▸ Operating characteristics include higher speeds and more signalized intersections.	▸ Provide service to any county seat not on an Arterial route, to the larger towns not directly served by the higher systems and to other traffic generators of equivalent intra-county importance such as consolidated schools, shipping points, county parks and important mining and agricultural areas; ▸ Link these places with nearby larger towns and cities or with Arterial routes; ▸ Serve the most important intra-county travel corridors.

Source: FHWA

Table 3.4 - Characteristics of Urban and Rural Minor Collectors (FHWA)

Minor Collectors	
Urban	**Rural**
▸ Serve both land access and traffic circulation in lower density residential and commercial/ industrial areas; ▸ Penetrate residential neighborhoods, often only for a short distance; ▸ Distribute and channel trips between Local Roads and Arterials, usually over a distance of less than three-quarters of a mile; ▸ Operating characteristics include lower speeds and fewer signalized intersections.	▸ Be spaced at intervals, consistent with population density, to collect traffic from Local Roads and bring all developed areas within reasonable distance of a Collector; ▸ Provide service to smaller communities not served by a higher class facility; ▸ Link locally important traffic generators with their rural hinterlands.

Source: FHWA

3.1.4.6 Local Roads

Roads classified as local account for the largest percentage of all roadways in terms of mileage. They are not intended for use in long distance travel, except at the origin or destination end of the trip, due to their provision of direct access to abutting land. Bus routes generally do not run on Local Roads. They are often designed to discourage through traffic. Local Roads are often classified by default, in other words, once all Arterial and Collector roadways have been identified, all remaining roadways are classified as Local Roads.

Table 3.5 - Characteristics of Urban and Rural Local Roads (FHWA)

Local Roads	
Urban	**Rural**
▸ Provide direct access to adjacent land; ▸ Provide access to higher systems; ▸ Carry no through traffic movement; ▸ Constitute the mileage not classified as part of the Arterial and Collector systems.	▸ Serve primarily to provide access to adjacent land; ▸ Provide service to travel over short distances as compared to higher classification categories; ▸ Constitute the mileage not classified as part of the Arterial and Collector systems.

Source: FHWA

3.2 CASE 2: NCHRP RESEARCH REPORT

The National Cooperative Highway Research Program (NCHRP) published '*An Expanded Functional Classification System for Highways and Streets*' (NCHRP Research Report 855) in July 2018. The purpose of this report was to arrive at an expanded Functional Classification System for the United States. If adopted, this system will replace the existing one described in section 3.1 above.

The report approaches the issues of network classification from a multimodal viewpoint. The automobile, bicycle, pedestrian, transit and freight networks are considered separately, and a functional classification system is proposed. The report summarizes the proposed FCS in a matrix format with two main dimensions. Automobile network is one of the dimensions, the other is the roadway context. Despite the emphasis on automobile network, other modes are given consideration and overlaid on top of the matrix. The report also considers the needs of separate

blocks of users and builds a framework that aims to address them. This report is not a design code; it does not always provide exact quantitative figures, rather focusing on giving general guidance.

3.2.1 CONTEXT DEFINITION

Context is strongly emphasized in the report and expanded into five separate categories summarized in Table 3.6 below. The five context categories proposed take a gradual progress from urban core to rural.

Table 3.6 - Context Definition in the NCHRP Report

Category	Density	Land Use	Building Setback
Rural	Lowest (few houses or other structures)	Agricultural, natural resource preservation, and outdoor recreation uses with some isolated residential and commercial	Usually large setbacks
Rural Town	Low to medium (single-family houses and other single-purpose structures)	Primarily commercial uses along a main street (some adjacent single-family residential)	On-street parking and sidewalks with predominately small setbacks
Suburban	Low to medium (single/multifamily structures and multistory commercial)	Mixed residential neighborhood and commercial clusters (includes town centers, commercial corridors, big box commercial and light industrial)	Varied setbacks with some sidewalks and mostly off-street parking
Urban	High (multistory, low-rise structures with designated off-street parking)	Mixed residential and commercial uses, with some institutional and industrial and prominent destinations	On-street parking and sidewalks with mixed setbacks
Urban Core	Highest (multistory and high-rise structures)	Mixed commercial, residential and institutional uses within and among predominately high-rise structures	Small setbacks with sidewalks and pedestrian plazas

Source: An Expanded Functional Classification System for Highways and Streets (NCHRP, Research Report 855, 2018)

3.2.2 TRANSPORTATION NETWORKS

3.2.2.1 Automobile Network

The report states that the simplicity of the current functional classification (U.S. Classification described by FHWA) is both its strength and weakness. Simplicity is useful in facilitating effective communication among policymakers, planners, designers and citizens. However, this simplistic approach does not recognize all the other layers, users and functions a roadway is often called upon to fulfill.

The expanded FCS roadway classes follow basic transportation system functions and are defined based on their network function and connectivity. The existing hierarchy is simplified by removing the two levels of collector roads (major and minor). Key characteristics of each roadway type are as follows:

1. **Interstates/Freeways/Expressways:** Corridors of national importance providing long-distance travel:
   - Limited access;
   - Through traffic movements;
   - Primary freight routes;
   - Possible transit network support;
   - No pedestrian or bicycle traffic;
   - Guided by FHWA design standards.

2. **Principal Arterial:** Corridors of regional importance connecting large centers of activity:
   - Through traffic movements;
   - Long-distance traffic movements;
   - Long-haul public transit buses;
   - Primary freight routes;
   - Pedestrian and bicycle movements.
3. **Minor Arterial:** Corridors of local importance connecting centers of activity:
   - Connections between local areas and network principal arterials;
   - Connections for through traffic between arterial roads;
   - Access to public transit and through movements;
   - Pedestrian and bicycle movements;
4. **Collector:** Roadways providing connections between arterials and local roads:
   - Traffic with trips ending in a specific area;
   - Access to commercial and residential centers;
   - Access to public transportation;
   - Pedestrian and bicycle movements.
5. **Local:** All other roads
   - Direct property access—residential and commercial;
   - Pedestrian and bicycle movements.

Factors used in determining classification for road networks are summarized below:

Context: The report stipulates that context has great influence on the facility speed (mobility provision). As an example, even though a principal arterial may connect multiple cities in a region, if it traverses an urban core area, it should be designed as a low-speed urban roadway capable of accommodating all users, not a high-speed facility focused only on automobile traffic. In the urban core context defined above, provision of pedestrian and cyclist facilities is important.

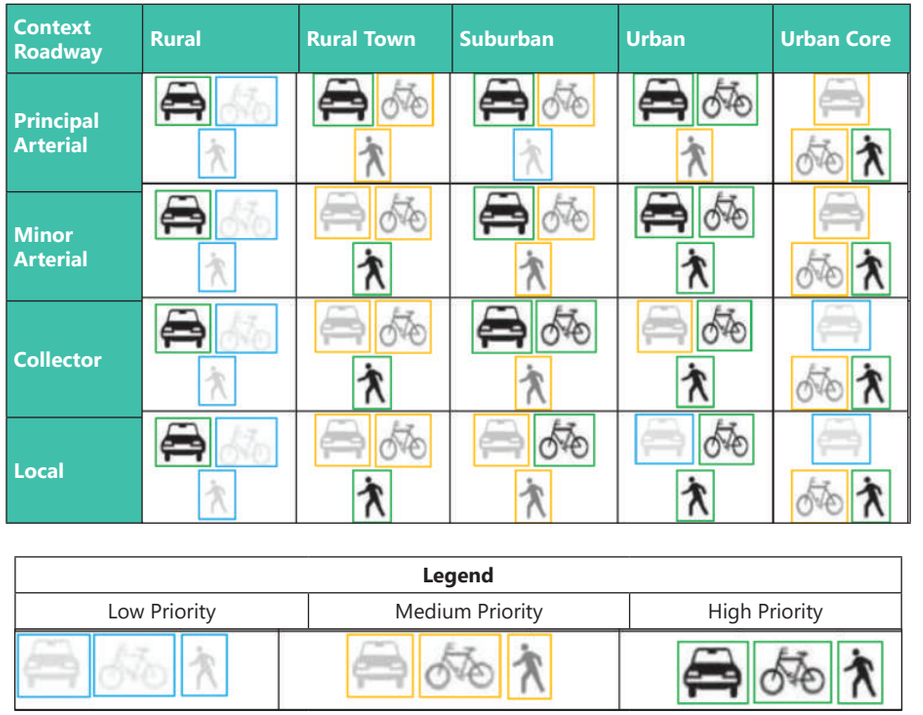
Efficiency of Travel: The extent to which a road minimizes delays and travel time, measured as Level of Service (LOS).

Route Spacing: Refers to the space between more or less parallel roadways of the same hierarchical level. Spacing between roadways higher on the hierarchy should be larger that of lower level roads. And spacing of all roads within densely populated urban areas should be smaller than that of sparsely populated rural areas. The report acknowledges that local geographical considerations usually have great influence on route layouts and spacing.

Vehicle Volumes: The number of vehicles per unit of time at the current and design year is considered an important indicator of the functional class of a facility. The volume indicates the required capacity per lane and the number of lanes for current year demand, and potentially, ROW requirements if in future scenarios the need arose to increase capacity. Therefore, design recommendations should be developed with not only opening year, future year, and intermediate operations in mind, but also an understanding of the impacts on peak and off-peak operating conditions in order to develop the "best" phased approach scenario for all users throughout the entire design life and not just the peak hour.

The Proposed Functional Classification Framework is presented in a matrix format based on the context and the hierarchical classification of the automobile network. The user priorities for motor vehicles, bicycles and pedestrians within this matrix are presented in Figure 3.2 below.

Figure 3.2 - User Prioritization in the NCHRP Report



Source: An Expanded Functional Classification System for Highways and Streets (NCHRP, Research Report 855, 2018)

Freight and transit users are not included here because the format of the report considers them as overlay networks to be placed on top of the automobile network (since they use the same travelled way).

3.2.2.2 Bicycle Network

Classes for bicycle routes are also ranked based on the structure and connectivity they provide; in that sense this is similar to the classification for the automobile network. The scale is modified to reflect the shorter trips lengths of bicycles.

The proposed classes are:

1. **Citywide Connector (CC):** providing citywide connections, connections to major activity centers, or regional bicycle routes stretching over several miles that attract a high volume of users as they serve a primary commute or recreational purpose.
2. **Neighborhood Connector (NC):** Providing neighborhood or sub-area connection, which establishes connections to higher-order facilities or local activity centers such as neighborhood commercial centers.
3. **Local Connector (LC):** Providing local connections of short lengths, which provide internal connections to neighborhoods or connect to higher-order facilities.

Aside from connectivity, other factors should be used in planning bicycle routes:

Efficiency of Travel: To provide sufficient LOS, higher-order bicycle facilities should be planned within a network to connect major centers of activity by considering recreational, work/commuting and other trip types.

Mode Range: The average and maximum length of a bicycle trip should also be considered. The National Survey of Pedestrian and Bicyclist Attitudes and Behaviors Report identified an average trip length of 65 minutes in the United States, with an estimated range of 4–8 kilometers (NHTSA, 2002). In Qatar, the range is likely to be shorter. In establishing a bicycle network, trip lengths longer than this range should factor in integration with public transit facilities.

Bicyclist Safety: Cyclists are far more vulnerable than motor vehicles. Providing necessary safety facilities requires coordinating the bicycle network classification with the automobile network.

Route Spacing: Same requirements of automobile networks apply. Spacing between bicycle paths sitting higher on the hierarchy should be larger that of lower level roads. And spacing of all bicycle paths within densely populated urban areas should be smaller than that of sparsely populated rural areas.

Bicycle Volumes: Anticipated bicycle volume is a critical consideration in functional classification. The report considers context as a guide to anticipated volume. The most dense urban core areas are meant to expect higher volumes since they are expected to have a lot of commuters and controls on motor vehicles. The least densely populated rural areas may also to be expected to have high bicycle volumes, because these areas are attractive to recreational users. Suburban areas are expected to have relatively less volume.

3.2.2.3 Pedestrian Network

Pedestrian transport lends itself far less to a network compared to other modes. This is because of the short range and greater localization of pedestrian routes.

In urban areas, pedestrian routes need to be considered carefully based on the local context, for example, a pedestrian path connecting a university to an area downtown will require enhanced pedestrian facilities even if the less dense urban context may not imply that.

The main factors affecting pedestrian networks classification are:

Efficiency of Travel: Higher-order pedestrian facilities need to be planned within a network to connect major centers of activity, considering recreational, work/commuting and other trip types.

Mode Range: The average and maximum length of a walk trip should also be considered. A typical pedestrian range of 0.4–0.8 kilometers is often used as an acceptable walking distance in the United States; however, this length may increase in urban areas where walking is the preferred method of transport (NHTSA, 2002). Longer trips should be considered in conjunction with the public transit network. The short range of pedestrian

traffic means that the level of a given route is directly related to land use and context.

Pedestrian Safety: Pedestrians are the most vulnerable among the modes of transport. High pedestrian volumes require high level facilities to ensure safety.

Block Length: The length of blocks affects pedestrian travel demand. In general, desirable block lengths range from 60–120 meters and should not exceed 180 meters (ITE and Congress for the New Urbanism, 2010). Long blocks tend to discourage pedestrian movements.

Pedestrian Volumes: The amount of pedestrian traffic anticipated to use a facility needs to be considered in determining the type of facility and its functional classification. Pedestrian volumes affect several factors, including the capacity of pedestrian facilities, delays of motorized vehicles and pedestrian safety. Pedestrian volumes are classified into four categories:

- Rare or occasional volume;
- Low volume, which has a few pedestrians;
- Medium volume, which has several pedestrians;
- High volumes.

Each of these volumes will require a different facility based on the context–roadway interaction.

The needs of pedestrian and cyclist users are accommodated with specific facilities in the planning and design of the corridors.

3.2.2.4 Transit Networks

Transit routes are typically fixed and well-defined by the local transit agency to meet the demands of transit ridership. It is very important that transport network planners and designers consider the transit network as a part of the overall network, not separately. Recent trends of increased ridership (in the United States) may require a closer examination of such transit overlays and their potential impacts on design. A close coordination with transit agencies, which typically are independent from State Departments of Transport, is essential to properly define transit overlays for roadways where transit either exists or is anticipated to be located. The functional classification is impacted by the transit network overlay.

3.2.2.5 Freight Network

Freight networks usually describe the path of large trucks needing special accommodation and their concentration on the roadway network. Determining freight networks can be achieved by studying land use to identify industrial centers and/or multimodal ports and manufacturing and commercial areas that are likely to generate freight traffic. Once such land uses are identified, likely destinations are also to be located, then preferred supply and delivery routes can be identified that connect these origin-destination flows. Heavier freight (i.e., large trucks) should be routed to larger, higher classification roadways where increased mobility is preferred. Context is also an important consideration in overlaying of the freight network and its effect of the functional classification of the road network; freight routes should avoid urban and urban core areas. Freight routes should be characterized based upon the frequency and size of expected freight traffic. Lower classification roadways should accommodate occasional through freight vehicles.

3.2.3 MODAL CONSIDERATIONS AND USER ACCOMMODATION

The accommodation for different types of users and modes of transport within the proposed expanded functional classification system matrix is summarized in this section.

3.2.3.1 Driver Accommodation

The accommodation for drivers of motorized vehicles is measured using the following metrics:

Target operating speed: is classified based on the same categories for design speed in the current AASHTO green book standards:

- Low – less than 50 km/h;
- Medium – between 50–70 km/h;
- High – Greater than 70 km/h.

Generally, operating speed should decrease from rural to urban core contexts and from high level principal arterials to low level local roads.

The target operation speed is the selected speed criterion for driver accommodation purposes in the Expanded FCS. This is due to the need to recognize the influence of driver desire and expectations. Also, the operation speed of a facility should be as close as possible to the design speed which results in an environment with smaller speed differences among drivers. Smaller speed differences are desirable because they improve safety.

Speeds should be considered for existing volumes and future design year volumes. The speed of 40 km/h should be considered the upper limit for the low-speed environments (local streets and dense urban areas). A note to take is that 30 km/h is considered the survivability speed for pedestrians and bicyclists in the event of a collision with a vehicle. Collisions at a speed equal to or lower that the survivability speed typically result in injuries for typical non-drivers, but they have a high chance of surviving. As such, speeds of 30 km/h or less should be considered in all areas of higher pedestrian activity and generally in the urban and urban core environments. Target speeds for urban and rural towns should be designated as low/medium. Designers should examine the available speed range to select the operating speed most appropriate for all users given the facilities and context.

Access and Mobility: The typical tradeoff between access and mobility presented in the existing classification system (FHWA/AASHTO system in Section 3.1) is meant to be enhanced in the expanded FCS to reflect the higher influence of context and to organize it in the FCS matrix format.

Access is defined as the frequency of driveways or intersections and is classified into three categories based on distance between access points:

- Low access – spacing greater than 1.2 km;
- Medium access – spacing between 1–0.4 km;
- High access – spacing lesser than 0.4 km.

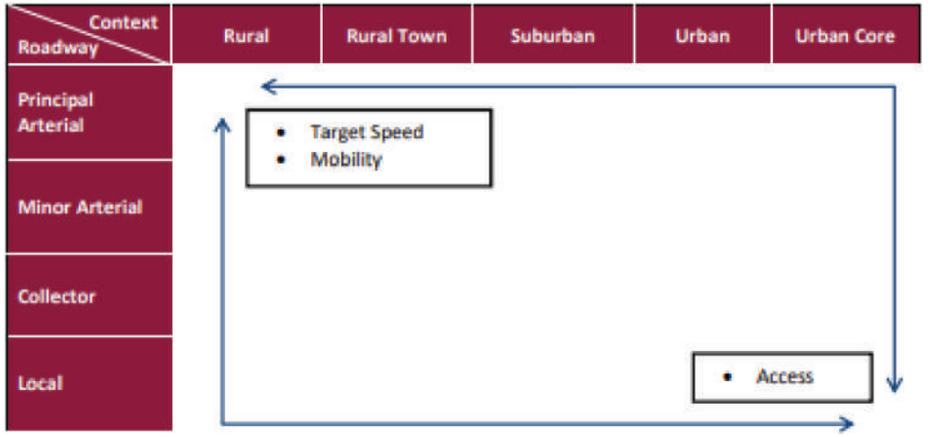
Mobility is defined (qualitatively) as a function of congestion level:

- Low (congested conditions);
- Medium (some congestion);
- High (no congestion, i.e. free flow).

Peak-hour conditions are used for this measure. Mobility levels are based on generalized concepts of the level of service (LOS) for a facility.

The interaction of access and mobility changes as the context and roadway class change. Mobility decreases and access increases from rural to urban core contexts and from high hierarchical level principal arterials to lower level local roads. Figure 3.3 below summarizes this interaction.

Figure 3.3 - Relationship between Context, Hierarchy and Key Functions in the NCHRP Report



3.2.3.2 Bicyclist Accommodation

This section is meant to present the concepts underlying the treatment of bicyclists in the bicycle facilities classifications in the expanded FCS. The primary consideration for a bicycle facility is the level of separation between motorized and bicycle traffic along a corridor.

Separation: Bicycle facilities are categorized based on separation from motorized vehicles as follows:

- High separation—provides physical separation from traffic in the form of physical barrier or lateral buffer.
- Medium separation—provides a dedicated space adjacent to motorized traffic.
- Low/No separation—provides joint-use facilities for motorized and non-motorized traffic.

The amount of separation necessary for a facility is dependent mostly on the following:

- Bicycle volumes.
- Motorized vehicles speed in the same roadway.
- Motorized vehicles volume in the same roadway.

Roads with high motorized vehicle speeds and volumes and high bicycle volumes require high separation. Conversely, lower speed local roads with potentially lower bicycle volumes require low/no separation.

The proposed expanded FCS matrix identifies a proposed level of separation that may be considered for each bicycle facility category.

Potential specific bicycle facilities that may be included within each of the separation levels are as follows:

- Low/No-separation treatments:
  - No specific facilities, for cases with rare or occasional bicycle traffic;

Figure 3.4 - Shared Bicycle Lanes (Sharrows)

  - Sharrows: (shown in Figure 3.4) shared car/bicycle lanes used for cases when a bicycle lane is not feasible and they can be used with narrow lanes, ensuring that a driver cannot pass a cyclist except very slowly. Not recommended in Qatar for safety considerations, considering the higher speeds in operation.
- Medium-separation treatments:
  - Bike lanes used for separating bicycles from vehicular traffic.
- High-separation treatments:
  - Buffered bike lane/cycle track used for cases with high bicycle volume;
  - Multi-use path used for cases with high bicycle and pedestrian traffic.

The variation in the amount of separation as the context changes reflects the effects of target operating speed. For example, higher speeds on principal arterials (for bicycle and motorized traffic) require some balancing of the separation to be determined based on the bicycle volume and the context.

For rural and suburban contexts, high bicycle volumes require high separation. In all other contexts with lower speeds, a medium separation is recommended for high-volume traffic.

Similarly, there is an interaction between the amount of bicycle separation and hierarchical roadway type. For example, on local roads, the slow-moving traffic does not require any special separation for bicyclists; therefore, for all bicycle facility classes, low separation is recommended. These examples of interactions are expanded in Table 3.7 below which shows the level of bicycle separation based on context, roadway classification and bicycle route classification. The classes of vehicle routes explained in Section 3.2.2.2 impact on the level of separation required as well.

Table 3.7 - Provision for Bicycle Users

Context / Roadway	Rural	Rural Town	Suburban	Urban	Urban Core	Bicycle Route Classification
Principal Arterial	Low/None	Low/None	Low/None	Low/None	Low/None	Local Connector
	Medium	Medium	Medium	Medium/ High	Medium	Neighborhood Connector
	High	Medium	High	High	Medium	Citywide Connector
Minor Arterial	Low/None	Low/None	Low/None	Low/None	Low/None	Local Connector
	Medium	Medium	Medium	Medium	Medium	Neighborhood Connector
	High	Medium	High	Medium	Medium	Citywide Connector
Collector	Low/None	Low/None	Low/None	Low/None	Low/None	Local Connector
	Medium	Low/None	Medium	Medium	Low/None	Neighborhood Connector
	Medium	Medium	Medium	Medium	Medium	Citywide Connector
Local	Low/None	Low/None	Low/None	Low/None	Low/None	Local Connector
	Low/None	Low/None	Low/None	Low/None	Low/None	Neighborhood Connector
	Low/None	Low/None	Low/None	Low/None	Low/None	Citywide Connector

Source: NCHRP Report

3.2.3.3 Pedestrian Accommodation

According to the report, the primary consideration of a pedestrian facility is its width. Some other factors that can help determine the proper treatment of a pedestrians' facility are also discussed.

Facility Width: Pedestrian facilities are categorized by their width as follows:

- No designated facilities for pedestrians, except for occasional site-specific facilities;
- Minimum width—the minimum required width based on the requirements of the ADA (Americans with Disabilities Act, a law that guarantees the rights of disabled people);
- Wide width—wider than minimum required width for a pedestrian facility;
- Enhanced width—more space than the wide width to accommodate congregating groups of pedestrians and street furniture.

Aside from the width of a facility, another design element is the level of separation of pedestrian traffic; however, this is highly dependent on the speed of the roadway. Typically, medium and high-speed roadway facilities will require separation from the travelled way whether in the form of a landscaped buffer, bicycle lanes, shoulders or parking areas. For low-speed facilities, a buffer area is not required.

The width necessary for a pedestrian facility depends on many factors, but most notably on the following:

- The pedestrian traffic volume adjacent to the roadway;

- The speed of motorized traffic on the adjacent roadway and required separation;
- The motorized traffic volume on the adjacent roadway.

In cases where there is no separation between the sidewalk and the roadway, the effective sidewalk width may become less than its actual width, because pedestrians tend to shy away from the edge of the travelled way. So, considerations should be made to increase the width.

The proposed functional classification matrix identifies a proposed level of facility width that may be considered for each pedestrian facility category according to roadway hierarchical type and context.

For pedestrian facilities, width is determined for the potential levels of pedestrian traffic based on the context and roadway type. The level of separation of the pedestrian facility from the travelled way is based on the speed of the motorized traffic along the corridor. Width changes with variations in the context reflecting the traffic volumes anticipated for the facility. For example, principal arterials in high-speed environments should consider the pedestrian traffic volumes to determine the appropriate width. For rural and suburban contexts, high pedestrian volumes require wide width, low or non-existent pedestrian volumes may require no facilities (consideration should be given for future volumes). Table 3.8 shows the matrix of interactions between context and pedestrian facility width. Table 3.8 need to be reviewed in the context of Table 3.7.

The report shows no interaction between the hierarchical class and the pedestrian facility width; only interactions depend on the context. However, it does mention an interaction between the traffic volumes on the main roadway and the pedestrian separation, and since volumes are related to the hierarchical class, some interaction is implied.

Table 3.8 - Provision for Pedestrian Users

Context Roadway	Rural	Rural Town	Suburban	Urban	Urban Core	Pedestrian Traffic Volume
Principal Arterial	None/SD[a]	-	None/SD[a]	-	-	Rare/None
	Minimum	Minimum	Minimum	Minimum	-	Low
	Wide	Wide	Wide	Wide	Wide	Medium
	Wide	Enhanced	Wide	Enhanced	Enhanced	High
Minor Arterial	None/SD[a]	-	None/SD[a]	-	-	Rare/None
	Minimum	Minimum	Minimum	Minimum	-	Low
	Wide	Wide	Wide	Wide	Wide	Medium
	Wide	Enhanced	Wide	Enhanced	Enhanced	High
Collector	None/SD[a]	-	None/SD[a]	-	-	Rare/None
	Minimum	Minimum	Minimum	Minimum	-	Low
	Wide	Wide	Wide	Wide	Wide	Medium
	Wide	Enhanced	Wide	Enhanced	Enhanced	High
Local	None/SD[a]	-	None/SD[a]	-	-	Rare/None
	Minimum	Minimum	Minimum	Minimum	-	Low
	Wide	Wide	Wide	Wide	Wide	Medium
	Wide	Enhanced	Wide	Enhanced	Enhanced	High

a SD: site dependent, depends on the specific current and future conditions of the site
Source: NCHRP Report

3.2.4 FINAL EXPANDED FCS MATRIX SUMMARY

The final matrix shown in Table 3.9 puts together the elements described above in addition to giving consideration for transit and freight networks as overlays.

Table 3.9 - Overall Functional Classification Matrix

Context Roadway	Rural	Rural Town	Suburban	Urban	Urban Core	Network Elements
Principal Arterial	High Speed, High Mobility, Low Access	Low/Medium Speed, Medium Mobility, High Access	Medium/High Speed, Medium Mobility, Medium Access	High Speed, High Mobility, Low Access	High Speed, High Mobility, Low Access	**Motor Vehicle Driver**
	LC: Low Separation NC: Medium Separation CC: High Separation	LC: Low Separation NC: Medium Separation CC: Medium Separation	LC: Low Separation NC: Medium Separation CC: High Separation	LC: Low Separation NC: Medium/High Separation CC: High Separation	LC: Low Separation NC: Medium Separation CC: Medium Separation	**Bicycle Rider**
	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P3: Wide; P4: Enhanced	**Pedestrian**
Minor Arterial	High Speed, High Mobility, Medium Access	Low/Medium Speed, Medium Mobility, High Access	Medium Speed, Medium Mobility, Medium Access	High Speed, High Mobility, Low Access	High Speed, High Mobility, Low Access	**Motor Vehicle Driver**
	LC: Low Separation NC: Medium Separation CC: High Separation	LC: Low Separation NC: Medium Separation CC: Medium Separation	LC: Low Separation NC: Medium Separation CC: High Separation	LC: Low Separation NC: Medium Separation CC: Medium Separation	LC: Low Separation NC: Medium Separation CC: Medium Separation	**Bicycle Rider**
	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P3: Wide; P4: Enhanced	**Pedestrian**
Collector	Medium Speed, Medium Mobility, Medium Access	Low Speed, Medium Mobility, High Access	Medium Speed, Medium Mobility, High Access	High Speed, High Mobility, Low Access	High Speed, High Mobility, Low Access	**Motor Vehicle Driver**
	LC: Low Separation NC: Medium Separation CC: Medium Separation	LC: Low Separation NC: Low Separation CC: Medium Separation	LC: Low Separation NC: Medium Separation CC: Medium Separation	LC: Low Separation NC: Medium Separation CC: Medium Separation	LC: Low Separation NC: Low Separation CC: Medium Separation	**Bicycle Rider**
	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P3: Wide; P4: Enhanced	**Pedestrian**
Local	Medium Speed, Medium Mobility, Medium Access	Low Speed, Medium Mobility, High Access	Low Speed, Low Mobility, High Access	High Speed, High Mobility, Low Access	High Speed, High Mobility, Low Access	**Motor Vehicle Driver**
	LC: Low Separation NC: Low Separation CC: Low Separation	LC: Low Separation NC: Low Separation CC: Low Separation	LC: Low Separation NC: Low Separation CC: Low Separation	LC: Low Separation NC: Low Separation CC: Low Separation	LC: Low Separation NC: Low Separation CC: Low Separation	**Bicycle Rider**
	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P3: Wide; P4: Enhanced	**Pedestrian**

Legend:

Bicycle facility class: *CC = Citywide Connector, NC = Neighborhood Connector, LC = Local Connector*

Pedestrian traffic levels: *P1 = Rare/occasional, P2 = Low, P3 = Medium, P4 = High*

Pedestrian facility width: ** = Site Specific, Min = Minimum, Wide = Greater than minimum, Enhanced = Wide for large congregating pedestrian groups*

3.3 CASE 3: ABU DHABI

The '*Abu Dhabi Roadway Design Manual*' (ADRDM) (version 2.0, 2014) was produced by the Internal Roads and Infrastructure Directorate of the Abu Dhabi Municipality (ADM), as the primary engineering design code for highways in the city. The manual is focused on engineering design and thus gives less attention to transport planning. On the other hand, another manual, the '*Abu Dhabi Urban Street Design Manual*' (USDM), is focused on transport planning which is mostly performed in the process of developing streets in urban areas. The Urban Street Design Manual is used in conjunction with other adopted standards and guidelines developed by the ADM, Department of Transport and Urban Planning Council as applicable and it is intended to supplement and integrate with, rather than replace, existing and upcoming engineering and environmental standards.

Abu Dhabi classifies roads based on context into urban and rural. Table 3.10 below summarizes the overall FCS in Abu Dhabi. Urban roadways classification is based on the guidelines in the USDM.

Table 3.10 - Functional Classifications in Abu Dhabi

First Tier Classification	Roadway Type for Design	
	Urban	Rural
Primary	– Boulevard – Avenue	– Freeway – Expressway
Secondary	– Street	– Collector
Local	– Access Lane	– Access Road

The manual allows for some overlap between the classes and categories. The main example is freeways and expressways, and that they may penetrate urban areas. In Qatar, the context of a roadway is considered to be important, so when a rural freeway enters an urban area, the classification would change to reflect the change in context, despite the discontinuity.

3.3.1 RURAL ROADWAYS

Rural roadways are classified into the following:

3.3.1.1 Freeway

A freeway is a rural roadway with both a very high capacity and speed, with dual 3-lane (or more) carriageways. All intersections and crossings are grade separated. Access to pedestrians and non-motorized vehicles is forbidden. Posted speeds of 120 km/h typically apply.

3.3.1.2 Expressway

An expressway is generally built to similar standards to a freeway, but normally operates at lower speeds, may permit increased levels of access and have dual 2-lane carriageways. Posted speeds of 100 km/h typically apply, although 120 km/h can also be used.

In transitioning from rural to urban context, freeways are typically "downgraded" to expressways on the transition. Posted speeds of 80 km/h to 100 km/h are typical in these cases.

3.3.1.3 Collector

A collector is a low to medium capacity rural road that serves to move access road traffic from local streets to primary roads. Collectors may be single or dual carriageway roads.

3.3.1.4 Access Road

An access road is a low volume capacity low speed single carriageway street. They mainly serve to provide direct access to destinations.

3.3.2 URBAN ROADWAYS

Urban areas are more densely populated, thus urban networks are required to accommodate high degrees of both vehicular movements and accessibility, and to provide the level of service needed to satisfy current and future demands. Urban roadway classification characteristics are based on the street family classifications provided by the USDM. The highest-level freeways and expressways with access control and grade separated interchanges are always considered rural in the Abu Dhabi FCS; when a rural freeway enters an urban area, it usually transitions to a rural expressway but is not considered an urban roadway.

The relationship between the USDM urban roadway classifications and the classification system of the United States Federal Highway Administration is shown in the form of matrix in Figure 3.5.

Figure 3.5 - Relationship between FHWA Functional Classes and the USDM Urban Road Hierarchy

USDM Street Family	FHWA Functional Classification			
	Principal Arterial	Minor Arterial	Collector	Local
Boulevard	▬	▬		
Avenue	▬	▬	Major Collector	
Street			Minor Collector	▬
Access Lane				▬
Mushtarak[a]				▬

[a] Shared street between multiple modes, e. g. motor vehicles, pedestrian and bicycles.

Urban roadways are classified as follows:

3.3.2.1 Boulevard

A boulevard is a high vehicle capacity 6-lane street, which may have frontage lanes (service roads). Existing urban street with 8 lanes are classified as boulevard, but for future urban roads, 6 lanes is considered as the maximum.

3.3.2.2 Avenue

An avenue is a medium vehicle capacity 4-lane urban street, which may have frontage lanes (service roads).

3.3.2.3 Street

A street is a low vehicle capacity undivided street, with typically low traffic volumes and speeds.

3.3.2.4 Access Lane

An access lane is a very low capacity single carriageway street, with typically very low traffic volumes and speeds.

3.3.3 ABU DHABI URBAN STREET DESIGN MANUAL (USDM)

The Abu Dhabi Urban Street Design Manual is a street planning guidance document that aims to promote context sensitive design for urban streets where the urban context is strongly related to the local land use characteristics, nearby activities, historical and environmental considerations and the general character of the neighborhood. Traditional access/mobility functions are considered of less importance for the manual's purposes.

3.3.3.1 Urban Contexts

Within the overall urban context, five separate land use related context categories are defined in the USDM, and these are discussed in this section. The purpose of this expansion of context definition is to fulfill the goal of promoting context sensitive design. Within the USDM, priorities in all streets is given to pedestrians, then to transit users, then to cyclists, and finally to motor vehicle drivers.

3.3.3.2 City Context

This context is characterized by mixed-use Central Business Districts land use. Urban core areas and high-density neighborhoods with high levels of pedestrian activity are considered city context areas. Buildings in this context are typically five stories and higher.

In the city context, designing roadways for the comfort and safety of pedestrians is considered the highest priority in the USDM. The second priority is public transit in terms of efficiency, reliability and passenger comfort. A bicycle facilities network is to be provided within the city context. Within the pedestrian realm, provisions should be made for focus shade, landscaping, café seating, public art and other amenities, particularly at major destinations such as prominent retail areas, mosques, schools and tram stops. Design of roadways in this context is required to provide frequent, signalized pedestrian crossings, especially at the high level (primary) Boulevards and Avenues in areas of high pedestrian activity, it is fit to note that this would reduce the mobility for motor vehicles. Transit stops and taxi lay-bys are to be included with care given the need to ensuring comfortable waiting areas for passengers without interrupting cycle tracks or pedestrian through movement.

3.3.3.3 Town Context

The town context is mainly characterized by mixed-use land use areas with medium levels of pedestrian activity, where buildings are typically three to five stories. Design considerations are generally the same as in the City context, but given the relatively lower pedestrian volumes expected, pedestrian realm dimensions are slightly smaller.

3.3.3.4 Commercial Context

This context is intended to represent urban areas that provide a variety of working, shopping and other commercial service options.

The land use pattern in this context is considered more car-oriented, accommodation for pedestrians must still be guaranteed, with the same level of safety and comfort as any other urban street. The manual requires that care be taken to minimize the number of driveways and reduce motorists' speed at pedestrian crossings using traffic calming measures. Landscaping should provide shade and comfort to pedestrians.

3.3.3.5 Residential Context (including Emirati Neighborhoods)

This context represents housing areas. The residential density has some variation ranging from light density villas to higher density multi-dwelling residential buildings. Emirati neighborhoods are a type of residential land use of very low density, comprising only of villas.

Within this residential context, regardless of density, the USDM considers pedestrian safety is the most important consideration. One safety case in some residential streets and all access lanes is the case of playing children, which should be accommodated in the roadway by ensuring very low speeds for automobiles. Landscaping and shade should be provided for pedestrians. High levels of street connectivity, including the use of Sikkak (pedestrian-only routes) should also be provided to allow direct access for all residents to transit stops, retail centers, mosques and schools.

3.3.3.6 Industrial Context

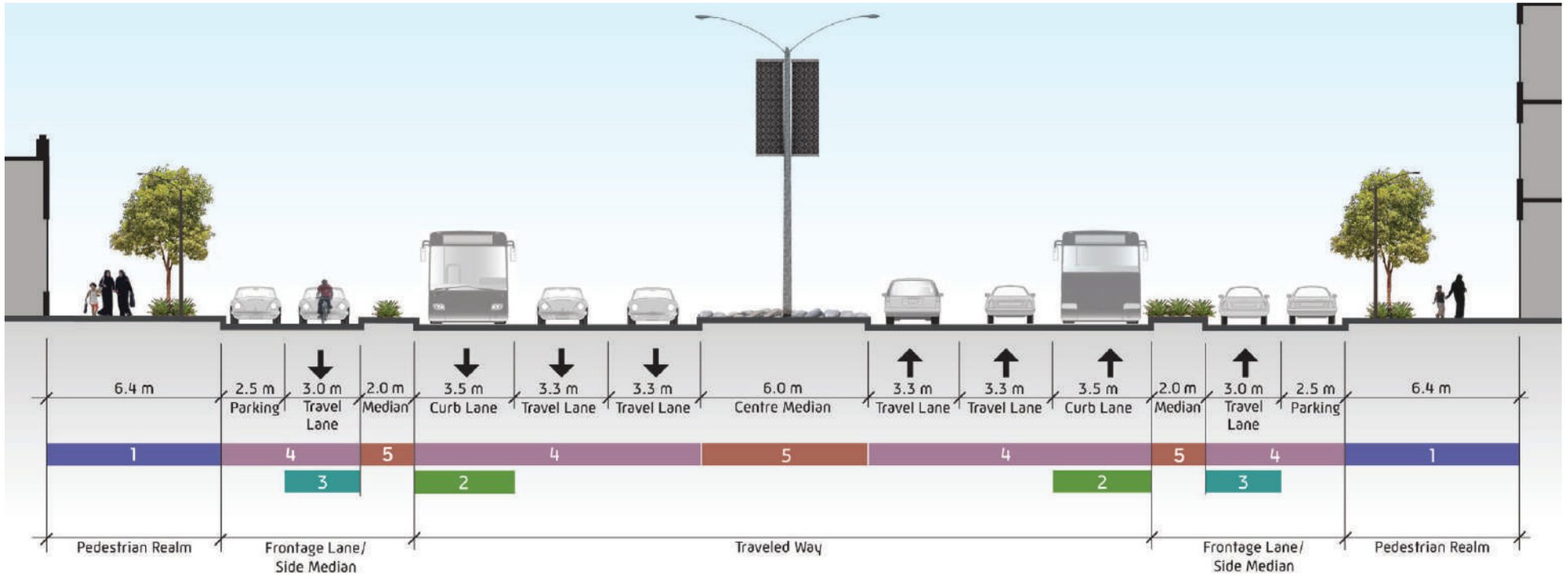
This context is for industrial land use areas which are likely to produce noise and freight traffic. Examples of uses include warehousing and distribution with supporting commercial services, ancillary office space and guest worker accommodation.

Industrial land use is considered more car-oriented; yet, pedestrians and cyclists must still be accommodated. Walking and cycling safety and comfort should not be compromised. The USDM requires minimizing the number of driveways in this context. However, landscape investment should be limited and focused on providing shade and comfort to pedestrians.

3.3.3.7 Cross Sectional Elements

The cross-sectional elements of urban streets are divided into three broad sections: Pedestrian Realm, Frontage Lane (service lanes) and Travelled Way. Figure 3.6 below shows a typical commercial context boulevard roadway, which is a primary roadway, the highest in the urban road hierarchy.

Figure 3.6 - Example Cross Section in the USDM



Source: Abu Dhabi Urban Street Design Manual

The range of dimensions for these cross-sectional elements based on context and family classification is presented in Table 3.11 below. The philosophy of the USDM shows in these suggested dimensions the strong focus on pedestrian and bicycle facilities and the de-emphasis on motorized vehicles within these urban areas. The maximum lane width for motor vehicle reflects this; in all contexts, except industrial, it is 3.3 meters. This is far less than the maximum allowed (and in some situations, required) by the FHWA and the QHDM of 3.65 meters. Even in the case of curb lanes, a lane width of 3.5 m is advised only if buses use curb lane as part of a regular transit route.

Table 3.11 - Dimensions of Cross Sectional Elements in the USDM

Street Family	Pedestrian Realm										Frontage Lanes						Travelled Way									
	Frontage		Through		Furnishing		Cycle Track		Edge[a]		Parking[d]		Travel Lane[d]		Side Median		Parking		Cycle Lane		Curb Lane		Travel Lane(s)		Center Median[b]	
											Curb Extension		Cycle				Curb Extension				Bus[c]					
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
City Context																										
Boulevard	0.5	1.5	2.8	4	1.2	3.5	1.5	2.5	0.2	2	2.5	2.5	3	3.3	0.5	4	N/A	N/A	N/A	N/A	3.3	3.5	3.3	3.3	2	6
Avenue	0.5	1.5	2.4	4	1	3	1.5	2.5	0.2	2	2.5	2.5	3	3.3	0.5	4	2.5	2.5	1.5	2.5	3.3	3.5	3.3	3.3	2	6
Street	0.5	1.5	2.4	3	1	2.4	1.5	2.5	0.2	2	N/A	N/A	N/A	N/A	N/A	N/A	2.5	2.5	1.5	2.5	3.0	3.5	N/A	N/A	N/A	N/A
Access Lane	N/A	N/A	1.8	2.5	N/A	N/A	N/A	N/A	0.2	1.5	N/A	N/A	N/A	N/A	N/A	N/A	2.5	2.5	N/A	N/A	3	3.3	N/A	N/A	N/A	N/A
Town Context																										
Boulevard	0.5	1.5	2.4	3.5	1.2	3	1.5	2.5	0.2	2	2.5	2.5	3	3.3	0.5	4	N/A	N/A	N/A	N/A	3.3	3.5	3.3	3.3	2	6
Avenue	0.5	1.5	2	3	1	2.4	1.5	2.5	0.2	2	2.5	2.5	3	3.3	0.5	4	2.5	2.5	1.5	2.5	3.3	3.5	3.3	3.3	2	6
Street	0.5	1.5	2	2.4	1	2	1.5	2.5	0.2	2	N/A	N/A	N/A	N/A	N/A	N/A	2.5	2.5	1.5	2.5	3	3.5	N/A	N/A	N/A	N/A
Access Lane	N/A	N/A	1.8	2.5	N/A	N/A	N/A	N/A	0.2	1.5	N/A	N/A	N/A	N/A	N/A	N/A	2.5	2.5	N/A	N/A	3	3.3	N/A	N/A	N/A	N/A
Commercial Context																										
Boulevard	0.5	1.5	2.4	3.5	1.2	3	1.5	2.5	0.2	2	2.5	2.5	3	3.3	0.5	4	N/A	N/A	N/A	N/A	3.3	3.5	3.3	3.3	2	6
Avenue	0.5	1.5	2	3	1	2.4	1.5	2.5	0.2	2	2.5	2.5	3	3.3	0.5	4	2.5	2.5	1.5	2.5	3.3	3.5	3.3	3.3	2	6
Street	0.5	1.5	2	2.4	1	2	1.5	2.5	0.2	2	N/A	N/A	N/A	N/A	N/A	N/A	2.5	2.5	1.5	2.5	3	3.5	N/A	N/A	N/A	N/A
Access Lane	N/A	N/A	1.8	2.5	N/A	N/A	N/A	N/A	0.2	1.5	N/A	N/A	N/A	N/A	N/A	N/A	2.5	2.5	N/A	N/A	3	3.3	N/A	N/A	N/A	N/A
Residential Context (Including Emirati Neighborhood)																										
Boulevard	0.5	1	1.8	3.5	1.2	2	1.5	2.5	0.2	2	2.5	2.5	3	3.3	0.5	4	N/A	N/A	N/A	N/A	3.3	3.5	3.3	3.3	2	6
Avenue	0.5	1	1.8	3	1	2	1.5	2.5	0.2	2	2.5	2.5	3	3.3	0.5	4	2.5	2.5	1.5	2.5	3.3	3.5	3.3	3.3	2	5
Street	N/A	N/A	1.8	3.4	N/A	N/A	1.5	2.5	0.2	2	N/A	N/A	N/A	N/A	N/A	N/A	2.5	2.5	1.5	2.5	3	3.5	N/A	N/A	N/A	N/A
Access Lane	N/A	N/A	1.8	3.4	N/A	N/A	N/A	N/A	0.2	1.5	N/A	N/A	N/A	N/A	N/A	N/A	2.5	2.5	N/A	N/A	3	3.3	N/A	N/A	N/A	N/A
Industrial Context																										
Boulevard	0.3	0.5	2	3.6	1.2	2.4	1.5	2.5	0.2	2	3.3	3.7	3.3	4	0.5	4	N/A	N/A	N/A	N/A	3.3	3.7	3.3	3.7	2	6
Avenue	0.3	0.5	2	3.4	1	2.4	1.5	2.5	0.2	2	3.3	3.7	3.3	4	0.5	4	3.3	3.7	1.5	2.5	3.3	3.7	3.3	3.7	2	5
Street	0.3	0.5	2	3	1	1.5	1.5	2.5	0.2	2	N/A	N/A	N/A	N/A	N/A	N/A	3.3	3.7	1.5	2.5	3.3	3.7	N/A	N/A	N/A	N/A
Access Lane	N/A	N/A	1.8	2.5	N/A	N/A	N/A	N/A	0.2	1.5	N/A	N/A	N/A	N/A	N/A	N/A	3.3	3.7	N/A	N/A	3	3.7	N/A	N/A	N/A	N/A

[a] Edge zone must be a minimum of 1.5 m where there is on-street parking or a cycle track. It may only go down to 0.2 m when sufficient room is available for signing, lighting, and utilities within an adjacent Furnishings zone.
[b] Minimum pedestrian refuge in the median shall be 2 m (or 3 m where there is high pedestrian activity). An additional 3 m is required to accommodate left turn lanes.
[c] Use 3.5 m if buses use curb lane as part of a regular transit route.

[d] Dimensions provided here are assuming parallel parking. In situations of alternate parking configurations, refer to DoT standards.

Optional

3.3.4 ABU DHABI ROADWAY DESIGN MANUAL (ADRDM)

In the Abu Dhabi Roadway Design Manual, the primary characteristics based on functional classification are related to engineering geometric design.

3.3.4.1 First Tier Classification

Table 3.12 below shows a summary of the overall characteristics based on first tier classification.

Table 3.12 - First Tier Classification Primary Design Parameters (ADRDM)

Characteristic	Primary Roads	Secondary Roads	Local Roads
Function	Regional Transportation	Regional transportation and/or service to major land developments	Local circulation
Service Points	Connects multiple regions. Serves international connections and major military installations	Connects two regions. Serves international connections, military installations and seaports not served by Primary Roads. May connect two Primary Roads	Residential, industrial and recreational areas not served by a higher class.
Access	Access is controlled	May be controlled	Minimal control
Minimum Level of Service	D	D	D
Weather related road closures – Allowable frequency	Once per 100 years	Once per 50 years	Once per 25 years

Source: ADRDM

More detailed urban/rural context based characteristics of functional classes used in ADRDM are shown in Table 3.13.

Table 3.13 - Context Based Characteristics of Functional Classes (ADRDM)

Type	Primary Roads	Secondary Roads	Local Roads
Traffic Service (Mobility):			
Urban and Rural	Traffic movement primary consideration	Traffic movement and access of equal importance	Traffic movement secondary consideration
Plot Service (Access):			
Urban and Rural	Plot access secondary in consideration	Traffic movement and plot access of equal importance	Plot access primary consideration
Traffic Flow Characteristics:			
Urban	Uninterrupted flow except at intersections	Interrupted flow	Interrupted flow
Rural	Uninterrupted flow	Interrupted flow	Interrupted flow
Private and Commercial Access:			
Urban and Rural	None or limited	Permitted	Permitted
Connection Type for Public Roads:			
Urban	At-grade intersections	At-grade intersections	At-grade intersections
Rural	Grade separated interchanges, or slip ramps	At-grade intersections	At-grade intersections
Connects to:			
Urban	– Boulevards – Avenues – Streets	– Boulevards – Avenues – Streets – Access Lanes	– Streets – Access Lanes

SECTION 3

Table 3.13 - Context Based Characteristics of Functional Classes (ADRDM)

Type	Primary Roads	Secondary Roads	Local Roads
Rural	– Freeways – Expressways – Collectors	– Freeways – Expressways – Collectors – Access Roads	– Collectors – Access Roads
Average Running Speed for Off-Peak Conditions:			
Urban	40 – 60 km/h	30 km/h	20 km/h
Rural	60 – 110 km/h	50 – 90 km/h	45 – 80 km/h
Design Speed:			
Urban	60 – 80 km/h	40 km/h	30 km/h
Rural	120 – 140 km/h	60 – 100 km/h	60 – 80 km/h

Source: ADRDM

The characteristics within the Roadway Design manual are consistent with the requirements of the USDM for urban roadways.

3.3.4.2 Second Tier Classification

For the purposes of design, some more detailed quantitative characteristics based on the second tier functional classification are suggested in the roadway design manual, and they are consolidated in Table 3.14.

Table 3.14 - Second Tier Classification Design Parameters (ADRDM)

Classification		Speed (km/h)		Typical Number of Lanes	Design vehicle	Control of access
	Posted	Design				
Urban	Boulevard	60	80	6	WB-12	Partial Access Control
	Avenue	40-50	60	4		
	Street	30	40	2	Single Unit Bus/Truck[a]	Approach Road and Driveway Regulations
	Access Lane	20	30	2		
Rural	Freeway	120	140	8	WB-12	Full Access Control
	Expressway	80-100	100-120	6		Full or Partial Access Control
	Collector	60-80	80-100	4	Single Unit Bus/Truck[a]	Partial Access Control
	Access Road	40-60	60-80	2		Approach Road and Driveway Regulations

[a] for streets with designated public bus routes, City-Bus M is to be used

Source: ADRDM

3.4 SUMMARY OF REVIEW

This section provides a summary of the review of best international practices presented in the previous sections. The purpose of the study is to consolidate the best lessons applicable to the functional classification system in Qatar.

Of note here is that there is no international framework of functional classification (even outside the three reviewed here) which offers as much complexity and details as the existing framework in Qatar, for example:

- No system has as many or more different functional classes, 13 in total, as Qatar's existing system;
- Qatar's existing system is the only one which gives some roads forming part of the ROW of a freeway, expressway, or arterial a separate functional classification category i.e. collector-distributer;
- No other system provides parameters and criteria as detailed and numerous.

A summary of the main points from international best practices is provided below.

From Case 1: FHWA functional classification system the main points include:

- Functional classification is based on the concept of a hierarchy of movement and the function of Access/Mobility provided by the road within the wider network. This is similar to the main framework of the existing QHDM system;
- Urban and rural roads are mirror images of each other, with each urban class having and equivalent rural class. This was done to enable easy change of classification as cities expanded their boundaries, with the classification of a road simply shifting from rural to urban. However, this is not recommended in Qatar because it unnecessarily complicates the functional classification of rural roads;
- The functional classification system in the FHWA provides best practices and procedures for assigning functional classification, maintaining the databases, and communicating the data in a mutually intelligible way between states' agencies and the federal government.

From Case 2: NCHRP research report, which is based on the FHWA system, the takeaways include:

- The classification of the road network based on context is expanded from simple urban and rural to five categories starting from the urban core to the rural. This was considered for application in the Qatar system, but it would introduce a level of complexity that is superfluous in local conditions. Although the system in the QHDM already emphasizes the role of land use in the classification of urban roads, which can be considered as a form of sub-context of the classification system, consideration is given to this sub-context in Section 4.1.4;
- Strong emphasis is placed on the needs of different road users. Pedestrians, cyclists, transit buses, and trucks are considered separately. This emphasis on the needs of multimodal users is considered in the proposed framework for Qatar (Section 4.2.3);
- A quantitative definition of mobility and access based on the frequency of access points is a good definition which is useful in assigning the functional classifications.

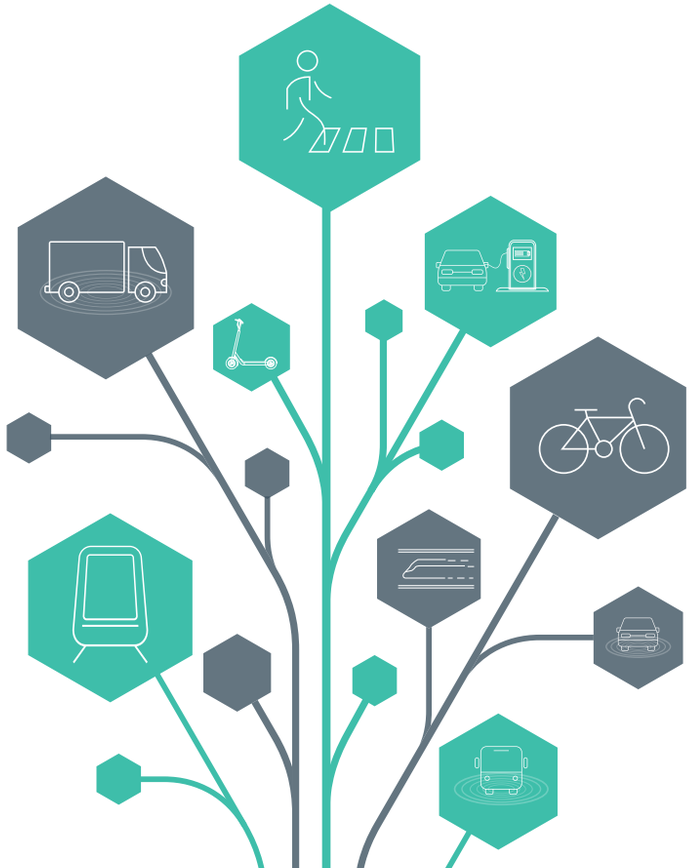
From Case 3: Abu Dhabi, which includes both the Roadway Design Manual (ADRDM) and the Urban Street Design Manual (USDM), the main points include:

- The design standards in the ADRDM have a simple system of functional classification based on the FHWA guidelines. It contains only four urban and four rural functional classes;
- The classification of urban roads aims to compel planners and designers to give consideration for the pedestrian and other non-

motorist road users. The design parameters reflect this, the highest speed in urban roads is 60 km/h and the width of most urban lanes can be no more than 3.3 meters;

- A relatively large portion of the right of way is reserved, in most urban roads, for the pedestrian realm, cycle tracks, public bus curb lanes, and shared cycle/car lanes. The hierarchy places strong focus on "livable pedestrian environment" with requirements to provide street furniture, shading, public art and landscaping for the benefit of pedestrians on urban roads;
- The context for urban roads is expanded based on five categories of land use: city, town, commercial, residential and industrial.

The themes from these lessons will be considered for incorporation in the proposed modified functional classification system in the following sections.



2050

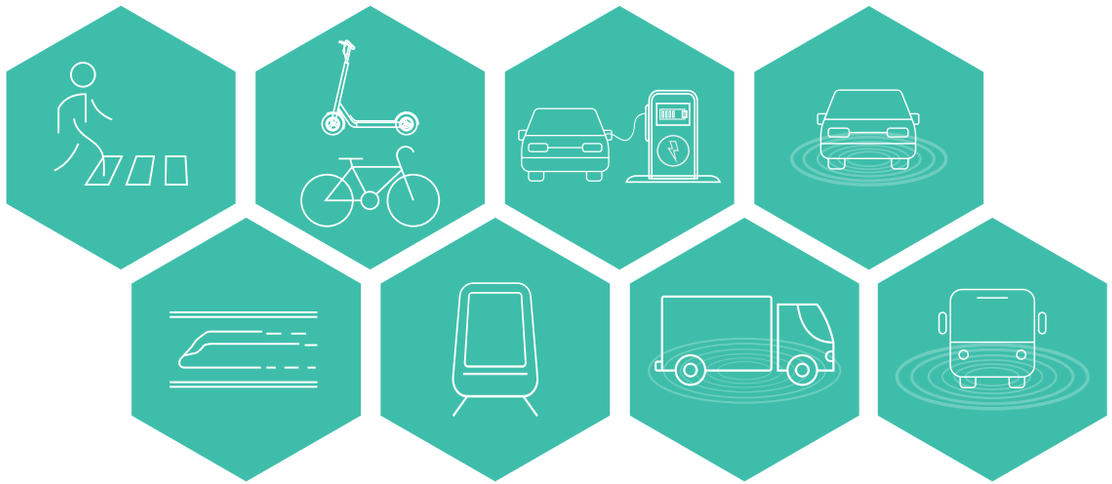
نقـل متكامـل ومسـتدام للجميـع

INTEGRATED & SUSTAINABLE TRANSPORT FOR ALL

2070

SECTION - 04

DEVELOPMENT OF THE PROPOSED FUNCTIONAL HIERARCHY FRAMEWORK



4 DEVELOPMENT OF THE PROPOSED FUNCTIONAL HIERARCHY FRAMEWORK

4.1 PURPOSE OF NETWORK CLASSIFICATION

The main purpose of a road hierarchy is to ensure the orderly grouping of roadways in a framework, which allow authorities to plan and implement various construction, maintenance, and management schemes and projects. It also assists authorities with the adoption of appropriate standards for roadways. It is good practice for an effective network planning to define the class of all roads based on the two main functions the roads play, providing access to roadside developments and providing a high degree of mobility. There is a tradeoff between these two functions that naturally create a hierarchy of classes. This hierarchy is referred to as the hierarchy of movement**.** It is the primary foundation of functional classification and explained in Section 4.1.3.

A uniform and consistent FCS facilitates communication among urban planners, designers and the public.

4.1.1 PURPOSE FOR TRANSPORT PLANNING

Understanding of the hierarchy of movement is essential for transport planners. Functional classification provides a systematic way of defining and using hierarchy of movement in the planning process.

The road hierarchy principles assist planners with:

- Planning and provision of public transport routes;
- Planning and provision of pedestrian and bicycle routes;
- Planning of heavy vehicle and dangerous goods routes;
- Identifying the effects of development decisions in and on surrounding areas and roadways within the hierarchy;
- Development design that facilitates urban design principles such as accessibility, connectivity, efficiency, amenity and safety;
- Assigning control over access onto traffic carrying roads to ensure safe and efficient operation for traffic;
- Identifying treatments such as barriers, buffers and landscaping to preserve amenity for adjacent land uses.

4.1.2 PURPOSE FOR ENGINEERING DESIGN

Functional classification does not dictate design; however, the two influence one another. An understanding of road hierarchy is the prerequisite to start the road design. It provides the designer with ideas of the various engineering design parameters like anticipated traffic volume, traffic composition, design speed, roadway type, mobility and accessibility requirements, ROW requirements, permitted intersection types, parking requirements, etc. Hence, geometric elements of the roads are chosen based on the functional classification and category of the road.

Understanding of road hierarchy is also very important to design a safe and cost-effective transport network. Different classifications of roads

have a significant influence on traffic safety, so they need to provide an acceptable safety level throughout the network. There is a great deal of latitude in the design of a roadway relative to its functional classification, and considerations for safety and project specific conditions are likely to override guidance from functional classification as a design constraint.

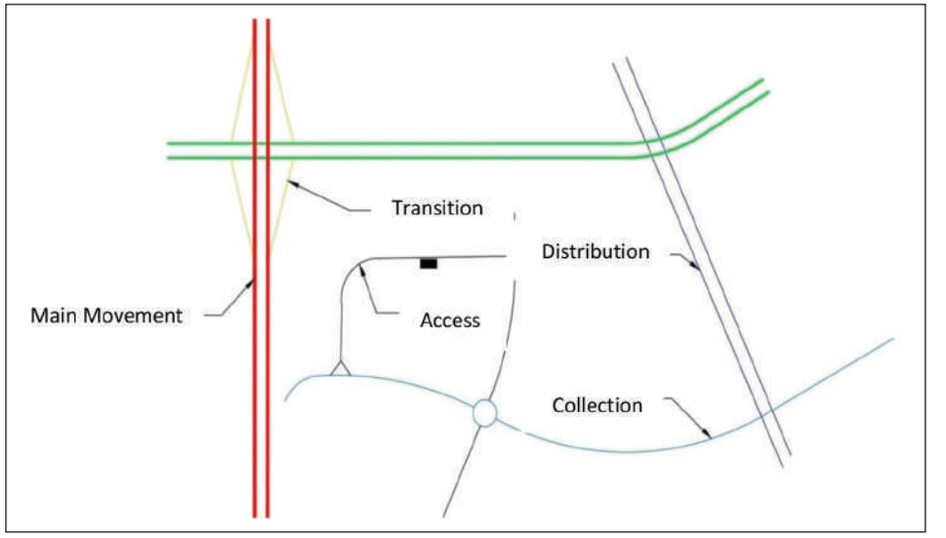
4.1.3 HIERARCHY OF MOVEMENTS

While the network of roads should support multiple modes of travel including private cars, public transport, pedestrians, cyclists and freight trucks, the functional classification at its core is founded on the character of the function the road provides to motor vehicles. Building on this foundation, provision of facilities for multimodal users can be included. A hypothetical trip taken by a motor vehicle can be divided into six phases:

1. Main movement: Vehicle travels at high speed flow without interruption (on freeways or expressways).
2. Transition: on approaching destination, vehicle slows down on the highway exit ramp, transitioning from uninterrupted high-speed flow into a high speed interrupted flow.
3. Distribution: Vehicle enters a moderate speed road acting to distribute the vehicle bringing it into the vicinity of the destination's neighborhood.
4. Collection: Vehicle enters collector road that runs across the destination's neighborhood.
5. Access: Vehicle enters local access road which provides direct approaches to individual destinations egress and exit lanes.
6. Termination: vehicle enters its destination and is parked.

Figure 4.1 demonstrates these movement phases.

Figure 4.1 - Phases of Movement in a Hypothetical Trip

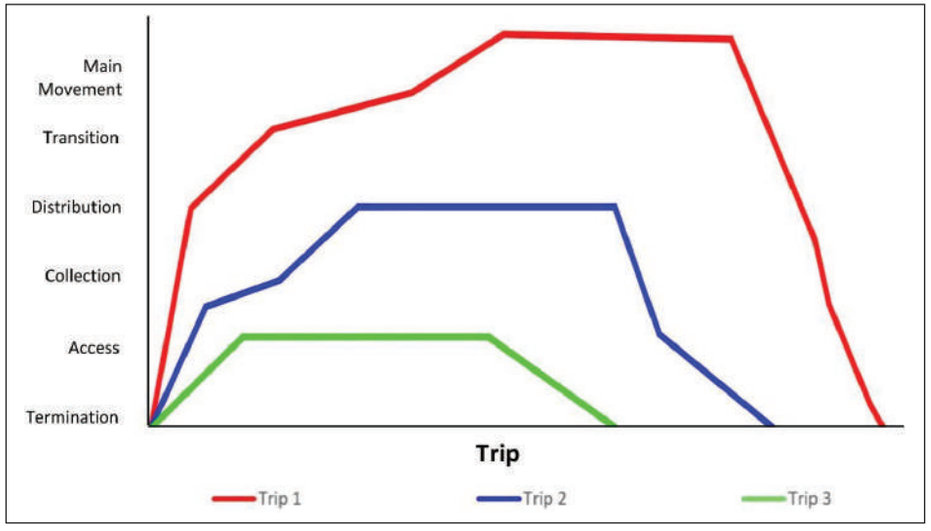


The road network is designed to serve these phases of movement, with each phase having its specific function. Main movement phase requires parts of the network to serve high mobility function; transition phase requires a high mobility function but with some limited access (served by Arterial roads), and so on with distribution, collection and access.

The level within the hierarchy is defined by the volume of traffic handled by the specific roadway facility corresponding to it, thus the main expressway or freeway movement is the highest level and so on. Not all trips follow all these phases of movement, but generally trips start at the lowest level, rise enough in the hierarchy depending on the distance (the longer the trip,

the higher the rise), then fall back toward the destination at the lowest level. Figure 4.2 shows examples of trips illustrating this concept.

Figure 4.2 - Example Trips Showing Hierarchy of Movement



An important note is that these functional needs are always served by some facility in the network because they are naturally arising. If they are not served by the external network, some parts of an internal network would have to serve them.

Following the study of the existing framework of functional classification and identification of main issues in Section 2.1.3, this section details the proposed framework of functional hierarchy based on the findings of the International Best Practice set out in Section 1. The structure of the framework is as follows:

- Context Definition: Functional classification depends on the surrounding context of the road, two main contexts are defined, urban and rural. Section 4.1.4 defines both contexts;
- Land use: Classification of roads in the urban context is sensitive to the type of land use surrounding the road, Section 4.1.5 defines the deferment land use categories and provides guidance on cases of mixed land use;
- Functional Classification Categories: The definitions of separate functional classes for urban and rural roads are detailed in Sections 4.1.6 and 4.1.7;
- Key Parameters: Section 4.2 lists and defines the parameters or criteria associated with functional categories;
- Network Connectivity Requirements: guidelines on preserving the connectivity of the network by prescribing allowable network connections based on functional classification are shown in Section 4.2.2;
- Provision for Multimodal Users: Functional classification requirements for the road users other than motorized cars (pedestrians, cyclists, transit buses, LRT, heavy trucks) are given in Section 4.2.3.

A summary of functional classification categories is presented in Table 4.1 for both urban and rural roads.

Table 4.1 - Proposed Functional Classification Categories

Urban Roads			Rural Roads		
Road Classification	**Sub-division by Role**	**Sub-division by Land Use**	**Road Classification**	**Sub-division by Role**	**Sub-division by Land Use**
Expressway	-	-	Freeway	-	-
Arterial	Major	-	Rural Arterial	-	-
	Minor	-			
Boulevard	-	-	-	-	-
Collector-Distributor	-	-	-	-	-
Collector	Major	Industrial	Rural Collector	-	-
		Commercial			
		Residential			
		Recreation			
	Minor	Industrial			
		Commercial			
		Residential			
		Recreation			
Service Road	-	-	-		
Local Road	-	Industrial	Rural Local Road	-	-
		Commercial			
		Residential			
		Recreation			

4.1.4 CONTEXT DEFINITION

Urban and rural areas are fundamentally different in their characteristics regarding the nature of travel patterns and density of street networks. These differences necessitate different procedures and practices in transportation planning and design.

After completing the Review of International Best Practice (Section 3), consideration was given to expanding the contexts of roads beyond urban and rural, as has been suggested in the Section 3.2 review of the NCHRP research report. The main issue with the current QHDM 2020 approach, as identified in Section 2.1.3, is that all urban areas are placed together in one category, without consideration for the level of development or the density of population. In practice, patterns of demand and travel characteristics differ considerably between high density towers land use and low density suburban land use.

The disadvantage, however, in expanding the current high-level context classification by introducing categories such as those suggested in the NCHRP research report (see Table 3.6) is that it would introduce substantial and unnecessary complexity to the framework, making it unwieldy and less useful for users.

The issue of density only applies to urban areas. Density is not a criterion or a parameter for functional classification; all functional classes of urban roads can run through land uses with any level of development density. Parameters for functional classification, such as ROW width and junction spacing are not impacted by the level of density in a substantial manner. Rather, the main effects of the level of density are manifest in the planning of roads, for example spacing between more or less parallel roads of the same classification depends on the density of development. Further consideration of development density is provided in Section 4.3 where guidelines in the application of functional classification system to planning of future roads are set out.

4.1.4.1 Urban Roads

Urban roads are roads within the urban boundaries of cities, towns or villages. They are defined as the following:

- Roads which run through developed (built) land, or
- Roads running through areas planned to be developed in the near future, defined here as within the design life of the road.

4.1.4.2 Rural Roads

Rural roads are roads which lie outside the urban boundaries of cities or towns, instead, they run through areas of little or no development.

4.1.5 LAND USE

Land use frontage indicates which type of land uses are acceptable or not recommended to be directly adjacent to each functional class of road. The existing four land use categories (industrial, commercial, residential, and recreational) developed in the TMPQ 2008 and then subsequently adopted in the QHDM 2020 standards are considered to be sufficient and require no changes.

The main impact of land use frontage as a parameter is on the needs for parking, loading and access provision. Effects on connectivity requirements and provision for multimodal users are also prominent, especially on collectors and local roads.

In the case of defining an appropriate land use in the mixed land use context, consideration should be given to the impact of the prevailing mixed use development in terms of roadside activity (pedestrian, truck, or otherwise) and the requirement/desirability of providing parking/loading. Ultimately, the acceptable designation choice depends on these factors and care should be taken to identify them and identify any other relevant project/site specific conditions.

4.1.6 FUNCTIONAL CLASSIFICATION IN URBAN AREAS

Functional classification categories for urban roads are defined in this section. The definitions of most of these categories are retained as it is in the existing guidelines. However, as was identified in Section 2.1.3, some categories require clarification in their definition to provide consistency and eliminate some ambiguities.

4.1.6.1 Expressway

The exclusive function of expressways is mobility. They are intended to carry free flow traffic, at high speeds and for long distances. Trips entering and leaving an urban area are carried on expressways. Heavy trucks demand is served, to a great extent, by expressways and intercity bus routes can travel along them. To enable this high level of mobility, strict access controls are used and through movement along an expressway is always grade separated from cross street movements. In addition, spacing between junctions and spacing between access points must be sufficiently large.

4.1.6.2 Major Arterial

Major arterials serve the major centers of activity in urban areas and accommodate through traffic. The primary function of major arterials is mobility, access accommodation is minimal. Although they have high operating speeds, major arterials typically intersect at grade with cross streets, grade separated junction may be used in rare cases.

4.1.6.3 Minor Arterial

Minor arterials offer less mobility than major arterials and place more emphasis on land access. Intersections along minor arterials are always at grade. Minor arterial roads are also important for pedestrians and cyclists. Vehicle speeds and volumes are higher on these roads than on local and collector roads and, therefore, special facilities such as separate bike and pedestrian provisions should be provided to the extent possible to improve the environment for non-motorized road users.

4.1.6.4 Boulevard

Boulevards are used in areas with a high level of retail or recreational frontage, or developments with high levels of density (high rise buildings) where pedestrian activity may be reasonably high. They have wide sidewalks, frequent pedestrian crossings, and traffic calming measures to accommodate pedestrian activity. Traffic volumes along boulevards may be similar to those along arterials, but travel speeds will be slower.

4.1.6.5 Collector-Distributor

Collector-distributor roads are part of an urban expressway where access controls are used. They are designed to operate as highway facilities, with a primary function of providing mobility. On-street parking and direct access to adjacent land uses is prohibited. They are provided between adjacent intersections or interchanges to reduce the need for weaving traffic on the main through route.

4.1.6.6 Major Collector

Major collectors distribute trips from arterials into nearby land uses and collect traffic from local roads to feed it to arterials. Equal emphasis is placed on mobility and access functions.

4.1.6.7 Minor Collector

Minor collectors have slower travel speeds and less mobility than major collectors. Their primary function is to provide access, with mobility a secondary function.

4.1.6.8 Service Road

They provide direct access to adjacent land uses while also distributing traffic on to roads with higher functional classification. The primary function is access, and mobility function is minimal. They run parallel to collector-distributors or arterials. On-street parking on service roads is common, and traffic speeds are low on service roads. When they are running parallel to arterials, they are typically one-way and form part of the arterial facility whereas when they are running parallel to collector distributors, they are typically two lane undivided roads.

4.1.6.9 Local Road

The exclusive function of local roads is access and they should serve no mobility function for through traffic. They provide access to adjacent land uses and typically feed into and terminate at collectors. Through traffic is

actively discouraged from using local roads by traffic-calming measures. Local roads should not have long continuous runs connecting different neighborhoods.

4.1.7 FUNCTIONAL CLASSIFICATION IN RURAL AREAS

Rural roads are classified into four functional categories. The definitions of these categories below is mostly the same as the existing system.

4.1.7.1 Freeway

Rural freeways connect inter-urban centers on a national level. The only function of freeways is mobility and they serve no access function. They have very high speeds and exclusively use grade-separated interchanges along with access control. Similar to expressways, they serve the needs of the heavy trucks transporting freight between urban areas or shipping points.

4.1.7.2 Rural Arterial

Rural arterials connect major land uses within a smaller region serving a high mobility function in the rural context. They have medium to high traffic volumes.

4.1.7.3 Rural Collector

Rural collectors distribute traffic from arterials into local roads. Direct access from collectors to adjacent land uses is possible.

4.1.7.4 Rural Local Road

Local roads feed traffic from adjacent land uses and distribute it to collectors. For example, many local rural roads in Qatar lead to farms and accommodation for farm owners and workers.

4.2 KEY PARAMETERS AND CHARACTERISTICS

This section presents guidelines in the form of certain key design and planning parameters of each functional category. Additionally, network connectivity requirements, and guidelines for the provision for non-car modal users are detailed based on functional categories.

4.2.1 KEY PARAMETERS

The functional class of a road will have a fundamental influence on its design. This section provides some key parameters for each road class. The parameters guide the designers in the preliminary stages of the process and provide an understanding of the design requirements related to the functional class of the road.

Table 4.2 and Table 4.3 summarize key functions, characteristics, and design parameters of each road class for urban and rural roads respectively. A definition of each parameter and its application follows the two tables, these definitions are broadly similar to the existing standards.

It should be noted that the data in Table 4.2 and Table 4.3 should be viewed as guidance in the context of the design standards and requirements identified in the relevant codes and regulations. The tables highlight the need for different parameters in different locations to meet specific demands. The values provided are not absolute, they are for guidance only, and key parameters such as traffic flows, posted speed, cross section, appropriate intersection provision, and access control shall be in line with the relevant design requirements which guarantee safety.

Table 4.2 - Proposed Key Design Parameters of Urban Roads

Through Roadway	Land Use Frontage	Function	AADT Range[a]	Roadway Type	Mobility vs. Access	Intersections Type	Minimum Intersection Spacing[b] (m)	Posted Speed[c] (km/h)	ROW[d] (m)	Parking Provision	Min. LOS
Expressway	Not recommended in residential or recreational	Mainly free-flow traffic connecting major land uses across wide urban area. Medium to high traffic volumes.	50,000–10080,000	8- to 10- lane divided highway	Primary function is mobility. No access.	Grade-separated interchange	1,500	80/100	64–264	Prohibited	C
Major Arterial	Commercial Industrial preferred	Connect urban districts. Medium to high traffic volumes.	30,000–60,000	4- to 8-lane divided highway	Primary function is mobility. Limited access.	Signalized or priority right-in/right-out (exceptionally grade-separated interchange)	600[e]	50/80	64	Prohibited	C
Minor Arterial	Commercial Industrial preferred	Connect urban districts. Medium to low traffic volumes.	20,000-50,000	4- to 8-lane divided highway	Primary function is mobility. Access is secondary function.	Signalized or priority right in/right-out	150	50/80	40-64	Restricted	C
Boulevard	Retail or commercial or recreational	Special[f] arterial. Medium to high traffic volumes.	30,000–60,000	4- to 8-lane divided highway	Primary function is access. Mobility is secondary function.	Signalized, roundabout, or priority right-in/right-out, pedestrian crossings	300	50	64-80	Restricted	D
Collector Distributor	Not residential or recreational	Distribute traffic between expressway interchanges. Medium to low traffic.	5,000–10,000	One directional	Primary function is mobility. No access	Grade separated and priority right-in/right-out	NA	50/80	Not applicable[g]	Prohibited	D
Major Collector	Industrial	Collect traffic from service roads and local roads and distribute to arterials. Medium to low traffic volumes.	20,000–50,000	4- to 6-lane divided highway	Mobility and access given equal importance.	Signalized, roundabout, or priority	100	50	32–40	Some restrictions	D
	Commercial		20,000–50,000			Signalized, roundabout, priority, or pedestrian crossing	100	50		Restricted	D
	Residential		20,000–30,000				100	50		Restricted	D
	Recreational		10,000–20,000				50	50		Restricted	D

Table 4.2 - Proposed Key Design Parameters of Urban Roads

Through Roadway	Land Use Frontage	Function	AADT Range[a]	Roadway Type	Mobility vs. Access	Intersections Type	Minimum Intersection Spacing[b] (m)	Posted Speed[c] (km/h)	ROW[d] (m)	Parking Provision	Min. LOS
Minor Collector	Industrial	Collect traffic from service roads and local roads and distribute to arterials. Low traffic volumes.	5,000–20,000	4-lane divided highway or 2-lane undivided highway	Primary function is access. Mobility is Secondary function.	Signalized, roundabout, or priority	50	50	20–32	Some restrictions	D
	Commercial		5,000–20,000			Signalized, roundabout, priority, or pedestrian crossing	50	50		Restricted	D
	Residential		5,000–20,000				50	50		Restricted	D
	Recreational		5,000–10,000				50	50		Restricted	D
Service Road	Any	Provide access to adjacent land. Distribute traffic to collectors and boulevards.	<5,000	2-lane undivided highway or one lane one directional	Primary function is access. Mobility is secondary function.	Signalized, roundabout, or priority	50	50	Not applicable[g]	Permitted	D
Local Road	Industrial	Provide access to adjacent land.	<5,000	2-lane undivided highway	Primary function is access. Minor mobility function. Through traffic is discouraged with traffic-calming.	Signalized, roundabout, priority, or pedestrian crossing	As required	50	20-24	Permitted	D
	Commercial						As required	30/50[h]			D
	Residential						As required	30/50[h]			D
	Recreational				Minimal mobility and access functions.		As required	30/50[h]		Restricted	D

[a] Indicative values, neither minimums nor maximums.

[b] Taken from intersecting road centerlines.

[c] Expected posted speed values; other posted speeds may be appropriate and should be agreed upon with the Overseeing Organization before use.

[d] New roads minimum 20 meters.

[e] One access to development between intersecting roads permitted at mid-point.

[f] Adjacent to high-quality development where lower vehicle speeds and greater integration of non-motorized users is required or demanded.

[g] Collector-distributor and service roads are included within the right-of-way of other road types.

[h] An exception would be 30 km/h with traffic calming, signage and markings for example, in the vicinity of schools.

Table 4.3 - Proposed Key Design Parameters of Rural Roads

Through Roadway	Function	AADT Range	Roadway Type	Mobility vs. Access	Intersections Type	Minimum Intersection Spacing	Posted Speed	ROW (m)	Parking Provision	Minimum LOS
Rural Freeway	Connect regions and major cities on national and international scale. Free-flowing traffic. Capable of accommodating high traffic volumes.	> 8,000	6 or more lanes, divided highway	Maximum mobility. No access[a]	Grade-separated interchange	3000	100/120	64–264	Prohibited	B
Rural Arterial	Connect major land uses within a smaller region. Medium to high traffic volumes.	2,000–8,000	4-or 6-lane divided highway	Mobility is primary function. Limited access possible.	Grade-separated interchange, roundabout, or priority right-in/ right-out	1000	80/100	64	Prohibited	C
Rural Collector	Collect and distribute traffic to adjacent rural land uses. Medium traffic volumes.	1,000–2,000	4-lane divided highway	Equal mobility and access functions.	Roundabout, priority right in/right out, or pedestrian crossing	500	50/80	24–40	Permissible with conditions	D
Rural Local Road	Provide access to adjacent rural property and land.	< 1,000	2-lane undivided highway	Primary function is access. Mobility is secondary function.	Roundabout, priority, or pedestrian crossing	As required	50	20 or less	Permissible with conditions	D

[a] Conditional access to petrol stations and rest areas permitted.

4.2.1.1 Land Use Frontage

The land use frontage criteria indicate which types of land uses are acceptable or not recommended that are adjacent to each road classification. Other characteristics of the road are also on some occasions based on the land use context as well as the functional classification.

4.2.1.2 Function

A general description of the character of the function the road category is meant to perform within the network.

4.2.1.3 Traffic Volume

Refers to the annual average daily traffic (AADT) flow that each road is designed to accommodate by the design year. All roads shall consider traffic for a 20-year design period.

4.2.1.4 Roadway Type

The typical range for the number of lanes and divided/undivided status of the functional category.

4.2.1.5 Mobility versus Access

This designation refers to the extent of mobility or access that a road class provides. The two main functions of roads are defined as follows:

- Mobility: provision and priority for through traffic, which concerns traffic that has no direct business in or relationship with the land uses it is passing through.
- Access: enabling access to land uses adjacent to the roads, which concerns traffic with direct business in or having a direct relationship with the area it passes through.

These two purposes are inversely proportional and provision of one tends to inhibit the other. They need to be balanced when planning and designing new roads, and also when undertaking rehabilitation and improvements.

A road that places emphasis on mobility will have limited access. Thus, access from/to freeways, expressways, and arterials shall be controlled so as not to impede their primary purpose of serving through traffic. Conversely, the primary purpose of local streets is to provide access, and this limits their ability to offer mobility. Collectors offer an approximately balanced mobility and accessibility function.

4.2.1.6 Permitted Junction Types

This refers to the types of intersections that are permitted along each road class. The most appropriate type and layout will be dependent on the site and the nature of intersecting flows.

4.2.1.7 Intersection Spacing

Intersections enhance accessibility, but they also interrupt the flow of traffic. This criterion refers to the minimum distance that should

exist between intersections on each road class, measured between the respective intersecting centerlines.

4.2.1.8 Posted Speed

This is the posted speed limit for each category of road. While posted speeds may vary for vehicle types, the speeds identified in the tables relate to light vehicles and, therefore, the highest posted speed on that road classification. Depending on local conditions, the designer may propose a speed limit within the range that is lower than the preferred speed; for example, in areas of frontage or high pedestrian activity.

4.2.1.9 Right of Way (ROW) Width

This is the width in meters of the area of land in which the route is accommodated. It is based on typical design dimensions, conditions and terrain. Right-of-way for public roads is government owned. The ROW values stated in Table 4.2 and Table 4.3 include allowances for utility reserves. However, these values are not absolute and given for the guidance only.

4.2.1.10 Parking Provision

The extent to which parking and loading provision is permissible on each of the road classes is presented in this column. Three cases are considered:

- Prohibited: No parking or loading provision is allowed directly adjacent to the road. It is applicable to freeways, expressways, collector-distributors and major arterials.
- Restricted: Parking is restricted to areas where it is safe and practicable. Parking areas shall be clearly defined and strictly enforced.
- Permitted with Conditions: Parking is permitted alongside the road, although time-of-day or location-specific restrictions may be implemented to deal with potential operational objectives.

4.2.1.11 Minimum Level of Service (LOS) at the Design Year

This is the minimum LOS at which the road should operate. The LOS describes the travel experience in terms of operating speed, delays, the ability to safely overtake vehicles, traffic congestion, overall safety, and driver and passenger comfort.

4.2.2 NETWORK CONNECTIVITY REQUIREMENTS

The interconnection between roads as a matter of planning and design is related to the functional classification framework. It is desirable to maintain a smooth hierarchical stepping and transition between roads at intersections (including right-in/right-out intersection points). For example, a collector should not intersect with an Expressway, and a major arterial should not connect directly to a local road.

The interconnectivity for urban and rural roads is presented in Table 4.4 and Table 4.5 respectively. The matrices shown in these tables indicate allowable connections between roads of different functional classifications. Rows represent the main through route and columns represent the connecting route, given two intersecting roads, whichever is higher in the hierarchy is considered the through road.

In addition to the allowable connection requirements, planners should adhere to the following guidelines to ensure good network connectivity:

- Roads of higher functional hierarchy level terminating at roads of lower level should be avoided whenever possible, as shown in Figure 4.3 below.
- The continuity of functional classification should be preserved, sharp changes in functional classification along the same continuous corridor should be avoided.

Figure 4.3 - Example of Acceptable and Undesirable Connectivity Structure

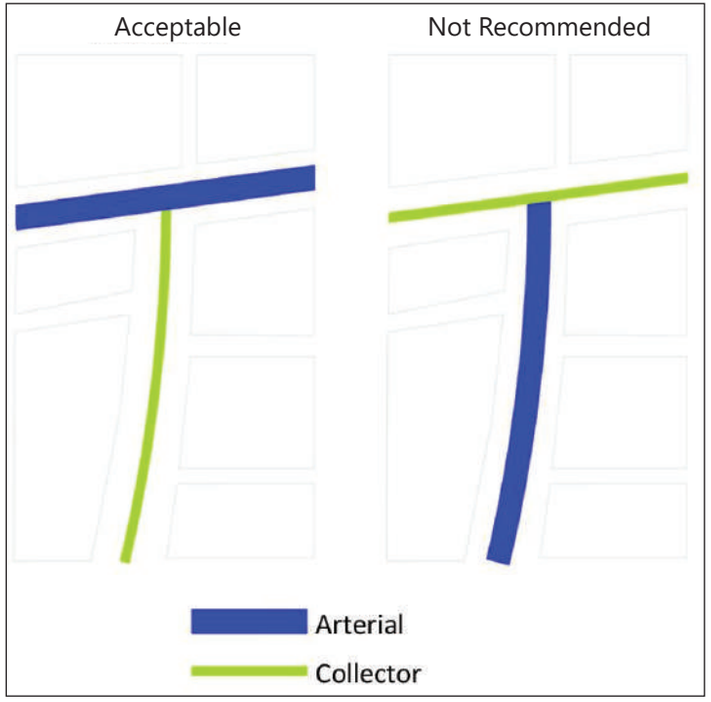


Table 4.4 - Proposed Permitted Network Connections of Urban Roads

Expressway		Connecting Route																	
		Major Arterial	Minor Arterial	Boulevard	Collector Distributor	Major Collector				Minor Collector				Service Road	Local Roads				
Through Route	Land Use Frontage	Not Residential or Recreational	Commercial/ Industrial Preferred	Commercial/ Industrial Preferred	Retail/ Commercial/ Recreational	Any	Industrial	Commercial	Recreational	Residential	Industrial	Commercial	Recreational	Residential	Any	Industrial	Commercial	Recreational	Residential
Expressway	Not Residential or Recreational	✓	✓	O	O	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Major Arterial	Commercial/ Industrial Preferred		✓	✓	✓	✓	✓	✓	✓	O	O	O	O	O	✓	X	X	X	X
Minor Arterial	Commercial/ Industrial Preferred			✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	O	O	O	O
Boulevard	Commercial/ Recreational				✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Collector Distributor	Any					O	O	O	O	O	O	O	O	O	✓	X	X	X	X
Major Collector	Industrial						✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Commercial							✓	✓	✓	O	✓	✓	✓	✓	X	✓	✓	✓
	Recreational								✓	✓	O	✓	✓	✓	✓	X	✓	✓	✓
	Residential									✓	O	✓	✓	✓	✓	X	✓	✓	✓
Minor Collector	Industrial										✓	✓	✓	O	✓	✓	✓	✓	✓
	Commercial											✓	✓	✓	✓	X	✓	✓	✓
	Recreational												✓	✓	✓	X	O	✓	✓
	Residential													✓	✓	X	O	O	✓
Service Road	Any														✓	O	O	O	O
Local Roads	Industrial															✓	✓	✓	✓
	Commercial																✓	✓	✓
	Recreational																	✓	✓
	Residential																		✓

Key: ✓ Recommended O Permitted, but not recommended X Strongly not recommended

Table 4.5 - Proposed Permitted Network Connections for Rural Roads

Through Route	Connecting Route			
	Rural Freeway	Rural Arterial	Rural Collector	Rural Local Road
Rural Freeway	✓	✓	X	X
Rural Arterial		✓	✓	O
Rural Collector			✓	✓
Rural Local Road				✓

Key: ✓ Recommended **O** Permitted, but not recommended
X Not recommended

Grade separated interchanges should be reserved for nearly exclusive use along expressways and rural freeways. They may be used on major and rural arterials in exceptional cases, using them along minor arterials is not recommended. The appropriate connections and movements to be provided by interchanges depending on the functional classification of intersecting roads are as follows:

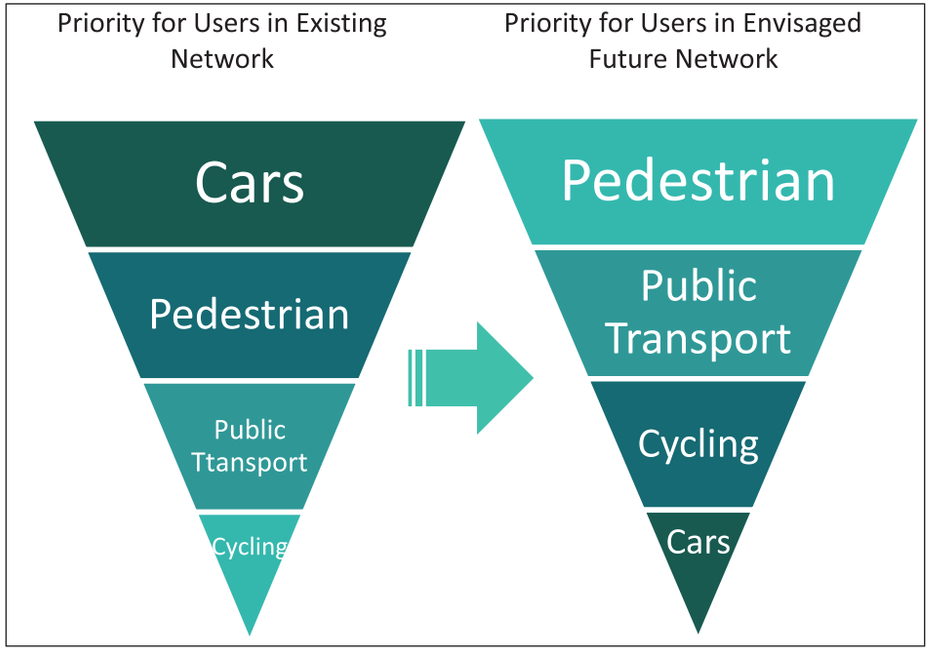
- **Urban Expressway to Urban Expressway Connection**: All movements, both through and turning between two expressways, should be free flowing and unstopped.
- **Rural Freeway to Rural Freeway Connection**: All through movements and all turning movements, should be free-flow movements.
- **Expressway to Urban Arterial Connection**: The through movement on the expressway should be uninterrupted. Both the through and turning movements on the arterial should be signalized.
- **Rural Freeway to Rural Arterial Connection**: The through movement on the freeway should be free uninterrupted flow, but the movement to the freeway and to the arterial can be through signalized intersections or roundabouts.

4.2.3 PROVISION FOR MULTIMODAL ROAD USERS

Transport planning and design requires a focus on all users of the road. The vision of the TMPQ, stemming from strategic national plans such as the QNDF and the Qatar Vision 2030, envisages a futures transport system less reliant on private cars. To enable this vision, planners and designers should give due considerations to the needs of all road users and give priority to non-car users. The extent of this priority depends mainly on the local context of the road and its functional classification. However, in the overall network, user priority is envisaged to be in the order shown in Figure 4.4 below. The guidelines presented in this section will aim to reflect these user priorities while simultaneously giving planners and designers enough flexibility to meet the needs of all users.

The detailed guidelines for the planning and design of integrated multi-modal transportation system are presented in "Road Planning Guide for Qatar". The Road Planning Guide address the travel needs of people and business in terms of non-motorized transportation, public transport, private vehicles and freight. It also seeks to manage the role of road corridors as important public spaces and the way in which they relate to their immediate context within towns, cities, or regional areas.

Figure 4.4 - Existing and Future User Priority



4.2.3.1 Pedestrians

Provision for pedestrians should be of top priority in all urban roads in Qatar. The existing pedestrian network in Doha and the regional cities suffers from interruptions and discontinuities. High posted speed limits of 80 km/h and above on urban major arterials in high density centers can deter pedestrian activity. High speed roads are sometimes combined with very narrow sidewalks in places with high pedestrian activities, strongly deterring pedestrian trips and possibly raising issues of safety. Enforcing requirements of provision for pedestrians is critical to achieving the stated goals of encouraging pedestrian trips.

Promoting increased pedestrian activity requires providing more crossing opportunities on major roads, especially in major high-density centers where pedestrian activity is likely to concentrate. This requires a consistent approach to planning, design, and approval of projects.

Providing more Traffic Calming Measures (TCMs) in lower mobility roads (minor collectors and local roads) is another method of promoting pedestrian trips. Speed humps are already in widespread use in minor collectors and local roads in Qatar, especially in pedestrian areas such as school zones. However, other TCMs should be considered for use, such as:

- Narrowing lanes: this has the advantage of freeing more space for the realm of pedestrians and cyclists, narrowing also the width of the road they have to cross. It should be considered without prejudicing the safety requirements of the road, based on applicable design standards.
- Chicanes are horizontal shifts in the roads, as shown in Figure 4.5, which force reduction in speed and more careful driving. More space becomes free to be used in the realm of pedestrians and cyclists, while designers can provide parking where required in conjunction with chicanes.

Figure 4.5 - Example of a Chicane as a Traffic Calming Measure in a Local Road

More consideration should be given to promoting pedestrian facilities along urban roads which have particularly high pedestrian demand. Wider sidewalks and supplementary facilities, such as shade, public art, seating, rest areas and drinking water facilities, are recommended, as are more crossing facilities. The pedestrian network can also be extended beyond the standard road network in such areas by providing pedestrian-only zones in public street areas.

Guidelines for allowable levels of provision for pedestrian sidewalks and pedestrian crossings on roads of different functional classifications are provided in Table 4.6 and Table 4.7 in the "Pedestrians" column. The guidance for sidewalks indicates whether they should be segregated from the travelled way, and the pedestrian crossing guidelines indicate the type of crossing which can be used on different categories of roads.

4.2.3.2 Cyclists

The cycling network in Qatar is very small and fragmented. Effort is needed to expand provision for cyclists and encourage bicycle trips. Current design standards separate bicycle facilities into:

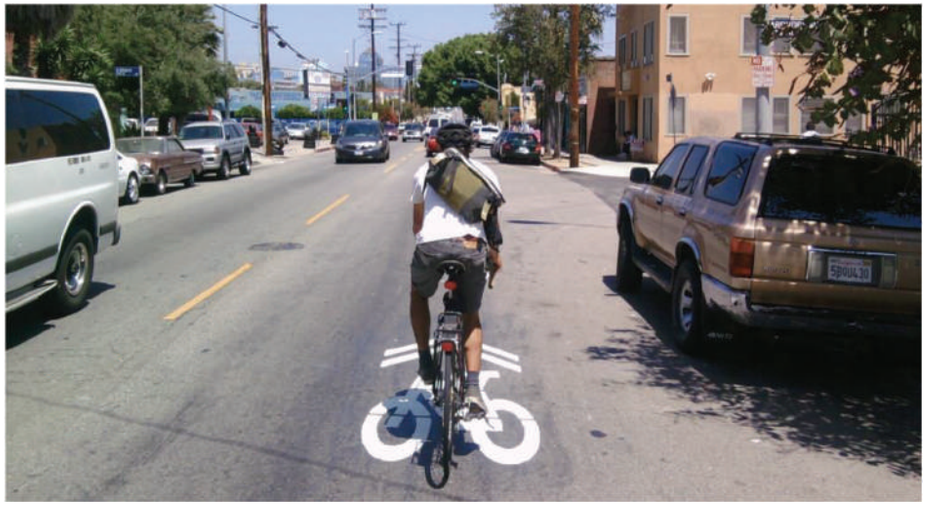
- On-Road Facilities: cyclists may use the same lane as cars, with either full integration or only partial integration with the road. Partial integration restricts bicycles to a widened curbside lane to be shared with cars, while full integration means the entire travelled way is shared.
- Off-Road Facilities: Full separation facilities where separated bike paths are provided with complete segregation from the traveled way.

On-road facilities with full integration can only be used on local and service roads, while partial integration facilities can be used only on local roads, service roads and minor collectors. Using on-road facilities on minor collectors should be studied carefully and avoided when traffic volumes are high, in that case using off-road facilities with full separation is recommended.

Cyclists are currently allowed to use local roads in Qatar as full integration facilities according to existing standards and regulations. However, more encouragement should be provided using signage and pavement marking (sharrows as shown in Figure 4.6) to let both cyclists and drivers know the full integration status of such roads, especially if high cyclist demand exists or is anticipated. This is, of course, reserved for use only on low speed local roads for reasons of safety, and it would provide the advantage of a

traffic calming effect on cars as well. Such full integration should also be considered on service roads.

Figure 4.6 - Shared Bicycle Lane Marking (Sharrows)



Off-road bicycles facilities can be provided along roads of all functional classifications except local roads:

- Bike Path: A separate path away from the roadway that is used exclusively by cyclists.
- Shared Path: A separate path away from the roadway is shared by cyclists and pedestrians.
- Segregated Path: A separate bike path is separated by a verge away from the roadway. Part of the path is used by cyclists, the rest by pedestrians. Segregation may be achieved by a white line or by a physical feature such as a verge, a fence, or a curbed level difference.

Cyclist provision guidelines are summarized in Table 4.6 and Table 4.7 for urban and rural roads, respectively.

4.2.3.3 Public Transport Facilities

Qatar either already operates or plans to construct the following public transport infrastructure to support its growing urban population and reduce heavy reliance on inefficient private cars:

- Public Bus Network
- Bus Rapid Transit (BRT)
- Tram
- Light Rail Transit (LRT)
- Metro
- Rail

Planners and designers must give full consideration to the existing and planned network of each of these modes and study the type and level of provision required on roads under consideration. Guidelines based on functional classification on the provision for public transport buses, BRT, LRT and tram are provided in Table 4.6 and Table 4.7 for urban and rural roads respectively. The "Road-Based Public Transport Services" column is for transit busses and similar modes, whereas "Light Rail-Based Public Transport" encapsulates LRT, BRT, tram, and any other services using rail or not sharing the travelled way with motor vehicles. services.

4.2.3.4 Heavy Trucks

All freight movement in the base year 2018 network is transported by heavy trucks, the percentage of trucks on Doha's urban streets is relatively high (over 25% in some roads outside industrial land uses) owing to the huge levels of construction and development throughout the country, these patterns are expected to change in future years. Heavy trucks are primarily served by roads with high levels on the hierarchy and restriction should be placed on heavy trucks making use of lower level roads. Planners should study the level and pattern of demand for heavy trucks to ensure the provision of expressways and freeways within the network is sufficient to meet the demand without disruptions. Separate truck lanes can be provided only in expressway or freeways, in cases of very high levels of demand. Guidelines for restrictions and prohibition of heavy trucks based on functional classification and land use context are provided in Table 4.6 and Table 4.7.

4.2.3.5 Summary

Table 4.6 and Table 4.7 summarize the proposed provision for multimodal transport in urban and rural areas.

Table 4.6 - Proposed Provision for Multimodal Transport in Urban Areas

Through Route	Land Use Frontage	Pedestrians		Cyclists (bike lane and path)	Road-Based Public Transport Services	Light Rail-Based Public Transport	Heavy Trucks
		Sidewalks	Crossings				
Expressway	Not residential or recreational	Segregated sidewalks	Grade separated crossings	Segregated bike paths	Express services only	Light rail (segregated from road)	No restrictions
Major Arterial	Commercial or Industrial preferred	Segregated sidewalks	Grade separated crossings or one at-grade crossing between junctions	Segregated bike paths	Local services (with priority lane where required)	Light rail (segregated from road)	Some restrictions
Minor Arterial	Commercial or industrial preferred	Segregated sidewalks	At-grade or grade-separated crossings	Segregated bike paths	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Restricted
Boulevard	Retail, commercial or recreational	Sidewalks on both sides of road and sitting areas	At-grade crossings	Segregated bike paths	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Restricted
Collector Distributor	Not residential or recreational	Segregated sidewalks	Grade separated crossings	Segregated bike paths	Local services (with priority lane where required)	None	Some restrictions
Major Collector	Industrial	Sidewalks on both sides of road	At-grade crossings	Segregated bike paths	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	No restrictions
	Commercial	Sidewalks on both sides of road	At-grade crossings	Segregated bike paths	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Some restrictions
	Residential	Sidewalks on both sides of road	At-grade crossings	Segregated bike paths	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Local access only
	Recreational	Sidewalks on both sides (segregated from road)	At-grade crossings	Segregated bike paths	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Prohibited

Table 4.6 - Proposed Provision for Multimodal Transport in Urban Areas

Through Route	Land Use Frontage	Pedestrians		Cyclists (bike lane and path)	Road-Based Public Transport Services	Light Rail-Based Public Transport	Heavy Trucks
		Sidewalks	Crossings				
Minor Collector	Industrial	Sidewalks on both sides of road	At-grade crossings	Segregated bike paths	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Some restrictions
	Commercial	Sidewalks on both sides of road	At-grade crossings	Partial integration within roadway	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Local access only
	Residential	Sidewalks on both sides of road	At-grade crossings	Partial integration within roadway	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Local access only
	Recreational	Sidewalks on both sides (segregated from road)	At-grade crossings	Partial integration within roadway (separate bike path or shared road use)	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Prohibited
Service Road	Any	Segregated sidewalks	At-grade crossings	Segregated bike paths	Local services	None	Local access only
Local Road	Industrial	Sidewalks on both sides of road	At-grade crossings	Cyclists may use roadway (Full integration)	Local services	Not recommended	Some restrictions
	Commercial		At-grade crossings				Local access only
	Residential		At-grade crossings				Local access only
	Recreational		At-grade crossings				Prohibited

Table 4.7 - Proposed Provision of Multimodal Transport in Rural Areas

Through Route	Land Use Frontage	Pedestrians		Cyclists (bike lane and path)	Road-Based Public Transport Services	Light Rail-Based Public Transport	Heavy Trucks
		Sidewalks	Crossings				
Rural Freeway	-	Segregated sidewalks where required	Grade separated crossing where required	Segregated bike paths	Express services only	Light rail (segregated from road)	No restrictions
Rural Arterial	-	Segregated sidewalks where required	Grade separated crossing where required	Segregated bike paths	Local services (with priority lane where required)	Light rail (shared with priority lane where required)	Some restrictions
Rural Collector	-	Sidewalks where required	At-grade crossing where required	Segregated bike paths	Local services (with priority lane where required)	Not recommended	Local access only
Local Road	-	Sidewalks where required	At-grade crossing where required	Cyclists may use roadway	Generally, not provided	Not recommended	Access only

4.3 PROPOSED FUNCTIONAL CLASSIFICATION OF FUTURE ROAD NETWORK

The proposed road functional classification for the future road network in the updated TMPQ is presented in Figure 4.7 and

Figure 4.8 for Greater Doha and whole Qatar respectively. The roads are classified based on the Functional Classification System described in Section 4.1 and 4.2 and as per planning principles developed in the Road Planning Guide for Qatar. The road hierarchy is established for existing roads and planned future schemes in TMPQ (38 highway schemes). The road hierarchy maps do not include classification of roads within the Ashghal Local Roads and Drainage Program which shall be updated according to its transportation studies.

The network was created based on the output of the Qatar Strategic Transport Model (QSTM2) for the ultimate Horizon Year 2050 of the updated TMPQ. Functional classification was applied by analyzing the specific characteristics of each road in the model and comparing them with the proposed FCS. The model outputs used in this exercise are:

- Daily traffic volumes on links;
- Posted traffic speeds on links;
- Number of lanes;
- Permitted transport modes.

In addition, all the available information was also reviewed and used while establishing the road classification, such as, land use frontage, function of the road, intersection types and spacing, ROW, parking provision etc. Other existing and future roads not included in TMPQ schemes shall be studied and classified using the principles and criteria explained in sections 2.2.2 and 4.2

The GIS database containing the proposed road classification shown in Figure 4.7 and Figure 4.8 is attached to this report.

It should be noted that updates to the classification of existing roads within Capital City, District Centers and Town Centers must be carried out by conducting a contextual study that follows the criteria in this report in conjunction with the principles provided in the Guide for Planning Roads (2020).

Figure 4.7 - Proposed Functional Classification of the Future Road Network (HY 2050) - Qatar

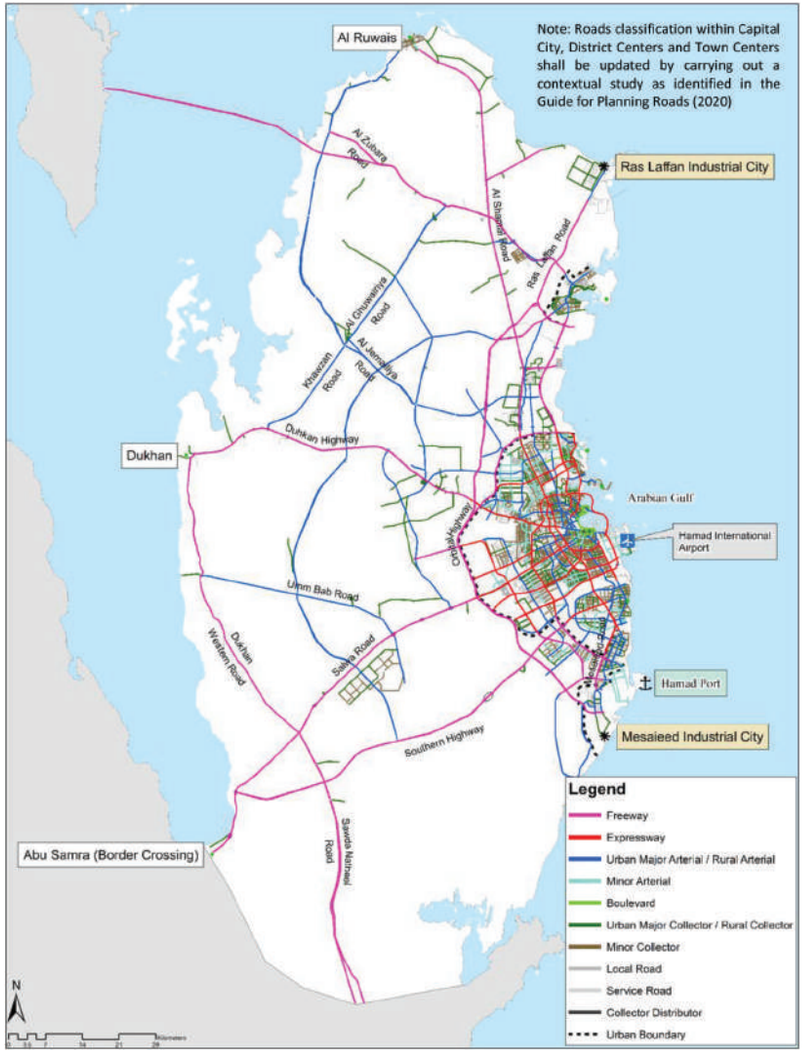
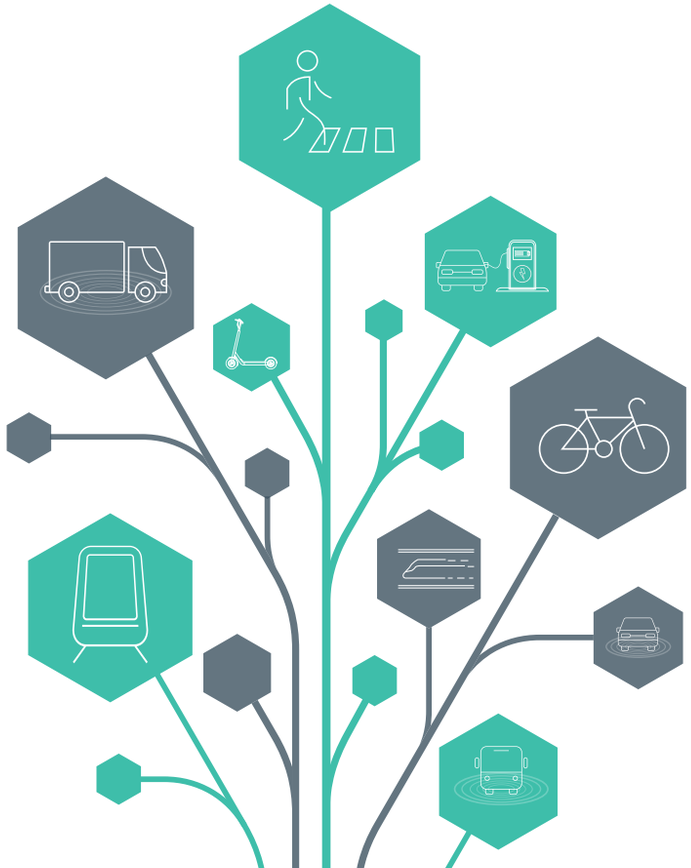


Figure 4.8 - Proposed Functional Classification of the Future Road Network (HY 2050) - Greater Doha

SECTION 4



2050

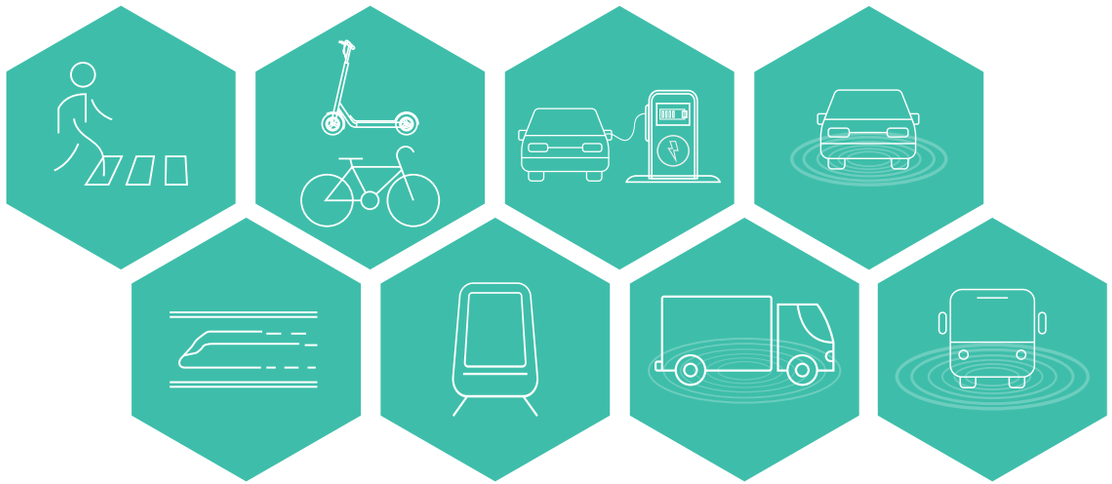
نقـل متكامـل ومسـتدام للجميـع

INTEGRATED & SUSTAINABLE TRANSPORT FOR ALL

2050

SECTION - 05

APPLICATION OF THE FUNCTIONAL CLASSIFICATION SYSTEM



5 APPLICATION OF THE FUNCTIONAL CLASSIFICATION SYSTEM

This section offers guidelines for applying the system of functional classification during roadway planning in Qatar.

5.1 PROCESS FOR DETERMINING CLASSIFICATION

The procedure for determining the functional class of a road or network of roads is set out in this section, based on the framework established in Section 4. Assigning functional classification to roads is required either during the planning process when new roads are developed, or in order to change the classification of existing roads. While the classification of existing roads will change over time, this happens far less frequently compared to the development of new roads. Reasons for updating the functional classification of existing roads include:

- Changes to the road, such as the expansion of the number of lanes, or addition of new facilities to the right of way;
- The expansion of the urban boundary due to new development of land, making exiting rural roads part of the urban network;
- Changes in the land use frontage of the road.

Whether updating the classification of existing roads or assigning classification to planned new roads, the procedure is similar. The roads should be classified in hierarchical order by starting from higher mobility roads (freeways and expressways) and moving down to local roads. The following should be followed when determining the functional classification of roads.

5.1.1 STEP 1: DEFINE THE LOCAL CONTEXT

Understanding the local context of the road is the first critical step in arriving at the functional classification. This means both clearly defining the formal functional classification context (as established in Section 4.1.4) and understanding the local conditions surrounding the road, and its place in the network. This is required to define the function served by the road in the wider network.

In defining the local context, the first task is to define the formal context of the road based on Section 4.1.4. This means determining whether the road is urban or rural, and if urban, determining the land use sub-context based on the frontage on both sides of the road. The Guide for Planning Roads (2020) provides further subclassification within urban area context i.e. Capital City, District Centers and Town Centers.

The next task is to form an understanding of the place of the road within the wider network:

- Identify the main traffic generators and sources of demand for the road. Traffic generators include population centers, recreational areas, schools, malls, shipping points, hospitals, industrial and commercial centers, sports stadia, etc.
- Define the volume of traffic and its composition, i.e. the percentage of trucks and public transport buses.

- Define the needs of multimodal users by looking at the land use frontage. Identify potential sources of pedestrian and cyclist demand for the road. Look at the need for taxi and transit bus drop off locations, the need for LRT and any other modal users.
- Consider the needs of the immediate vicinity of the road and the impact of the road functional operation on the local neighborhood.

Basically, a comprehensive analysis of the local context and demand needs to be performed, taking into account the land use profile and the local community, especially active roadside frontage.

5.1.2 STEP 2: DEFINE THE FUNCTION

The second step is to define the function of the road in terms of mobility and access, that is, to place the road on the mobility/access spectrum in Figure 2.3, and therefore selecting one functional classification. This choice is to be informed by the local context identified in the previous step.

General considerations when selecting different functional classes are set out below.

5.1.2.1 Expressways and Freeways

The mobility only function of freeways and expressways makes it a simple matter to classify them. These higher classes of roads provide a good starting point for understanding the hierarchical layout of the whole network. Rules of thumb for the classification include:

- Complete access control on the facility including the use of collector-distributer roads and ramps;
- Exclusive use of grade-separated interchanges in all junctions, if at-grade intersections are used for through moving traffic, the facility is not an expressway or a freeway;
- Posted speed of 120 km/h is used almost exclusively on freeways.

5.1.2.2 Arterials

Arterials serve a very wide range of functions on the mobility/access spectrum. They form the main skeleton of the network. Considerations for the designation of arterial include:

- The continuity of expressways and freeways should be preserved as much as possible, so they should extend to become arterials if they are to be reduced in the hierarchy;
- Arterials should not penetrate neighborhoods, they should run between them instead, acting as dividing lines or buffers for them.
- Arterials carry high volumes for long distances of continuous through movement. Their function in urban areas is connecting entire districts, urban blocks, or main traffic generators. It should be noted that in some contexts with very high density (urban core areas), roads which carry high volumes may instead perform the function of collectors.
- All arterials are divided roadways with at least 4 lanes (2 lanes in each direction).
- The network of minor arterials roads will often connect with all other types of roads.

- In urban areas, major arterials differ from minor arterials in that they typically serve:
  - Major activity centers such as CBDs
  - Important air, rail, bus and truck terminals or stations
  - Big malls or shopping centers
  - Large schools, colleges or university campuses
  - Major commercial or industrial centers
  - Large parks and recreational areas
- Major arterials provide mainly mobility (with negligible access function), while minor arterials provide more access (although access is still a secondary function).
- Spacing between major arterials should be larger than spacing between minor arterials, this is a general rule and may not apply in some cases based on the details of the development plan.
- Minor arterials should provide service to all traffic generators not served by major arterials within the network.
- Local context is important when differentiating between major and minor arterials based on traffic volume. In urban core areas, a minor arterial may carry greater volumes than a major arterial in a sparsely populated suburban area.

5.1.2.3 Collectors

Collectors have a more prominent access function, compared to arterials, and provide direct entry/egress to roadside developments. However, the main function of collectors is to act as a funnel for traffic between local roads or land uses and arterial or collector-distributes. After eliminating the possibility of an arterial designation, a road is likely to be classed as a collector, the following considerations apply for the collector designation:

- Roads which connect major traffic generators but have been deemed not to be appropriately classified as arterials, are likely to be best classed as major collectors;
- Inside residential neighborhoods, clustered local roads that are not served by arterials or major collectors should have minor collectors to serve them;
- Rural collectors distribute traffic from rural destinations and local roads to rural arterials and freeways.

5.1.2.4 General Considerations

During the process of functional classification, the following are some general considerations which apply to all classifications and should be taken into account:

- In keeping with the network connectivity guidelines, roads which connect to interchanges are likely intersecting with expressways or freeways. These intersection roads at interchanges are either expressways, freeways or arterials. In rare cases, they may be major collectors;
- Assigning the same classification to parallel subsequent roads should be avoided whenever possible, local roads are an exception;
- Generally, the spacing between parallel roads which have the same functional classification depends on the density of the local land use. The higher the development density, the lesser the spacing;

- The continuity of the network should always be preserved by ensuring that wherever a road functional class changes it is continued with the functional class one level higher or lower in the road hierarchy.

5.1.3 STEP 3: REVIEW SELECTED CLASSIFICATION CATEGORY

After a functional classification has been assigned based on the primary function of mobility/access, the final step is to review the characteristics of the selected classification. The aim is to check the consistency of the chosen functional classification with the relevant key parameters laid out in the functional classification framework (Section 4.2).

5.2 GOOD PRACTICES

This section discusses a set of good practices for the adoption of professionals and agencies responsible for transport planning, design or maintenance of the functional classification database network in Qatar. The aim of these practices is to ensure the functional classification database is as accurate as possible.

5.2.1 MAINTENANCE OF FUNCTIONAL CLASSIFICATION DATABASE

On-going maintenance of a database of functional classification of the Qatar road network based on the applicable standards is critical for the effective planning and design established from those same standards. A continuous update of the database is needed as land development status and land use change and as the road network changes. In Qatar, relevant agencies should consider performing an update of the entire database every five years to coincide with the census and the update to the population and land use profile it entails.

As transportation planners work on roadwork projects and upgrades, issues related to functional classification changes should be kept in consideration. These minor updates make the task of periodic update every five years simpler and cheaper. The following are some useful questions that should be asked:

- Are any new significant roadways being constructed which would impact the functional performance of the network and merit consideration of functional classification changes?
- Are any new significant developments being constructed which are considered big traffic generators and which would alter the patterns of traffic demand?
- Has there been any significant growth in population and/or economic activity of an area where it would cause some roads to serve more access or mobility needs than previously?
- Has any specific road experienced significant growth in traffic volume?

If any of these questions was answered in the affirmative, serious consideration to reviewing the functional classification of the local network is warranted and recommended. The procedure suggested in Section 5.1 should be incorporated with standard formal processes currently followed by the relevant authorities. The integrated procedure should incorporate standard forms declaring the following information:

- The location of the road, clearly marking the start and end points and the total length;
- Description of the roadway segments;
- Existing and proposed functional classification;
- Background and reason for raising the change request;
- Detailed reasons for changing the classification;
- Impact of the change in classification;
- Documentation of consultation with stakeholders and the local community.

The process of designating functional classification requires good judgment and experience. It should be as systematic, logical and reproducible as possible. Clear and full documentation of the process should be performed every time it is applied. This enables later review and identification of issues and errors making the process more effective.

5.3 CONSIDERATIONS FOR FUTURE TRANSPORTATION SYSTEM

The future transport system in Qatar has been envisaged by many national strategic plans including the Qatar National Vison 2030, the Qatar National Development Framework and the Qatar National Development Strategy. The vision of the updated TMPQ is directly inspired, in part, by the same transport system. The main features of this system include:

- De-emphasizing private cars as a mode of travel and changing the culture to become more favorable of public transport. This is achieved through policies and strategies as well as mega projects such as the metro.
- Encouraging pedestrians and cyclists to roam safely the streets of Qatar, particularly in urban areas and for short trips. The aim of this is to promote the healthier lifestyle of exercise as opposed to driving everywhere.
- Emphasizing the public realm and amenities within it during planning and design of urban roadways.

This system of transport will result in great benefits to the state of Qatar including the improvement in public health resulting from a more active transport style and the reduction in emissions of carbon dioxide and nitrogen oxide in the atmosphere. In addition, savings due to the more efficient transport system resulting from widespread adoption of public transport are an economic boon to the country.

The framework of functional hierarchy is designed to accommodate the future system of transport. The flexibility of the boulevard class of road in the urban system was developed with this aim in mind. Boulevards are roads designed for the benefit of pedestrians. The wide range of functions on the mobility/access spectrum served by the boulevard gives planners the freedom to give more priority to pedestrian users in a wide range of roads.

Source: MME

Source: MME

It is also conceivable that new modes and forms of transport would become widely used in the longer-term future. The following is a summary of the most prominent emerging trends:

- Electric Cars: Each of the giant global car makers is making its own version of an electric car. In addition, big electric only car makers are expanding into the scene; Tesla is the biggest example. The main driving force behind this trend is the environmental push to keep the planet from warming 2 °C above preindustrial levels as per the Paris Climate Accord (which was signed by most countries including Qatar). Both China and the EU (two huge markets which shape the decisions of car manufacturers) have set target years after which the sale of a purely hydrocarbon burning vehicle is not allowed. Electric cars are expected to become globally ubiquitous somewhere within 2030 to 2050. Infrastructure associated with electric cars is also advancing. Beside regular charging station, advances in the technology of batteries are in progress. Additionally, new battery charging technologies are in development, such as inductive charging which is wireless;
- Self-Driving Cars: Driverless cars are fast becoming a reality in some places in the world due to the tremendous recent advances in Artificial Intelligence (AI). This technology relies on training algorithms using huge sets of data so that they learn to do human level tasks, such as driving a car. AI driven car technology is already being used on an experimental basis in many cities around the world, and the rate of advancement in the field is accelerating. Self-driven cars are 100 times safer than human driven cars according to The Economist and they are getting better. The technology will advance greatly as more and more data is available for training AI algorithms, and as advances in technology of sensors

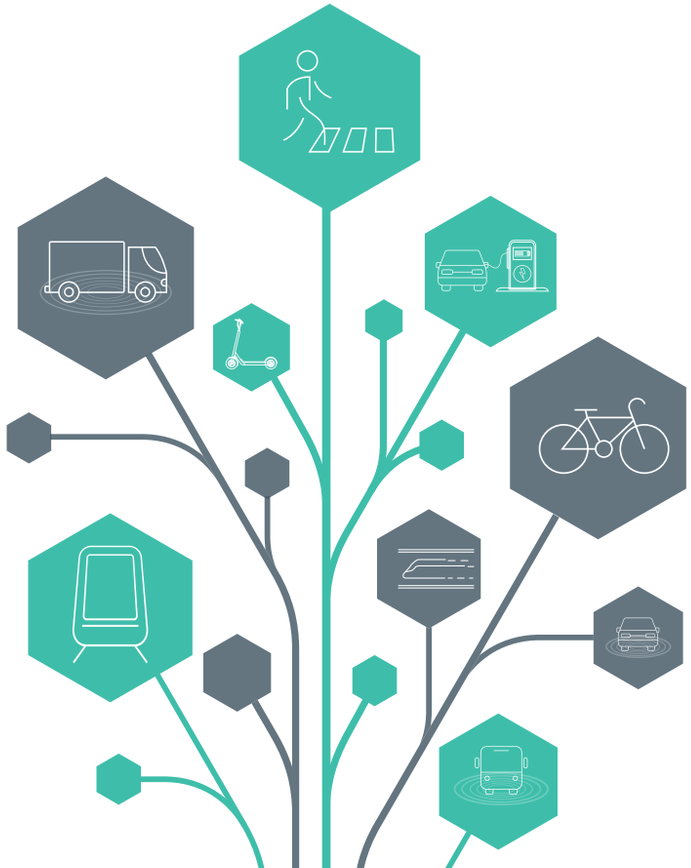
continue. Proponents of this trend say that at some point it will be irresponsible to allow humans to drive since that would raise the probability of fatal crashes by hundreds or thousands of times.

- Mobility as a Service (MaaS): Putting the previous trends together, Transport may become transformed to a service provided on demand by ride hailing. The main providers of this service are:
  - Uber: The inventor of ride sharing that started a big change in the taxi industry by matching between drivers and riders online using GPS and clever AI algorithms that handle pricing and nudge drivers to locations where demand is predicted to concentrate. Uber doesn't publish all relevant country specific data, but it is thought to have a strong presence in Qatar's ride hailing market. Uber is investing heavily in self-driving cars, indicating that they believe MaaS is likely to be enabled through self-driven cars;
  - Kareem: One local rival to Uber in Qatar (and 14 countries in the Middle East and south Asia). Based in the Dubai, the company started operations in 2012 as a service for corporate car bookings and evolved to become a transportation network company with car hire for everyday use;
  - Karwa: The Qatar taxi company Mowasalat has released its own app for booking rides in 2016.
- MaaS is a form of public transport, if it becomes widely available, widespread car ownership would become rare to nonexistent. In that scenario, private transport is transformed to an on-demand service provided by ride hailing, using human or AI-driven cars. The logic behind this prediction is that the cost of car ownership (it sits idle taking valuable space for 90% of its lifetime and depreciates in value by the month) would exceed the cost of MaaS for the same benefits (on-demand transport). Big car manufacturers are investing in self-driving cars technology and MaaS.
- Personal Mobility Devices (PMDs): are compact electric or small internal combustion engine powered vehicles for use by one person. They normally do not travel faster than 25 km per hour. Many of these devises have existed in the past, but many others are newly emerging in popularity due to advances in battery and electric motor technology and the inventive use of some old technologies allowing for self-balancing. Regulators in cities are grappling with the consequences of these vehicles. This mode of transport, for the time being, is largely restricted to recreational use, relatively short commutes or as a disability aid. Examples include:
  - Motorized Standing Scooters: Are electric two wheeled scooters with a thin long deck for the user to stand on. Other big electric standing Scooters have a wider deck with two or three wheels. "Segways" fall into this category;
  - Seated Motorized Scooters: Are three or four wheeled PMDs for a seated driver. They range from off-road quad runners to elderly and disabled aid devices;
  - Self-Balancing Scooter: Usually called "hoverboards", these are a newer type of PMDs that use one wheel or two wheels on one axle and the power of the motor along with gyroscope devices to maintain balance.

The system of functional hierarchy aims to aid future planners and designers in accommodating these trends. Electric cars and self-driving cars are likely to be designed to function within the existing infrastructure built for regular cars, therefore, they are easily accommodated within the existing system.

Mobility as a service and the end of widespread car ownership would have a sizable impact if it were to become reality. The need for parking provision could be drastically reduced or become non-existent, meanwhile, most roads, especially in urban areas, would be required to provide drop-off and pickup points, instead of parking. In practice, car ownership is unlikely to be eliminated entirely in Qatar. While mobility as a service may become very widespread, some people are likely to still prefer car ownership despite potentially having to bear more cost. The sizable shift to MaaS will nonetheless have a significant impact on the transport system. This shift is in-line with the overarching goal of encouraging public transport (MaaS can be considered as a form of public transport). It would require planners and designers to give more consideration to the changing requirements on urban roads.

As for PMDs, they can be considered functionally close to bicycles, currently in use. Depending on the exact device, they may require more space than today's bicycles, but for the most part they can be accommodated within the bicycle network.



2050

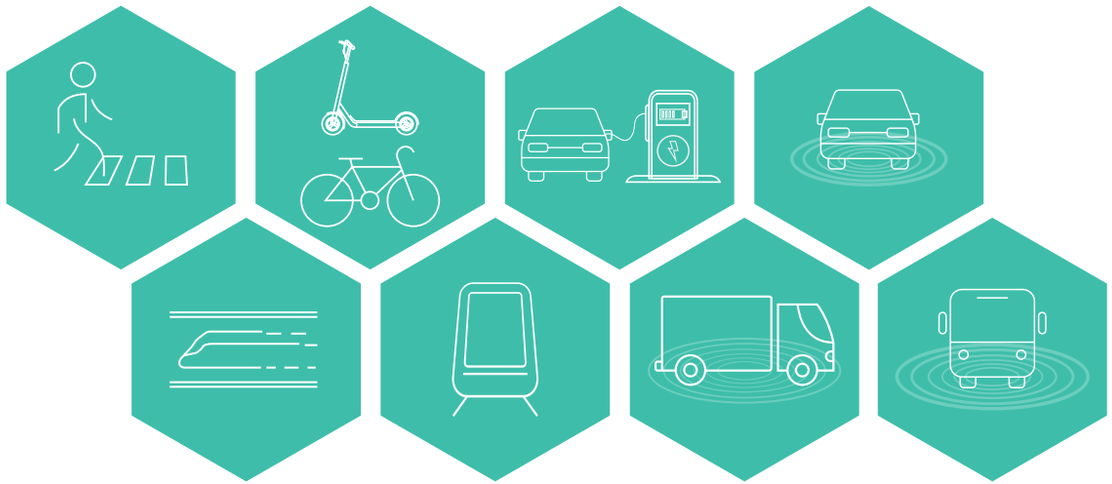
نقـل متكامـل ومسـتدام للجميـع

INTEGRATED & SUSTAINABLE TRANSPORT FOR ALL

2050

APPENDIX 1

GIS DATABASE FOR ROAD HIERARCHY (EXISTING AND FUTURE ROAD NETWORK) - SOFT COPY



وزارة المواصلات
MINISTRY OF TRANSPORT

ص.ب. 24455 P.O.
الدوحة, قطر Doha, Qatar
ت 1111 4045 974+ T
motc.gov.qa

نقل متكامل ومستدام للجميع
INTEGRATED & SUSTAINABLE TRANSPORT FOR ALL