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Master Plans of Urban Centres of Khyber Pakhtunkhwa

Master Plan of Charsadda City 2042

Task C – Master Plan & Scenario Maps

Urban Policy & Planning Unit
Planning & Development Dept.
Government of Khyber Pakhtunkhwa

PEPAC Pvt. Ltd & Associates

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Protect Detail: CHARSADDA CITY MASTER PLAN 2042

Client: Urban Policy & Planning Unit (UPPU)
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Executive Summary

Khyber Pakhtunkhwa (KP) is the third most populous province in Pakistan, with a population of 30.5 million residents, despite having the smallest land area (74,521 km^2). The population has grown at a rate of 2.89%, which is higher than the national average of 2.40%, from 17.7 million in 1998 to 30.5 million in 2017. Several factors, including a young population and a relatively high birth rate, have contributed to the natural increase in population over time. To cope with the population growth and rapid urbanisation[1] of KP cities, the Urban Policy & Planning Unit of the Planning and Development Department, Government of KP, has commissioned the preparation of Master Plans for the development and planning of twenty urban centres in the Khyber Pakhtunkhwa province, including Charsadda, i.e., Charsadda City Master Plan 2042. The consulting firm PEPAC Pvt Ltd & Associates have been assigned as consultants for the project and have proposed development solutions for Charsadda considering the area's spatial, economic, and existing resources.

Geographically, Charsadda is situated at the west of Khyber Pakhtunkhwa between the 71° 53' to 71° 28' East longitudes and 34° 03' to 34° 38' North latitudes. The district is bounded in the North by District Malakand, in the East by District Mardan, in the South by District Charsadda and Peshawar and in the West by District Mohmand. The city is located at an elevation of 276 meters. The population of the city was 87,218 in 1998 which has grown with the average growth rate of 1.44% over the nineteen years.

The boundary adopted for the purpose of developing the master plan is greater than the existing city boundary and comprises of eleven neighborhood councils and ten Village Councils (VCs) making the total area to be 44.74 km^2. The neighbourhood councils form the existing urban boundary of the city while the village councils construct the proposed boundary of the city, with the anticipation that these will be converted into neighbourhood councils in the future, constituting the city boundary in 2042. The vacant area available within the neighbourhood councils is to be used for infill development, and the village councils, excluding the built-up within, have been taken as "proposed areas" for future development and expansion of the existing city.

Since the boundary is greater than the existing urban area, the population of the study area is also greater than the existing urban area. In 2017, the population of study area i.e., neighborhood councils and village councils. was 209,745, in which 114,565 lived in neighbourhood councils (urban area) and 95,180 lived in village councils (proposed development area), respectively[2]. This population has been projected using three methods of

[1] Definition of Urbanisation: The term "Urbanisation" describes the process through which a society takes on a more urban character. Typically, this process entails the growth and extension of cities, towns, and other urban regions, as well as a corresponding rise in the percentage of a population that resides in these areas. This can involve individuals moving from rural to urban regions, urban areas expanding due to natural population increase, building additional infrastructure and housing, and expanding economic activities including industry, commerce, and services.

[2] Data provided by the concerned local government.

population projections, namely Geometric Growth, Exponential Growth, and Declining Growth method. The projected population for the year 2022 is 240,777 while for 2042 it is estimated to be 378,326 with an average growth rate of 2.33%.

The Charsadda Master Planning/Scenario Development Report is the fourth deliverable of the project which has been prepared after submission of Inception Report (first deliverable), Vision Development & Community Consultation Report (second deliverable), and Background Studies Report (third deliverable). This report outlines development proposals for Charsadda city by considering the area's spatial, economic, and existing resources and upon the agreed vision *"A Vibrant Agro-Based, Industrial, Educational and Pollution Free City"* and utilizing advanced technology. Furthermore, this deliverable is divided into three volumes i.e., Volume I Proposed Master Plan report, Volume II Proposed Scenario Maps and Volume III Annexures.

The master plan for Charsadda aims to complement the existing District Land Use Plan of Charsadda by encouraging similar development patterns, the direction of growth, compact development. This approach aims to increase city density and reduce urban sprawl while protecting the existing prime agricultural land. These proposals align with the Sustainable Development Goal 11 (Sustainable Cities and Communities) objectives and ensure that every citizen has access to public and commercial facilities. The report outlines proposals for different sectors to achieve the stated objectives and their summary is given below:

Residential & Housing

With respect to the residential facilities in the city, the current situation depicts that most of the residential facilities in the city are in form of horizontal development covering an area of almost 2477.25 acres. The proposed residential plan for Charsadda city comprises a residential area covering over 1610.47 acres having 645.03 acres within the neighbourhood councils in the form of vacant and agriculture and the remaining has been proposed as a separate residential zone in the south-western direction. The area selection was based on the, land suitability, proximity to other uses, presence of prime agriculture land, existing approved housing societies, and availability of barren land. The consultant has proposed three housing scenarios, of which ***Scenario 1*** *is based on horizontal housing development covering infill land and suitable agricultural land within village councils,* ***Scenario 2*** *exploring vertical development pattern upon vacant and agricultural land available land within VC's and* ***Scenario 3*** *giving a combination of horizontal and vertical development in equally divided ratios.* But after careful consideration, the scenario 3 has been recommended as the best scenario for Charsadda providing a balance between vertical and horizontal development which will last many benefits, including efficient land use, reduced traffic congestion, improved access to amenities, and preservation of natural resources. By promoting a mix of high-rise and low-rise development, the city can create a more liveable, sustainable, and resilient community.

While there is no perfect example of a city that has achieved a 80/20 balance between vertical and horizontal development, Winnipeg, Canada is a very good examples of this balance. The proposal has been recommended by being mindful of the fact that it is not possible to exactly achieve a 80/20 balance, however, this is for the future and after amalgamation with existing built-up, the development under this scenario will ignite a trend of vertical development in the city which is anticipated to have a snowball effect and lead to compact, sustainable, green and more liveable Charsadda.

The primary objective of introducing vertical development is to increase the standard of living for most of the population and to curb the horizontal spread of cities. Vertical development has the potential to provide positive environmental benefits and elevate the standard of living for the country's population. It can also become an effective solution to decreasing informal settlements.

Commercial

Commercial areas in a city are developed to support business activities. In Charsadda city, currently there is 321 acres area dedicated for commercial land use divided in retail, wholesale and others categories. The proposed commercial plan for Charsadda city has been provided according to the land suitability analysis performed and along with the primary, secondary and tertiary roads. For this purpose, 657.22 acres area has been proposed for the development of commercial areas. However, it is important to note that the creation of these commercial hubs can have several benefits for the city. First, these hubs can provide employment opportunities for local residents, stimulating economic growth and development in the area. Additionally, they can attract investment and promote trade, helping to create a vibrant and dynamic business environment.

Moreover, these commercial hubs can also serve as important centers for social and cultural exchange, providing opportunities for residents to interact and engage with one another. This can help promote a sense of community and enhance the overall livability of the city. In conclusion, while the creation of additional commercial development may not be strictly necessary according to NRM standards, the proposed development plan for Charsadda recognizes the potential benefits that such development can bring to the city, including increased economic growth, job opportunities, and community engagement.

Health, Education and Civic Facilities

For assessing the existing health, education and civic facilities, primary data has been assessed and proposals are given using the projected population till 2042. Viewing the educational facilities, the study area currently possess 15 primary schools, 10 middle schools, 10 secondary schools and 5 colleges. It was identified that the current educational facilities are insufficient to cater with the needs of city even in 2017. Viewing this, the requirement calculated for year 2017 is of 28 primary schools, 12 middle schools, 3 secondary schools and 1 college. Similarly, the projections made for 2022-2042 showed that there will be a need of 18 primary schools, 8 middle schools, and 2 secondary schools in the study area.

Alike educational facilities, the consultant has identified that the existing health facilities are insufficient for the population of Charsadda City. According to NRM requirements, there should be at least eight BHU facilities to serve a population of 209,745. A single BHU can serve up to 25,000 people but in study area of Charsadda there are only three of these facilities. Likewise, there should be at least 13 dispensaries, yet there is just one. In the study area a health care zone is proposed by the consultant having an area of around 37.98 acres which will cater the land demand for development of health facilities.

Furthermore, in Charsadda study area, around 87.11 acres of land already consists of civic and community facilities present within the study area boundary. Meanwhile, an existing civic zone present in the eastern side of study area has been identified having the potential to cater city's civic facility demands till 2042.

Environment & Disaster Management

Based on the analysis of the current situation regarding the quality of drinking/groundwater, surface water, ambient air and noise, and soil quality, it is evident that there is a need to address the air quality at some locations.

To mitigate the impact of human activities and climate change on the environment, the proposal suggests a set of measures aimed at promoting sustainable development practices. These measures include tree plantation and ecological corridors, green space preservation and green infrastructure, biodiversity protection, climate resilience planning, and collaborative efforts.

With reference to the requirement of TORs, the aforementioned proposals also highlight the importance of wildlife protection and conservation. The key proposals in this regard include minimizing habitat destruction, reducing human-wildlife conflict, promoting wildlife-friendly urban planning, increasing public awareness, enforcing wildlife protection laws, supporting research and monitoring, establishing protected areas, regulating wildlife trade, strengthening enforcement efforts, encouraging sustainable use of wildlife, enhancing research and monitoring, engaging with local communities, promoting international cooperation, providing financial support, and raising public awareness.

In addition, the proposals to manage aggregate natural resources, conserve environmental conservation areas and floodplains, and promote sustainable green city development. These measures include community engagement, education and outreach, monitoring and evaluation, financial incentives, research and development, improved waste management, green space development, flood protection infrastructure, water conservation, renewable energy and sustainable transportation, sustainable livestock management, floodplain mapping and zoning, and community education and engagement.

In Conclusion, the the measures outlined in this report are critical steps towards promoting sustainable development and protecting the environment. It is imperative that these measures be implemented and promoted to ensure that our planet remains healthy and habitable for future generations. The government has a significant role to play in this regard, and it should take an active part in supporting and implementing these proposals. This includes allocating resources and providing financial support to local communities and organizations working towards environmental protection and conservation. By working together, a greener and more sustainable future could be created.

Charsadda City is vulnerable to various disasters, including floods, heatwaves, windstorms, earthquakes, conflicts, industrial hazards, political unrest, and transportation accidents. These disasters can cause significant damage to the city's communities and infrastructure, leading to loss of life and property damage. To manage these disasters, the government and NGOs play a critical role in disaster management. To this end, the government has established the Provincial Disaster Management Authority (PDMA) to manage disasters at the provincial level. The role of these authorities is to ensure that disaster preparedness plans are in place and that appropriate actions are taken in response to disasters. Moreover, proposals have been formulated that are resilient and compatible with the city's disaster profile. The flood-resistant infrastructure, heat-absorbing green spaces, wind-resistance, and earthquake-resistant structures should be enforced to protect communities and infrastructure from the impacts of natural disasters, ensuring a safer and more sustainable future for all.

Transportation

Comprehensive mobility planning is based on land use and urban design strategies to increase accessibility and mobility of a city. To complement land use with transportation network, short term and long-term strategies have been suggested to improve traffic and transportation in Charsadda city. A balanced and well-planned roadway network is proposed with the removal of encroachments, widening of primary roads, and addition of service lanes and footpaths to serve both active and motorized traffic accessing the adjacent land with ease. Lane marking at 10 feet width, dedicated lane intended for bicyclists/ motorcyclists, cars, and public transport vehicles shall reduce traffic speed, instil cautiousness in drivers' perception and improve mobility on primary roads. For better traffic management and connectivity of primary roads, certain crossovers with secondary roads shall be signalized to maintain orderly movement and regulate traffic volume approaching major junctions such as Farooq-e-Azam Chowk and Utmanzai Chowk. Similarly, to further improve traffic mobility on primary roads, forced turns at the crossover with some secondary roads, installation of speed tables on tertiary roads directly linking with the primary road, and specified U-turn at major junctions are proposed for the management of traffic. Footpaths shall be available on all primary and secondary roads for easy access to commercial markets, retail shops, plazas, educational centres, and banks.

Moreover, a well-planned public transportation hierarchy with local wagons and rickshaws operating on secondary roads feeding passengers to the main bus operational with fixed stops on all major corridors and serving the majority of passengers traveling to and from major commercial, industrial, and educational institutions. To efficiently manage parking demand for major commercial and industrial land use, existing vacant land on prime locations along Mardan Road, Charsadda Road, and near Charsadda Road has been identified on the perimeter of the activity center. The availability of a parking plaza would encourage people to park their vehicles for free and walk to their nearest destination. Similarly, paid temporary parking is suggested on primary roads to discourage long-term illegal roadside parking and promote the use of public transport. The installation of traffic signage along primary roads, intersections, and tertiary roads has been proposed to guide vehicles throughout their commute. These signs include slow speed signs, destination & distance signs, parking plaza ahead signs, and other signs to guide people on the road. In conclusion, the roadway network improvements in Charsadda city are proposed to enhance accessibility to adjacent land use, provide multimodal transportation options to reduce average trip time, and congestion and improve overall mobility.

Water and Sanitation

The water supply and sanitation for master plan project is aimed at providing a comprehensive and sustainable plan for the management and delivery of water and sanitation services in a city. The project aims to analyze the existing infrastructure and service delivery systems to identify gaps and opportunities for improvement.

The project thoroughly assesses the current water supply and sanitation systems in the city, including the availability and quality of water sources, treatment facilities, distribution networks, and wastewater treatment facilities. The project team will also conduct a needs assessment to identify the future demand for water and sanitation services and assess the capacity of the current systems to meet these needs.

Based on the findings of the assessments, the project team will develop a comprehensive water supply and sanitation master plan that outlines short-term and long-term strategies to improve the city's water and sanitation systems. The plan will include recommendations for expanding and rehabilitating existing infrastructure, developing new infrastructure, and adopting new technologies and practices to improve efficiency and sustainability.

The ultimate goal of the water supply and sanitation master plan project is to improve access to safe and reliable water and sanitation services, promote public health and environmental sustainability, and enhance the overall quality of life for the city's residents.

Solid Waste

Three scenarios have been considered to manage solid waste management in Charsadda city. After analyzing the three proposed scenarios for solid waste management in Charsadda, it has been determined that Scenario-3-Composting, RDF, Recycling, and Landfilling

is the most suitable option. However, it is recommended to adopt and implement Option - 3 for sustainable waste management. To ensure the success of the proposed system, key factors such as institutional arrangement, operational plan, and business model need to be developed. An enabling environment must be created to facilitate the implementation and success of the advanced treatment option. Municipalities in low-income, developing countries face significant challenges in SWM, and the situation is likely to worsen due to continuing population growth and urbanization.

This sectoral plan aims to provide a practicable and result-oriented solution to a long-standing predicament affecting almost all municipalities. The plan outlines a detailed strategy for transforming TMA Charsadda SWM sector and supporting its transition to a fully functioning, integrative, and sustainable system by 2042. The plan is guided by principles such as administrative and functional changes, documentation and evaluation, people's participation, stakeholder partnerships, recognition of the informal sector, waste minimization, affordability, and sustainability. It is important to recognize that lack of financial resources is not the main issue, and SWM must be seen in a wider context. Gradual minimization of landfill should be a priority.

Recreational and Open Spaces

Green spaces, such as parks and urban forests, have numerous benefits for the environment, physical and mental health, and community well-being. In line with the Sustainable Development Goals (SDGs), proposals have been made to increase the availability of green spaces in the city. Currently, there is an area of 46.94 acres allocated for recreational and open spaces in the city. Viewing the future demand, recreational zones have been proposed covering 337.57 acres which will include parks, and other recreational facilities to improve the physical and mental health of city residents and enhance their quality of life.

Furthermore, by prioritizing the creation and preservation of green spaces, the city can promote biodiversity conservation, climate change mitigation, and environmental protection, while also enhancing the overall liveability and sustainability of the community.

Safety and Security

A city is considered to be safe and secure when all of its inhabitants are able to live, work and participate in urban life without fear of bodily harm or intimidation. There are 43 police stations that fall within the boundary of District Charsadda while only 9 police stations/chowkies are within the boundaries of Charsadda city. The number of police chowkies have decreased over the period of 13 years as in 2009 the number of police chowkies were 37 in Charsadda district which now have fallen to 30. The number of police stations have stayed the same. Viewing the existing crime ratios and availability of security facilities, certain proposals have been given to cater with the security situation and needs of the city.

Regardless of financial development and social achievement, urban areas from one side of the planet to the other keep on battling with difficulties of uncertainty, unsteadiness, viciousness, and defilement. These issues are welcomed by individual shortcomings, perilous environmental factors, and territorial risks that bring up issues about well-being and security. While security endeavors to totally destroy risks and establish a protected living climate for everybody, well-being alludes to limiting or keeping takes a chance with that outcome from collaborations between individuals, things, and the environment.

To make the city's urban environment peaceful, there is a need for introducing well-being measures. By executing viable security and safety efforts, residents can reside locally where they have a good sense of security and safeguarded, which can prompt social, financial, and political turn of events. It is prescribed to adopt a thorough strategy to security by executing numerous systems that address various parts of wellbeing and security. The consultant has proposed some safety and security proposals such as installation of CCTV camera at public sites, Increased interaction of police with people, and a comprehensive disaster management plan, which will enable the city to respond effectively to natural disasters such as floods, earthquakes, and other emergencies. The detail of these proposals will be discussed in the action plans.

In conclusion, the Charsadda City Master Plan will serve as a thorough and strategic road map for the sustainable growth of the city in the years to come. This Master Plan intends to address the existing and future difficulties faced by the city and maximise on its opportunities through a collaborative and inclusive planning process, involving stakeholders from diverse sectors. The proposed Master Plan of Charsadda presents a vision of "A Vibrant Agro-Based, Industrial, Educational and Pollution Free City" that promotes equitable development, improves quality of life for its citizens, attracts investment, and fosters innovation. It does so with a focus on economic growth, social inclusion, environmental sustainability, and resilience. Furthermore, the successful implementation of this Master Plan will require concerted efforts from all stakeholders, including the government, private sector, civil society, and the local community.

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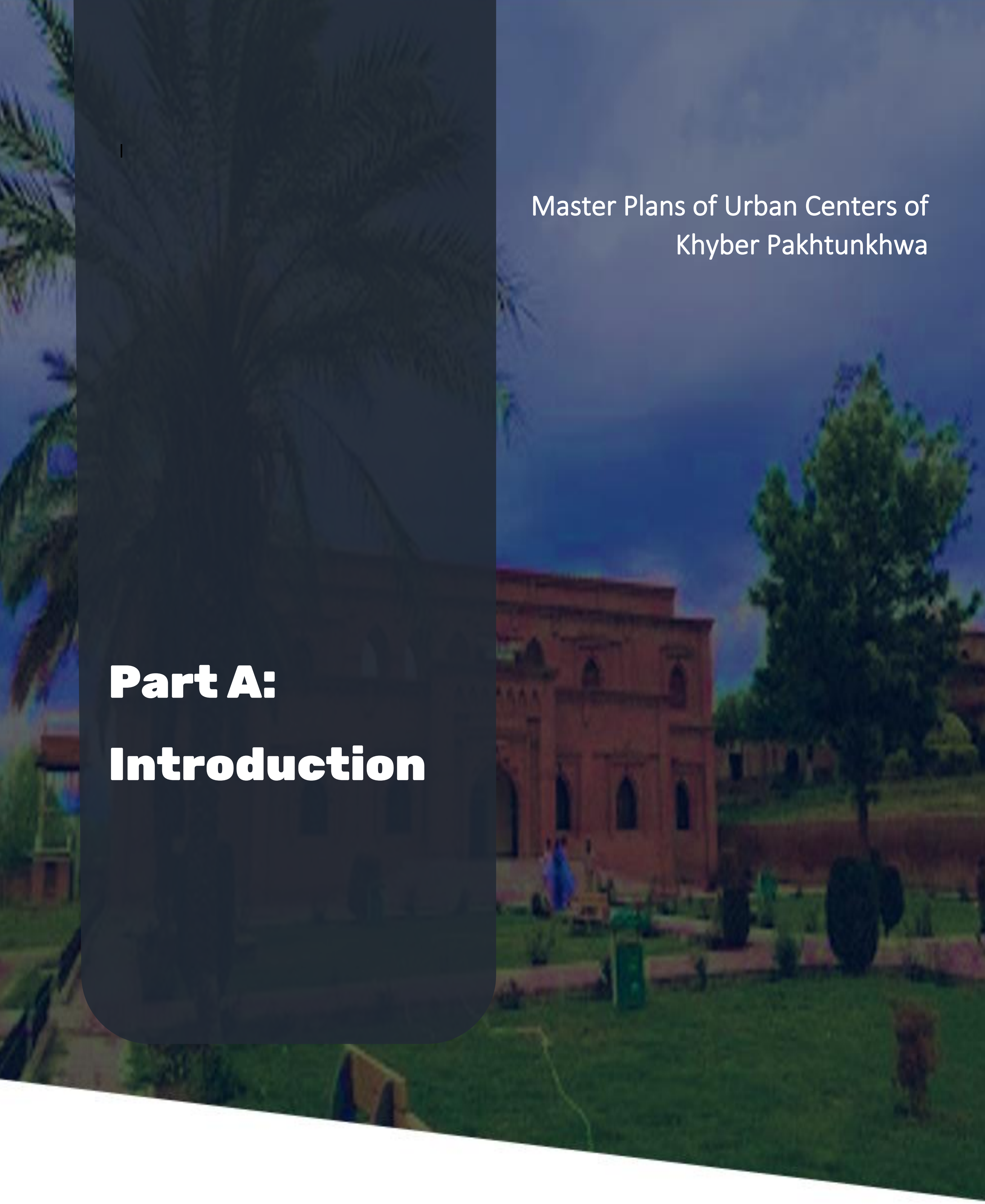
AHP	Analytical Hierarchy Process
CBD	Central Business District
EIA	Environmental Impact Assessment
GIS	Geographic Information System
GoKP	Government of Khyber Pakhtunkhwa
KP	Khyber Pakhtunkhwa
LOS	Level of Service
LSA	Land Suitability Analysis
MC	Municipal Corporation
MCC	Manual Classified Count
NC	Neighbourhood Council
NGO	Non-Governmental Organisation
PCU	Passenger Car Unit
PHV	Peak Hour Volumes
SDG	Sustainable Development Goals
SWOT	Strengths, Weakness, Opportunities & Threats
TDM	Travel Demand Management
THQ	Tehsil Headquarter
TMA	Tehsil Municipal Administration
ToRs	Terms of Reference
UN	United Nations
UPPU	Urban Policy & Planning Unit
VC	Village Council



Master Plans of Urban Centers of Khyber Pakhtunkhwa

Part A: Introduction

Chapter 1: Project Background

1.1. Project Scope

Khyber Pakhtunkhwa (KP) is a province located in the northwest region of Pakistan. Despite having the smallest land area of 74,521 km^2, it is the third most populous province in the country, with a population of 30.5 million residents. This population growth has been significant, with the number of inhabitants increasing from 17.7 million in 1998 to 30.5 million in 2017, reflecting a growth rate of 2.89% per year, which is higher than the national average of 2.40%. Several factors including natural growth and temporary and permanent internal migration have contributed to the population growth in KP especially major cities.

With the raising issue of rapid urbanization[3], population growth and influx of internal migrants in KP, there is a need to effectively manage and plan for development of KP cities in a planned and sustained manner. Incognizant of these issues, the Urban Policy & Planning Unit of the Planning and Development Department, Government of KP, has commissioned the preparation of Master Plans for the development and planning of twenty urban centres in the Khyber Pakhtunkhwa province, including Charsadda, i.e., Charsadda City Master Plan 2042. The purpose of these Master Plans is to provide comprehensive development planning and policy intervention for these urban centers, ensuring their growth is sustainable and meets the needs of the expanding population.

For the development and planning of Charsadda, the Charsadda City Master Plan 2042, the consulting firm PEPAC Pvt Ltd & Associates has been assigned as consultants for the project. Their scope of work focuses on proposed development solutions for Charsadda considering the area's spatial, economic, and existing resources. Their role revolves around the assessment of the spatial, economic, and existing resource aspects of the area and to propose appropriate development planning proposals for Charsadda city.

Charsadda city is located in Charsadda District, Khyber Pakhtunkhwa, Pakistan. Division wise city falls within Peshawar Division. The city lies about 29 kilometers (18 mi) from the provincial capital of Peshawar at an altitude of 276 meters (906 ft). The project area consists of 11 NCs and 10 VCs for which Master Planning and future proposals have been developed. According to the Term of Reference (TOR), the scope of the project caters following tasks but is not limited to it:

- Identification of the study area boundary, demographic composition, ethnic and tribal makeup, customs, climate, and hydrology. A comprehensive socio-economic analysis

[3] Definition of Urbanisation: The term "Urbanisation" describes the process through which a society takes on a more urban character. Typically, this process entails the growth and extension of cities, towns, and other urban regions, as well as a corresponding rise in the percentage of a population that resides in these areas. This can involve individuals moving from rural to urban regions, urban areas expanding due to natural population increase, building additional infrastructure and housing, and expanding economic activities including industry, commerce, and services.

to assess the current situation and identify potential growth zones for future development.

- Provision of amenities and infrastructure, including connectivity routes, industrial zones, commerce and trade zones, and frameworks in the form of Action Plans to support the growth and development of the city over a 20-year period.
- Inception report outlining the project's abstract and methodological framework, including a vision formulation process involving key stakeholders and the general public.
- Land use and land suitability analysis based on mapping of historical growth and housing trends, detailed field surveys, situational analysis of the existing urban structure, and sectoral profiles. This analysis will inform suggestions for further proposals and future land demand calculations to accommodate the projected population growth.
- Scenario mapping, land use zoning, master plan development for the city, and an implementation framework and action plan for specific areas.
- Continuous coordination between the client, consultant, and associated stakeholders at every stage to ensure clarity and agreement on project deliverables.
- Development of specific action plans for implementation of the master plan, including timelines, budgeting, and stakeholder responsibilities. These action plans will ensure that the master plan is executed effectively and efficiently, leading to the sustainable development of each headquarter city in the study area.

1.2. Project Objectives

According to Project TOR’s, these specific objectives will eventually achieve the goals of the project.

- To critically review the current policies and on-going schemes of urban development to pinpoint the short comings, suggest appropriate changes in the current policies and strategies to remove its deficiencies.
- To assess the impact of urbanization (population growth, re-classification and expansion in the urban boundaries) on the basic services and to suggest strategies to upgrade/extend urban infrastructure to keep pace with the urban growth.
- To examine the existing regulatory and institutional framework, including governance measures of the city and suggest improvements.
- Devise strategies for affordable housing, livelihood and recreation facilities for all in close proximity both in the existing city and new areas;
- Devise strategies for urban regeneration/slum up gradation and to encourage mixed used high density vertical development at appropriate location within the existing urban core;

- Devise a policy framework and specific design guidelines to address local issues affecting intensification / densification currently and in the future;
- Assess the adequacy of municipal services (storm water, solid waste management, sewage treatment and municipal water supply) and social amenities such as (parks and playground, public and private transits, bus stops and terminals; roads capacities, junctions' improvement and parking facilities) to achieve the required levels of intensification for identified and conceptualized development scenarios;
- To suggest a legal, financial and technical mechanism between urban planning and land administration systems to enable feasible land to be accessed and used for development in future.
- Recommend appropriate criteria for intensification proposals. Criteria should address matters such as, but not be limited to:
  - Compatibility/suitability of the new development with existing built-up area.
  - Relationship between density, massing and height of existing and proposed buildings including minimum and maximum permitted densities.
  - Provision of appropriate access to existing and proposed development.
  - Existing built and natural environments.
  - Transit supportive densities/proximity to transit facilities.
  - Connections to existing transport system.
  - Contributions to attractive, safe, and comfortable pedestrian environments.
  - Traffic impacts.
- Strategies to ensure coordination among public/private institutions to carry out desired development in a coordinated manner (Proper development control mechanism);
- Strategies to enhance urban security issues;
- Strategies to conserve heritage, built and natural environments of the region;
- Strategies to explore and enhance urban tourism to serve as an essential part of future urban economy;
- Strategies to improve system of revenue generation/economic productivity of the institutions through the, identification of buoyant sources of tax and revenue generation such as land valuation (betterment) taxation; urban land taxation etc.
- Enhance connectivity and transit mobility to support and complement mixed-use high-rise development to reduce financial and environmental burdens of conventional communing;
- Strategies for the plan Implementation and to establish a system of monitoring and review of the plan proposals.

1.3. Milestones Reached

The master planning project for Charsadda city initiated with the submission and approval of the Inception Report containing a detailed methodology for the entire project which was the first deliverable of the project. The report incorporated contents of the master plan, adopted methodology, a list of various surveys along with their questionnaires which were required as per the terms of reference. The second deliverable, namely Vision Development and Public Consultation, was approved after detailed focus group discussions with the different city stakeholders, public and a comprehensive vision formulation exercise. The main purpose of vision formulation was to develop a vision statement for the future growth of cities, and identify community goals and objectives that clarified what the residents of the community desired for their future. After a detailed discussion at the vision workshop, a comprehensive SWOT analysis activity was held that assisted in formulating a final vision statement for the Charsadda City as ***"A Vibrant Agro-Based, Industrial, Educational and Pollution Free City".*** The third deliverable, named Background Study, has been successfully submitted to the client. The report covers a comprehensive analysis of primary surveys conducted, which formed the basis for collecting data that was further analyzed to provide insightful results. In addition, the report also includes a detailed analysis of secondary reports, surveys, and relevant maps of each sector. An essential component of the report was in-depth analysis of land use which provided valuable insights regarding current land use patterns, trends, and potential areas for development. On the basis of the aforementioned submitted and approved deliverables, the Master Plan and Scenario Mapping, which is the fourth deliverable of the projects, is currently being prepared. This Master Plan report has been prepared to formulate and provide the development proposals for the Master Plan of Charsadda City. After consultation with UPU and other stakeholders and a public hearing, draft Master Plan will be revised and submitted to the client. Following that, approval of the master plan, the Sectoral Action Plans will be formulated as final deliverables of the Master Plan of Charsadda City.

1.4. Report Anthology

The Report on Master Plan and Scenario Maps is divided into three volumes; Master Plan report (Volume 1), Proposed Master Plan maps (Volume 2) and Annexures (Volume 3). In this volume 1, the Master Plan report comprises of four sections which are further subdivided into different chapters. Overall, there are 21 chapters of the report covering all the aspects as per the Terms of Reference and the requirements of the client.

Part A: Introduction

The 1st section describes the introduction to the project and its importance from different perspectives. It consists of the following chapters;

Chapter 1 deals with describing the project background that includes Project scope, objectives, summary of deliverables submitted and report breakdown.

Chapter 2 describes the holistic planning approach adapted to carry out the 4th deliverable. It investigates and presents a systematic review of the methods and strategies that have been adopted for the preparation of Master Plan and Scenario maps for Charsadda City.

Chapter 3 explains the City's Vision for growth. It highlights the vision formulation process that has been done and takes into account the aspirations and requirements of residents, and how they wish to see their city in the next two or three decades. It also highlights vision formulation models, strategies to finalise vision statement and SWOT analysis of Charsadda.

Part B: Existing Urban Structure of the City

The 2nd section describes the existing development pattern of the city by following chapters;

Chapter 4 Spatial Growth and Urban Form describes the physical background, study area boundary analysis including NC/VC with population, area, and sample size. The chapter also explains the demographic profile of the study area i.e.; population density and future population projection for the next 20 years. Furthermore, the chapter also includes spatial urban form and city structure identifying Charsadda urbanization by a mixture of formal and informal development patterns, with the decentralized and dispersed arrangement of urban spaces.

Chapter 5 explains the comparative analysis of existing land use with National Reference Manual (NRM). Existing land use patterns and future land use requirements as per NRM standards are also discussed under this chapter. Furthermore, the actual city requirements other than NRM standards are discussed to ensure provision of every facility adequately as per the city needs.

Part C: Multi-Criteria Scenario Development/Master Plan

The 3rd section is the description of multi-criteria decision making which is the approach used to facilitate the consideration of multiple criteria by decision makers. Scenario development based on the land suitability analysis and the proposed master plan are also the part of this section. It consists of the following chapters;

Chapter 6 explains the multi-criteria and land suitability analysis on the basis of which, zoning is done. This includes suitability mapping, multi-decision criteria analysis, constraint and factor mapping. Based on the aforementioned techniques, the Land Suitability Analysis of the land uses are discussed, as well the GIS tools used in LSA are also discussed in the chapter.

Chapter 7 is the description of scenario development for master plan of Charsadda city. It includes existing scenario analysis of the city, multiple future scenarios (residential, commercial, industrial and agriculture) based on different assumptions and variables like population growth, land use patterns, transportation infrastructure, environmental conditions, economic development etc. and scenario selection for master plan based on assumptions, vision, and SWOT analysis of the city.

Chapter 8 Master plan development blueprint depicts the salient features of the proposed master plan and their role in fulfilling actual need of the city.

Part D: Comprehensive Master Plan Proposals

Comprehensive master plan proposals include different proposed land uses including residential and housing proposals, commerce & trade, industry and other allied uses. Also, it highlights the existing situation for certain areas of study i.e., quality of life, citizens behavior, heritage and urban design, etc., covered as per the requirements mentioned in ToR's for which action plans will be proposed after completion of Task C. These include;

Chapter 9 gives detailed residential and housing Proposals that includes existing housing shortfall and future demand estimation. The chapter briefly explains three housing scenarios given by the consultant and the selected scenario of residential development for the Master Plan.

Chapter 10 describes the existing situation of commerce and trade zone in the city, future requirement and the zone proposed for commerce and trade activities. And explains the comprehensive industry proposal.

Chapter 11 Health, education and civic facilities describes the existing number of facilities available within the NC/VCs and the requirement of facilities as per NRM standards. The area and number of proposed health, education and community facilities is also given in this chapter.

Chapter 12 is the detailed description of environment and urban infrastructure of the city. This includes methodology for environmental baseline, results derived from environmental baseline studies and environmental proposals for fisheries, tree plantation and ecological corridors wildlife and environmental conservation areas.

Chapter 13 deals with transportation and mobility sector. Existing transportation pattern, methodology of comprehensive mobility plan and detailed transportation proposals.

Chapter 14 deals with Water, Sanitation and Solid Waste section including existing situation of water supply, sewerage and sanitation, Future requirement and proposals for Water supply, Sanitation and solid Waste.

Chapter 15 describes the existing parks and recreational facilities, their future requirement of the city and proposed zones for the provision of parks and recreational facilities.

Chapter 16 defines proposed livestock facilities in the study area.

Chapter 17 deals with safety and security proposals for Charsadda city.

Chapter 18 provides brief overview for the measures taken to identify the current quality of life aspects of the city.

Chapter 19 delineates the assessed perspectives of citizen's behavior through certain selected parameters and provide a brief description.

Chapter 20 outlines the current land management practices in the city and identifies specific actions which could be taken to enhance the land management practices in the city.

Chapter 21 defines the existing heritage and cultural aspects of the city and provide possible options for preservation and protection of historical places and city's cultural values.

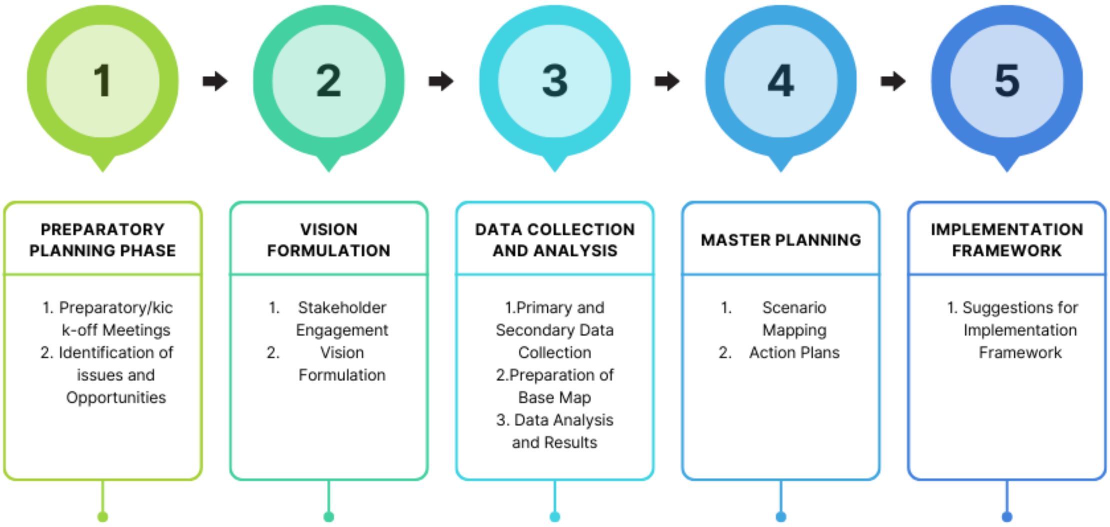
Chapter 22 the chapter identifies the current city scape through different dimensions and certain proposals for betterment and uplifting of city design measures are given.

Chapter 2: Holistic Planning Approach

The holistic planning approach defines the overall procedure adopted for creating the Master Plan of Charsadda city. It broadly consists of five phases including:

1. Preparatory Planning Phase
2. Vision Formulation
3. Data Collection & Analysis
4. Master Planning
5. Action Plans

Figure 1: Master Planning Methodology – Charsadda Study Area



The details of each step are defined in the upcoming sections below.

2.1. Preparatory Planning Phase

During the preparatory planning phase of the Charsadda City Master Plan, the planning professionals laid the foundation for the entire planning exercise. Numerous dynamics of the study area were observed and initial understandings regarding various sectors operating within the city were sketched. The different stages identified during preparatory planning phase for the master plan of Charsadda city are defined below.

2.2.1. Preparatory/Kick off Meetings

For envisioning the execution strategies of entire master plan for Charsadda city, initial meetings were held among different concerned personals of the organization and with planning experts involved in the project. These meetings were supposed to perform a thorough analysis of different options and pathways which could possibly be adopted for the project execution and choose the best one having more economic and social feasibility.

2.2.2. Identification of Issues and Opportunities

The kick off meetings and several brainstorming exercises the issues and challenges in conducting the master planning exercise for the city were identified as posing risks to successful project completion. Key opportunities arising from the project were identified which consider several factors directly or indirectly related with the master planning project. Moreover, certain pros and cons associated with different options which could be utilized for project execution were seen from a broad perspective at city level.

2.2. Vision Formulation

Second stage of project involve the development of vision for next 20 years through active engagement of different stakeholders concerned with the master planning exercise. The core purpose of visioning exercise was to extract out the agreed set of goals desired to be fulfilled through an extensive city planning exercise. A set of guiding questions and different community engagement tools and techniques, i.e., focus group discussions, was utilized to develop an agreed vision from a wide range of different stakeholders.

2.3. Data Collection and Analysis

The next step included collection of primary and secondary data from the sampled population within the city. The primary data was mainly collected through the on-site surveys by the consultants, while the secondary data was acquired from different departments responsible for the active management of cities. Finally, the data was analyzed through several statistical and visual modes and existing situations regarding different sectors altogether serving the city were identified. The detail process of data collection and analysis is provided in the section below.

2.3.1. Primary and secondary data collection

Two types of data were collected for executing the master planning project. For collection of primary data, kobo toolbox; digital toolkit was used containing approved questionnaire by the client. The main sectors included, transportation, socioeconomic, land use, infrastructure and environment. Similarly, for secondary data collection, different departments directly or indirectly affecting the city management were approached i.e., taxation department, land management bodies, governance institutions, etc. and relevant data was collected.

2.3.2. Preparation of Base Map

Geographical Information system (GIS) based land use base maps were prepared on the scale of RF 1:2000 to RF 1: 2500. They contain contour lines drawn at the interval of 10 meters along with jurisdictional boundaries of the area. All major roads, streets, railway lines, airports, water bodies, residential areas (planned/unplanned) were mentioned on it. Following enlisted elements were shown on the map:

- Contour lines drawn at an interval of 10 meters.
- Jurisdictional boundaries within the project area
- All major and minor streets, roads, railway lines and airports

- Water bodies (spring, streams, river and other water bodies)
- Residential (planned and un-planned areas building heights, density, mixed-use)
- Commercial (retail, wholesale and warehouses)
- Industrial (all types)
- Amenities (education, health, religious, banks, police stations, libraries, and community halls etc.)
- Parks, play grounds and green fields
- Open spaces (agriculture all types, vacant, and graveyards etc.)
- Agricultural
- Touristic Spots
- Historical/heritage/places of interest

The step wise base map formulation process is given below;

- Acquisition of Satellite imagery (Landsat image) of 0.5m resolution for performing supervised classification.
- Development of vector shape files in the form of polygons as these files were utilized in the extraction of the areas.
- Digitization of selected area at the parcel level.
- Allotment of unique identification (ID) number to each parcel.
- Based on the ID number, the surveys were conducted at the UC level. The Ucs are than further divided into reasonable parts based upon the size or density.
- Reclassification of the map on the base of the survey.

2.3.3. Data Analysis and Results

After collecting the data, extensive analysis was performed using different tools and techniques ideally for finding out the existing working capability and situation of different sectors within the selected study area. Mainly, two sort of analysis were performed from one is based upon statistical manners and the other one has been analyzed through development of visual maps using Geographic Information Systems. The results generated from the performed analysis were then illustrated using infographics generating comparisons among several indicators and sub indicators selected while questionnaire formulation.

2.4. Master Planning

The final stage of the agreed project methodology includes the development of master plan through certain interventions i.e., scenario mapping and action plans. The scenario mapping majorly based upon the primary studies and maps developed to highlight existing situation of the study area. Aiding in defining policy measures for several sectors involved in overall city management. Furthermore, action plans will be proposed in which certain set of actions and guidelines for each sector will be discussed.

2.4.1. Scenario Mapping

The scenario mapping is done through identifying the most suitable land parcels through performed multi-criteria analysis for various land uses. Housing projections for all income groups, spaces required for commercial and industrial activities and all other land demand calculations are performed accordingly. The scenarios also cover identification of city's spatial urban form along with defining the range of land use potentials i.e., residential, commercial, agriculture, etc. Moreover, the major transportation, environmental and agricultural conservation areas are also identified to cater with the future city growth. A set of allied infrastructure to be provided in the city till the master plan duration have been proposed catering the expected city demands.

2.5. Action Plans

Action plans for several sectors including quality of life, health, education, zoning and management, rural urban fringe, heritage, zoning and land management, etc. will be prepared, devising policies and guidelines for dealing with the existing problems and covering the future demands of Charsadda city.

Chapter 3: City's Vision for Growth

3.1. Vision Formulation and Community Consultation

3.1.1. Theoretical/Conceptual Framework for Vision Formulation

The process of visioning involves articulating ultimate aspiration of the residents of Charsadda in a concise manner. It helps in depicting their vision and desires to see how they want their city to look like in the upcoming years. It also helps communities to think farther ahead and participate in planning mandates by ensuring their active participation in detailing out overview of the existing socio-economic, physical, environmental, and societal conditions of the city. It further encourages people to discuss their needs and challenges through comprehensive discussions with stakeholders via extensive consultations.

3.1.2. Purpose of Vision formulation

A well-defined vision statement helps to ensure that all stakeholders involved in the planning process are aligned and working for achieving a common goal ultimately leading towards sustainable development. It helps in guiding development strategies to meet the objectives of city master plan. Vision formulation is highly beneficial as it takes into account diverse community perspectives, built trust and soliciting input from the community make them invested with the overall process and its output. It also generates new innovative ideas as locals have deep insight regarding challenges being faced within the city. Furthermore, the exercise ensured that the planning process was understood and acknowledged by the community.

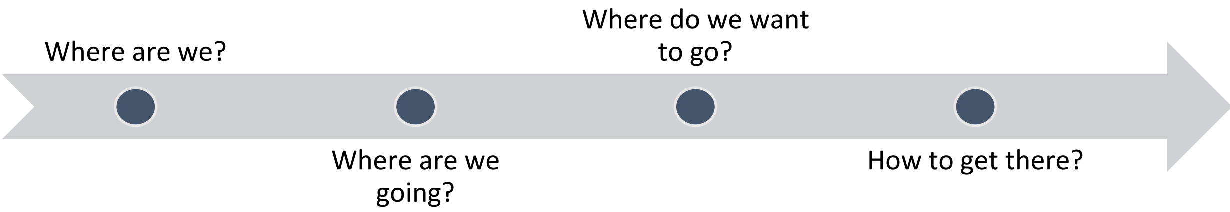
3.1.3. Models for Formulating Vision

For vision formulation, the consultant conducted Focused Group Discussions (FGDs) with a wide range of stakeholders in the area including Civil Society Organizations, Private and Public Sector Departments, and the general public. Participants freely opened up with their requirements which they desire to be indulged in the city master plan. While articulating a shared vision for the future, the consultant has identified their shared values and purposes and vision for the future of Charsadda, outlining their priorities goals and objectives associated with the entire master planning exercise.

Figure 2: Models for Formulating Vision for Charsadda City

For commencement of this project section, Oregon Model was utilized which comprises of four comprehensive steps for vision formulation. Each of these steps are based upon questions and criteria about various activities giving a certain outcome. The main steps used in the vision process are shown in the following figure:

Figure 3: Steps adopted for Vision Formulation

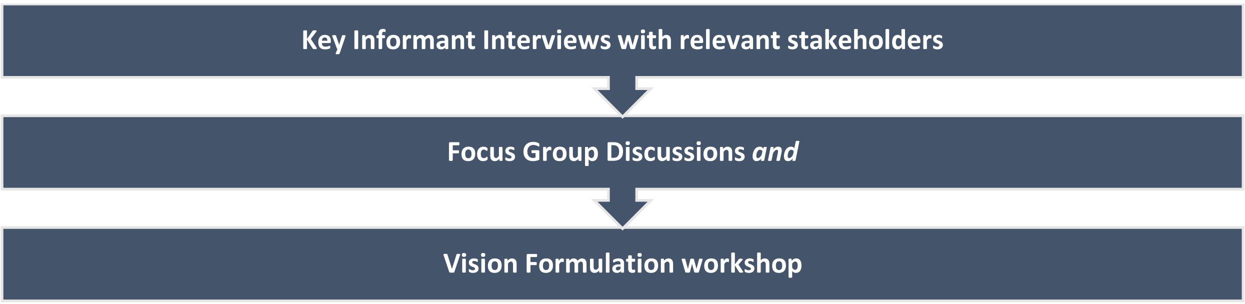


Source: Devised by the Consultant based on Oregon Model

3.1.4. Adopted Vision Formulating Strategies

The methodology adopted for the visioning exercise was comprised of qualitative approach where problem-oriented reasoning was performed along with three staged strategies for vision formulation including;

Figure 4: Adopted Vision Formulation Strategy – Urban Charsadda



Different tools were used like interactive consultation session, FGDs and household questionnaires for visioning. The consultation with the line departments were made where viewpoints and challenges being faced by their departments including major issues of the city and available potentials to improve basic services for its dwellers were discussed; (pictures attached in Annexure 2).

Focused grouped discussions with the general public were conducted as per the requirements mentioned in ToR's. Questionnaires consisting five general queries regarding master planning project for Charsadda city were circulated among the participants. Through this, various prevailing issues were highlighted including poor state of municipal services including sanitation, drainage and solid waste management system, inadequate utilities, i.e., clean drinking water, electricity and Sui gas within the city, improper disposal of municipal waste, poor education facilities and inflation. Furthermore, concerns like loss of agricultural land, inadequate healthcare facilities, transportation issues, lack of road infrastructure, traffic congestion and parking issues were also highlighted.

During the focused group discussions, various potentials of Charsadda city were also highlighted by the participants. The major potentials in Charsadda lies in its agricultural production of sugarcane and Industries (Cloth, Paper, Shoes and Sugar) which with the investment from the government or with the provision of incentives to private stakeholders in terms of investment will boost the agricultural yield and lead to industrial development in the city, having potential to generate employment opportunities and improving the quality of life of people. Further economic potentials of the city lies upon the export potentials of Jaggery, chappal and cloth, and Nephrite refinement, which shows a major source to drive the city's economic engine.

3.1.5. Vision Development Workshop

The workshop was held in Charsadda on 9th December 2021 at Salateem Wedding Hall. The facilitator led the workshop, which made sure that all participants actively participate in it. Various techniques for active participation were applied throughout the workshop.

The facilitator then divided the participants into groups and executed a SWOT analysis activity. The participants were divided into six groups to encourage participants to interact in an interdependent and cooperative way. Each group was assigned to prepare of strengths, weaknesses, opportunities and threats matrix (SWOT) of the city by mutual discussion. After the SWOT analysis, the facilitator continued the exercise by asking each group to develop a consensus-based vision statement for Charsadda city based on their respective SWOT analysis. This activity resulted in six different SWOT analyses and vision statements of the city upon which a final vision statement for the city was formulated.

3.1.6. The Statement for Vision:

A Vibrant Agro-Based, Industrial, Educational and Pollution Free City

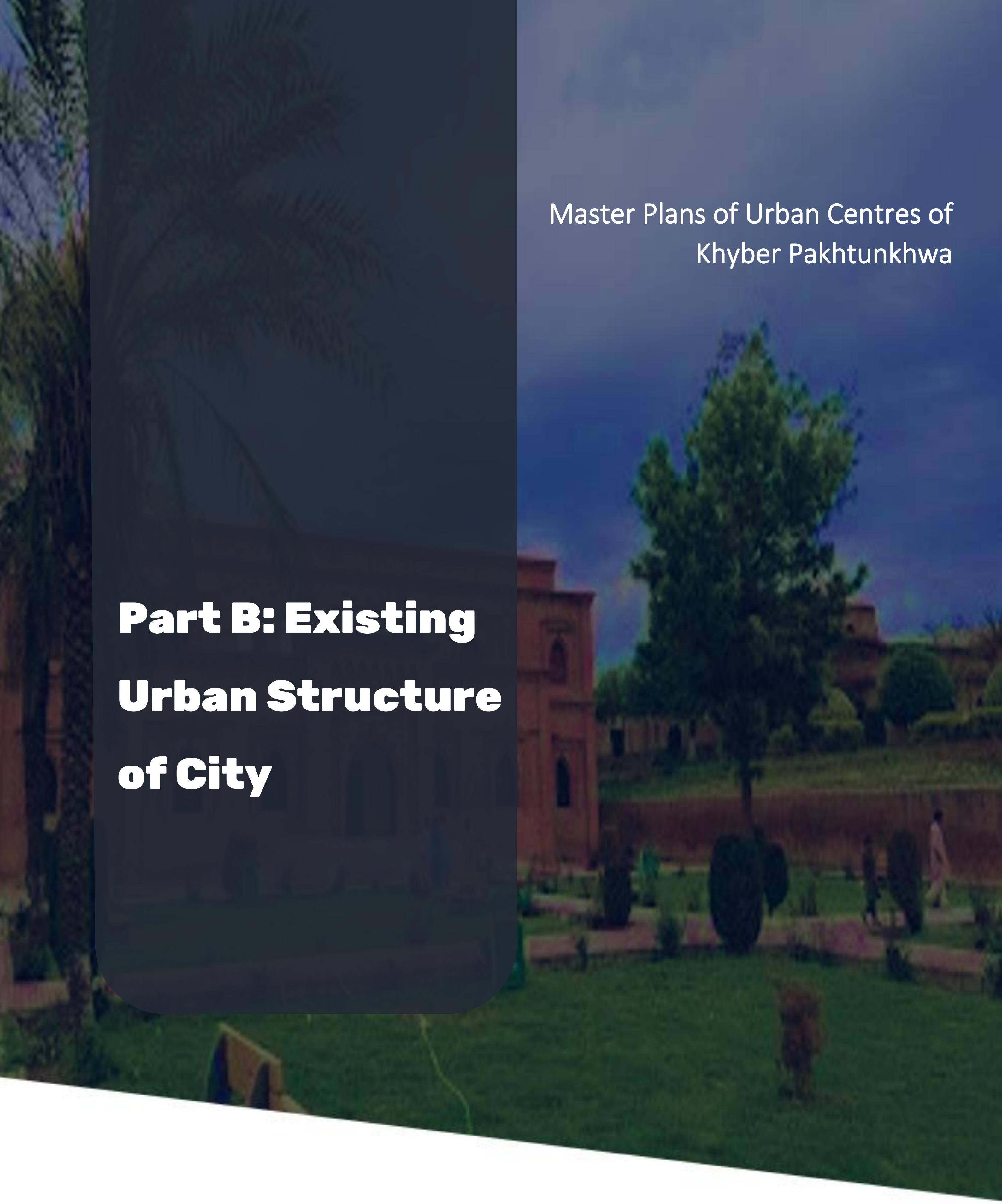
Source: Devised by Consultants

3.1.7. SWOT Analysis of Charsadda

Table 1: SWOT Analysis Charsadda Study Area

	Strength	Weakness
Internal	• Fertile/agriculture Land • Handicrafts • Shoe-making business • Tobacco • Marble • Fertile Land • Rivers • Politically, culturally and religiously strong • Talented youth • Livestock, fish and poultry farming • Small industrial estates/flour mills • Existing railway track & Road connectivity	• Reduction in agriculture land due to development of illegal housing schemes • Poor drainage and sanitation system • Poor law and order situation • Drug abuse • Encroachment • Poor infrastructure • Unemployment • Closure of industries and railways • Loss of agricultural land • Lack of health facilities • No parks/playgrounds • Endangered aquatic life • Outdated agricultural practices • Lack of traffic signals • Target killing • Inheritance issues (especially for females)
	Opportunities	**Threats**
External	• Advance agricultural development • Industrial Estate • Technical education • Tourism • Bus transit system • Textile industry • E-commerce • Mines & Minerals • Small dams • Aqua-culture • Sports	• Floods • Landlords • Pollution • Drug addiction • Water scarcity • Waterlogging and salinity • Further loss of agricultural land • The threat of wildlife extinction

Source: Devised by Consultants



Master Plans of Urban Centres of Khyber Pakhtunkhwa

Part B: Existing Urban Structure of City

Chapter 4: City's Spatial Growth and Urban Form

4.1. Physical Background

Charsadda city is a town and headquarters of Charsadda District, situated in the Khyber Pakhtunkhwa province of Pakistan. According to 2017 census, it is the eighty fifth largest city of Pakistan. Lying within the Peshawar Division. The Charsadda city covers a total area of around 44.74 square kilometers.

4.1.1. Topography

The city is located at the west of Khyber Pakhtunkhwa between the 71° 53' to 71° 28' East longitudes and 34° 03' to 34° 38' North latitudes, at an average elevation above sea level of 982 feet and very minor elevation changes up to 98 feet, the landscape within two miles of Charsadda is mostly composed of agriculture (70%), man-made surfaces (16%), and bare soil (14%). The area within 10 miles also has relatively minor elevational differences (272 feet), with 89% of it occupied by agriculture. The topography within 50 miles contains only minimal variations in elevation (8,435 feet), covered by cropland (40%) and bare soil (34%). The surrounding belt of high terrain, which descends from the foothills, and the two centre plains, "Doaba" and "Hashtnagar," which are all irrigated and extensively farmed, encompasses Charsadda's topography. Fine alluvial deposits constitute the Charsadda Plain itself, and their depth and composition vary depending on where they are located and how far below the surface they are. The majority of the plain's soil is light and permeable, and from one to six metres of it contains more or less sand. This is a sandy clay mixture that is usually followed by beds of nodular limestone, gravel, and sand.

4.1.2. Physiography

Located in the west of KP, Charsadda is surrounded by the districts Mera Prang, Fazlabad and Geedar Kalay.

4.1.3. Geology and Soils

Charsadda is largely covered by recent alluvium. These are Pleistocene-era deposits found in recent rivers, streams, flood plains, and lakes. The other rock types are also present in the Charsadda study area. These rocks are typically revealed in the outcrops that stretch in a belt which bounds the Charsadda.

4.1.4. Seismic Condition

Charsadda city falls in zone 2b of minor damage zone corresponding to PGA (Peak Ground Acceleration) value of 0.0667g to 0.1g. The only active faulting near the project area is near to Uch Khattak ridge which passes from Piran to Ghari Chandan near fault, above the Panjal Khairabad Thrust (PKT) in Attock Cherat range. Therefore, this active fault could be the future seismic risk for Charsadda.

4.1.5. Hydrography

Charsadda city consists of rich water resources comprised of Canals, tube wells, dug wells, shallow pumps and main rivers flowing through its terrain. A branch of Jindhi River flows in the north-western side of Charsadda, outside the study area. In addition to the surface constant water resources, the farmers and the city also use dug wells, shallow pumps and tube wells for irrigation and general water supply.

4.1.6. Surface and Ground water

The primary irrigation source of water for Charsadda city is the River Jhindi (also known as Nullah Jhindi) that flows outside of the study area. The shape of groundwater table generally follows the surface topography. The discharge from the groundwater reservoir in Charsadda city occurs mainly through existing water wells and outflow to river and evapo-transpiration water table is near to the ground surface particularly in areas adjacent to the rivers.

4.1.7. Climate

The climatic analysis of the study area was carried out by classifying it into different seasons as follows:

1. **Spring (mid-March to mid-June):** characterized by high temperatures, and high rainfall with moderate humidity and high-speed winds. Summer (mid-June to mid-September).
2. **Summer (Mid-June – mid-September):** hot and dry weather, with temperatures reaching highs of 35 C in July and average precipitation of 6-7mm per month.
3. **Autumn (mid-September to mid-November):** characterized by moderate temperatures and low rainfalls. The daily minimum reaches 5 C in November with moderate humidity, as the humidity again reduces after the monsoon and low-speed winds.
4. **Winter (mid-November to mid-March):** characterized by very low temperatures, with an average daily maximum of 10 C, moderate rainfalls, with an increasing amount of rainfall at the end of the winter.

In Charsadda, the summers are long, sweltering, and clear while the winters are cold and partly cloudy. Over the course of the year, the temperature typically varies from 39°F to 107°F and is rarely below 33°F or above 113°F.

Figure 5: The Climatic Conditions-Charsadda

1 Precipitation

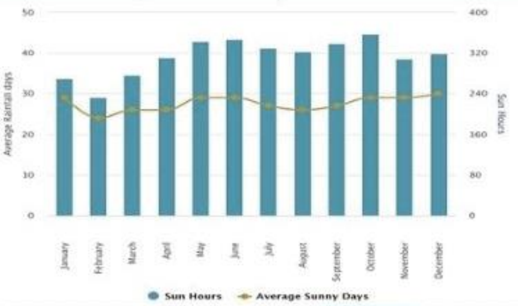
- Highest daily average temperature is 43oC
- Minimum temperature is also 26oC on average.
- Average of the hottest day and coldest night of each month for the previous 30 years is displayed in "Hot Days and Cold Nights."

Temperature 2

- Hot season lasts for 4.0 months, from May 12 to September 12, with an average daily high temperature above 36°C.
- Cool season lasts for 3.1 months, from December 3 to March 6, with an average daily high temperature below 21°C.
- Coldest month of the year is January, with an average low of 4.4°C and high of 16°C.

3 Average Sun Hours and Rainy Days

- Longest day in 2022 is June 21, with 14 hours, 26 minutes of daylight,
- Shortest day is December 22 with 9 hours, 53 minutes of daylight.

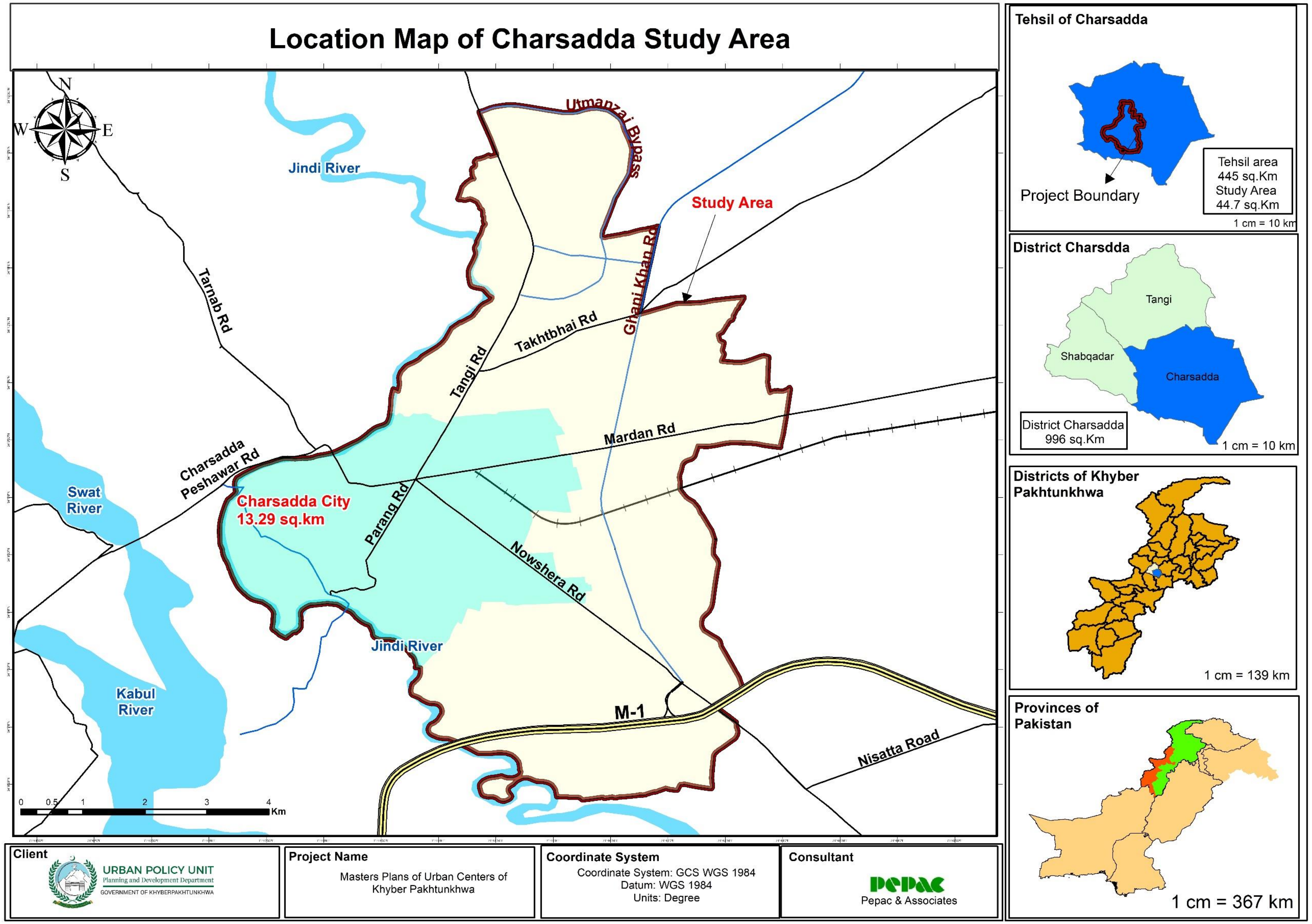


Cloud and Humidity 4

- Clearer part of the year in Charsadda begins around May 5 and lasts for 6.4 months, ending around November 19.
- Cloudiest month of the year is March, during which on average the sky is overcast or mostly cloudy 41% of the time.

Source: Devised by Consultants

Map 1:Location Map Charsadda Study Area



Source: Devised by Consultants

4.2. Study Area Boundary Analysis

4.2.1. Existing Study Area Boundary

Charsadda city is comprised of 11 neighborhood Councils (NCs) which make up the existing MC area of 13.29 km^2. While, the study area delineated for Charsadda comprises of 10 Village Councils (VCs) with the total area of 31.45 km^2. The rationale for adding these VCs in the planning area is based on the previous pattern of Charsadda city expansion, which gives a hint that the future expansion of the city will occur in these areas. Thus, both the NCs and VCs composed a proposed boundary for the city for 2042 with the anticipation that owing to proposed development in these VCs, these will be converted into NCs in the future.

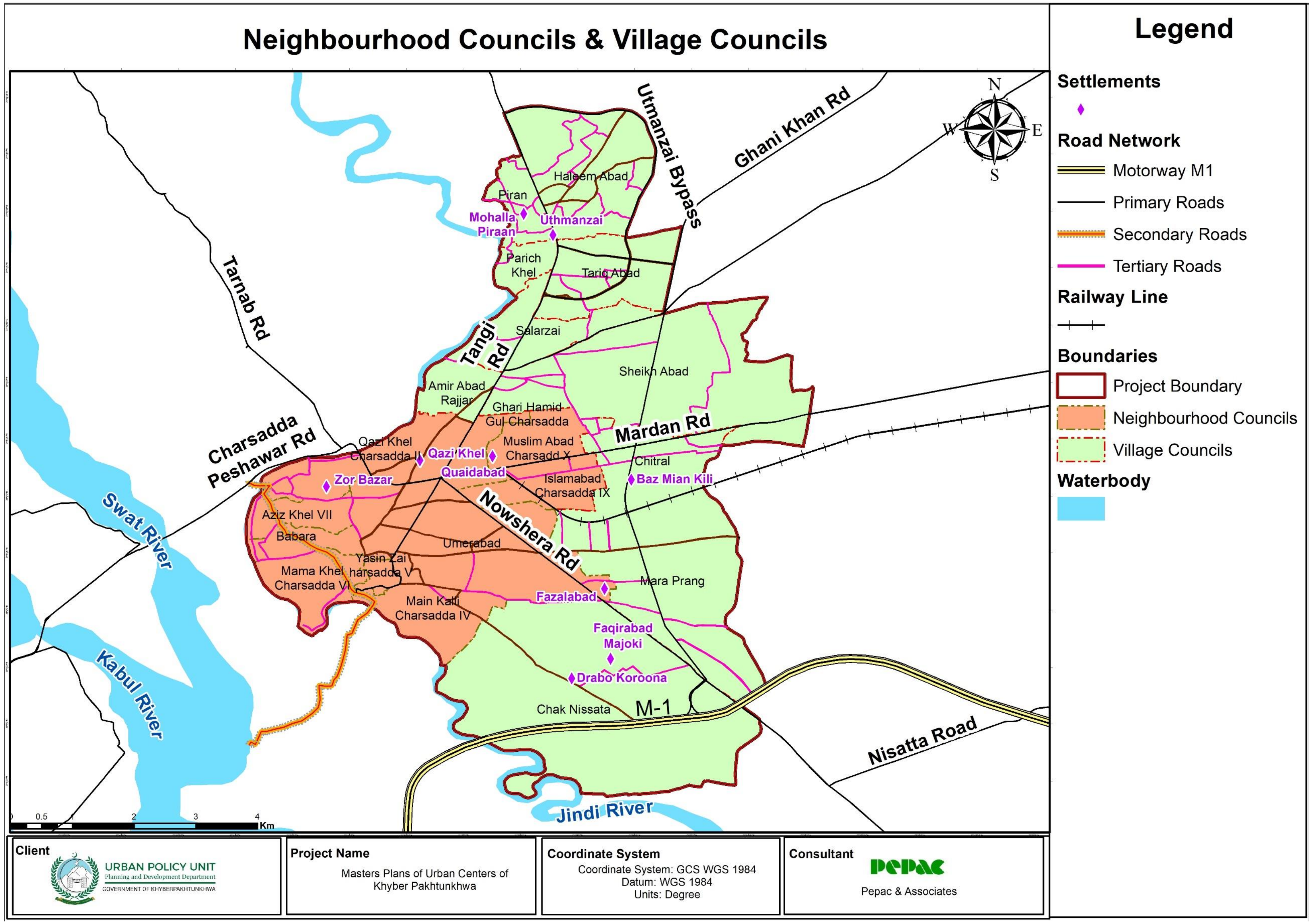
The vacant area available within the NCs is to be used for infill development, and the VCs, excluding the built-up within, have been taken as "proposed areas" for future development and expansion of the existing city. The map of existing urban boundary i.e., NCs and proposed city boundary i.e., VCs is attached below. The details of these administrative areas; NCs and VCs, are given below.

Table 2: Administrative area and population of Charsadda study area – 2017

Sr. No.	Name of Administration Unit	NC/VC	Area (acre)	Area (sq.km)	Population 2017
Existing Urban Boundary					
1	Mama Khel	NC	303.18	1.23	4,993
2	Yasin Zai	NC	54.65	0.22	8,352
3	Main Kalli	NC	369.25	1.49	15,169
4	Babara	NC	154.17	0.62	6,661
5	Aziz Khel	NC	179.06	0.72	18,096
6	Mirzagan	NC	201.60	0.82	12,156
7	Umerabad	NC	1,064.55	4.31	16,107
8	Qazi Khel	NC	182.38	0.74	7,184
9	Ghari Hamid Gul	NC	215.91	0.87	9,616
10	Muslim Abad	NC	342.53	1.39	7,258
11	Islamabad	NC	216.32	0.88	8,973
Total of NCs			3,283.59	13.29	114,565
Proposed Urban Boundary for Year 2042					
12	Chak Nissata	VC	2,289.18	9.26	4510
13	Mara Prang	VC	1,220.67	4.93	10,276
14	Ameer Abad Rajjar	VC	217.14	0.87	16,018
15	Salarzai	VC	399.87	1.61	11,813
16	Parich Khel	VC	127.26	0.51	7,116
17	Piran	VC	191.68	0.77	8,587
18	Haleem Abad	VC	782.29	3.17	6,370
19	Tariq Abad	VC	505.92	2.25	8,674
20	Chitral	VC	503.63	2.03	11,760
21	Sheikh Abad	VC	1,533.54	6.21	10,056
Total of VCs			7,771.17	31.45	95,180

Source: Primary Data Collected from Field Surveys

Map 2: NC/VC Map Charsadda Study Area



Source: Devised by Consultants

4.2.2. NC's Wise Sampling Size

The primary survey has covered a 2% sample of households as given in the TORs which were around 324 household out of 16,171 households[4]. The sample size was distributed proportionately to all neighbourhood councils of Charsadda city to make the sample representative of the whole urban population. Stratified sampling technique was used to make sampling more consistent while ensuring the representation of all segments including women-headed households, poor and ultra-poor households, disabilities, and other social and economic disparities.

For choosing sample from each union council of urban Charsadda, proportion allocation method was used, and the formula used is given in footnote[5].

The following table shows the sample size of each NC:

Sr. No.	NC Name	Population	Sample Surveyed
1	Aziz Khel	18,096	56
2	Barbara	6,661	21
3	Ghari Hameed Gul Mian	9,616	30
4	Islamabad	8,973	28
5	Mama Khel	4,993	16
6	Mian Killi	15,169	47
7	Mirzagan	12,156	38
8	Muslimabad	7,258	23
9	Qazi Khel	7,184	22
10	Umarabad	16,107	50
11	Yaseenzai	8,352	26
12	Total	114,565	357

Source: Devised by Consultants

[4] District Census Report, 2017
[5] Let there are N villages/union councils, where data should be collected from the field. Then
N=N1+N2+N3+N4……………Nh=∑Ni
A total of 'n' sample should be studied for analysis. The size of total sample is:
n=n1+n2+n3+…………. nh=∑ni
The sample size of each union council is:
ni =n*Ni/N…
Where:
ni=sample selected from each UC, n=Total sample size, Ni=population of each NC, N=Total population of all NCs

4.3. Demography

4.3.1. Population

According to 2017 Census, Charsadda MC has a population of 114,558 where 16,171 households are residing in 15,894 housing units[6] with a growth rate of 1.44%[7]. The 1998 census calculated the MC population to be 87,218 with a population growth rate of 1.39%[8]. The city spanning over 44.74 km^2 [9] is considered to have average household size of 7.08.[10]

4.3.2. Population Composition

The population composition of Charsadda is divided by age, gender, disability, ethnicity, and literacy in the 2017 census. The total male population highlighted in Charsadda city is 59,042 while the total female population is 55,513 making the gender ratio of 106.35. Although the population of transgender people in Charsadda is extremely small (there are only 3 of them) according to 2017 census[11] but still it will be accounted while defining the gender breakdown in the city.

In regard to the age composition in Charsadda MC, roughly 73% of the population is over the age of 10, while 55% are over the age of 18certainly requiring resources for their livelihood including, employment and opportunities to play a substantial role in economic development of the city. Only 6% of the population falls in the category of above 60 years. In term of religion, the Muslim and non-Muslim population composition of Charsadda MC shows that out of 114,558 people, 114,161 are Muslim and 397 are non-Muslim[12].

4.4. Population Density

4.4.1. Population Density

Since every city and country consists of different populations and areas, each is comprised of a certain distinct population density. There is no one scale fit all criteria to define population density. However, population density has been divided into three classes i.e., low, medium, and high based on the criteria given in KP Urban Policy 2022. According to this, medium density is accounted as 20,000 persons per square kilometre or 200 people per hectare. Therefore, low density refers to minimum number of people living in per unit area which is being 100-200 people per hectare, and high refers to maximum number of people living in per unit area which is being 301-400 people per hectare. This should be noted, however, that

[6] Selected Housing Characteristics of Urban Localities, Table 26, Charsadda, Census 2017, PBS
[7] Area, Population by Sex, Sex Ratio, Population Density, Urban Proportion, Household Size and Annual Growth Rate, Charsadda, Census 2017
[8] Urban Localities by Population Size and Their Population by Sex, Annual Growth Rate and Household Size, Census 2017
[9] Land Use Plan of District Charsadda Report, Table 2-5, UPPU, 2017
[10] Urban Localities by Population Size and Their Population by Sex, Annual Growth Rate and Household Size, Table 2, Charsadda, Census 2017
[11] Selected Population Statistics of Urban Localities
[12] Task B-Background Studies Report-Charsadda, UPU.

the criteria adopted in KP Urban Policy is solely based on distance from transit areas and it does not take into account other socio-economic factors.

Table 3: Density Criteria Given in KP Urban Policy

Density Zone	Distance from Transit	Average Population Density
Mixed Use with High Density Residential (CBD)	< 400 meters	301-400 PPH
Mixed Use with Medium Density Residential	400 – 800 meters	201-300 PPH
Low Density Residential	> 800 meters	100 to 200 PPH

Source: KP Urban Policy, 2022 to 2030

Viewing the international examples, New York city has population density of 10,852 per km^2, Delhi has population density of 10,000 per km^2, Lahore has population density of 6,300 per km^2 and Murree similarly attains population density of 539 per km^2. The overall population density of Charsadda study area is 4,919 per km^2 suggesting that this is the average population density of Charsadda city.

4.4.2. Charsadda Population Density by NC/VC

The population density for each neighborhood and village council has been calculated according to the standards given in KP Urban Policy 2022. The population density analysis has been performed for existing population of 2017, projected population of 2022 and overall projected population till 2042. The projection made depicts that most of the NC's currently possessing a low-density profile will attain the same population density status till 2042 being low for example Mama Khel NC, Umerabad NC, etc while some of the NC's currently having medium densities will convert to high density areas till 2042. Similarly, the projections made for VC's predicted very identical change in the population densities till the highlighted time period of master plan. A comparison table showing the population density of each neighborhood council and village council is as follows:

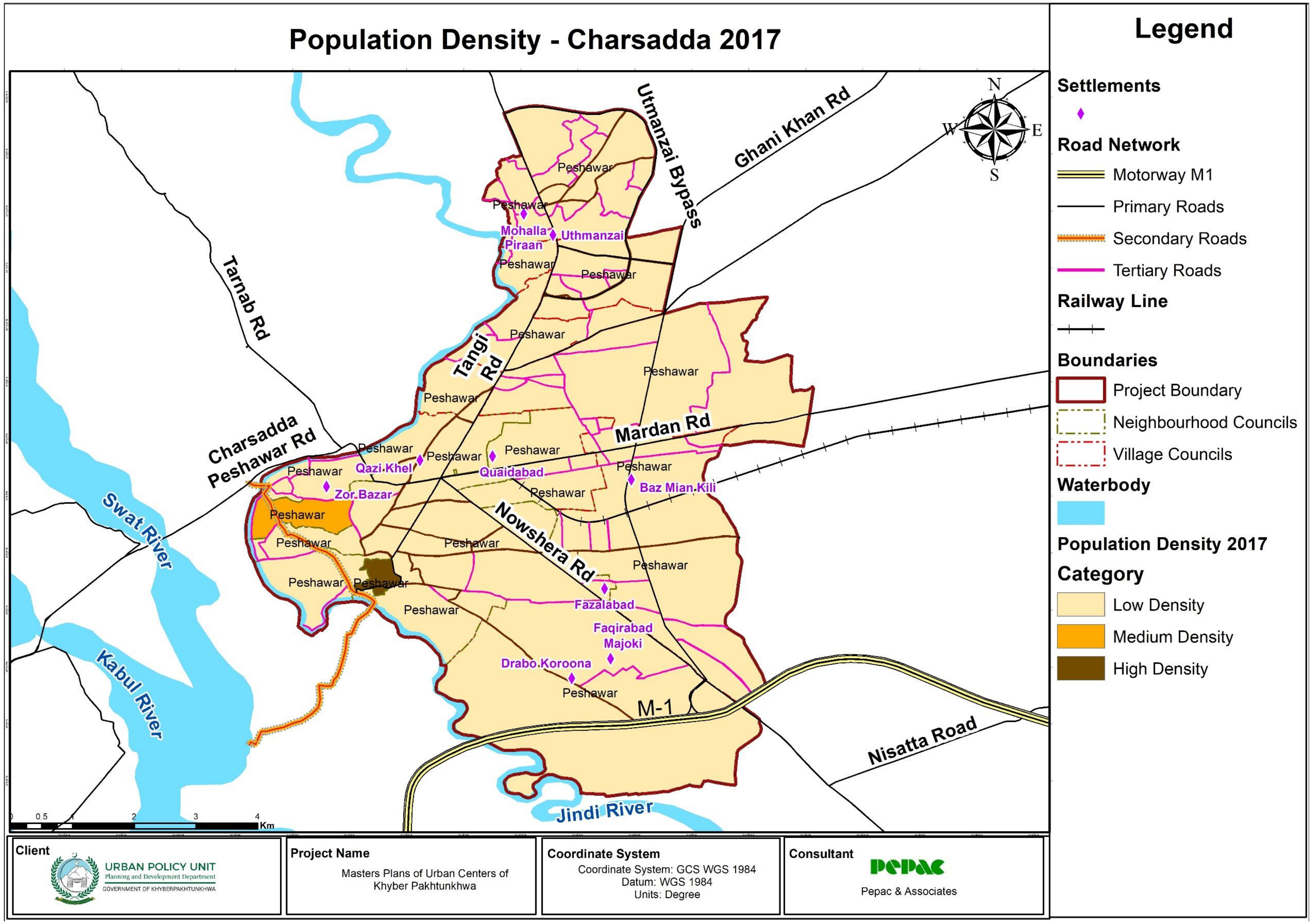
Table 4: Population Density by NC and VC of Charsadda Study Area

Sr. No	Name of NC/VC	NC/VC	Area (Acres)	Area (Hectares)	Population 2017	Density 2017 (PPH)	Density Scale	Pop Proj (2022)	Density 2022 (PPH)	Density Scale	Pop Proj (2042)	Density 2042 (PPH)	Density Scale
1	Mama Khel Charsadda VI	NC	303.18	122.69	4,993	41	Low	5,909	48	Low	9,417	77	Low
2	Yasin Zai harsadda V	NC	54.65	22.11	8,352	378	High	9,885	447	High	15,753	712	High
3	Main Kalli Charsadda IV	NC	369.25	149.43	15,169	102	Low	17,953	120	Low	28,610	191	Low
4	Babara	NC	154.17	62.39	6,661	107	Low	7,883	126	Low	12,563	201	Medium
5	Aziz Khel VII	NC	179.06	72.47	18,096	250	Medium	21,417	296	Medium	34,130	471	High
6	Mirzagan Charsadda I	NC	201.60	81.58	12,156	149	Low	14,387	176	Low	22,927	281	Medium
7	Umerabad	NC	1064.55	430.81	16,107	37	Low	19,063	44	Low	30,379	71	Low
8	Qazi Khel Charsadda II	NC	182.38	73.81	7,184	97	Low	8,502	115	Low	13,550	184	Low
9	Ghari Hamid Gul Charsadda	NC	215.91	87.37	9,616	110	Low	11,381	130	Low	18,137	208	Medium
10	Muslim Abad Charsadd X	NC	342.53	138.62	7,258	52	Low	8,590	62	Low	13,689	99	Low
11	Islamabad Charsadda IX	NC	216.32	87.54	8,973	103	Low	10,620	121	Low	16,924	193	Low
12	Chak Nissata	VC	2289.18	926.40	4,510	5	Low	5,338	6	Low	8,506	9	Low
13	Mara Prang	VC	1220.67	493.99	10,276	21	Low	12,162	25	Low	19,381	39	Low
14	Amir Abad Rajjar	VC	217.14	87.87	16,018	182	Low	18,958	216	Medium	30,211	344	High
15	Salarzai	VC	399.87	161.82	11,813	73	Low	13,981	86	Low	22,280	138	Low
16	Parich Khel	VC	127.26	51.50	7,116	138	Low	8,422	164	Low	13,421	261	Medium
17	Piran	VC	191.68	77.57	8,587	111	Low	10,163	131	Low	16,196	209	Medium
18	Haleem Abad	VC	782.29	316.58	6,370	20	Low	7,539	24	Low	12,014	38	Low
19	Tariq Abad	VC	505.92	204.74	8,674	42	Low	10,266	50	Low	16,360	80	Low
20	Chitral	VC	503.63	203.81	11,760	58	Low	13,918	68	Low	22,180	109	Low
21	Sheikh Abad	VC	1533.54	620.60	10,056	16	Low	11,902	19	Low	18,966	31	Low
Total			**11054.76**		**209,745**								

Source: Devised by Consultant using Secondary Data Collected from TMA Charsadda

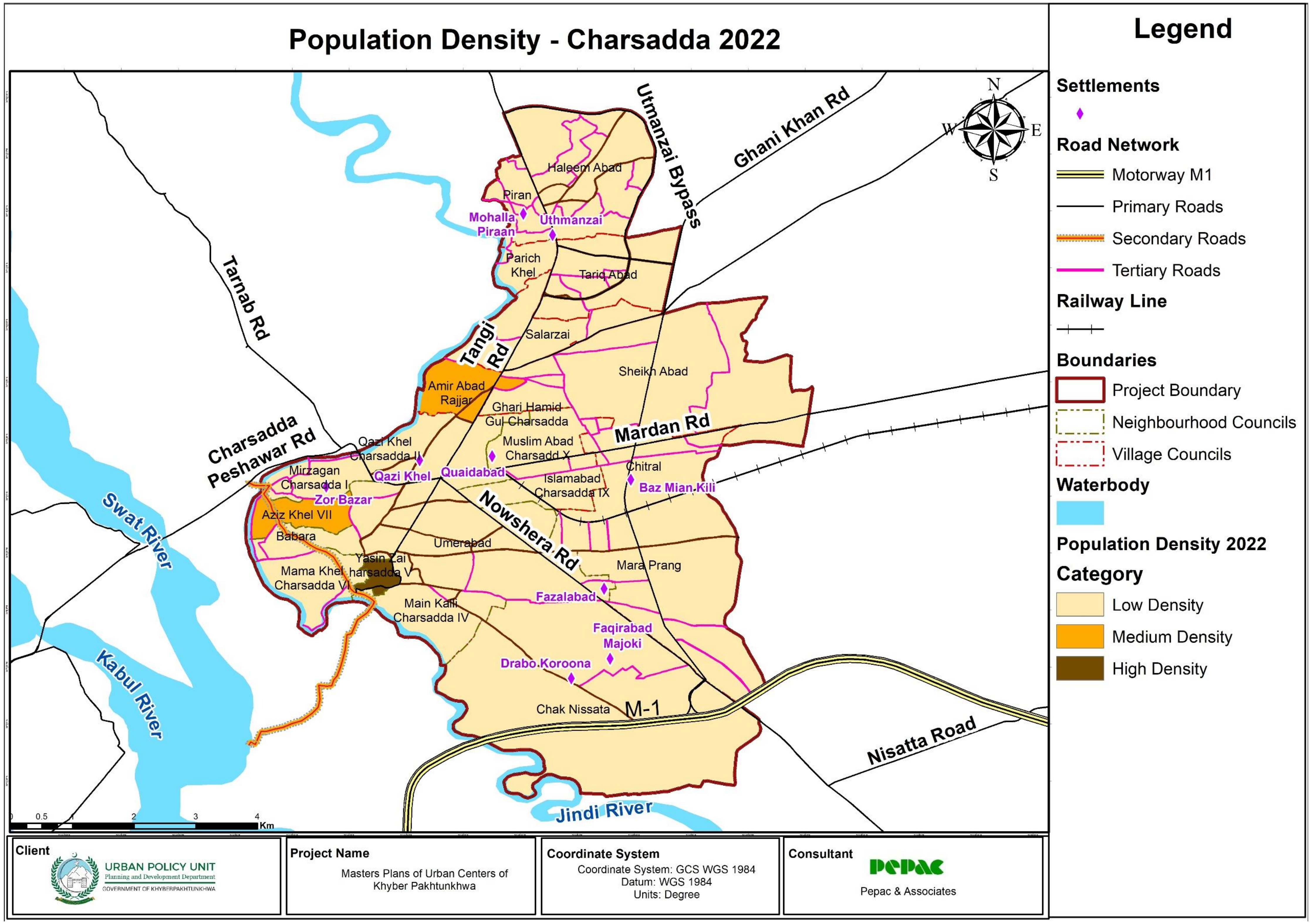
The following map depicts population density of all NCs and VCs.

Map 3: Population Density Map Charsadda Study Area 2017



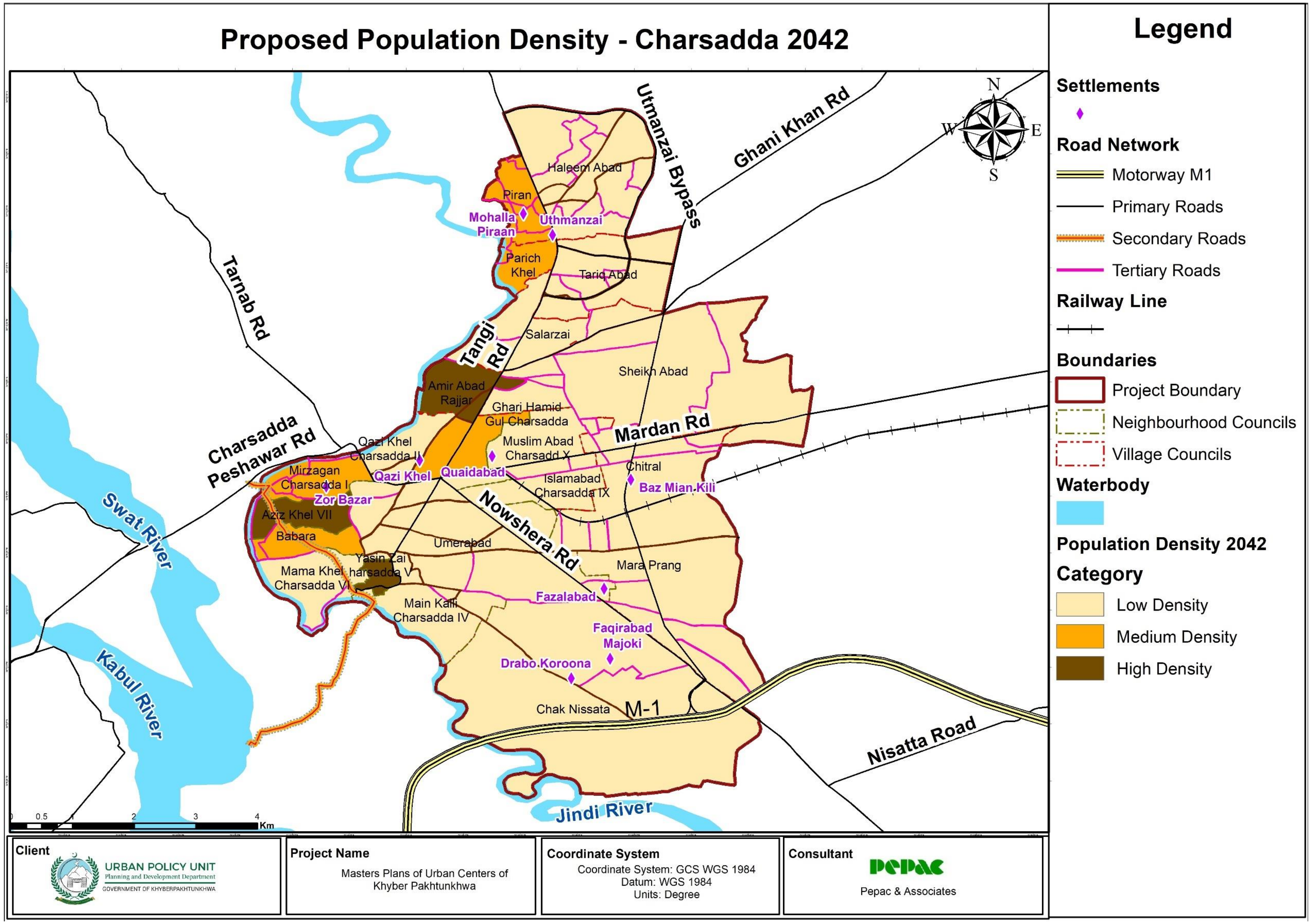
Source: Devised by Consultants

Map 4: Population Density Map Charsadda Study Area 2022



Source: Devised by Consultants

Map 5: Population Density Map Charsadda Study Area 2042



Source: Devised by Consultants

4.5. Population Projection

For population projection of the study area till 2042, three methods including geometric growth, exponential growth, and declining growth were utilized and their average has been considered for guiding future development. There were 114,558 people and 15,894 households in the Charsadda MC in accordance with 2017 census. However, since the study area consisted of neighbourhood councils and village councils rather than MC, the existing population of neighbourhood councils and village councils that fell within the study area boundary was used which was provided by the concerned local government. The population of all neighbourhood and village councils turned out to be 114,565 and 95,180 respectively, making the total population of the study area 209,745 in 2017.

The projected population of the study area with respect to the three methods highlighted and their average is given below while the details and rationale of each method is given in Annexure 3:

Table 5: Population Projection – Charsadda Study Area

Population Projection Methods	Base Year	Projection					Growth Rate (%)
	2017	2022	2027	2032	2037	2042	Average
Declining Growth	209,745	255,556	305,895	359,208	413,507	466,656	2.95
Exponential Growth	209,745	241,487	273,230	304,973	336,715	368,458	1.44
Geometric Method	209,745	225,287	241,982	259,914	279,175	299,862	2.61
Average	209,745	240,777	273,702	308,031	343,133	378,326	2.33

Source: Calculated by Consultant

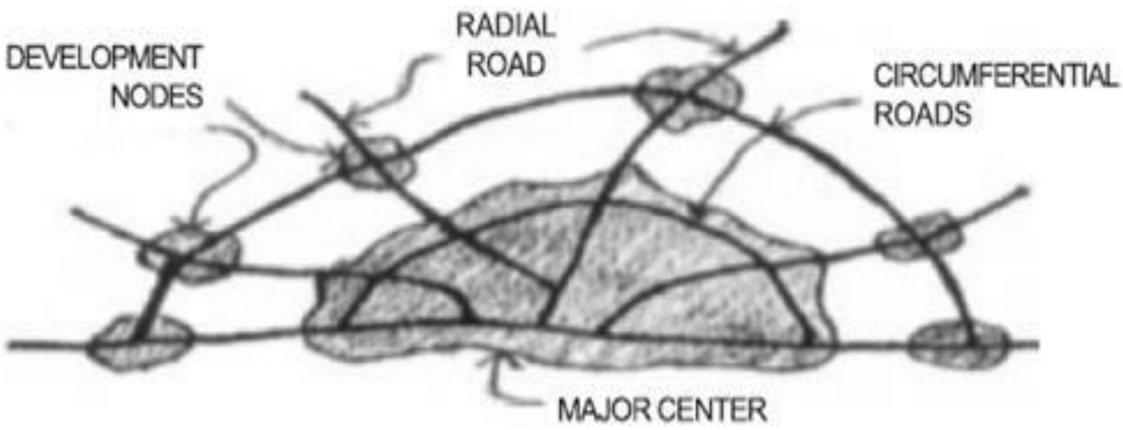
4.6. Spatial Urban Form

The spatial urban form of a city refers to the developed layout pattern with respect to spatial arrangement of different land uses. The spatial urban form can help identifying the possible future growth pattern of a city through identifying existing city extent. For Charsadda city, the assessments made to identify the existing spatial urban form highlighted two structure types i.e., radial and linear pattern upon which the existing and future development could possibly fit. The detailed identification of these patterns are defined in the coming sections.

4.6.1. Radial City Structure

The first concept envisioned for identifying the city's development structure and existing growth pattern is "Radial City". In radial patterned development, the city radiates outwards from a centralized hub which can be a commercial area, transportation hub, public amenity, i.e., university, etc. or any other similar central point of concentration. The reference image below shows that from a certain central point of attraction, radial roads diverge, and after a certain distance, these roads are intersected through circumferential roads ultimately connecting them with each other. As the city grows and the distance among radial roads increases, more circumferential roads are developed to maintain the arterial geometry. The population residing or close to the major centre has access to all basic services; however, the population located quite away from the centre may find it difficult to reach all the necessary amenities. Therefore, small development nodes will develop at unification points of radial roads and circumferential roads.

Figure 6: Concept of Radial city

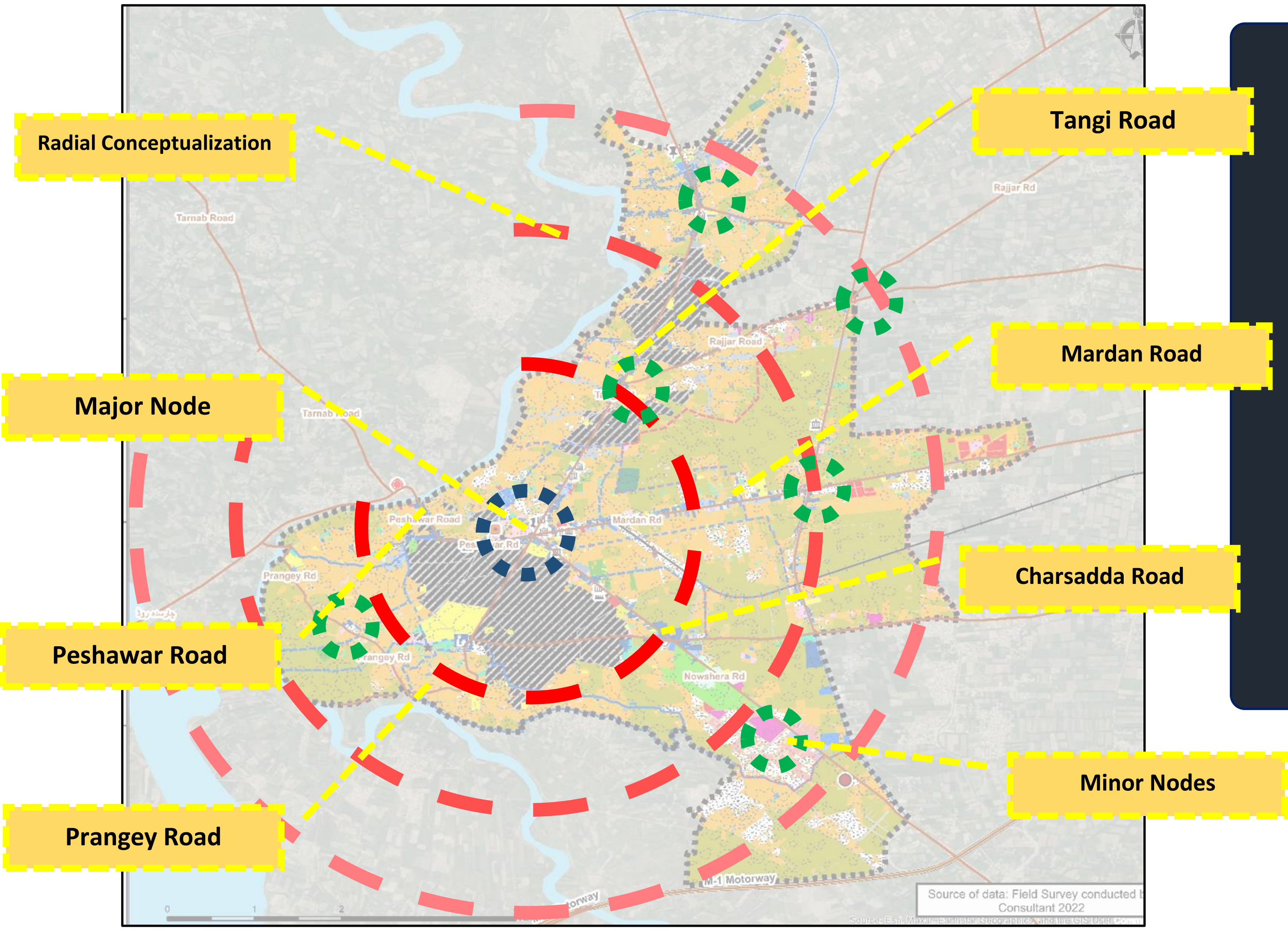


Viewing the existing spatial configuration, Charsadda is a unique city because of having a graveyard in the centre which has indulged development around it over the years. Since a graveyard cannot be a growth magnet, the commercial and residential development around it has been visualized as the major centre in Charsadda. This turns out to be Tehsil Bazaar on Main Charsadda road around Farooq Azam Chowk. Major basic amenities like DHQ Charsadda, District Jail, NADRA office, Regional Passport Office, bus stations, shopping centres, banks, schools and colleges are present within one kilometer of Farooq Azam Chowk. The chowk links four radial roads i.e., tangi Road, Peshawar Road, which extends from Charsadda Road and serves as a main corridor from and towards the main Peshawar city, Mardan Road and Charsadda Road, which connect Charsadda to Mardan and Charsadda respectively.

Mardan road, also known as the northeastern highway, attains a linear development pattern, and major commercial and mixed land use are located adjacent to the road in a longitudinal manner. Bus terminal for Mardan and Peshawar is also located on the road. The southeastern DHQ Hospital Road possess a similar elongated development pattern. However, due to the presence of Charsadda Cemetery on one side of the road, the intensity of development can be observed on one side of the road instead of both. Planned housing development has been observed on the road, and the road ultimately connects to M1 highway through Charsadda Nisatta Interchange. From the highlighted centre of the city, another highway crossing the study area vertically from north to south passes by defining the city's development pattern. The Tangi Road leads towards the northern side of the study area, which passes through compact linear urban development. At the same time, the extreme southern artery crosses through the main Charsadda Cemetery, ultimately connecting with Prang settlement through Prang Road.

The following illustration shows the conceptualization of the Radial City Model with respect to Charsadda city.

Figure 7: Radial City Structure – Charsadda Study Area



Source: Devised by Consultants

The model depicts that the city will continue to grow outwards from the highlighted center point i.e., Farooq Azam Chowk through major arteries including Mardan Road, Tangi Road, Charsadda Road, Charsadda Road and Prangey Road in a radial pattern. The primary network of roads will provide multiple options for the expected population to settle in near future meanwhile ensuring ease of commute with the central city. These roads will then be connected with major radial arteries to best fit with the highlighted scenario. However, it would not be essential for the city layout to adopt a perfect radial shape instead, the existing connecting roads in vertical and horizontal manner could also be utilized to fit with the model. Moreover, a guided development within the sliced chunks of land left through division of land with roads will facilitate planned development opportunities for different land uses.

4.6.1.1. Pros of Radial City Structure

- Direct commuting lines from and towards the city center i.e., central business district.
- Equidistant approach from entire city towards main city area increasing settlement options for city's population.
- Eliminate risk of traffic collisions through more controlled environment of traffic flow in comparison to those in linear pattern.
- Provide more enhanced primary options of transition for traffic reducing probability of secondary and tertiary roads utilization.
- More feasible in delimiting city premises reducing chances of uncontrolled urban sprawl.
- A more just provision of land uses over sliced trapezoidal chunks of land.

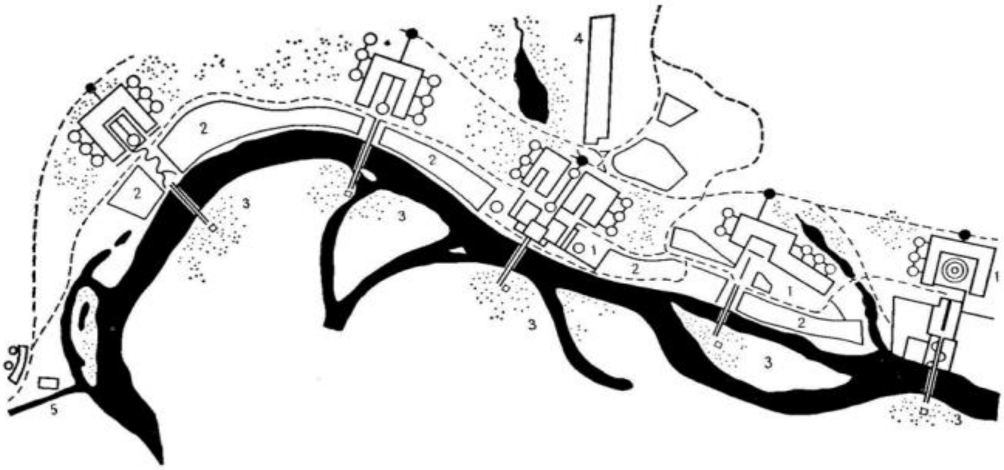
4.6.1.2. Cons of Radial City Structure

- More load on central city area with respect to traffic congestion and land utilization.
- Curved primary arteries may affect the maximum sight distance of travelers.
- Sort of irregularity in basic city layout is expected due to radial pattern.

4.6.2. Linear City Structure

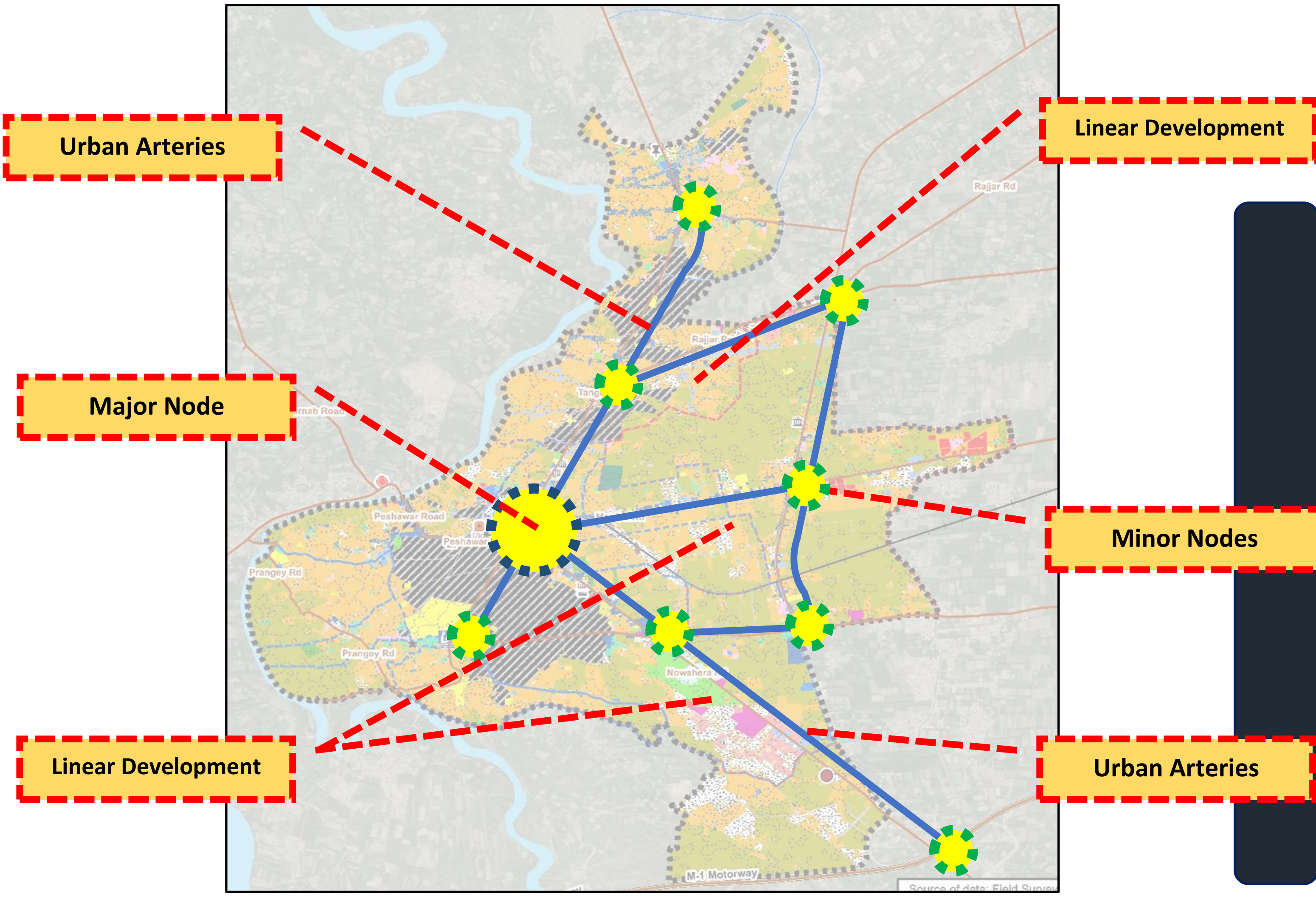
The second concept for visualizing city structure of Charsadda is the concept of linear city. The concept of linear city arose in the late 19th century certainly presented by Soria Y Mata in 1880's. The core idea of the linear city was to connect Madrid with several settlements located in the surroundings. According to the concept, the form of public transportation networks is supposed to determine the overall development pattern of the city, which ultimately endorses linear development along the proposed transportation lines. The land uses are allowed to freely grow on the either side of these transportation arteries and attain flexibility to reproduce their structure. The layout of linear development is not certainly supposed to be linear instead there could be curved or differently shaped lines which can facilitate linear development in an urban area. The following figure represents the development pattern which on which city development can rely.

Figure 8: The layout of Great Stalingrad by A. and L. Vesnin, 1930.



In Charsadda city, the existing development pattern nearly correlates with linear development due to connectivity of urban and village centers through arterial roads. The city possesses a big graveyard in the exact middle which somewhat disturbs the identification of central point in the city because of not representing a functional centrality. This also disturbs the application of radial model upon the area and makes the city more feasible for linear development model to be adopted. For instance, the main Farooq Azam Chowk is directly connected with the Utmanzai area in the north through Tangi Road in a linear pattern. Extensive land uses have been developed along the road including graveyards representing a linear development pattern. Similar linear development can be observed along DHQ Hospital Road leading towards M1 through Charsadda Nisatta Interchange. In the entire Charsadda city, such linear nodal connectivity can be seen through major roads already facing or expecting linear growth. Along with the immediate node of Farooq Azam Chowk, the secondary nodes within the populated areas also possess potential for linear development. For example, Ghani Khan Road laid vertically from north to south on eastern part of the study area has supported development on either side facilitating commercial and housing development. The following figure highlights the possible linear development pattern that the city currently attains.

Figure 9: Linear City Structure – Charsadda Study Area



Source: Devised by Consultants

The model depicts that the urban area of Charsadda will continue to grow in a linear pattern along with the connected roads. Despite its on-ground presence, it is hard to say that the city will best fit with the linear growth model because compact development along the several nodes including the main Farooq Azam Chowk has already been witnessed which endorses the suitability of radial pattern more than the linear growth model upon the city. But still, it can be seen that the arterial network on eastern side of the study area have the potential to adapt linear development pattern than other parts of the city area.

4.6.2.1. Pros of Proposed Linear City Structure

- All the development in linear cities take place along the main commuting line which increases accessibility of transportation facilities if provided properly.
- Linear patterned development provides more openness and flexibility for growth.

- Industrial hubs, being developed in a linear way become more accessible to reach for the working class through transportation means.
- Increased connectivity through direct routes of different towns falling within the city area.
- Brings more opportunities for planned urban development.

4.6.2.2. Cons of Proposed Linear Development Structure

- Linear development alongside roads may hinder effective land utilization because of the dependency of land use pattern upon roads.
- Linear sense of development may shadow the organic image because of not having a city center.
- Unnecessary elongation of overall urban pattern.
- More resistance in terms of utilities provision because of linear development nature.

Chapter 5: Comparative Analysis of Existing Land Use Pattern

5.1. Existing Land use Pattern

The administrative categorization of the district comprises of three Tehsils: Tangi, Charsadda and Shabqadar. Charsadda is an urban center consisting of several Neighbourhood Councils (NCs) which makes up the existing MC area. However, the study area delineated for development of Charsadda master plan 2042 also includes village councils along with the NC's. The rationale for adding these village councils in the planning area is based on the previous pattern of Charsadda city expansion, which gives a hint that the future expansion of the city will occur in these village councils. The Task B report provided areas and population projections for each NC, while in Task C, since future expansion proposals are to be accommodated in the areas of village councils, population of each has been determined. There are ten village councils comprising 29.5 km^2 and eleven neighbourhood councils comprising 13.29 km^2 within the study area.

The major land use categories have been developed using the classes given in Khyber Pakhtunkhwa Land Use and Building Control Act 2021 which have been further divided into sub-classes like agriculture land divided into agriculture and orchards, commercial land use divided into wholesale commercial, retail commercial and other commercial including workshops, convenience shops, and petrol pumps etc. The residential land use has been divided into planned and unplanned residential with planned residential only being in the approved housing schemes of Charsadda. The arterial connectivity includes major highways passing through the study area, primary roads and secondary roads.

The following table shows the area as well as the percentages of different other land uses in the city of Charsadda for the year 2022:

The major identified land use of the area is agriculture which comprises of 47.86% of Charsadda city, followed by residential that is 22.41%, and commercial is 2.90%. The roads network comprises of about 6.45% of the total land cover. The total vacant area available in the study area is 5.29% which is supposed to be used for infill development. The land uses are given with respect to the hierarchy defined in Khyber Pakhtunkhwa Land Use and Building Control Act, 2021 in the table below.

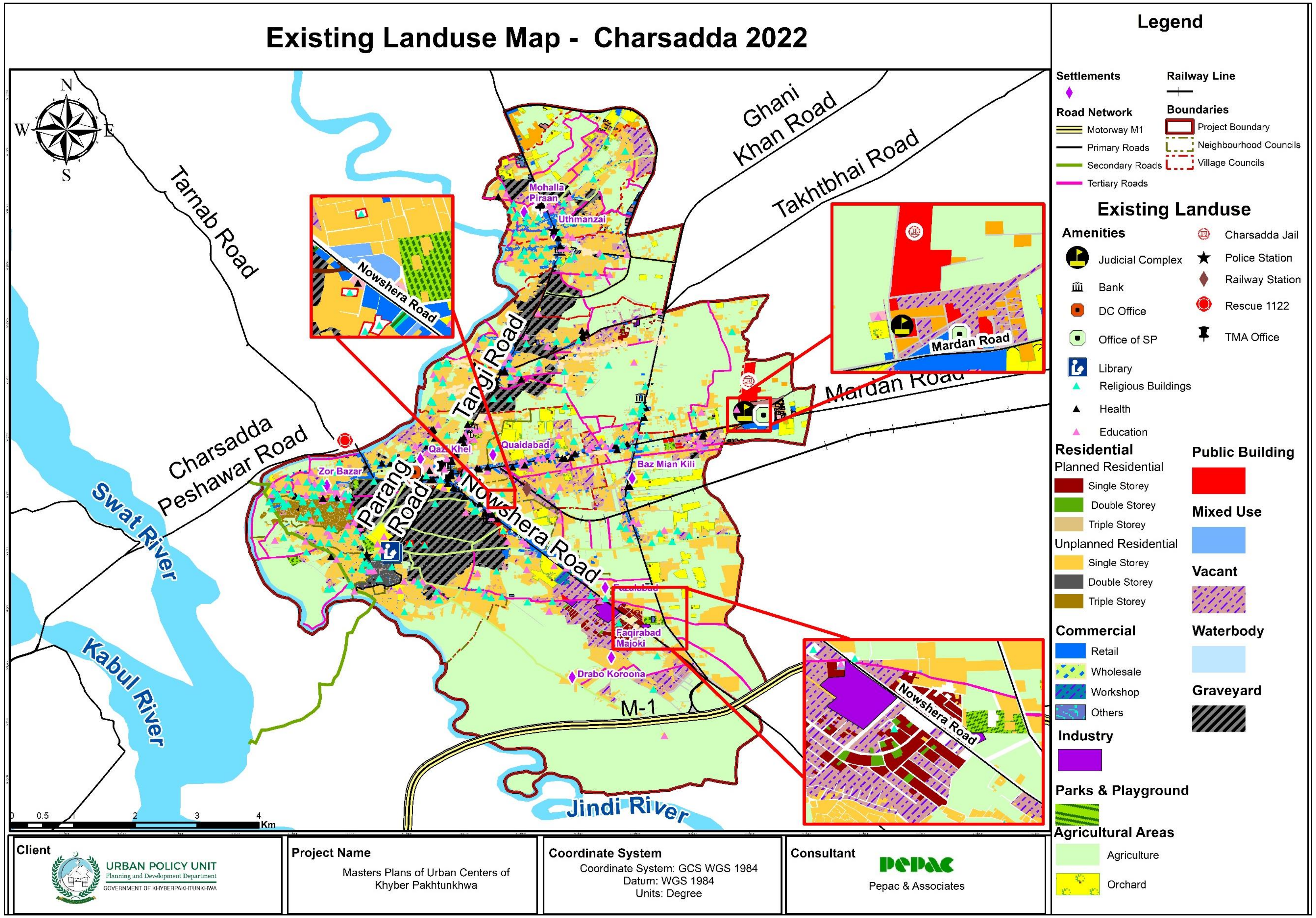
Table 6: Existing Land Use Division – Charsadda Study Area

Main Land Use	Category	Area (acre)	Area (km^2)	Percentage (%)
Residential Area	Planned (Single Storey)	45.86	0.19	0.41%
	Planned (Double Storey)	3.33	0.01	0.03%
	Planned (Triple Storey)	2.25	0.01	0.02%
	Unplanned (Single Storey)	2,273.26	9.20	20.56%
	Unplanned (Double Storey)	73.15	0.30	0.66%
	Unplanned (Triple Storey)	79.4	0.32	0.72%

Main Land Use	Category	Area (acre)	Area (km^2)	Percentage (%)
Commercial Area	Retail	193.33	0.78	1.75%
	Wholesale	66.71	0.27	0.60%
	Other	60.96	0.25	0.55%
Industrial Area	Industry	25.94	0.10	0.23%
Agricultural Area (irrigated, barani, fallow etc)	Orchard	368.1	1.49	3.33%
	Agriculture	5,291.31	21.41	47.86%
Amenities	Education	91.29	0.37	0.83%
	Graveyard	872.87	3.53	7.90%
	Health	23.53	0.10	0.21%
	Religious building	31.54	0.13	0.29%
	Mixed Use	15.85	0.06	0.14%
Concentrated Public Sector Area	Public building	55.57	0.22	0.50%
Recreational Area	Playgrounds	46.94	0.19	0.42%
Vacant Land	Vacant	584.72	2.37	5.29%
Waterbody	Waterbody	135.70	0.55	1.23%
Arterial Connectivity	Motorway M1	69.28	0.28	0.63%
	Primary Roads	104.60	0.42	0.95%
	Secondary Roads	66.38	0.27	0.60%
	Tertiary Roads	472.86	1.91	4.28%
Total		**11,054.75**	**44.74**	**100.00%**

Source: Devised by Consultant

Map 6: Existing Land use Map – Charsadda Study Area



Devised by Consultants

5.2. Land Use Comparison with National and International Standards

Due to the absence of standardized criteria for city-level land use comparisons, it is not advisable to make direct comparisons across cities. This is because various socio-economic, cultural, and industrial factors vary from city to city, resulting in unique requirements for each urban area. Therefore, it is crucial to consider the specific context and characteristics of each city when determining the allocation of land for different purposes. Furthermore, in order to promote vertical development within the city, requirement of additional land for development becomes redundant. Even then, a comparison has been generated using secondary data obtained from Land Use Distribution at Town/City Level (500,000+ Population) given in District Land Use Plan of Charsadda 2019, NRM standards of a city consisting of population 100,000 to 499,999, Khyber Pakhtunkhwa Urban Policy 2022-2030 and international standards of Botswana. Charsadda MC and study area falls within the category of urban city as its population is less than 500,000 and therefore is considered to be a small urban town here.

Table 7: Land Use Comparison with NRM Standards

Sr. No.	Land Use	Area (Acres)	Existing Land Use Percentages	Land Use Distribution at Town/City Level (500,000+ Population) given in District Land Use Plan 2019	NRM Standards for city of 100,000 to 499,999 people	Land Use Standards KP Urban Policy	Existing Landuse Division Gaborone, Botswana
1	Residential	2477.25	22.41%	45-52%	24-32%	30-50%	40%
2	Commercial	321	2.90%	2-3%	0.5-2%	40-60% (Including Industrial)	10%
3	Community Facilities (Health, Education, Mixed Use, Religious, Public etc.)	217.79	1.97%	7.5-10%	2-10%	10-20%	----
4	Green/Recreational / Open Spaces	46.94	0.42%	5-7.5%	1-7%	15-20%	----
5	Graveyard	872.87	7.90%	-	0.5-4%	2%	----
6	Vacant	584.72	5.29%	-	3-17%	---	----
7	Roads	713.13	6.46%	25-30%	12-29%	30-40%	----
8	Industry	25.94	0.23%	-	3-8%	40-60% (Including Commercial)	5%
9	Other/Reserved (agriculture, orchard etc.)	5795.11	52.42%	2-5%	2-5%	---	----

Source: Devised by Consultant

According to the aforementioned land use standards, Charsadda city attains varying nature with respect to the compatibility of different land uses in terms of percentage. Viewing the residential facilities as per NRM standards, it is required for a city to have 24% to 32% of residential facilities and Charsadda study area falls slightly below the range with 22.41% of residential area in total. Similarly, standards adopted in District land use plan of Charsadda city and Khyber-Pakhtunkhwa Urban Policy 2022-30 devise minimum standard of 45 and 30 percent for residential land use, respectively. According to both standards, the residential in the study area is not adequate. For commercial land use, the area currently possesses 321 acres (2.90%) of commercial areas which is adequate with respect to the standards mentioned in National Reference Manual i.e., 0.5-2% and district land use plan, i.e., 2-3%, but commercial is not adequate as per the International Standards (Botswana) and Land Use Standards KP Urban Policy.

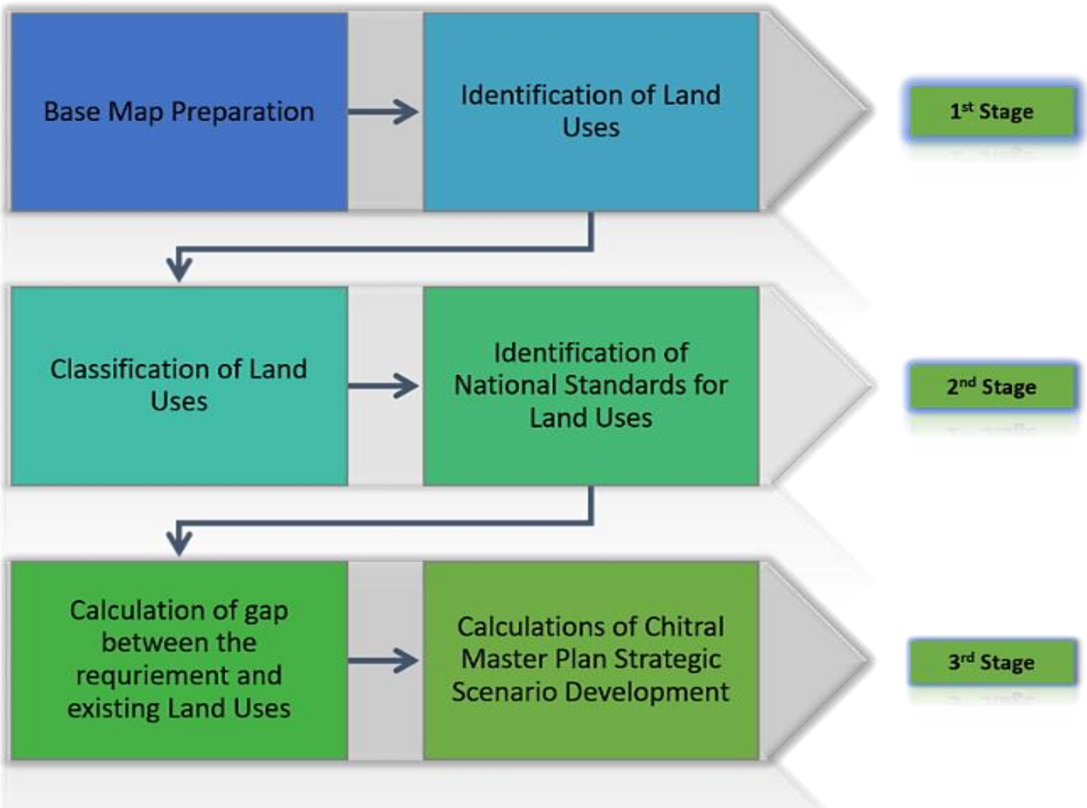
5.3. Existing Land Use Problems

- Existing open and green spaces are not located within each neighbourhood council and village council.
- Many non-conforming uses exist within the city such as education with graveyard.
- The industrial area in Charsadda is comparatively smaller in size compared to other urban areas.
- Commercial area is within the range but closer to lower end of the range.
- Charsadda has a relatively smaller institutional area when compared to other urban areas.
- Existing roads are either narrow or one way which cause major traffic congestion within the city.
- The city has developed haphazardly with no planning intervention and implementation of land use building bylaws of KP.
- There are only three approved housing schemes, and both are located on the outskirts of the city.
- Most of the buildings in the city are in poor condition in terms of façade and urban design.
- There is no specific pattern of roads and streets, and their width increases or decreases arbitrarily.

5.4. Land Use Demand Calculations

Land demand estimation is a critical step while conducting any master planning exercise as it helps in the planning and management of land resources, which are finite and essential for human well-being and economic development. It determines the amount of land that will be required for different land uses, such as residential, commercial, industrial, and institutional uses. The land demand can support sustainable development and guarantee that land has been used efficiently. Future land requirements are influenced by a variety of sociological and economic factors, existing land use regulations, and the regional physical characteristics. For integrated development, the proposals for 2042 are based on assessments of land use demand. The stages of Land use demand calculation can be broken down into the following three stages:

Figure 10: Stages for land Demand Calculation – Charsadda Study Area



The estimation of future built-up area demand is done by using NRM standards. The process typically involves several stages, beginning with the preparation of a base map of the study area and the identification of various land uses for classification. Next, the existing land uses are compared to the national standards set out in the NRM to determine any discrepancies. These comparisons enable the identification of any gaps between the existing land uses and the required estimates. Through this approach, it becomes possible to estimate the demand for land and to develop strategies for the optimal use of available land resources. The process helps to ensure that land is used efficiently, sustainably, and in accordance with national standards, promoting economic growth, and human well-being.

A detail Land use survey has been carried out for the existing area of Charsadda city. Like every city, Charsadda also consists of several land use zones having residential, commercial, and public buildings. The land use categories have been developed using National Reference Manual (Table. 10.2). The major land uses are agriculture and vacant, commercial, residential, institutional buildings including health, education, public building, mixed-use and religious buildings. Land demands are estimated with detailed existing data of land uses. The land use demand for the projected population of 2022 and the future requirements for 2042 are calculated. By comparing the required areas for various land uses reveals a deficit between existing and required land uses. Following are land demand calculations for Charsadda Study Area (2022-2042).

Table 8: Land Demand Calculations – Charsadda

Land Use Categories	Recommended Land Use Allocation Standard (For Population between 100,000-499,000 people)	Existing area (Acres)	2022		Minimum Gap	Maximum Gap	2042	
			Minimum Requirement (Acres) 2022	Maximum Requirement (Acres) 2022			Minimum Requirement (Acres) 2042	Maximum Requirement (Acres) 2042
National Reference Manual Standards (NRM)								
Housing / Residential	26-48%	2477.25	2874.24	5306.28	396.99	2829.03	2874.24	5306.28
Commercial	0.5–2%	321.00	55.27	221.10	-265.73	-99.91	55.27	221.10
Industrial	3-8%	25.94	331.64	884.38	305.70	858.44	331.64	884.38
Institutional	2-10%	217.79	221.10	1105.48	3.31	887.69	221.10	1105.48
Recreational Open space	1-7%	46.94	110.55	773.83	63.61	726.89	110.55	773.83
Vacant	3-17%	6379.83	331.64	1879.31	-6048.19	-4500.52	331.64	1879.31
Roads	12-29%	713.13	1326.57	3205.88	613.44	2492.75	1326.57	3205.88
Graveyard	0.5-4%	872.87	55.27	442.19	-817.60	-430.68	55.27	442.19

Source: Devised by Consultants

According to the aforementioned standards, Charsadda study area falls within the category of city whose population is less than 499,999 and more than 100,000. Therefore, it is considered to be a small urban city. The land demand estimates depicted above the requirements for projected population of 2022 and 2042. The maximum and minimum gap have been calculated by comparing existing land uses with maximum and minimum land use requirement of 2022.

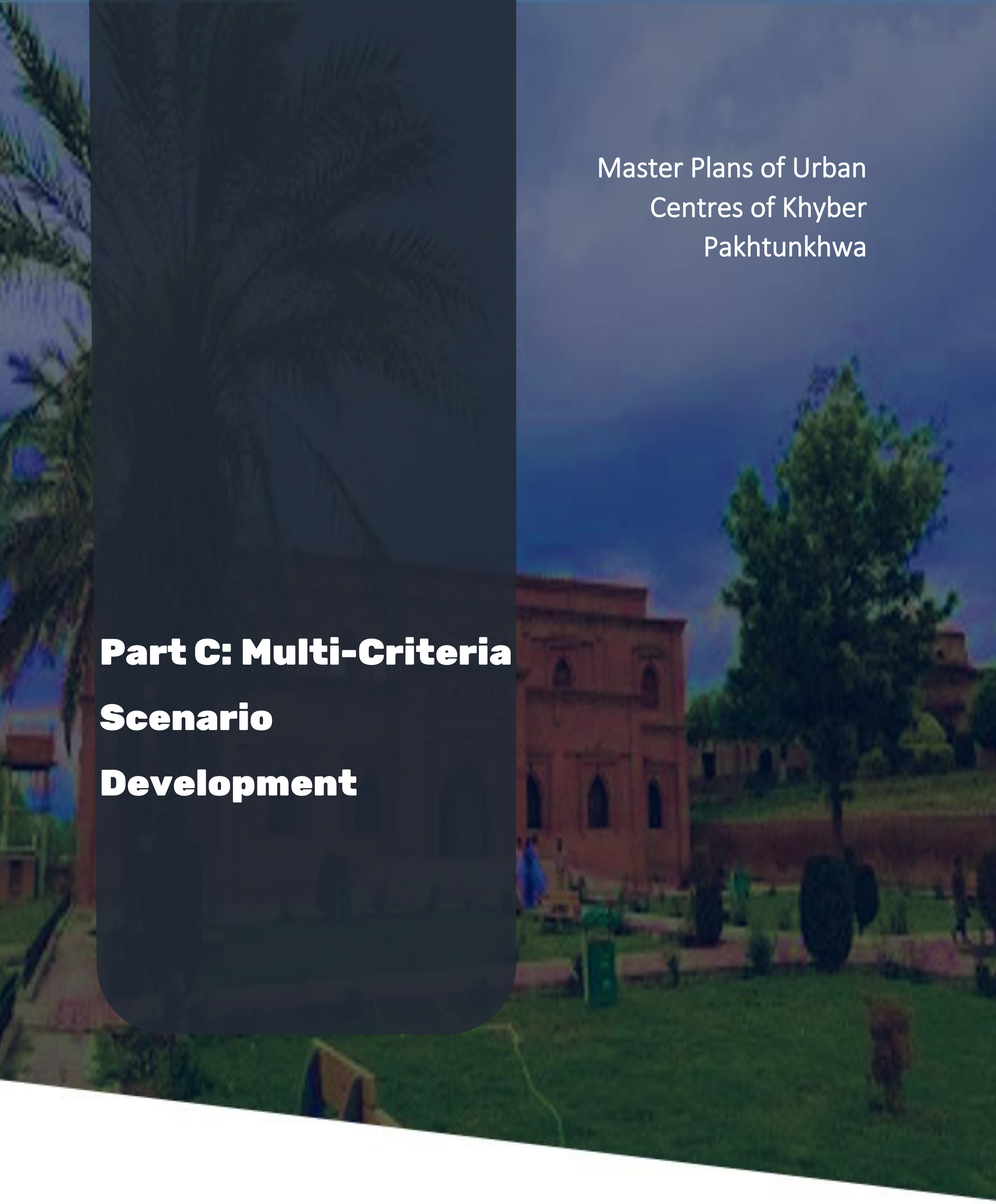
For 2042, the maximum land required for residential is 5306.28 acres, similarly, 884.38 acres is required for industrial purposes, and 1105 acres are recommended to serve the institutional demands of Charsadda study Area. 221.10 acres of land is required for commercial activities. Green spaces are vital for the dwellers of the city as they act as breathing spaces for the area. Around 773.83 acres is required for recreational open spaces in the city. The area falling under water body are not accounted for land demand calculation.

5.5. Actual Need of the City

The land use needs of a city are considered by a variety of factors i.e., population growth, economic development, transport infrastructure, environmental considerations, community preferences, etc. although the future land use needs of the Charsadda city have been estimated and compared with respect to certain standards, still a more just provision of variety of land uses being conforming in the most suitable way is inevitable to be done. For instance, viewing the calculations made for commercial demand in the area, the results showed a negative gap for commercial spaces in the study area but still viewing the constrains of residential development, a certain zone has been provided for commercial development in the city. for developing a more rationalized scenario, the commercial area proposed in already approved district land use plan is utilized for master plan zoning of the study area. Similarly, the institutional zone in form of civic zone has been proposed in accordance with the areas identified in district land use plan for covering institutional land use demand of the study area. For industrial land use, a minimum requirement of 842.98 acres of industrial land was observed through calculations.

Master Plans of Urban Centres of Khyber Pakhtunkhwa

Part C: Multi-Criteria Scenario Development



Chapter 6: Multi-Criteria Decision Analysis

6.1. Suitability Mapping

Modern-day challenges are often multifaceted and involve a range of conflicting interests and solutions. To address these challenges, it is essential for different groups to collaborate and compromise to find the most viable solution. Many of these problems have a geographic component, and the use of Geographic Information Systems (GIS) in combination with various analytical frameworks can facilitate the decision-making process. The criteria for evaluating potential solutions are not always clear-cut and can vary along a gradient. Therefore, it is necessary to assign weights to each input according to its significance or percentage of influence. The weight assigned to each input is relative and must add up to 100%, ensuring that all factors are considered in the decision-making process

6.2. Multi-Criteria Decision Analysis (MCDA)

Multi-criteria decision making is one approach used to facilitate the consideration of multiple criteria by decision makers. MCDA is used to logically evaluate and compare multiple, often conflicting, criteria in order to make the best possible decision. Especially useful when you have a wide range of stakeholders with conflicting interests, values and goals.

Though the multi-criteria analysis can be carried out in multiple ways, the consultant has pooled two criteria types into one i.e., land suitability classes and conditional suitability.

The general equation for multi-criteria analysis is as under:

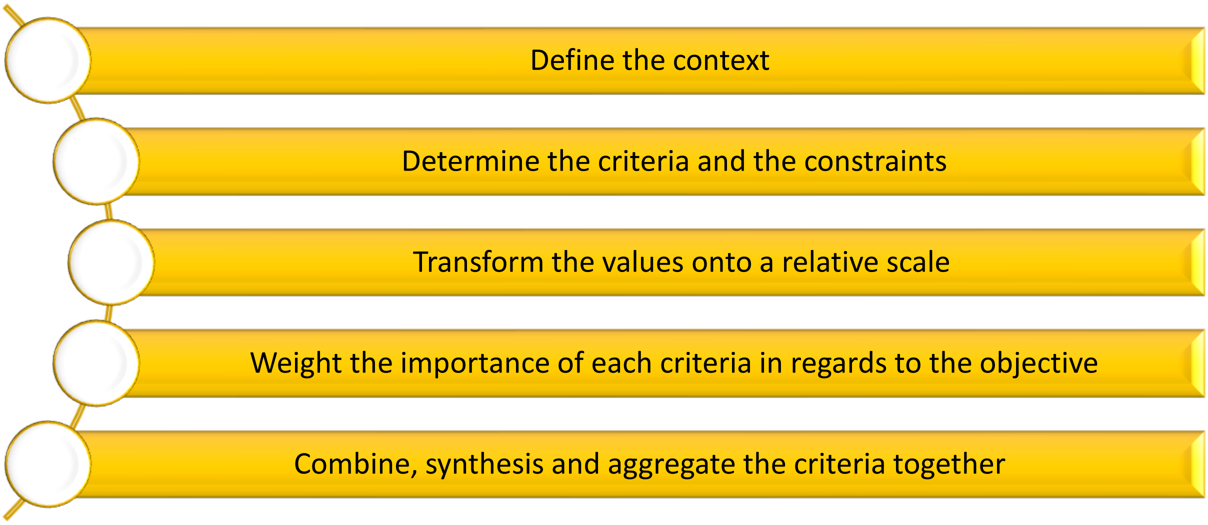
$$Multi\ Criteria\ Analysis = w \text{ x } C \text{ x } r$$

Where;
w = specified weightage to the class.
C = Criteria or Factors involved in criteria.
r = restrictions or constraints involved in the criteria.
Multi-criteria analysis can be performed using a variety of techniques. It can be performed using raster calculator method or it can be used using the weighted overlay method. In either case, the basic essence remains the same. The core of multi-criteria analysis revolves around the equation stated above.

6.2.1. Methodology of MCDA

A Multiple Criteria Decision Analysis (MCDA) is a structured process for evaluating options with conflicting criteria and choosing the best. The methodology of MCDA is given below:

Figure 11: Methodology of Multi-Criteria Decision Analysis (MCDA)



Source: Devised by consultants

6.3. Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP), introduced by Thomas Saaty in 1980, is a **pairwise** comparison method to be used on the criteria in regards to the objective. These pairwise comparisons are carried out for all relevant factors within an analysis- usually no more than 7.

Figure 12: AHP Criteria Explanation

Relative importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to objective
3	Weak importance	Experience and judgment slightly favour one activity over another
5	Strong importance	Experience and judgment strongly favour one activity over another
7	Demonstrated importance	One activity is strongly favoured and demonstrated in practice
9	Extreme importance	The evidence favouring one activity over another is of highest possible order of affirmation
2, 4, 6, 8	Intermediate values	When compromise is needed between two adjacent judgments

Source: Coyle, G. (2004). Analytic Hierarchy Process (AHP)

6.4. Constraint Mapping

Important components of constraint maps are identification of areas that will not be considered for residential development. This the type of Boolean map composed of ones and zeros. The pixels with a value of 0 represent places that cannot be utilized stating them as constraints. On the other hand, the pixels with a value of one represent areas with no restrictions and can be utilized for residential development as they meet the suitability requirement.

6.4.1. Method for Constraint Map Generation

To create the constraint maps, two conditions were considered. If no buffer zones were required, simply reclassify the original land use map by assigning the constraint class a value of zero and the remaining classes a value of one. On the other hand, regarding forest cover, water cover, and building cover, all the constraints are converted into zero and zeros to one, as they are all constraints for residential development and no buffers are assigned. In ArcMap, buffer analysis is applied to the original land use where buffer regions are required. The outcome of the buffer analysis is then reclassified by assigning zeros to pixels smaller than the buffer threshold and ones.

6.4.2. Method for Factor Map Generation

Two types of factor map need to be generated. A Euclidean distance calculation was performed to generate factor maps for distance to protected drinking water sources, roads and the downtown factor map. Then, based on the relationship between the suitability of housing development and the distance, suitable scores were calculated. To generate factor maps not related to distance, as slope factor map and hazards factor map, scores of suitability varies from 0 to 255 were calculated using the relationship between the suitability of housing development and the original data. The final factor map was created.

6.5. Factor mapping

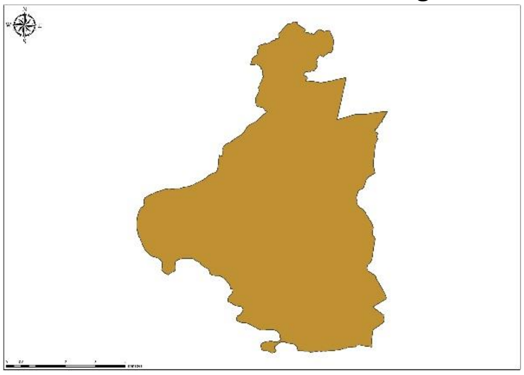
The factor mapping illustrates the several factors that affect the suitability of residential development. It permits the detection of classes or groups of persons whose descriptors are related. Unknown individuals can be simply put into factor graphics and then identified using a classification technique. The consecutive distances are usually made up of values from 0 to 255. The higher the value, the more appropriate the location for housing development.

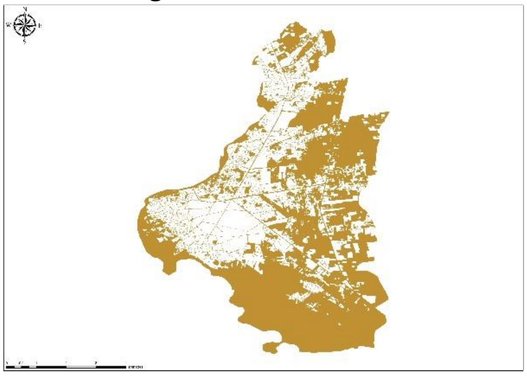
6.5.1. Method for Factor Map Generation

Two types of factor map need to be generated. A Euclidean distance calculation was performed to generate factor maps for distance to protected drinking water sources, roads and the downtown factor map. Then, based on the relationship between the suitability of housing development and the distance, suitable scores were calculated. To generate factor maps not related to distance, as slope factor map and hazards factor map, scores of suitability varies from 0 to 255 were calculated using the relationship between the suitability of housing development and the original data.

6.6. Land Suitability Analysis (LSA) for Land uses

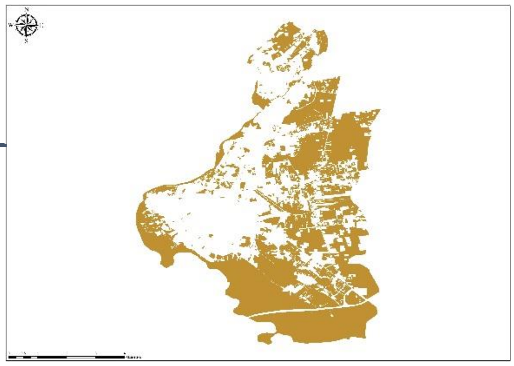
Figure 13: Suitable land for Zoning



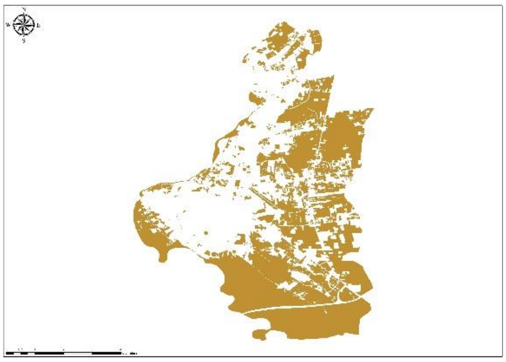


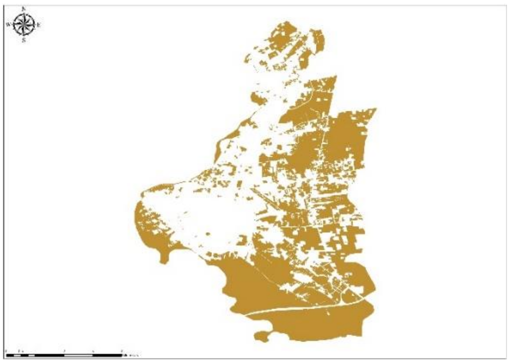
Project Boundary Area = 11054.75 Acres

Built-up Erase = 4239.89 Acre



Waterbody Erase = 135.70 Acres





Roads Extracted = 713.11 Acres

Total Land Available for Future Development = 5860 Acre

Source: Devised by Consultant

6.6.1. LSA Criteria for Residential

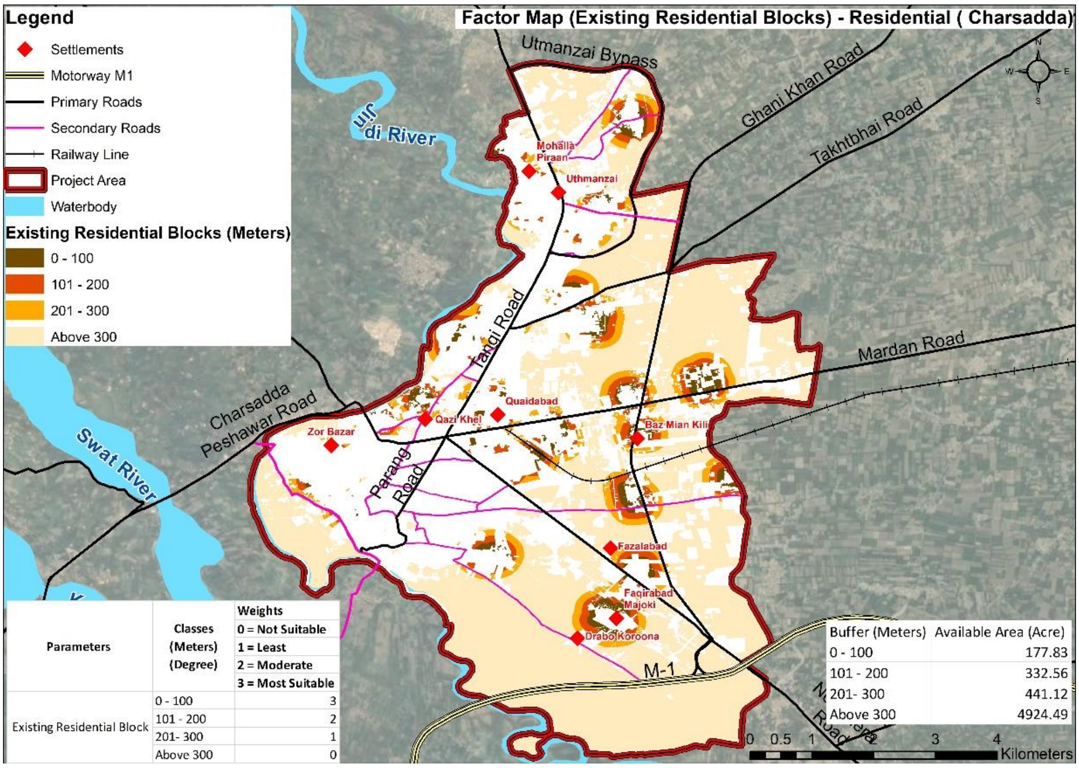
The residential criteria are made by using factors and constraints of planning development. The important factor is the proximal of land to road, community facilities and parks and playground. The table below shows the selected criteria for residential. The factor and constraint maps for residential land suitability analysis are given below.

Table 9: Factors and Criteria of Residential

Criteria For Residential				
S. No	**Parameters**	**Classes (Meters) (Degree)**	**Weights** **0 = Not Suitable** **1 = Least** **2 = Moderate** **3 = Most Suitable**	**Influence**
1	Primary Roads	11 – 50	0	10
		51 – 100	3	
		101 – 150	2	
		Above 150	1	
2	Secondary Roads	6 – 50	2	15
		51 – 100	3	
		101 – 150	1	
		Above 150	0	
3	Tertiary Roads	3 – 50	3	20
		51 -100	2	
		101- 150	1	
		Above 150	0	
4	Existing Residential Block	0 – 100	3	20
		101 – 200	2	
		201- 300	1	
		Above 300	0	
5	Slope	0 – 0.28	3	10
		0.29 – 0.58	3	
		0.59 – 0.97	2	
		0.98 – 1.63	2	
6	Land Cover	Built-Up	0	10
		Vacant	3	
		Vegetation	2	
7	Waterbodies	20 – 100	0	15
		101- 200	2	
		201- 800	3	
		Above 800	1	
8	Total			100

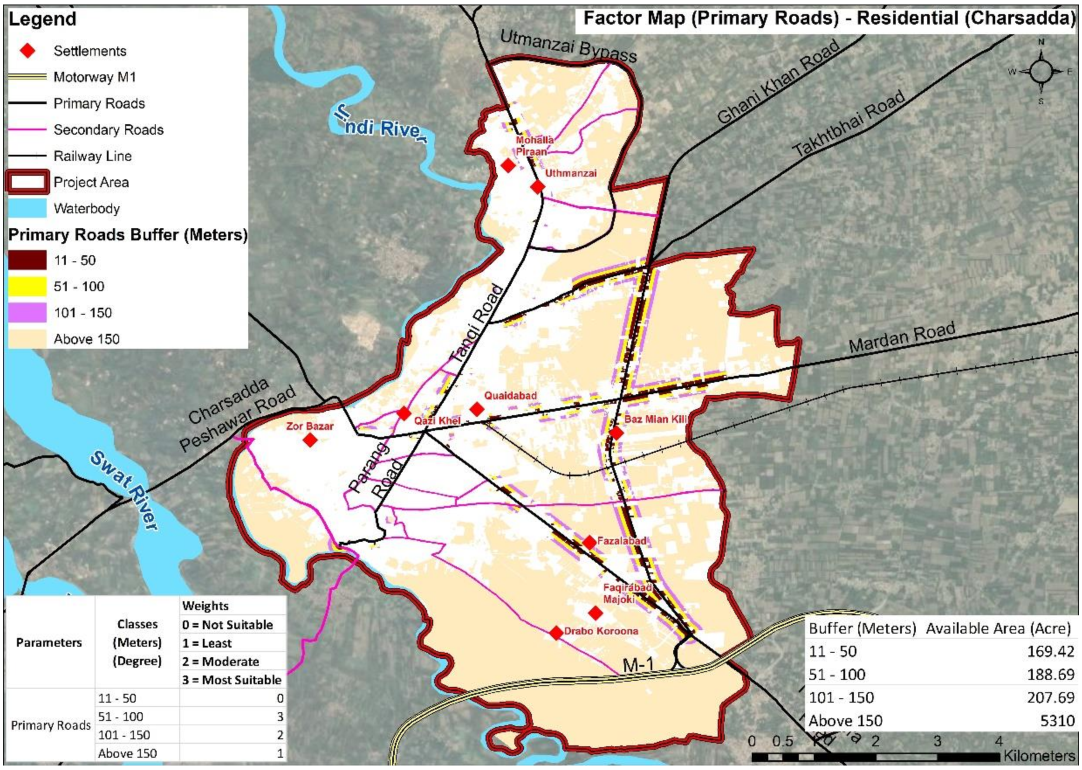
Source: Devised by Consultants

6.6.1.1. Factor Maps for Residential



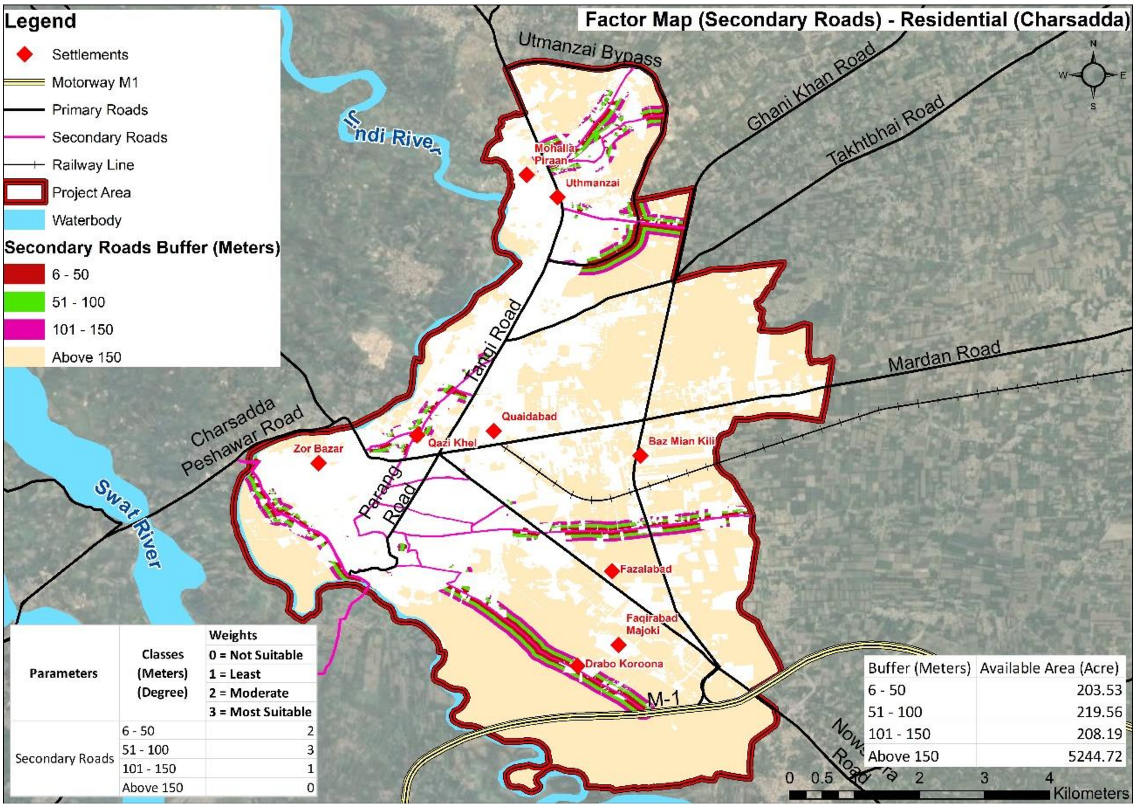
Parameters	Classes (Meters) (Degree)	Weights 0 = Not Suitable 1 = Least 2 = Moderate 3 = Most Suitable
Existing Residential Block	0 - 100	3
	101 - 200	2
	201- 300	1
	Above 300	0

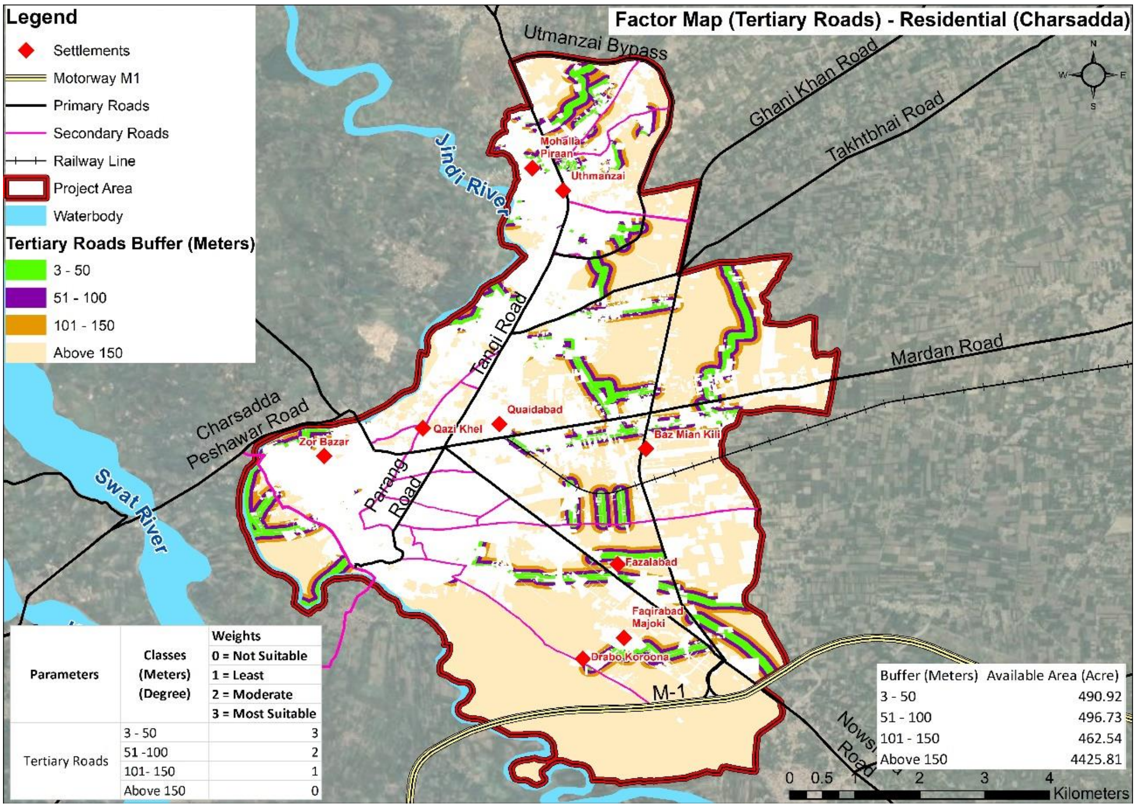
Buffer (Meters)	Available Area (Acre)
0 - 100	177.83
101 - 200	332.56
201- 300	441.12
Above 300	4924.49

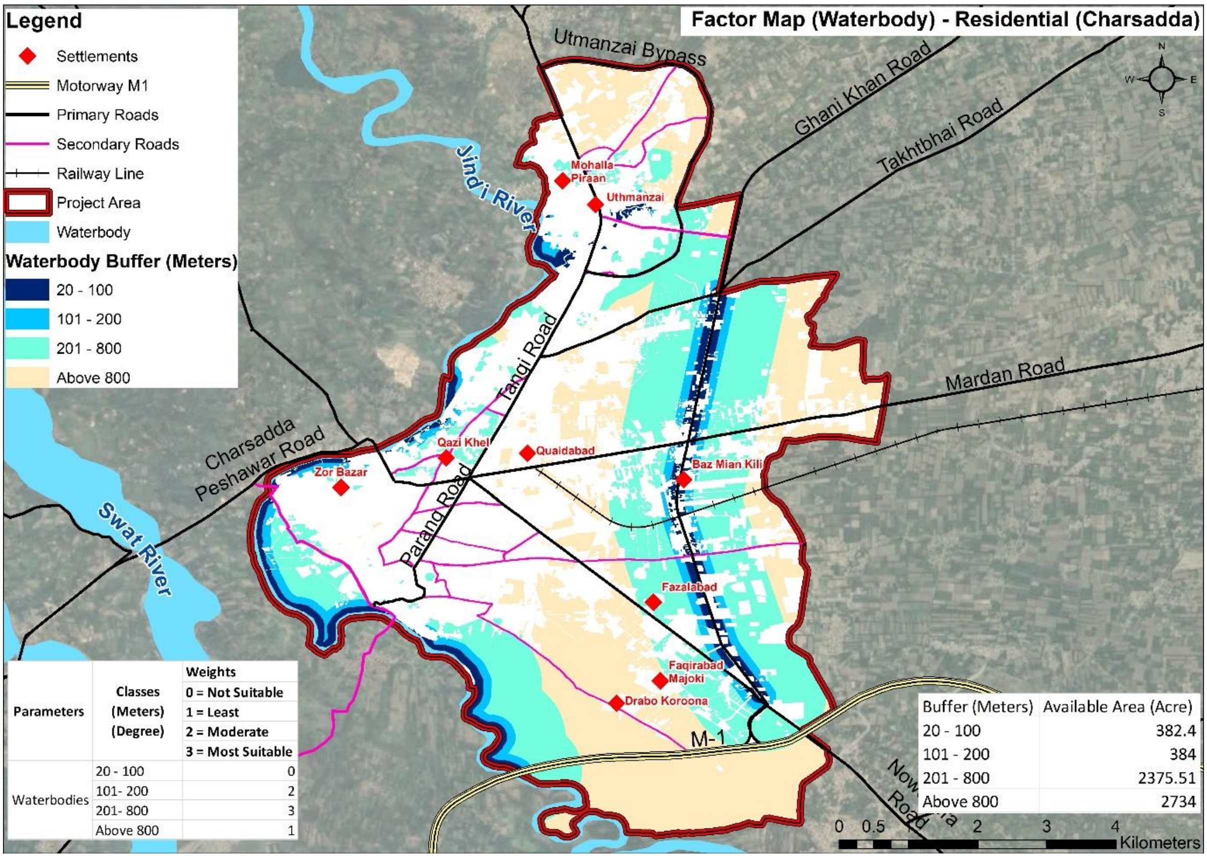


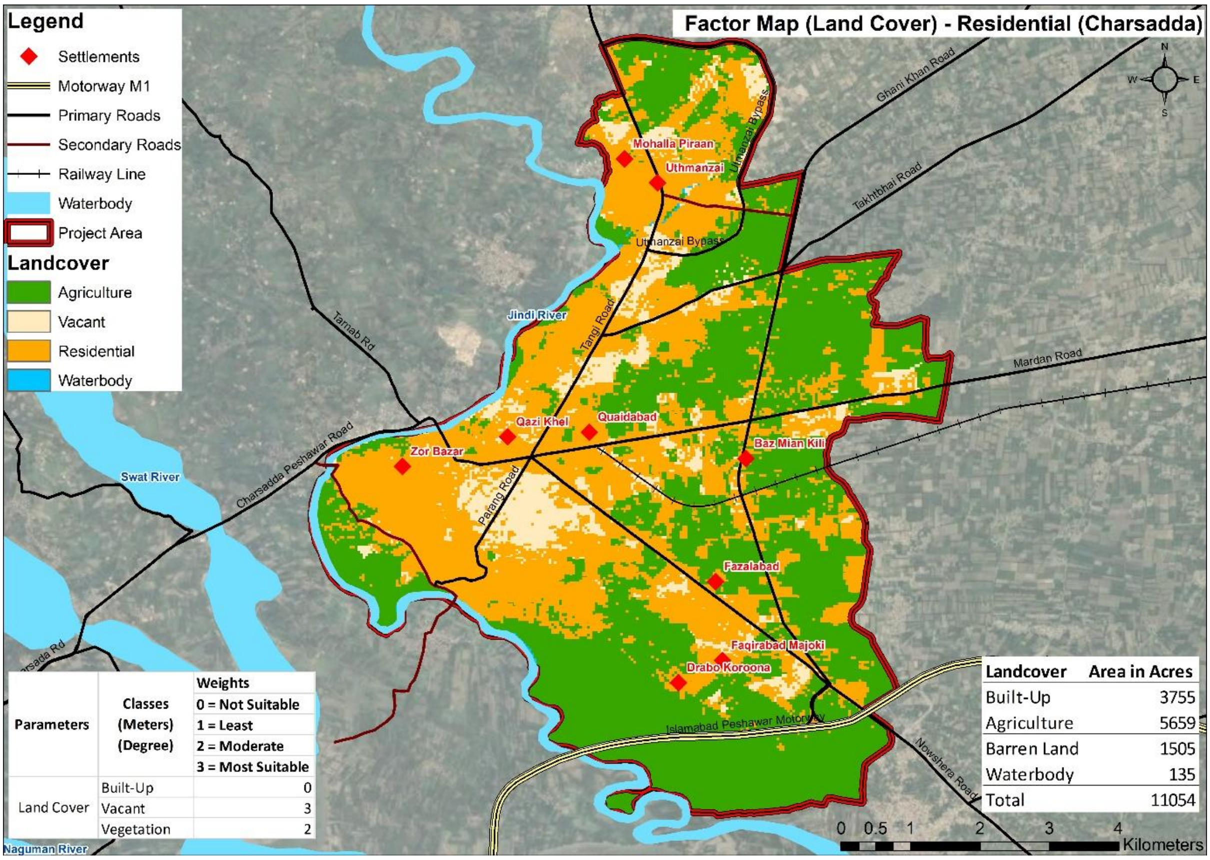
Parameters	Classes (Meters) (Degree)	Weights 0 = Not Suitable 1 = Least 2 = Moderate 3 = Most Suitable
Primary Roads	11 - 50	0
	51 - 100	3
	101 - 150	2
	Above 150	1

Buffer (Meters)	Available Area (Acre)
11 - 50	169.42
51 - 100	188.69
101 - 150	207.69
Above 150	5310


Factor Map (Secondary Roads) - Residential (Charsadda)
Legend
Settlements
Motorway M1
Primary Roads
Secondary Roads
Railway Line
Project Area
Waterbody
Secondary Roads Buffer (Meters)
6 - 50
51 - 100
101 - 150
Above 150
Utmanzai Bypass
Ghani Khan Road
Takhtbhai Road
Jindi River
Mohalla Piraan
Uthmanzai
Tangi Road
Mardan Road
Charsadda Peshawar Road
Quaidabad
Qazi Khel
Zor Bazar
Baz Mian Kili
Parang Road
Swat River
Fazalabad
Faqirabad Majoki
Drabo Koroona
M-1
Nowshera Road
Parameters | Classes (Meters) (Degree) | Weights 0 = Not Suitable 1 = Least 2 = Moderate 3 = Most Suitable
Secondary Roads | 6 - 50 | 2
51 - 100 | 3
101 - 150 | 1
Above 150 | 0
Buffer (Meters) | Available Area (Acre)
6 - 50 | 203.53
51 - 100 | 219.56
101 - 150 | 208.19
Above 150 | 5244.72
0 0.5 1 2 3 4 Kilometers


Factor Map (Tertiary Roads) - Residential (Charsadda)
Legend
Settlements
Motorway M1
Primary Roads
Secondary Roads
Railway Line
Project Area
Waterbody
Tertiary Roads Buffer (Meters)
3 - 50
51 - 100
101 - 150
Above 150
Utmanzai Bypass
Ghani Khan Road
Takhtbhai Road
Jindi River
Mohalla Piraan
Uthmanzai
Tangi Road
Mardan Road
Charsadda Peshawar Road
Quaidabad
Qazi Khel
Zor Bazar
Baz Mian Kili
Parang Road
Swat River
Fazalabad
Faqirabad Majoki
Drabo Koroona
M-1
Nowshera Road
Parameters | Classes (Meters) (Degree) | Weights 0 = Not Suitable 1 = Least 2 = Moderate 3 = Most Suitable
Tertiary Roads | 3 - 50 | 3
51 -100 | 2
101- 150 | 1
Above 150 | 0
Buffer (Meters) | Available Area (Acre)
3 - 50 | 490.92
51 - 100 | 496.73
101 - 150 | 462.54
Above 150 | 4425.81
0 0.5 1 2 3 4 Kilometers





Source: Devised by Consultant

6.6.2. LSA Criteria for Commercial

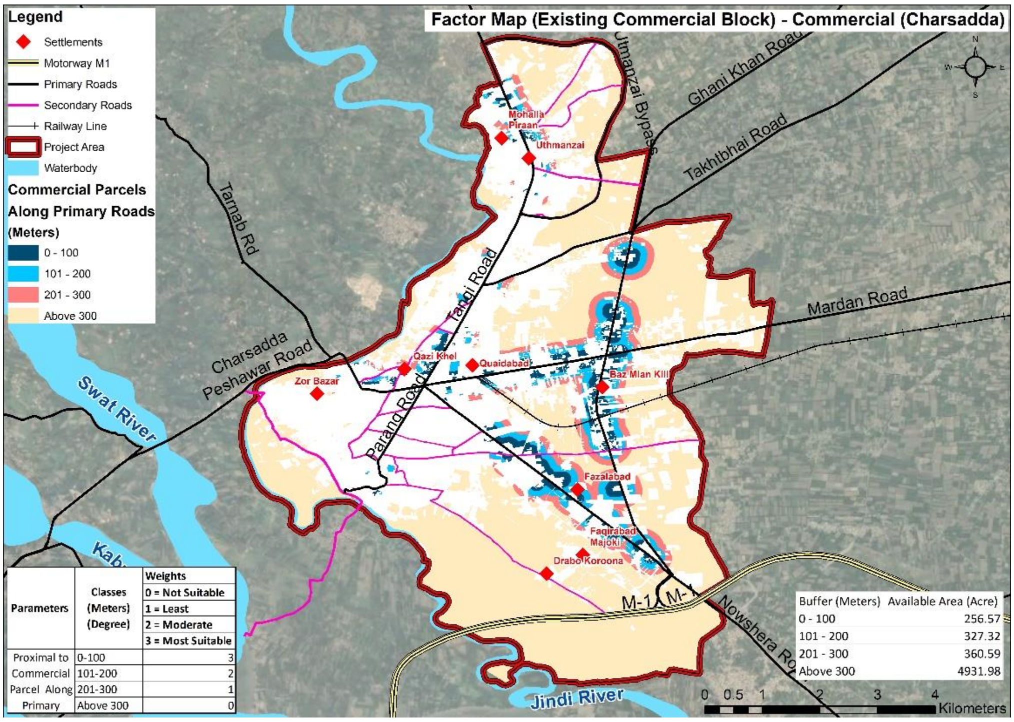
The commercial criteria are made by using factors and constraints of planning development. The important factor is the proximal of land to road, existing CBD and parks and playground. The table below shows the selected criteria for commercial land use. The factor and constraint maps for commercial land suitability analysis are also given under this section.

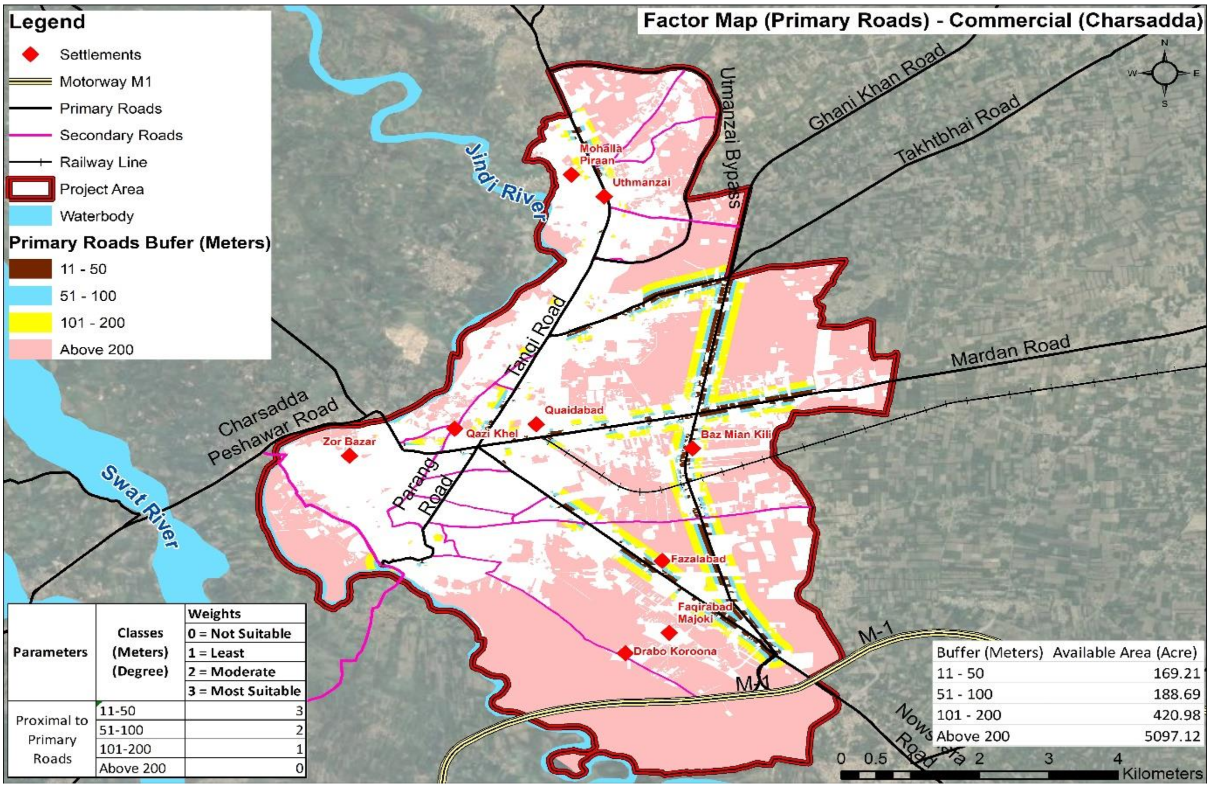
Table 10: Factors and Criteria for Commercial-Charsadda

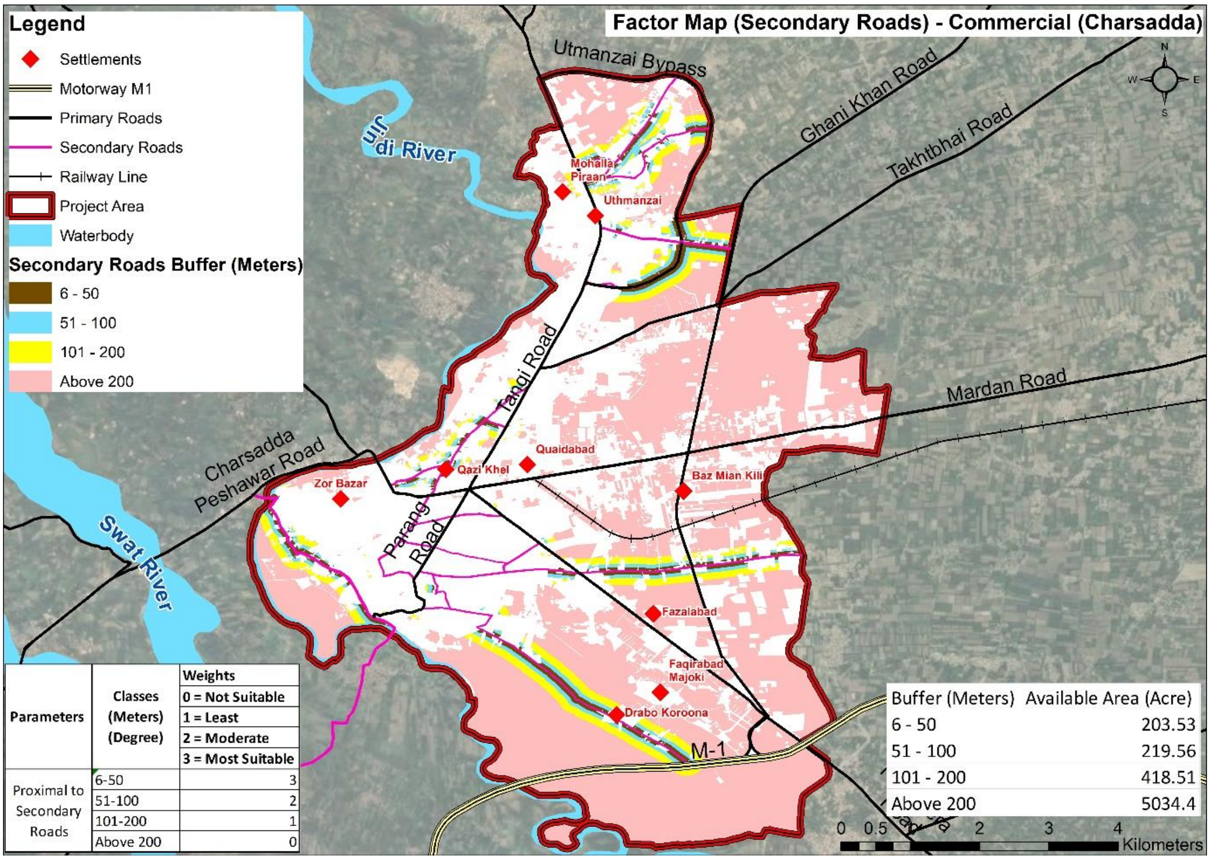
Scenario A				
Criteria For Commercial (Roads)				
S. No	**Parameters**	**Classes (Meters)**	**Weights** **0 = Not Suitable** **1 = Least** **2 = Moderate** **3 = Most Suitable**	**Influence**
1	Proximal to Primary Roads	11-50	3	50
		51-100	2	
		101-200	1	
		Above 201	0	
2	Proximal to Secondary Roads	6-50	3	30
		51-100	2	
		101-200	1	
		Above 201	0	
3	Proximal to Commercial Parcel Along Primary Roads	0-100	3	20
		101-200	2	
		201-300	1	
		Above 301	0	

Source: Devised by Consultants

6.6.2.1. Factor Maps for Commercial





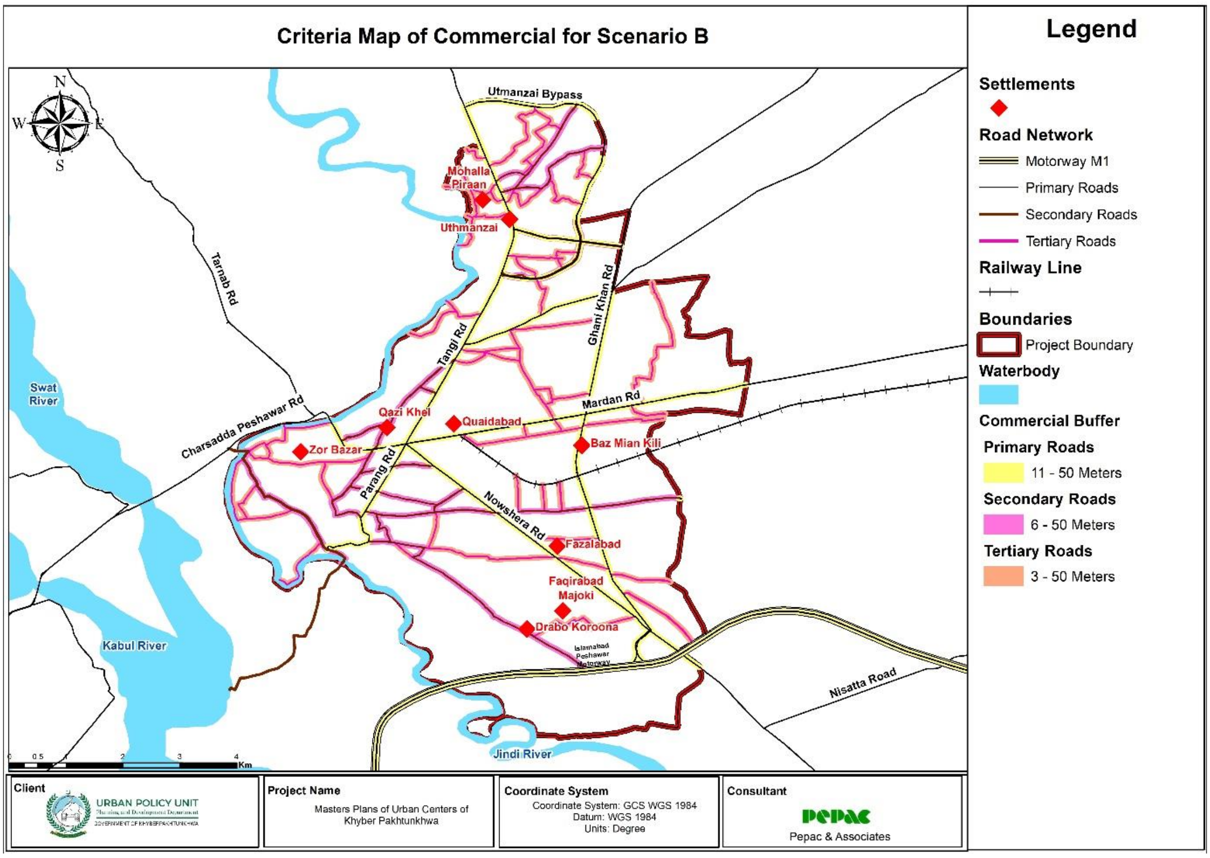


Source: Devised by Consultants

Table 11: Factors and Criteria for Commercial-Charsadda

Scenario B				
Category	**Buffer Along Roads**	**Density**		
Primary Roads	11 – 50 Meters	High Density	represents	G+12
Secondary Roads	6 – 50 Meters	Medium Density	represents	G+6
Tertiary Roads	3 – 50 Meters	Low Density	represents	G+3

Source: Devised by Consultants



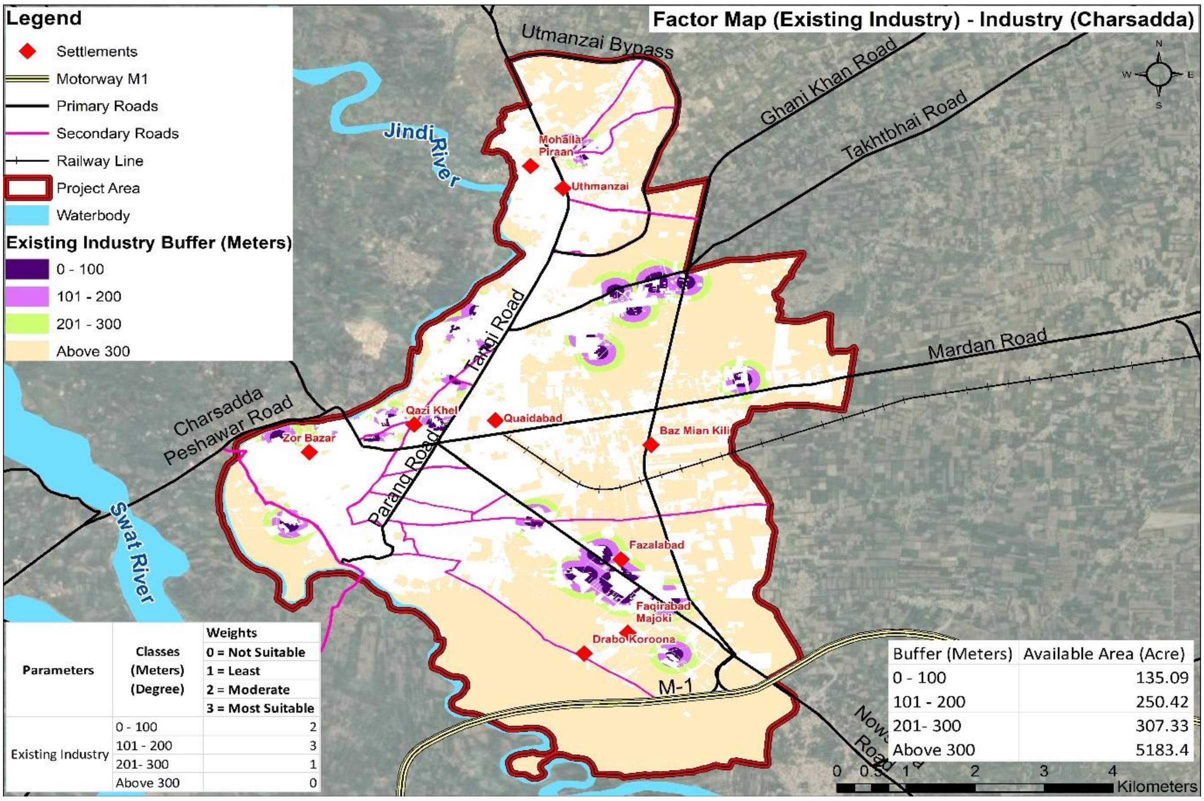
6.6.3. LSA Criteria for Industry

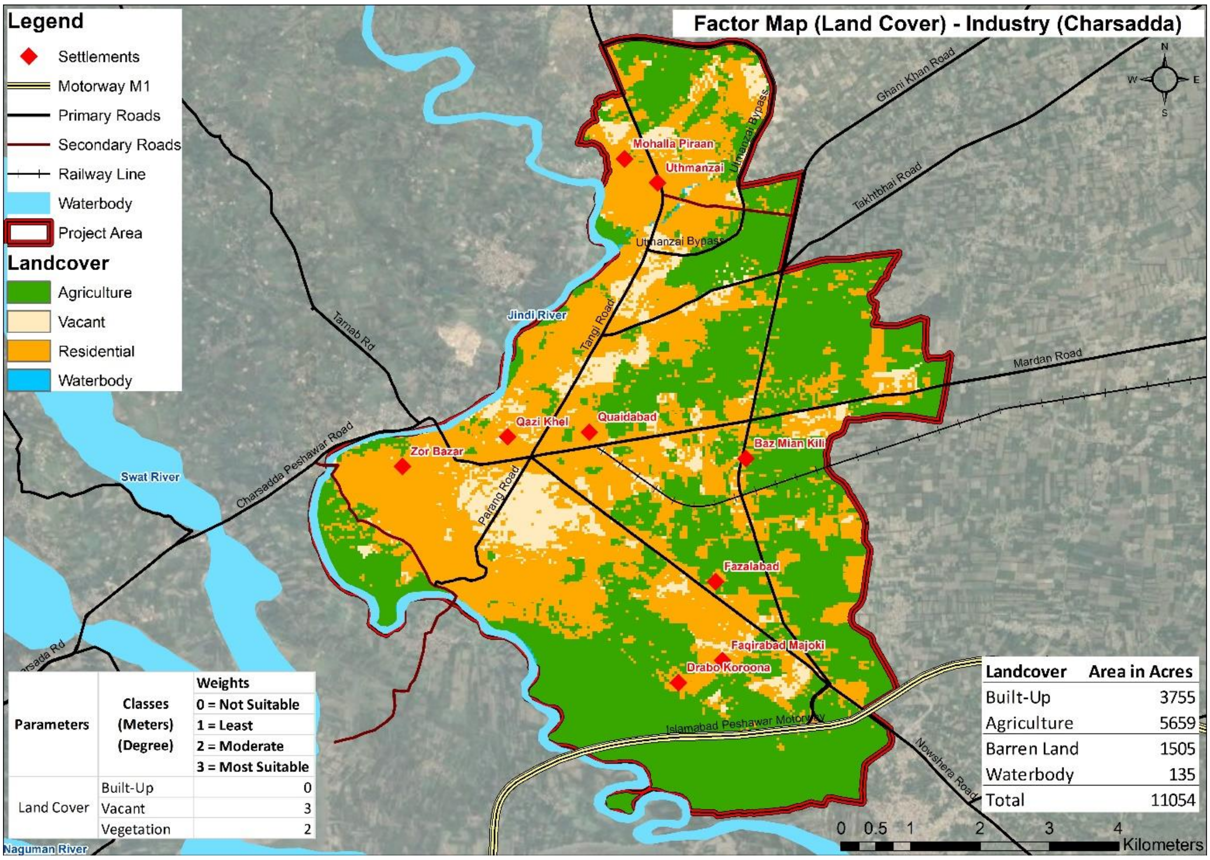
The Industrial criteria has been made by using factors of planning development. The important factor is the proximal of land to road, community facilities and parks and playground. The table below shows the selected criteria for residential. The factor and constraint maps for residential land suitability analysis are given below.

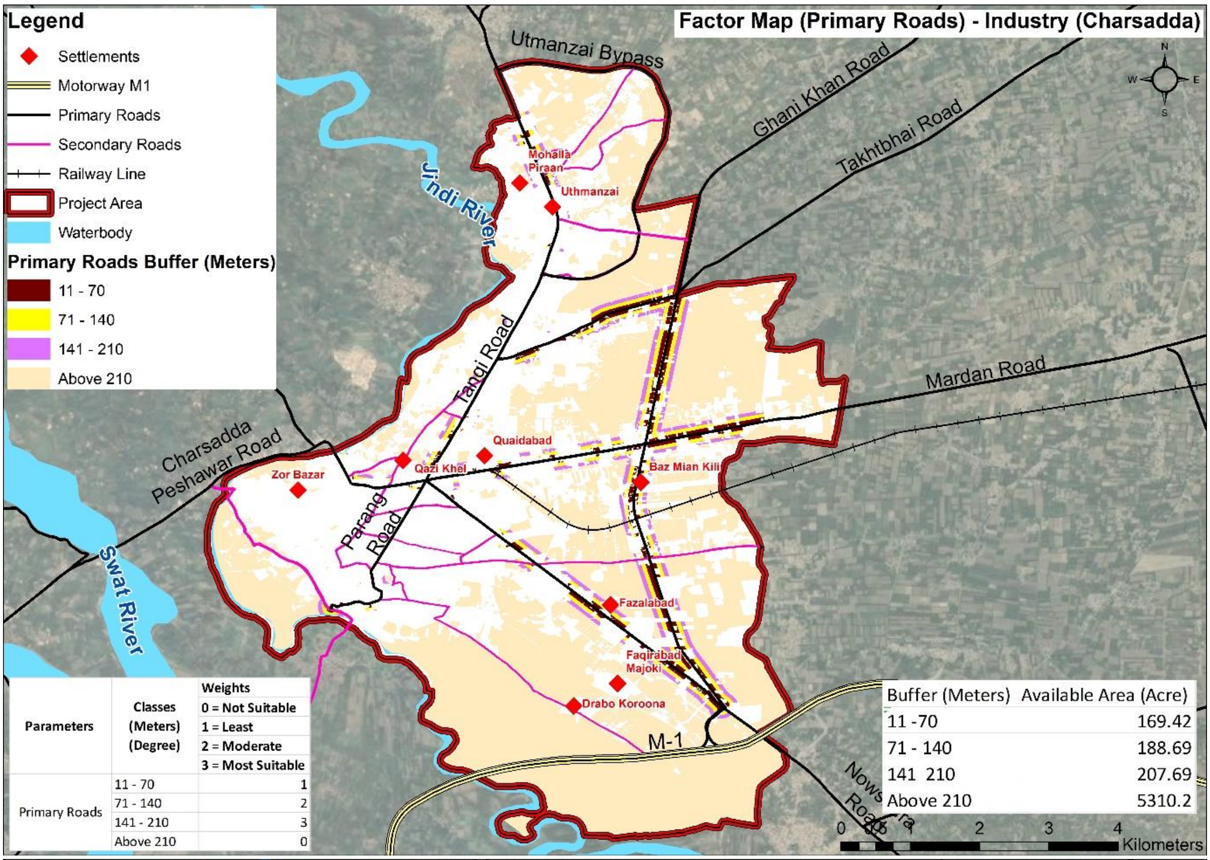
Table 12: Factors and Criteria of Residential

Criteria For Industry				
S. No	**Parameters**	**Classes (Meters)**	**Weights** **0 = Not Suitable** **1 = Least** **2 = Moderate** **3 = Most Suitable**	**Influence**
1	Primary Roads	11 – 70	0	10
		71 – 140	2	
		141 – 210	3	
		Above 210	3	
2	Secondary Roads	6 – 50	0	15
		51 – 100	2	
		101 – 150	1	
		Above 150	3	
3	Tertiary Roads	11 – 100	0	20
		101 -200	0	
		201 – 300	1	
		Above 300	1	
4	Existing Industry	0 – 100	2	20
		101 – 200	3	
		201- 300	1	
		Above 300	0	
5	Slope	0 – 0.28	3	10
		0.29 – 0.58	3	
		0.59 – 0.97	2	
		0.98 – 1.63	2	
6	Land Cover	Built-Up	0	10
		Vacant	3	
		Vegetation	2	
7	Waterbodies	20 – 100	0	15
		101- 200	1	
		201- 300	2	
		Above 300	3	

Source: Devised by Consultants

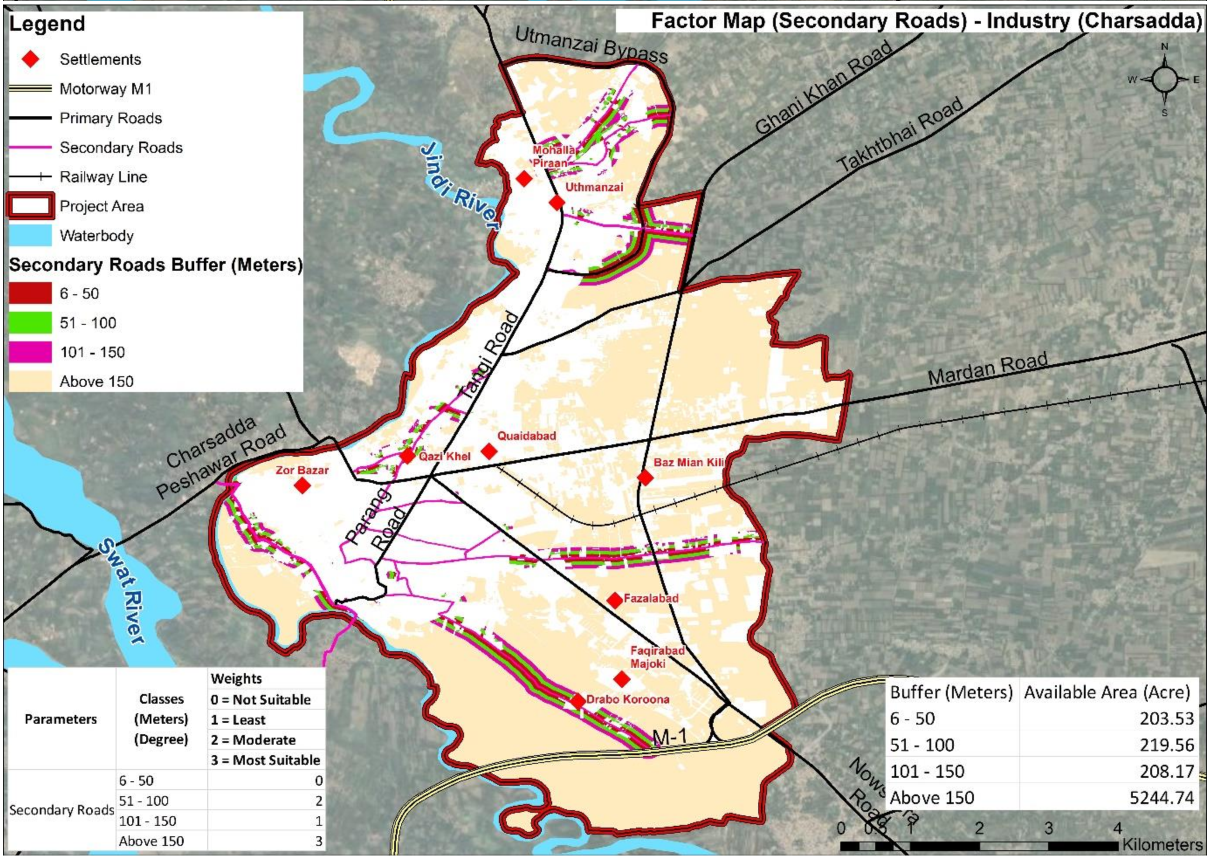

Factor Map (Existing Industry) - Industry (Charsadda)
Legend
Settlements
Motorway M1
Primary Roads
Secondary Roads
Railway Line
Project Area
Waterbody
Existing Industry Buffer (Meters)
0 - 100
101 - 200
201 - 300
Above 300
Utmanzai Bypass
Ghani Khan Road
Takhtbhai Road
Jindi River
Mohalla Piraan
Uthmanzai
Tangi Road
Mardan Road
Charsadda Peshawar Road
Qazi Khel
Quaidabad
Zor Bazar
Baz Mian Kili
Parang Road
Swat River
Fazalabad
Faqirabad Majoki
Drabo Koroona
M-1
Parameters | Classes (Meters) (Degree) | Weights 0 = Not Suitable 1 = Least 2 = Moderate 3 = Most Suitable
Existing Industry | 0 - 100 | 2
101 - 200 | 3
201- 300 | 1
Above 300 | 0
Buffer (Meters) | Available Area (Acre)
0 - 100 | 135.09
101 - 200 | 250.42
201- 300 | 307.33
Above 300 | 5183.4
0 0.5 1 2 3 4 Kilometers


Factor Map (Land Cover) - Industry (Charsadda)
Legend
Settlements
Motorway M1
Primary Roads
Secondary Roads
Railway Line
Waterbody
Project Area
Landcover
Agriculture
Vacant
Residential
Waterbody
Ghani Khan Road
Mohalla Piraan
Uthmanzai
Utmanzai Bypass
Takhtbhai Road
Jindi River
Tarnab Rd
Tangi Road
Mardan Road
Qazi Khel
Quaidabad
Zor Bazar
Baz Mian Kili
Charsadda Peshawar Road
Swat River
Parang Road
Fazalabad
Faqirabad Majoki
Drabo Koroona
Islamabad Peshawar Motorway
Nowshera Road
Naguman River
Parameters | Classes (Meters) (Degree) | Weights 0 = Not Suitable 1 = Least 2 = Moderate 3 = Most Suitable
Land Cover | Built-Up | 0
Vacant | 3
Vegetation | 2
Landcover | Area in Acres
Built-Up | 3755
Agriculture | 5659
Barren Land | 1505
Waterbody | 135
Total | 11054
0 0.5 1 2 3 4 Kilometers



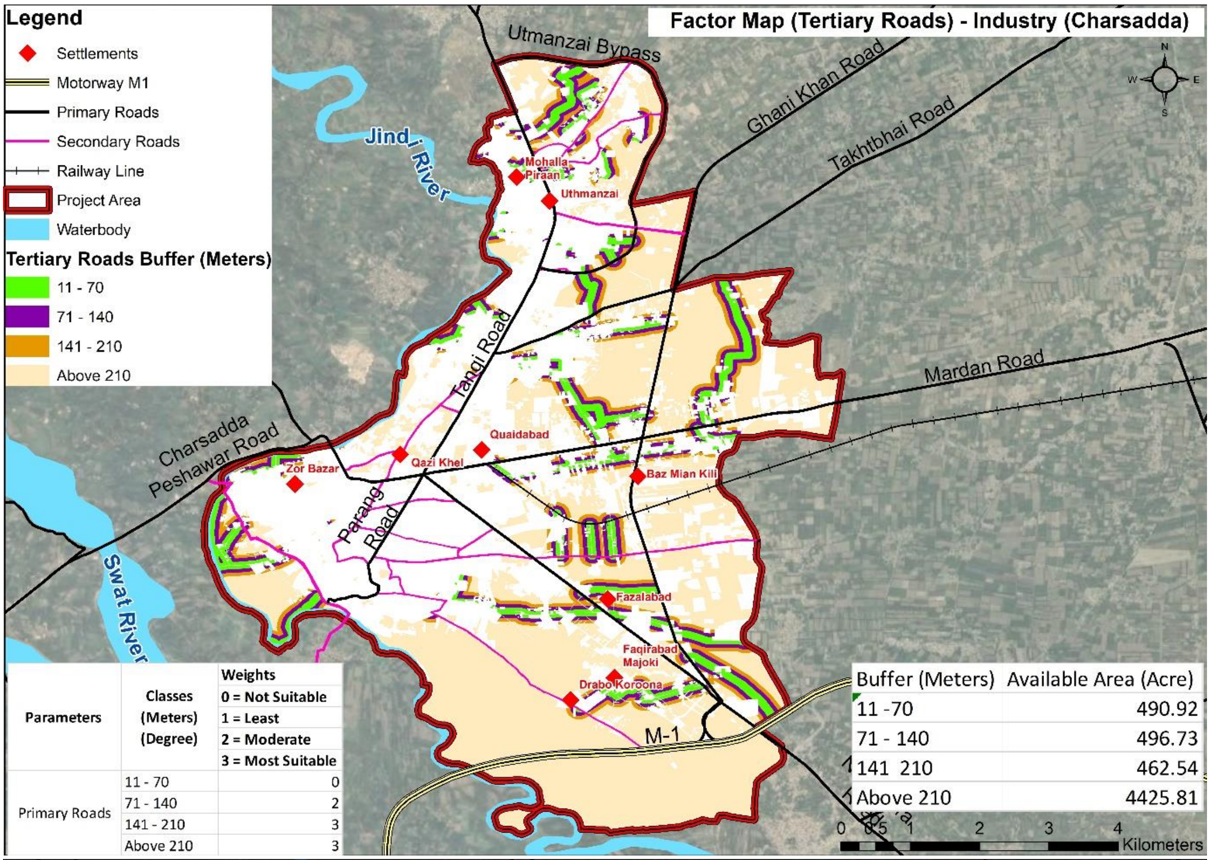
Parameters	Classes (Meters) (Degree)	Weights 0 = Not Suitable 1 = Least 2 = Moderate 3 = Most Suitable
Primary Roads	11 - 70	1
	71 - 140	2
	141 - 210	3
	Above 210	0

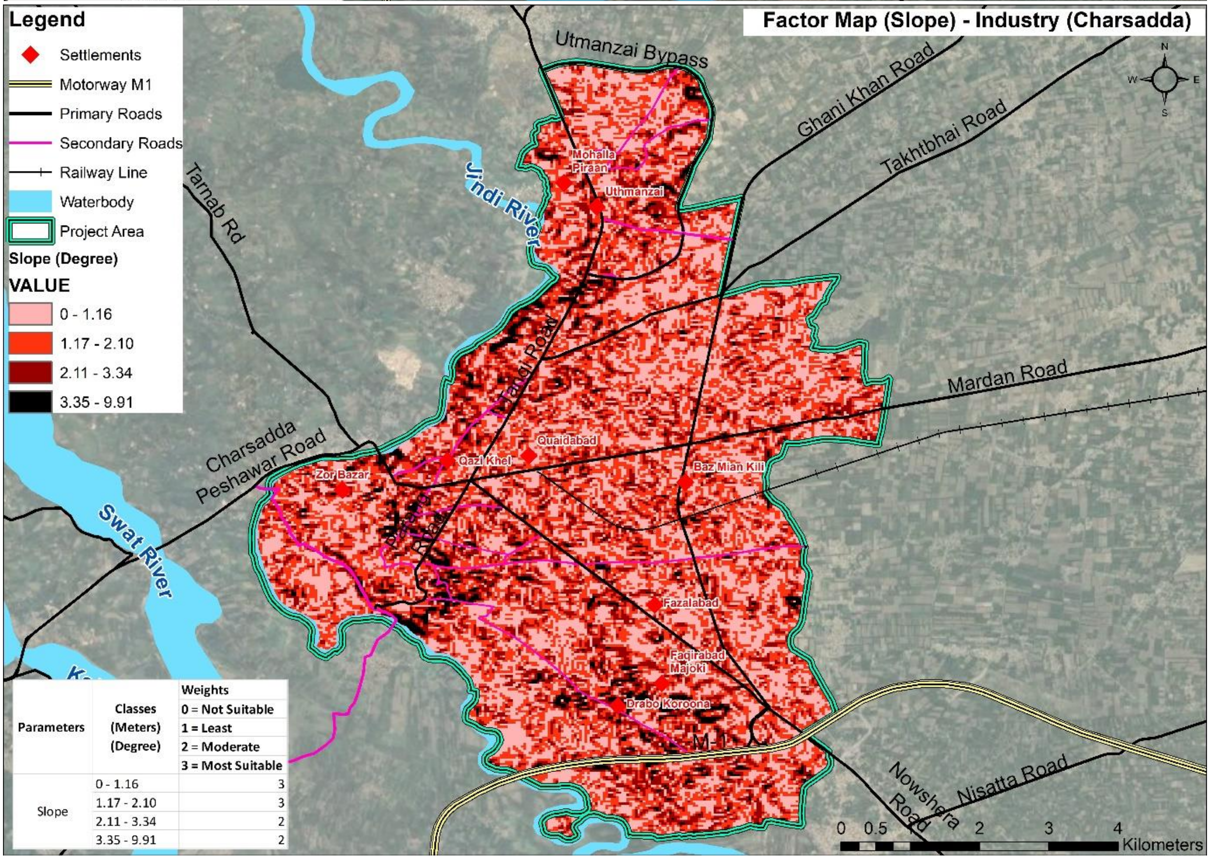
Buffer (Meters)	Available Area (Acre)
11 -70	169.42
71 - 140	188.69
141 210	207.69
Above 210	5310.2

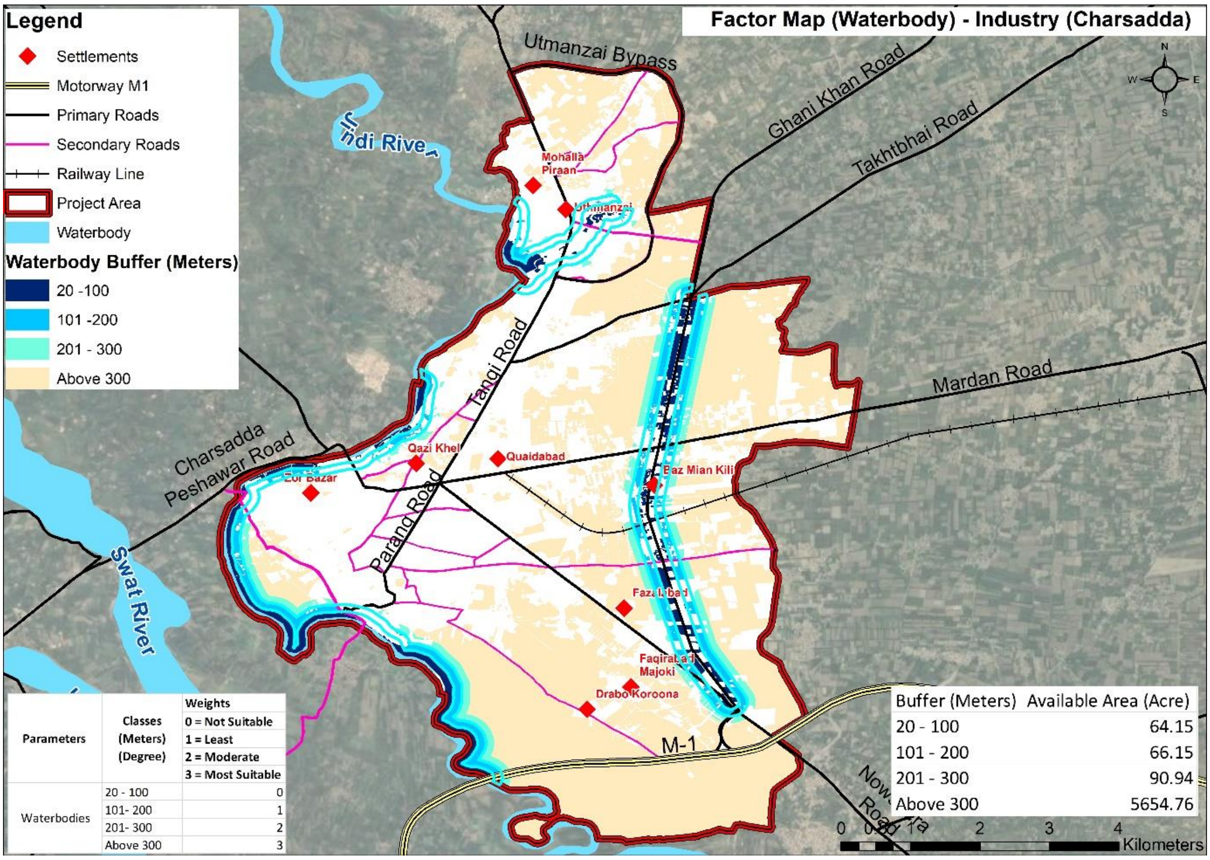


Parameters	Classes (Meters) (Degree)	Weights 0 = Not Suitable 1 = Least 2 = Moderate 3 = Most Suitable
Secondary Roads	6 - 50	0
	51 - 100	2
	101 - 150	1
	Above 150	3

Buffer (Meters)	Available Area (Acre)
6 - 50	203.53
51 - 100	219.56
101 - 150	208.17
Above 150	5244.74


Factor Map (Tertiary Roads) - Industry (Charsadda)
Legend
Settlements
Motorway M1
Primary Roads
Secondary Roads
Railway Line
Project Area
Waterbody
Tertiary Roads Buffer (Meters)
11 - 70
71 - 140
141 - 210
Above 210
Utmanzai Bypass
Ghani Khan Road
Takhtbhai Road
Jindi River
Mardan Road
Tangi Road
Charsadda Peshawar Road
Parang Road
Swat River
M-1
Mohalla Piraan
Uthmanzai
Quaidabad
Qazi Khel
Zor Bazar
Baz Mian Kili
Fazalabad
Faqirabad Majoki
Drabo Koroona
Parameters
Classes (Meters) (Degree)
Weights
0 = Not Suitable
1 = Least
2 = Moderate
3 = Most Suitable
Primary Roads
11 - 70 0
71 - 140 2
141 - 210 3
Above 210 3
Buffer (Meters) Available Area (Acre)
11 -70 490.92
71 - 140 496.73
141 210 462.54
Above 210 4425.81
0 0.5 1 2 3 4 Kilometers


Factor Map (Slope) - Industry (Charsadda)
Legend
Settlements
Motorway M1
Primary Roads
Secondary Roads
Railway Line
Waterbody
Project Area
Slope (Degree)
VALUE
0 - 1.16
1.17 - 2.10
2.11 - 3.34
3.35 - 9.91
Utmanzai Bypass
Ghani Khan Road
Takhtbhai Road
Tarnab Rd
Jindi River
Tangi Road
Mardan Road
Charsadda Peshawar Road
Swat River
Nowshera Road
Nisatta Road
M-1
Mohalla Piraan
Uthmanzai
Quaidabad
Qazi Khel
Zor Bazar
Baz Mian Kili
Fazalabad
Faqirabad Majoki
Drabo Koroona
Parameters
Classes (Meters) (Degree)
Weights
0 = Not Suitable
1 = Least
2 = Moderate
3 = Most Suitable
Slope
0 - 1.16 3
1.17 - 2.10 3
2.11 - 3.34 2
3.35 - 9.91 2
0 0.5 1 2 3 4 Kilometers



Source: Devised by Consultants

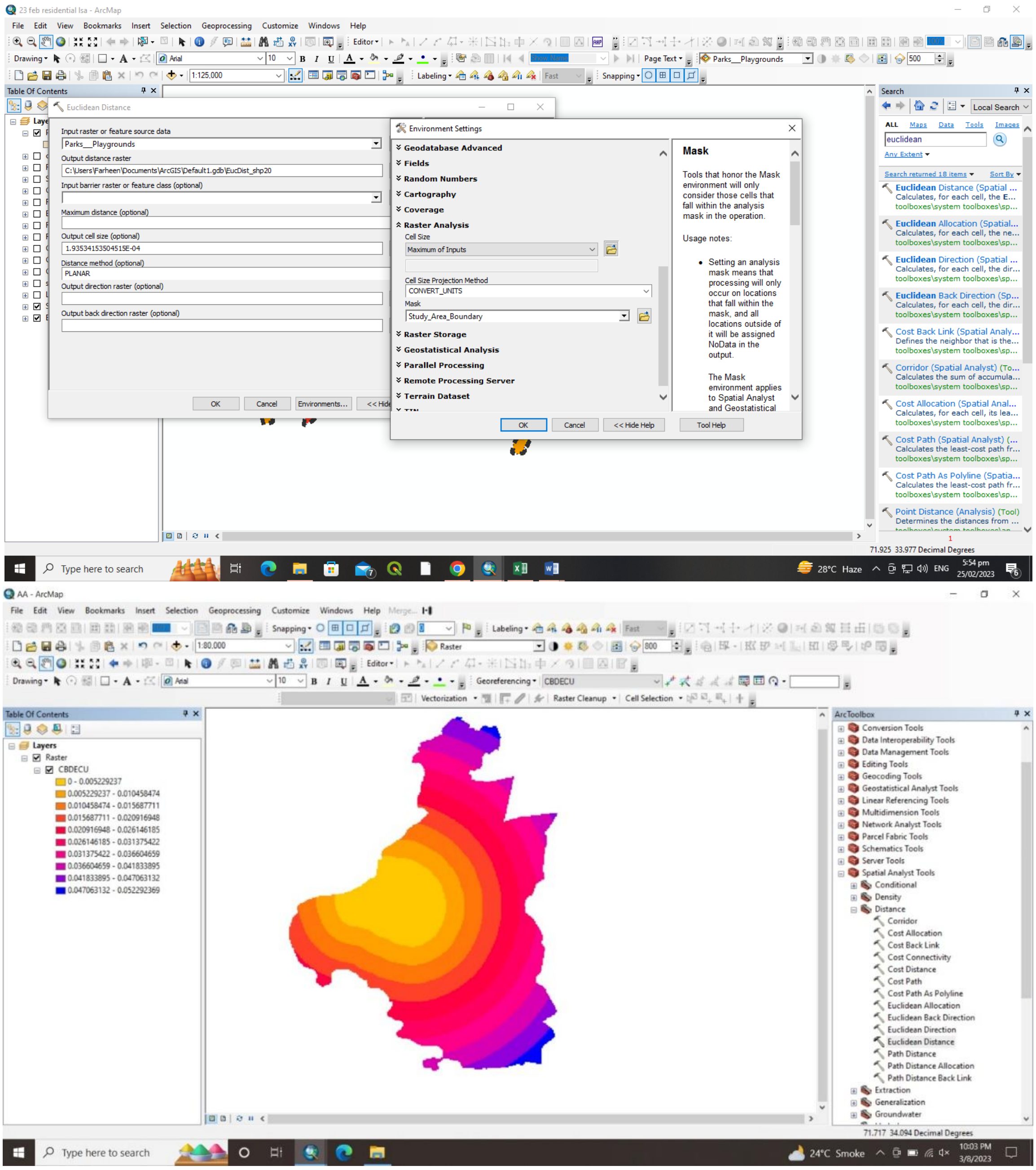
6.7. GIS Tools

The different tools used for multi-criteria decision analysis are given below:

6.7.1. Euclidean Distance

A distance function provides distance between the elements of a set. If the distance is zero then elements are equivalent else, they are different from each other. A distance function is nothing but a mathematical formula used by distance metrics.

Figure 14: Euclidean Distance Process

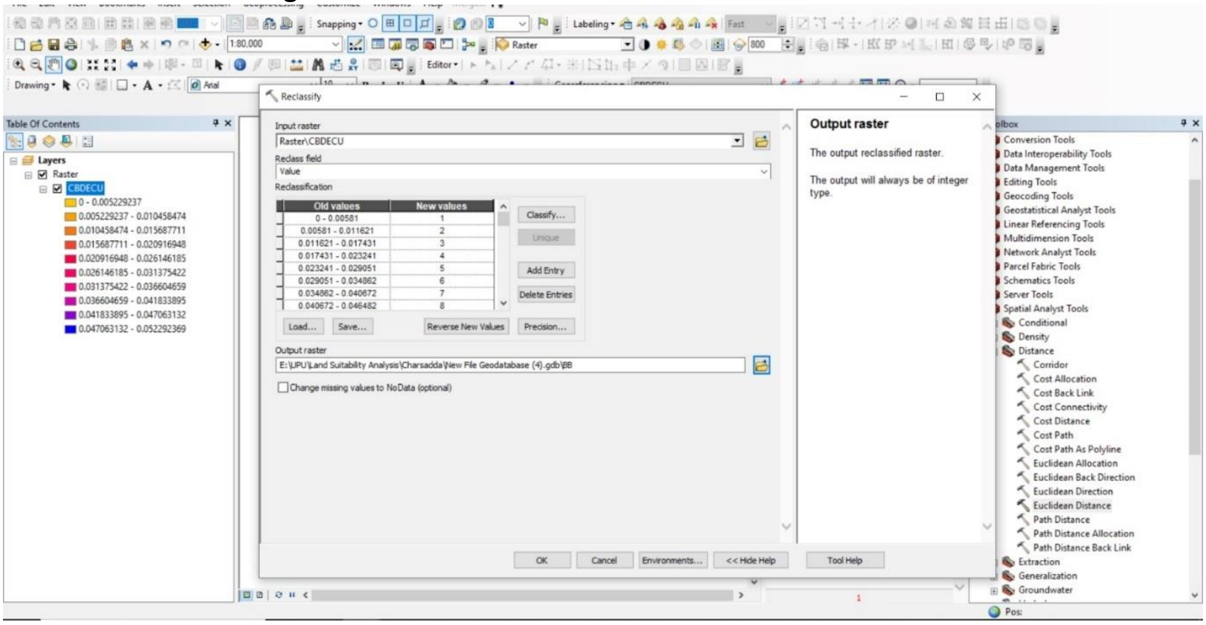


Source: Devised by Consultant

6.7.2. Reclassify

Reclassification of Euclidean Distance on scale of 1 to 7 (7 for most favorable and 1 for least favorable).

Figure 15: Reclassification of Euclidean Distance Process

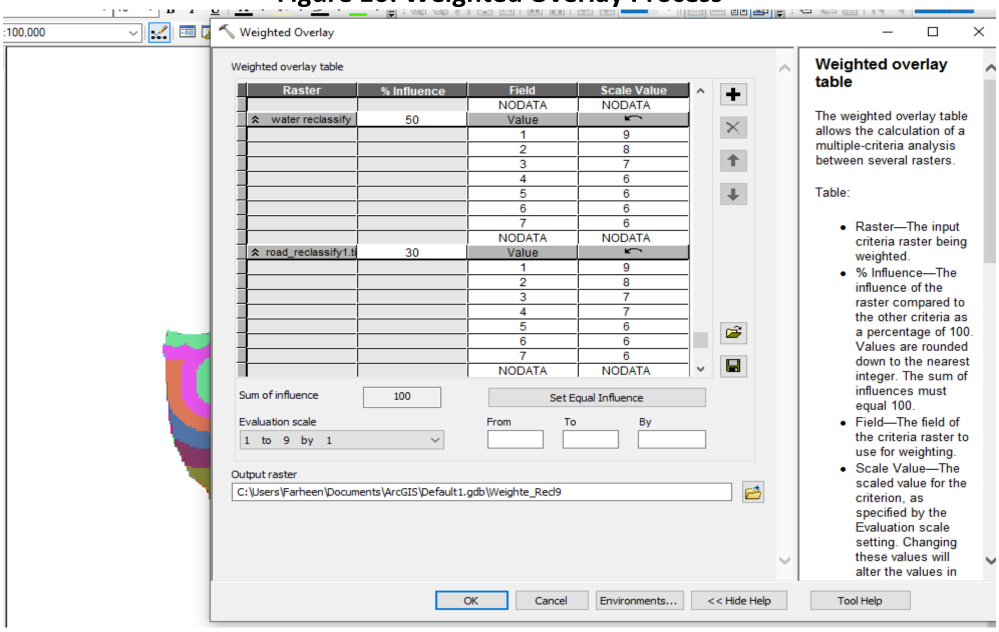


Source: Devised by Consultant

6.7.3. Weighted Overlay

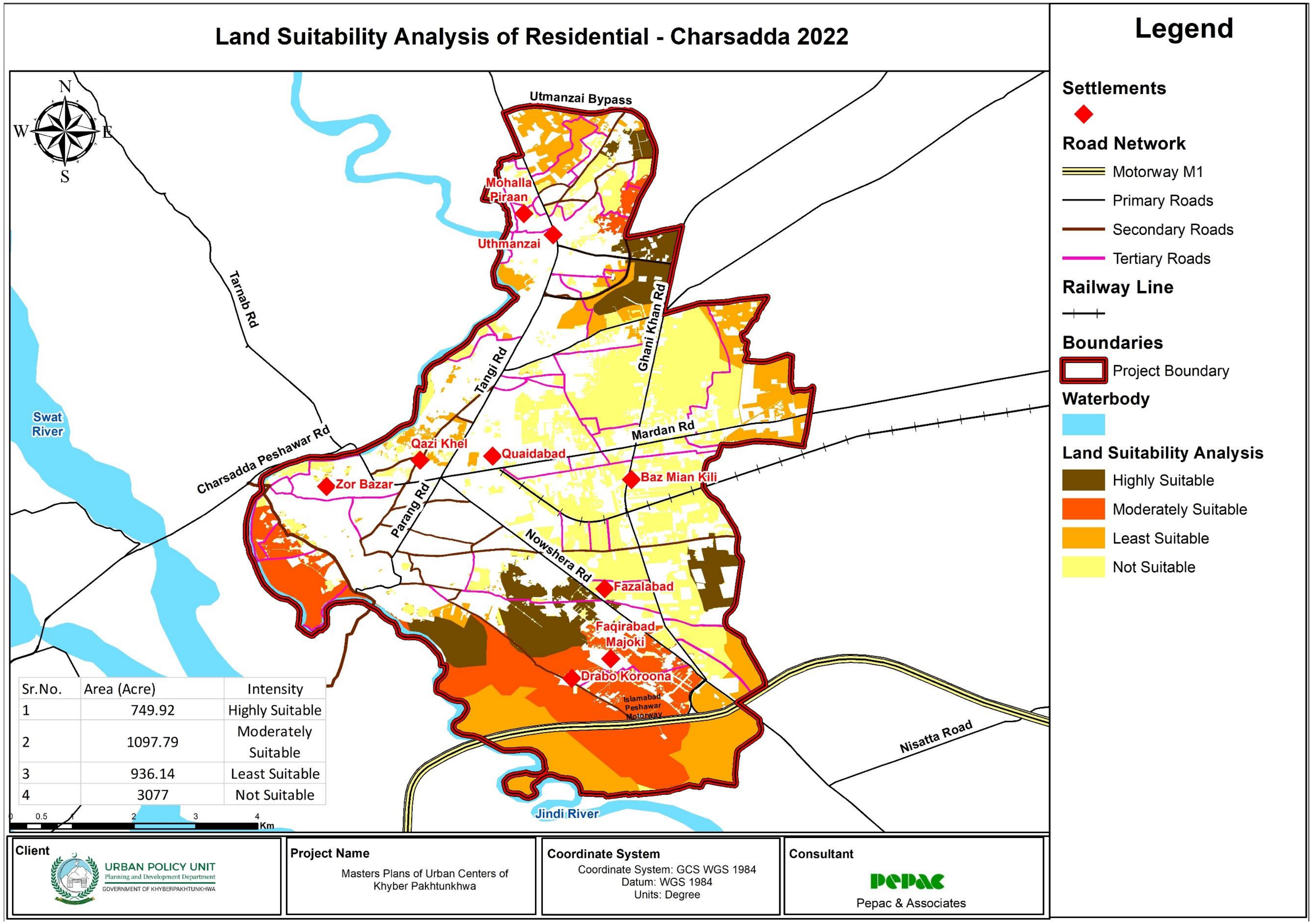
The weighted overlay table allows the calculation of a multiple-criteria analysis between several raster. List of input criteria raster being weighted. The options to browse for raster datasets or add map layers to the list of inputs and in which we define factor and constraints (restricted).

Figure 16: Weighted Overlay Process



Source: Devised by Consultant

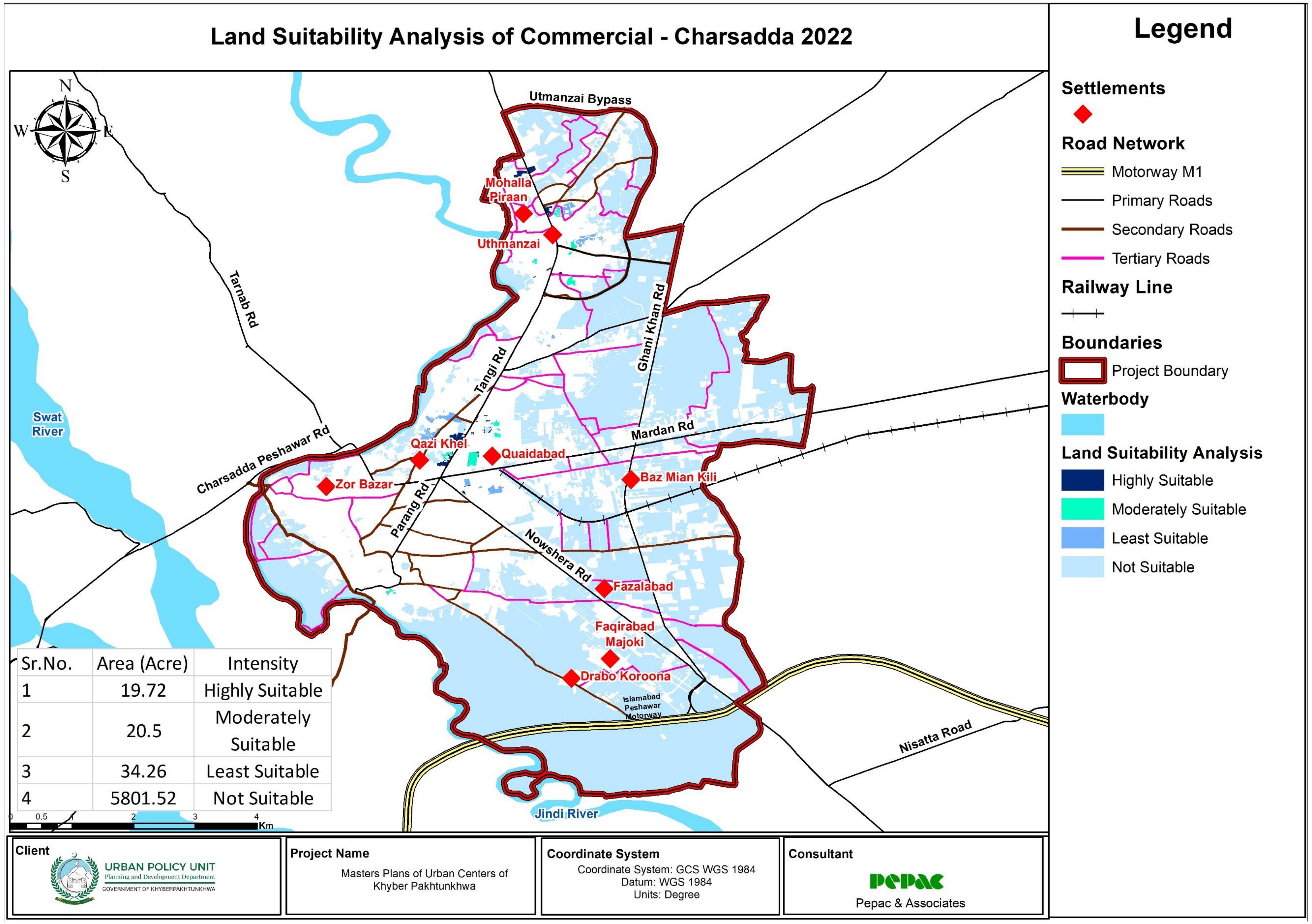
Map 7: Land Suitability Analysis Residential Use – Charsadda Study Area



Sr.No.	Area (Acre)	Intensity
1	749.92	Highly Suitable
2	1097.79	Moderately Suitable
3	936.14	Least Suitable
4	3077	Not Suitable

Source: Devised by Consultant

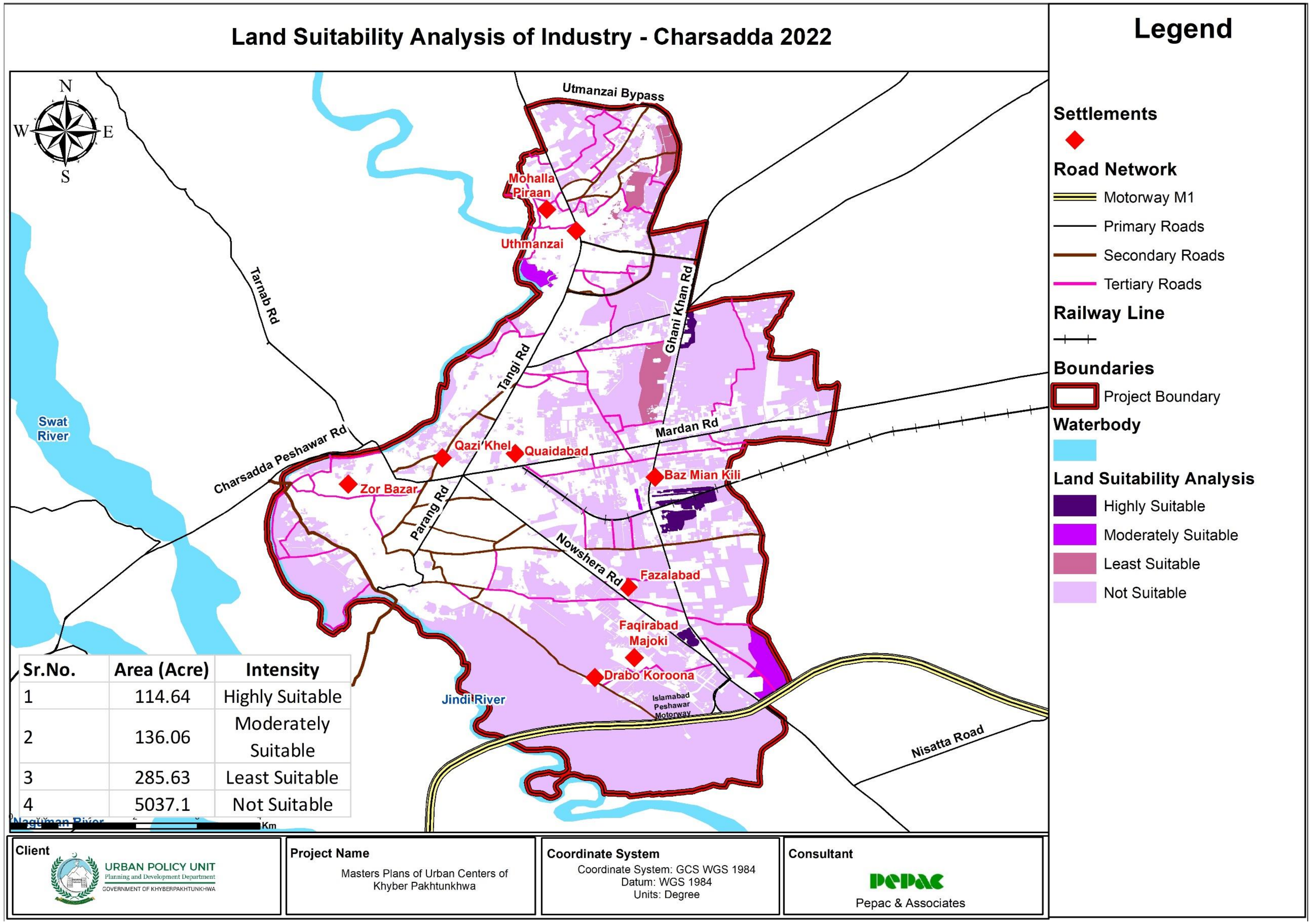
Map 8: Land Suitability Analysis Commercial Use – Charsadda Study Area



Sr.No.	Area (Acre)	Intensity
1	19.72	Highly Suitable
2	20.5	Moderately Suitable
3	34.26	Least Suitable
4	5801.52	Not Suitable

Source: Devised by Consultant

Map 9: Land Suitability Analysis Agriculture Use – Charsadda Study Area



Sr.No.	Area (Acre)	Intensity
1	114.64	Highly Suitable
2	136.06	Moderately Suitable
3	285.63	Least Suitable
4	5037.1	Not Suitable

Source: Devised by Consultants

Chapter 7: Proposed Development Scenarios Charsadda City

7.1. Introduction

Scenario planning has become a useful technique because of its supporting nature for master planning in times of uncertainty and complexity. Scenario planning and development identified various factors that can have an influence on the future development of a study area and also assists in creating multiple different futures. Following this, a future could be shaped more according to the needs, cultural and political situation and market conditions of a society. The approach has been used to develop two possible scenarios guiding the future development of the city.

There are numerous factors that are taken into account while developing a suitable scenario for a study area. These scenarios take into account the best potential areas indicated by land suitability analysis for allocating specific land uses to meet demand based on population projections, NRM criteria and criteria mentioned in KP Urban Policy. The primary consideration in these scenarios is the economic growth of the study area, proposing a sustainable future development in which diverse land uses are assigned alongside urban revitalization. In the attempt to produce more robust scenarios, several scenarios planning techniques are adopted in which both qualitative and quantitative data are gathered, and where quantitative information is translated into qualitative knowledge and vice versa. The scenario making process for Charsadda involve analyst-led, stakeholders and participatory approaches in correlation with existing city model scenario with the view to offer more flexible and adaptable conditions to cater to the existing and future challenges of the Charsadda study area The details of these proposed scenarios are given in the coming sections.

7.2. Scenario Design and Construction

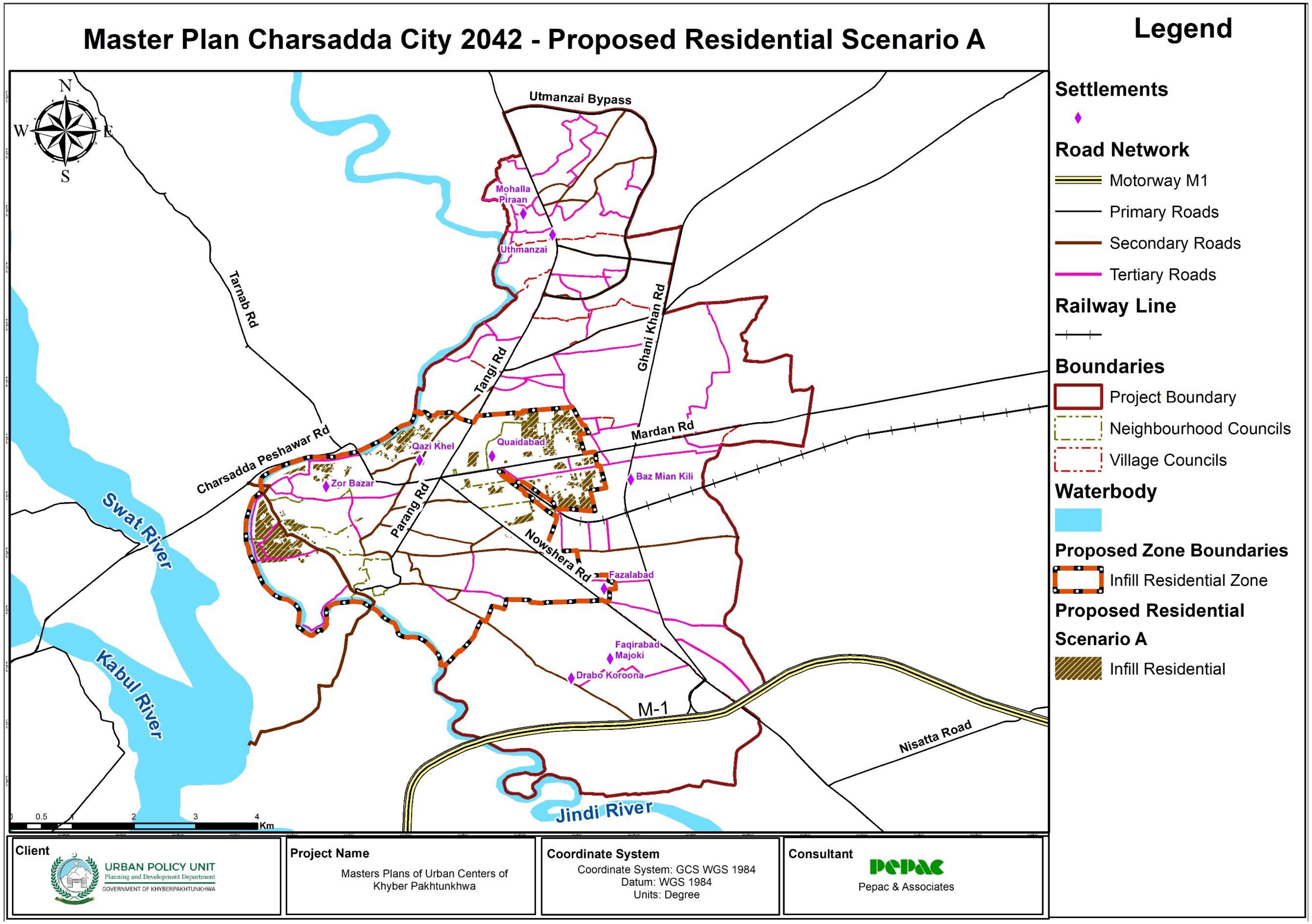
7.2.1. Scenario A

Based on the highlighted factors and results obtained from the land suitability analysis, the first scenario developed for envisioning the growth of Charsadda study area includes the assumptions made for possible residential, commercial, and industrial development in the city. For residential land use till 2042, scenario A encourages vertical development in the entire city for the provision of housing facilities. For this purpose, an area of 300 acres is allocated for multi-storey housing development on vacant land available within neighborhood councils in the area i.e., infill development. Apartment buildings having ground plus four stories and comprising of 1, 2 and 3 bedrooms are recommended to be built for vertical housing.

Similarly for commercial development, the first scenario carried out using Land Suitability Analysis produced insufficient area i.e., only 53 acres, owing to proposed criteria applied in computing, which did not fulfil land requirement instead of the total requirement i.e., 590 acres (which has been determined via standards given in KP Urban Policy).

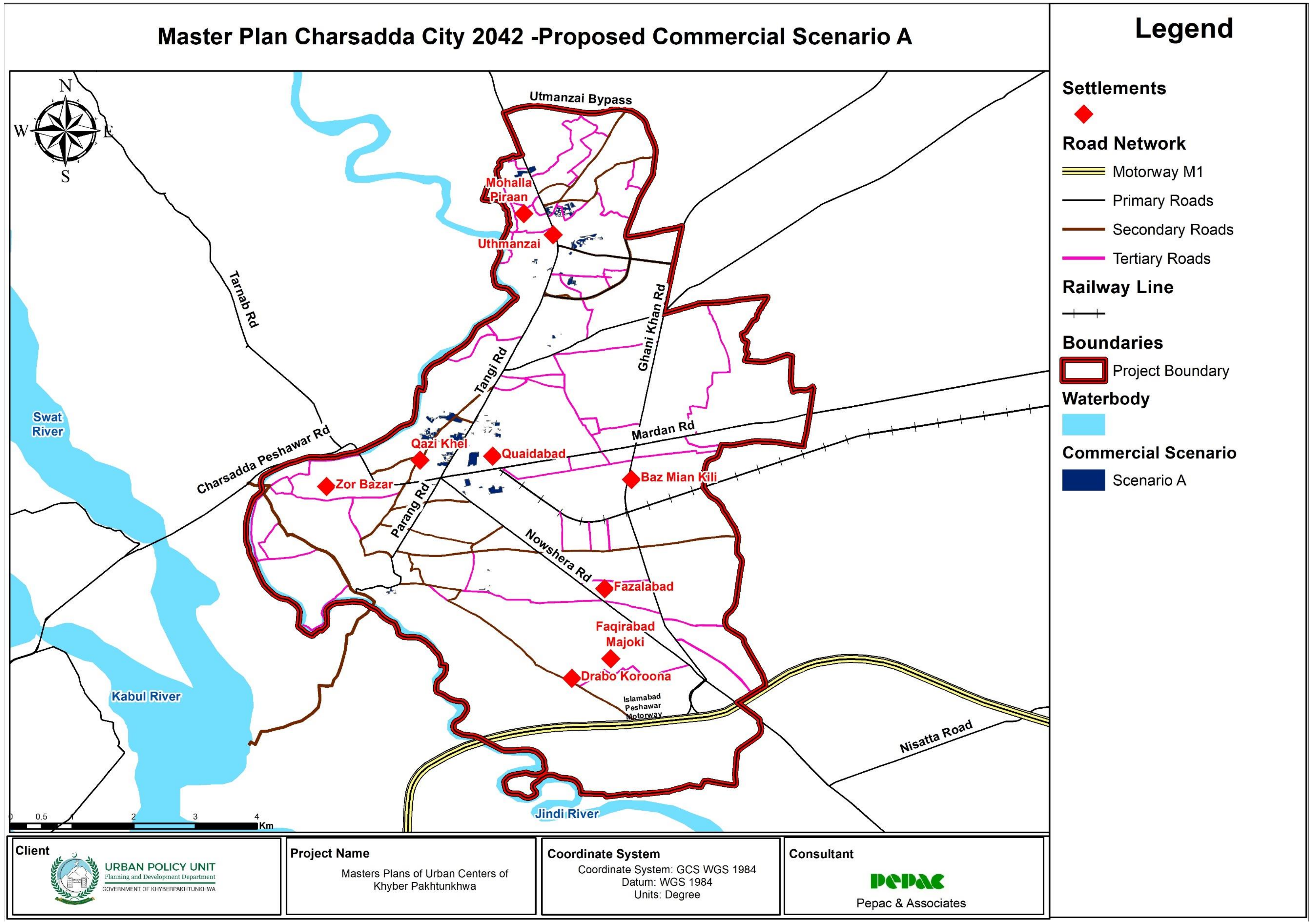
Similarly, the land requirement calculated for industrial development, the results generated through computing gave rise to various parcels which were most suitable for industrial allocation within the study area. Therefore, in the first scenario, the consultant has proposed industrial facilities having an area of 515.93 acres on the east-northern side of the study area.

Map 10: Proposed Residential Development Scenario A – Charsadda Study Area



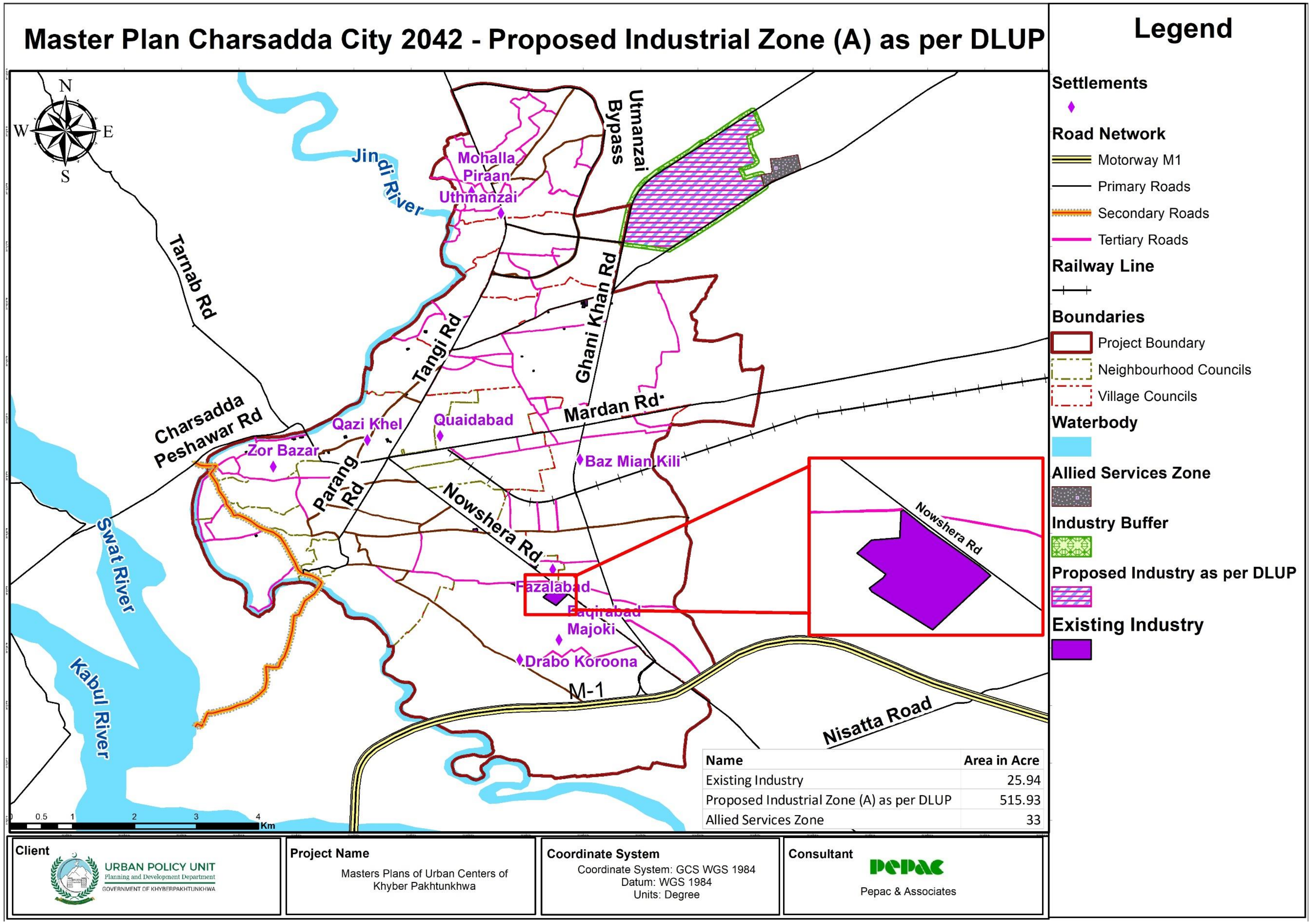
Source: Devised by Consultant

Map 11: Proposed Commercial Development Scenario A – Charsadda Study Area



Source: Devised by Consultant

Map 12: Proposed Industrial Areas Scenario A – Charsadda Study Area



Name	Area in Acre
Existing Industry	25.94
Proposed Industrial Zone (A) as per DLUP	515.93
Allied Services Zone	33

Source: Devised by Consultant

7.2.2. Scenario B

Alternatively, another scenario has also been developed i.e., Scenario B keeping in view the factors mentioned above and land suitability analysis. This scenario focuses more in fulfilling the required areas as per NRM and KP Urban Policy along with the nature of land uses provided which comparatively consume more land with respect to that utilized in Scenario A. Major land uses considered for this scenario are also residential, commercial, and industrial development.

For residential areas, the nature of development adopted comprised of both vertical and horizontal housing proposals in equalized ratio for the city. For vertical development, areas lying within the vacant land available in neighborhood councils is supposed to be catering vertical development in the city. Meanwhile for horizontal development, certain zones have been proposed within village councils of the study area outside NC's. however, a certain percentage for horizontal development will also be catered in infill development as the vertical housing will not be swallowing the whole NC's vacant area. The total area allocated for provision of housing facilities in scenario B is about 1610.47 acres of which 645.03 acres will be for infill development and remaining will be for Zone 1.

In Scenario B, commercial areas for the city have been proposed along the primary, secondary and tertiary roads through providing buffers having specific ranges with respect to the nature and use of road. For primary roads, buffer having range from 11-50 meters has been used for provision of commercial space. Similarly, a 6-50 meters buffer has been provided for secondary roads and 3-50 meters for tertiary roads in the city. The commercial areas on primary roads will be categorized as high-density commercial having G+10 storey plazas and it will continue to draw till tertiary roads where commercial density will be least with respect to that on the primary roads. The total area allocated for this purpose is calculated to be around 670 acres covering the entire city.

Finally for industrial use, the land for industrial development is proposed in correspondence with the one allocated in district land use plan for avoiding any sort of development conflict which may arise in the future. Also, it has been proposed viewing its capacity to cater the city's land demand till 2042.

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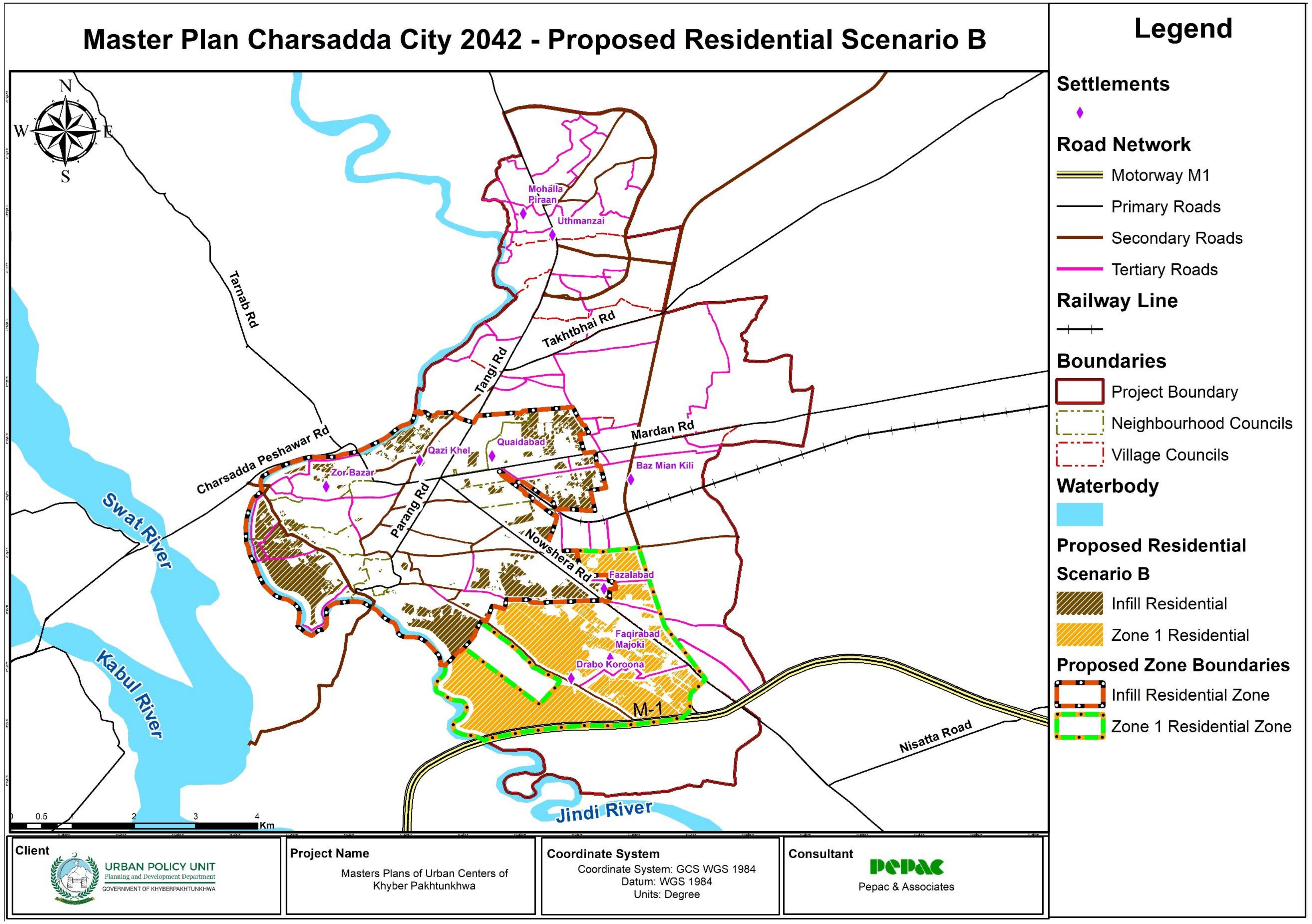
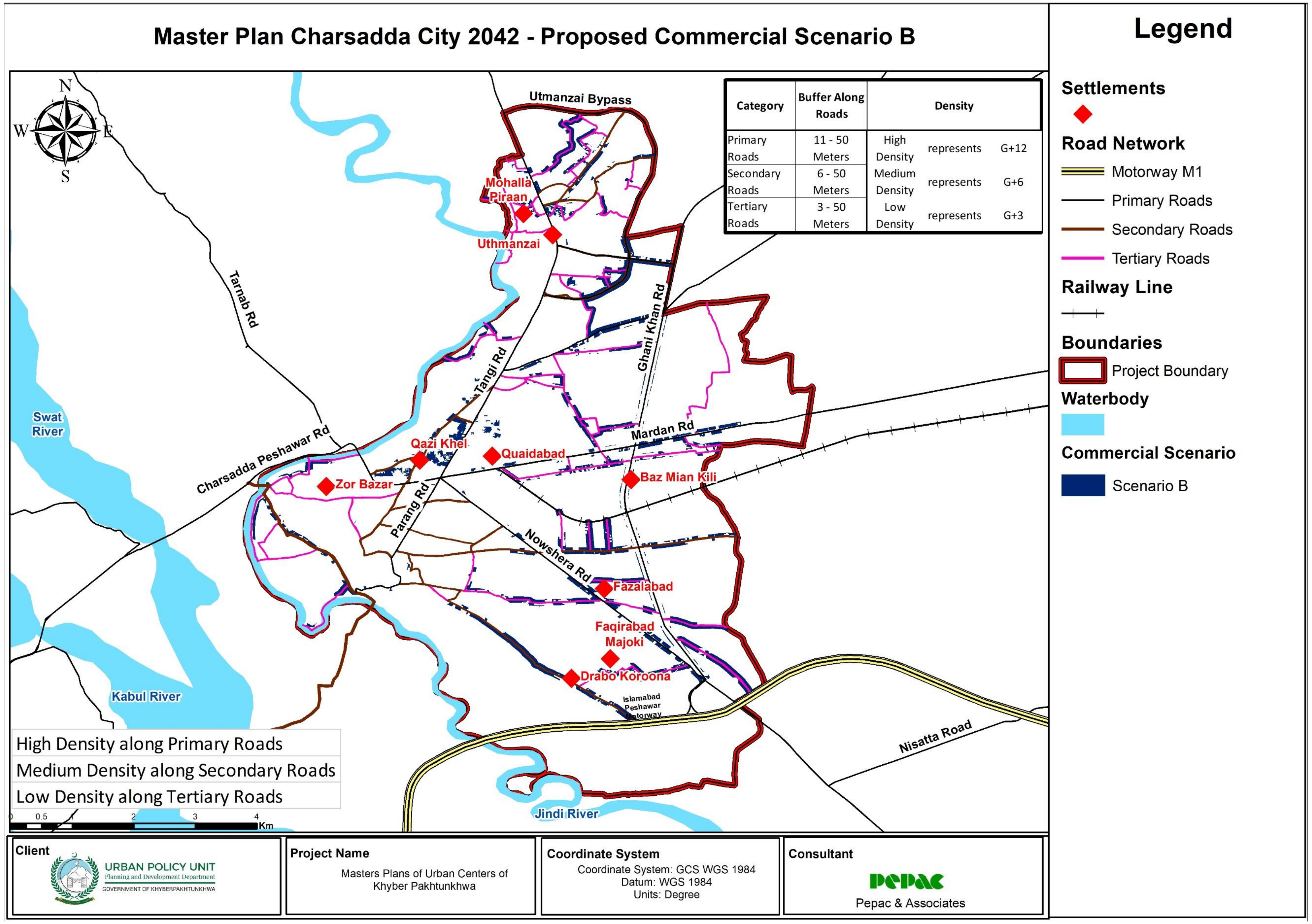
Map 13: Proposed Residential Development Scenario B – Charsadda Study Area



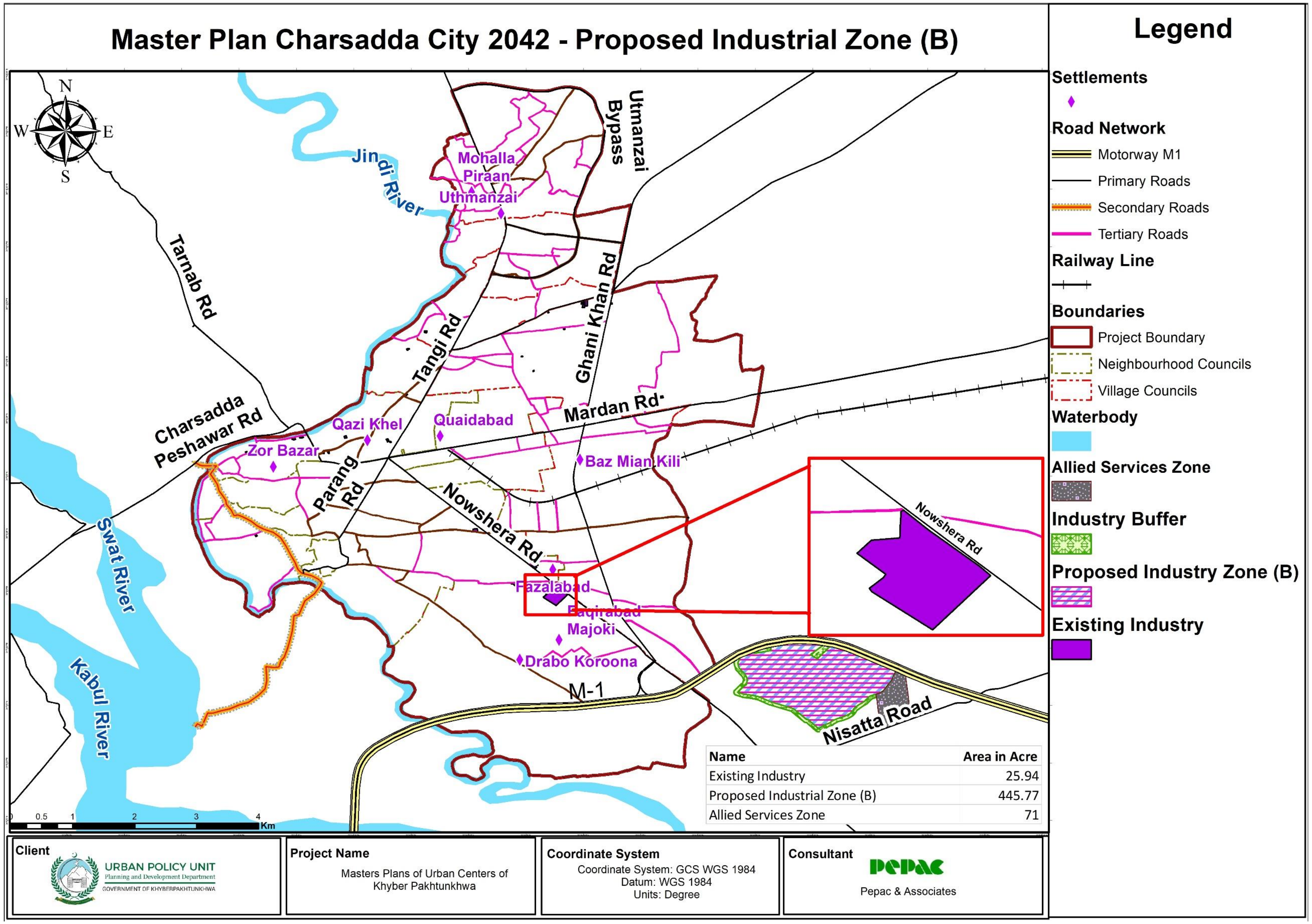
Source: Devised by Consultant

Map 14: Proposed Commercial Development Scenario B – Charsadda Study Area



Source: Devised by Consultant

Map 15: Proposed Industrial Areas Scenario B – Charsadda Study Area



Source: Devised by Consultant

7.2.3. Scenario Selection and Refinement

For preparation of proposed master plan, scenario B has been selected for the development of study area till 2042. The reason behind selecting scenario B stands the more balanced provision of land uses creating a perfect balance between built and natural environment. Being a scarce resource, the scenario supports compact development options through provision of vertical and horizontal housing development preserving the natural land at most. The proposed commercial area falling within the selected scenario has been given in accordance with the suitability and requirement to cater the future residential needs. Also, it has been provided keeping in view the land uses given in district land use plan Charsadda District. Similarly, the industrial land use is also proposed viewing the constraints of land requirement and the one proposed in district land use plan of Charsadda which is capable of catering the future needs of the study area. Finally, a large chunk of agricultural land is supposed to be preserved through the selected scenario which in other scenarios would have been utilized to a maximum extent. The detailed distribution of land uses through the selected scenario has been provided in the master plan section of report.

7.3. Model Selection for Guided Scenario Development

Cities around the globe are not only formed through collection of buildings and people instead they are organized in a proper spatial form ensuring mobilized functioning of different concerned city specific land uses i.e., education, commerce, production, and more. Another important factor influencing the orderly placement of these facilities is the value of land in terms of prices which in most cases is higher in the downtown area and lower in suburbs. Models predicting city development provide a comprehensive overview of the overall city growth and can help explore the possible future development options for a target city.

7.3.1. Adopted Model for Charsadda City

The proposed model for Charsadda city is centered around "Agro-Based Industrial and Educational Development." This model recognizes the growth potential of agriculture-based industries and educational institutions in the city. The identification of these potentials was based on data gathered from primary and secondary sources. Additionally, the model takes into account the desires of Charsadda city residents, as highlighted through a vision formulation exercise.

This model offers a framework for policymakers to leverage the city's strengths and take advantage of opportunities for growth. The focus on agro-based industries aligns with the region's untapped natural resources and could provide a boost to the local economy. The emphasis on educational development acknowledges the importance of investing in human capital to drive sustainable growth. Through this model, the city can plan a path forward that maximizes its potential and meets the needs and aspirations of its residents.

7.3.2. Model Classification

The selected model has been classified in the category of normative planning model. The main characteristics of this model type is that it captures the primary motivations of people and starts with a well-defined target and seeks for input from stakeholders. After target identification, the model seeks how to achieve the highlighted target through different means. The normative planning model has been sought and will continue to seek input from stakeholders to identify targets for development i.e., through vision development and through action plans. The desires of people living in Charsadda city have been highlighted through a vision formulation exercise, indicating that stakeholders' opinions and aspirations have been taken into account.

It set clear targets for development, which are to promote agricultural and educational activities in the near future. This provides measurable targets for development, making it easier to evaluate the outcomes and ensure accountability. It takes into account the available land resources and opportunities when determining the best means of achieving the target. For example, the model views the potential of growth for agriculture-based industries and educational development in the city, which aligns with the natural resources of the region and the aspirations of its residents.

By incorporating stakeholder input and considering available resources and opportunities, the normative planning model employed in the city can promote sustainable development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Provides a comprehensive understanding: The normative planning model provides a structured framework for decision-making that helps to ensure a comprehensive understanding of the target and the best approach for achieving it. In the case of Charsadda city, this means promoting agricultural and educational activities in a way that aligns with the values and motivations of stakeholders while being feasible and sustainable.

7.4. Target Outcome

The targeted outcomes to be achieved by the proposed development model are;

Figure 17: Target Outcomes of Green Economic Model for Charsadda City

Source: Devised by Consultant

- **Protection of Agricultural Land:** The preservation of agricultural land will ensure the long-term sustainability of the local economy and preserve the city's agricultural heritage.
- **Sustainable Economic Growth:** The model seeks to promote sustainable economic growth by promoting local businesses and industries, creating employment opportunities, and reducing the city's ecological footprint.
- **Environmental Protection:** The model aims to protect natural resources and biodiversity, reduce greenhouse gas emissions, and promote sustainable development practices.
- **Compact Urban Development:** The promotion of compact urban development and densification will reduce the ecological footprint of the city and promote sustainable urban development.
- **Preservation of Natural Beauty and Cultural Heritage:** The preservation of the city's natural beauty and cultural heritage will promote sustainable tourism and enhance the city's unique character.
- **Promoting General and Higher Education:** Promoting General and Higher education in the city will enhance overall literacy rate in the target area.

7.5. Model Construction and Analysis Tools

A qualitative tool has been used to generate a large number of potential scenarios, ideas, and solutions under the model for Charsadda City Master Plan 2042. The SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis tool has also been used to identify the strengths and weaknesses of different scenarios and to assess their potential opportunities and threats. Furthermore, Geographic Information System (GIS) models have been used to simulate and analyse different scenarios based on various spatial data and indicators. GIS models were used to assess the potential impact of different scenarios on land use, transportation, environment, and other factors, and to identify the best possible outcomes based on different scenarios.

7.6. Proposed Zoning

Viewing the constraints appeared through scenario development for land use provision in Charsadda city, the proposed zones are given in accordance with the scenario B selected for guiding the future development in the city. These zones are given keeping in view the land suitability, availability of land in form of vacant and agriculture and temporal justification with respect to temporal classifications. The land uses proposed include;

- Residential
- Reserve Agriculture
- Sports Complex Zone
- Commercial
- Industrial
- Apiculture Zone
- Cattle Market
- Civic Zone
- Cultural Zone
- Educational Zone
- Grain Market Zone
- Health Zone

Recreational Zone
Mixed Use Zone
Park Zone
Livestock Zone

Chapter 8: Proposed Master Plan Charsadda City

For final master plan of Charsadda city 2042, the consultant has adopted the best scenario for guiding future development of city accommodating existing built up and population along with the proposed development and future population, meanwhile without compromising natural resources at maximum including agriculture, pasture, green spaces and forest land situated within the study area boundary. The Proposed Master Plan for Charsadda is based upon the LSA and best scenario chosen in the above section. For master plan implementation three distinguish timeframe intervals are proposed to make the masterplan implementation efficient and sustainable. Following are implementation phases for master plan.

Table 13: Implementation Strategy Master Plan of Charsadda 2042

Sr. No	Time Period	Development Time Frame	Development Type	Population Served
1	2022-2027	Short Term	Infill Development Phase 1	32,926
2	2022-2032	Medium Term	Infill Development Phase 2	67,255
3	2022-2042	Long Term	Zone 1 Development	137,549

Source: Devised by Consultant

In light of the proposed scenarios, Land suitability analysis along with the land demand calculation for all land uses and their allied facilities including health, education, reactional spaces, civic zones as well as introduction of new road ways for connectivity; Master plan for Charsadda Study Area is being proposed by the consulting team. NCs and VCs are suggested to be developed in accordance to scenarios proposed in phases. The development is following a compact development route identified through LSA. Under the development scenarios being proposed in Master Plan selected area of VCs will be urbanized within the timeframe of the project.

8.1. Master Plan Implementation Strategy

To achieve the desired goals of entire master planning practice, the whole package is divided into three terms being short, medium and long in nature. These strategies are further explained in the sections defined next.

8.1.1. Short Term Plan 2022-2027

The short-term phase till 2027 will emphasize on infill development strategy mostly for provision of housing facilities in the area falling within neighborhood councils. This will facilitate the smart, environment friendly and sustainable development initiative through utilizing existing land parcels within developed residential areas. The planning phase is supposed to accommodate 32,926 people till 2027 being almost 5 years. The details of the NC’s covered in the development phase are given in the table below.

Table 14: Name of NC's for Short-Term Development

Sr. No.	Name of Administrative Unit	Status
1	Islamabad Charsadda IX	NC
2	Umerabad	NC
3	Qazi Khel Charsadda II	NC
4	Ghari Hamid Gul Charsadda	NC
5	Muslim Abad Charsadda X	NC

Source: Devised by Consultant

8.1.2. Medium Term Plan 2022-2032

In medium term, remaining neighborhood councils will be utilized for development till 2032. For this concern, area of NC's allocated on south-western side will be utilized for highlighted development. This will cater a population of 67,255 people till the mentioned period being 10 years in total. The details of the NC's facilitating development in medium term phase are given in the table below.

Table 15: Proposed NC's for Medium Term Development

Sr. No.	Name of Administrative Unit	Status
1	Main Kalli Charsadda IV	NC
2	Babara	NC
3	Aziz Khel VII	NC
4	Mama Khel Charsadda VI	NC
5	Main Kalli Charsadda IV	NC

Source: Devised by Consultant

8.1.3. Long Term Plan 2022-2042

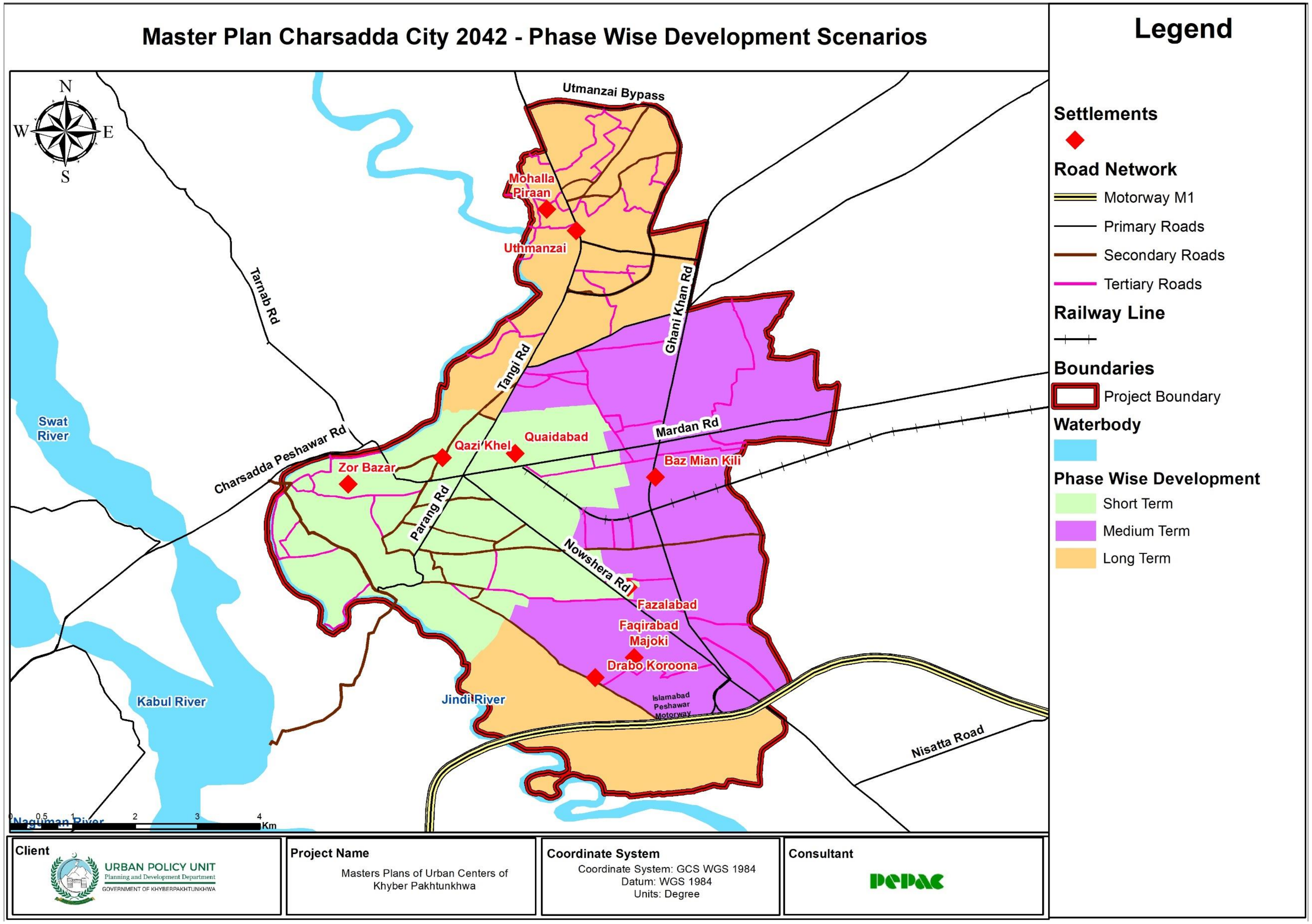
The final division of implementation strategy comprises of long-term planning initiatives till 2042. The major housing development is supposed to be made in VC's of the study area. Similarly, other land uses will be provided accordingly on the allocated areas of VC's while preserving the natural areas at maximum to ensure environmental sustainability. The total number of people calculated to be facilitated through this development are 137,549 till 2042 in the area. Also, there are possibilities that some of the land uses proposed in village councils could face development within short- and medium-term phase viewing the intensity of need. The details of the VC's to be used for development are given in the table below.

Table 16: Proposed VC's for Long Term Planning

Sr. No.	Name of Administrative Unit	Status
1	Chitral	VC
2	Mara Prang	VC
3	Sheikh Abad	VC
4	Chak Nisatta	VC
5	Amir Abad Rajjar	VC
6	Salarzai	VC
7	Parich Kharl	VC
8	Piran	VC
9	Haleem Abad	VC
10	Tariq Abad	VC

Source: Devised by Consultant

Map 16: Phase Wise Development Scenario – Charsadda Study Area



Source: Devised by Consultants

Further details of the provisioned land uses are given in the upcoming sections.

8.2. Salient Planning Features of Proposed Master Plan

8.2.1. Proposed Residential Zones

Based on the selected scenario for future development, the residential facilities in the Charsadda city are proposed on both vacant and agriculture land falling within NC's and VC's of the area. The zonal division with respect to the allocated areas are given in the following table.

Sr. No.	Residential Zone	Area (Acres)
1	Infill Development Zone	645.03
2	Zone 1	965.44

8.2.2. Proposed Commercial Zone

The commercial zone for master plan of Charsadda city has been proposed along the primary, secondary and tertiary roads in the city. A total area of 657.42 acres has been allocated for the desired commercial development along the highlighted roads. the proposed areas are supposed to be catering the future commercial needs of the city till the master planning time period.

8.2.3. Proposed Industrial Zone

Similar to proposed commercial zones, the zoning for industrial development in Charsadda city has been proposed in southern-eastern side of the city along motorway M1. The area allocated for the industrial zone is around 445.77 acres and is supposed to cover the future industrial demand of the city. The area proposed has been shown in the final map prepared for the master plan of Charsadda city 2042.

8.2.4. Proposed Civic Zones

Viewing the potential of existing civic zone in the study area, a certain extension for the civic zone has been proposed to cater the future demand of the city. the extension is proposed on the eastern side of the study area and entire civic zone covers an area of around 83 acres.

8.2.5. Proposed Agricultural Reserves

For safeguarding the natural reserved areas, agriculture zones on remaining areas have been proposed in the study area to be preserved till the master planning period of 2042.

8.2.6. Proposed Health Zone

Falling under the institutional needs of the city, certain health zones have been proposed in the VCs of study area. The allocated health land use is supposed to be serving total population to be increased till 2042 in the Charsadda city.

8.2.7. Proposed Educational Zone

Similar to health zones, certain educational zones have been proposed in the area being within VC boundaries for catering the future requirement of the city till 2042. The illustrations for the proposed educational zone have been made in the final map of master plan for Charsadda city 2042.

8.3. Proposed Areas for Land Uses

Existing residential area of Charsadda is around 2477.25 acres, so to accommodate the projected population of 2042 additional 1610.47 acres of new parcels are proposed for future residential development. In these new residential parcels, 80:20 ratio is proposed where horizontal and vertical development is suggested respectively to accommodate all income groups.

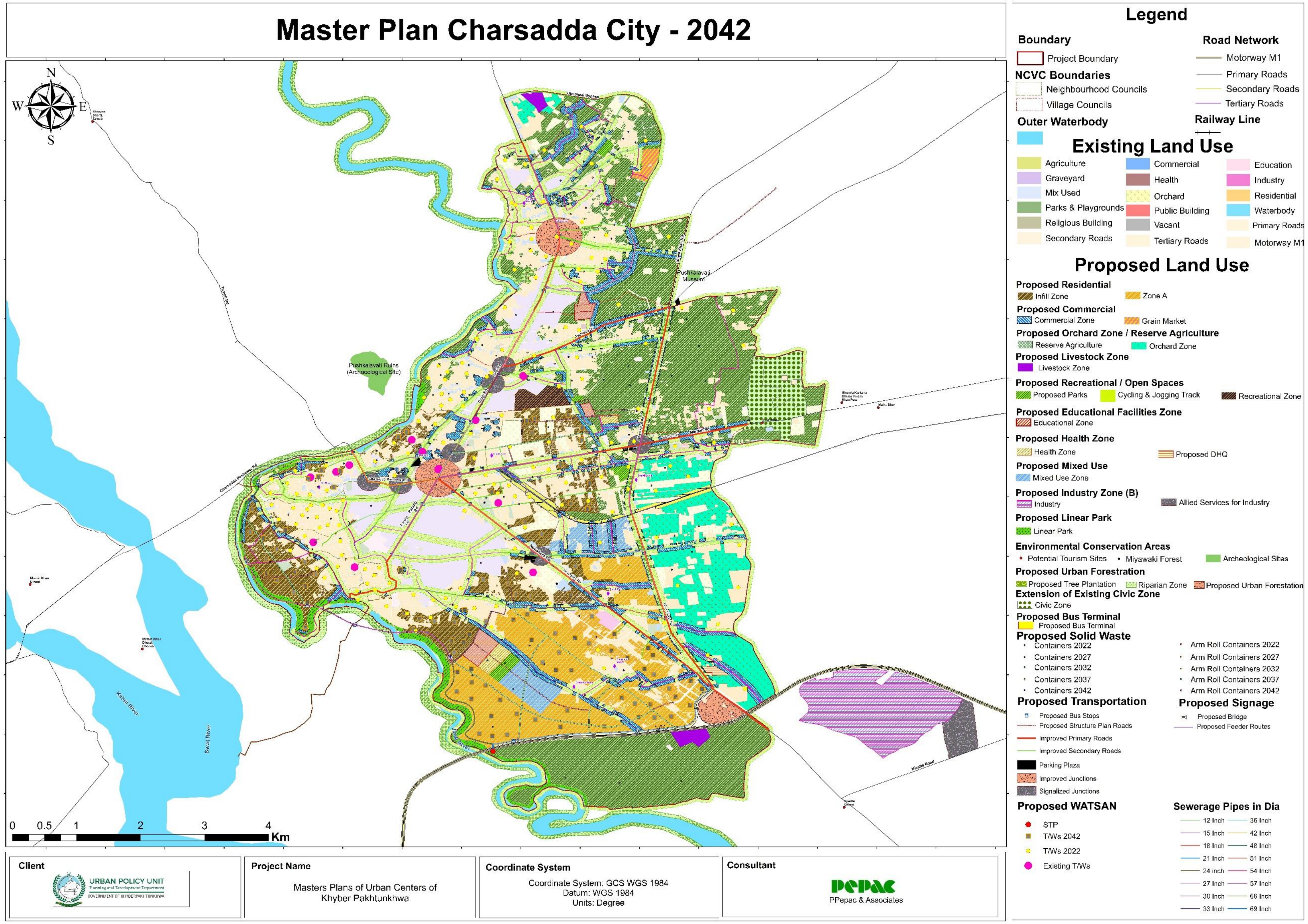
Charsadda study area has 46.94 acres of land parcels containing recreational open spaces and according to NRM standards around 1 to 7% of land should be present to meet the needs of 2042 population and the consultant has proposed 337.57 acres for recreational places. The existing area of graveyards in the study region is 872 acres which exceeds the NRM's minimum criterion; hence no area has been proposed for graveyards. The detailed calculations and comparison for the proposed land uses with existing land use and NRM standards has been given for the city in the table below.

Table 17: Existing and Proposed Land Use Comparison

Land Use	Sub-Category	Area (Acres)	Existing Landuse Percentage	NRM Standards	Proposed Land Use	Existing + Proposed	Existing + Proposed Percentage
Residential	Planned	51.44	22.41%	45-52%	1610.67	4087.72	36.98%
	Unplanned	2425.81					
Commercial	Retail	193.33	2.90%	2-3%	720.42	1041.42	9.42%
	wholesale	66.71					
	other	60.96					
Industry		25.94	0.23%	3-8%	0	25.94	0.23%
Agriculture	Agriculture	5291.31	51.19%	2-5%	2114.78	2114.78	27.50%
	Orchard	368.10			557.31	925.41	
Public Amenities	Education	91.29	1.97%	2-10%	58.05	149.34	4.81%
	Health	23.53			37.98	62	
	Religious Building	31.54			0	31.54	
	Mix Used	15.85			134.3	150.15	
	Public Building	55.57			83.84	139.41	
Parks/Playgrounds		46.94	0.42%	1-7%	337.57	384.51	3.48%
Graveyard		872.87	7.90%	0.5-4%	0	872.87	7.90%
Vacant		584.72	5.29%	3-17%	0	0	0
Waterbody		135.7	1.23%	---	0	135.7	1.23%
Road		713.13	6.45%	12-29%	221.29	934.42	8.45%
Total		11054.75	100%	---	5876.01	11054.75	100%

Source: Devised by Consultants

Map 17: Proposed Master Plan 2042 – Charsadda Study Area



Source: Devised by Consultant

Master Plans of Urban Centres of Khyber Pakhtunkhwa

Part D: Master Plan Proposals

9.1. Proposed Housing Scenarios Charsadda

9.1.1. Introduction

Housing is a basic human need but individual struggles to have a roof over his head. Unprecedented urbanization and population increase have left many cities with severe housing shortages, particularly in rising and developing countries. Despite the establishment of three new housing societies, finding a adequate housing unit in large cities remains a challenge. There is always demand for rental homes because not every household can build a home for itself. As a result, housing, a basic necessity, became difficult to meet in most emerging countries due to growing urbanization.

Housing demand is governed by the conceived population, household size and occupancy rate. Whereas the level of level of infrastructure provision, type of housing and plot sizes depend on economic situation of the residents living in the area; households with higher income tend to reside in planned area in parallel to low-income household who mostly occupy unplanned or dilapidated residential area. Thus, the physical location of housing is significant as it not only influences overall structure price, which is commonly neglected yet crucial, but also because it contributes to the response, we offer to an economic critique of numerous studies of housing demand.

9.1.2. Existing Housing Situation

As per the census report of 2017, the total population of 209,745 people in Charsadda city is accommodated in 28,809 housing units with a household size of 7.08. About 97.92% of the total housing in the city has grown organically without any pre planning while remaining 2.08% housing areas are well planned as identified through primary surveys. There are also slums identified in the city existing within the city fabric requiring suitable upgradation interventions by the responsible authorities. Further details of the housing facilities in the cities are given in the sections below.

9.1.3. Existing Housing Schemes

Three approved housing societies have been identified in the Charsadda study area. The approval of the housing schemes is granted by Tehsil Municipal Authority (TMA). The detail of these housing schemes are as follows:

Table 18: TMA Approved Housing Societies

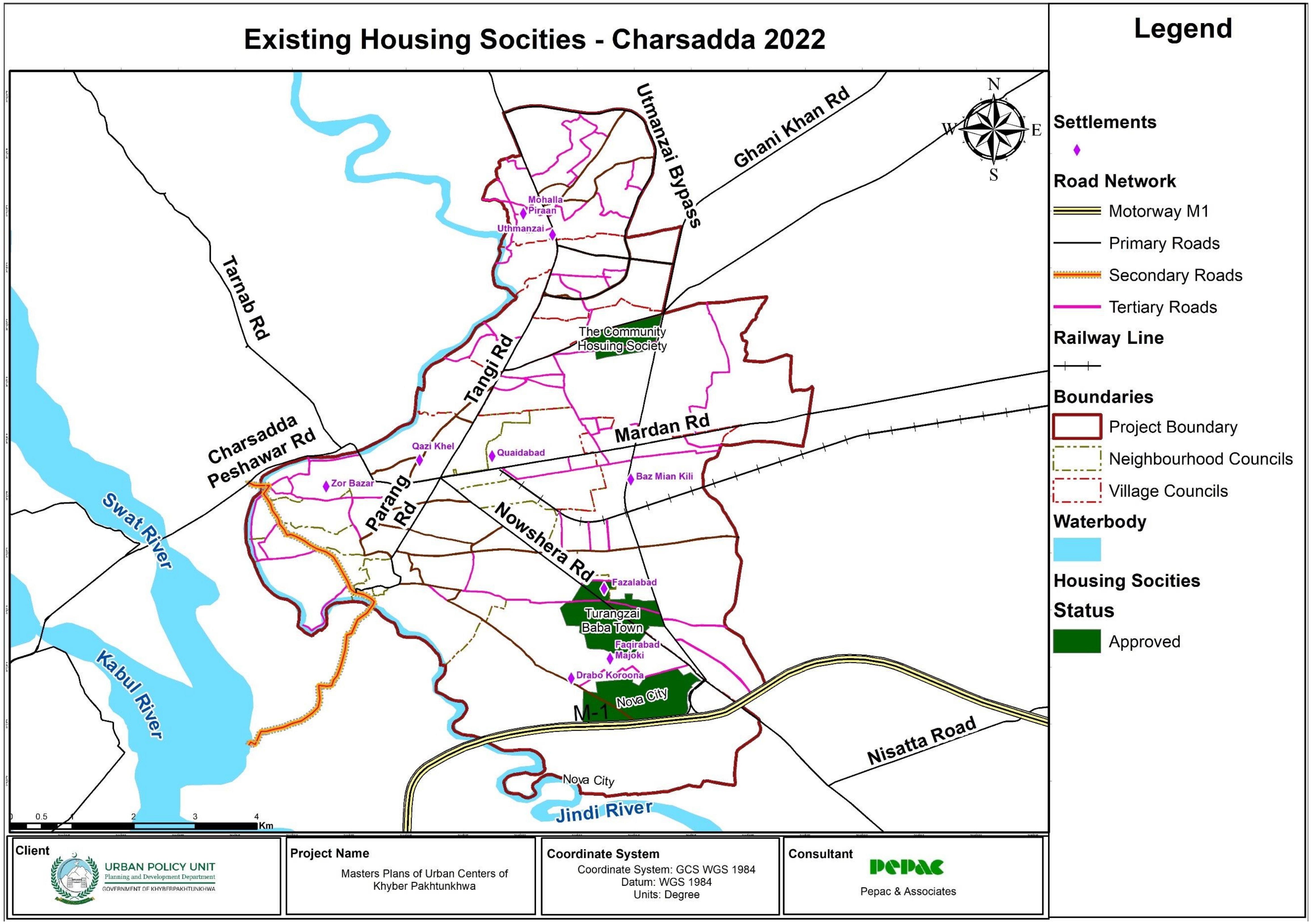
Sr. No.	Name of Housing Scheme / Society	Location
1	Turmangzai Baba Town	DHQ Hospital Road
2	The Community Charsadda Housing Scheme	Thakhtbai Road

Sr. No.	Name of Housing Scheme / Society	Location
3	Nova City	Nowshera Road

Source: Secondary Data obtained from TMA, Charsadda

The Turmangzai Baba Town is located in NC Umarabad. Whereas the Community Charsadda Housing Scheme is located on Thakhtbai Road and falls under the VC Utmanzai. Similarly, Nova city is located adjacent to Motorway M1 from south and on Nowshera road from eastern side. The map of existing housing schemes is as follows;

Map 18: Approved/Unapproved Housing Societies



Source: Devised by Consultants

9.1.4. Planned and Unplanned Residential

Using the land use data collected through primary survey, the consultant has divided the residential land use into two categories i.e., planned and unplanned. The unplanned residential, in essence, consists of all the existing residential area within the study area as the city has developed and grown without any planning rule, regulation and bylaws being in place. The planned residential includes housing units developed in the planned and approved housing schemes of the city. The analysis has shown that total planned residential in Charsadda study area is approximately 51.44 acres while unplanned is approximately 2425.81 acres.

9.1.5. Existing Housing Backlog

Housing backlog in the Charsadda city was calculated utilizing the population characteristics and household size obtained from 2017 census. By 2017, it was seen that population of 209,745 was residing in 28,809 housing units within the area. The population projected for 2022 represented an increase of 31,032 people in next five years giving rise to a total number of 240,777 people. Along with the population and housing units, the household size calculated was 7.08 in the city. The housing units. The calculations performed for identifying the housing backlog in the city are given in the following table.

Table 19: Housing backlog – Charsadda Study Area

Housing Backlog							
Year	Population	Household size	Expected Housing Units	Existing housing units	Backlogs	Replacement Demand	Total Requirement
A	B	C	D	E	F	G	H
			B/C	Calculated by Consultants	D – E	E*4.7%	F + G
2017	209,745	7.08	29,625	28,809	816		
2022	240,777	7.08	34,008	33,192	816	1,560	2,376

Source: Devised by Consultant

9.1.6. Future Demand Estimation

With increase in city's population, there will be more demand of housing units in the future for accommodating the expected population. In Charsadda city, 137,549 people are expected to be added in the city from year 2022 to 2042. This growth will ultimately require more housing units to be built in the city premises. Viewing the existing growth pattern and trends of Charsadda, it has been determined that the household size will decrease from 7.08 to 6.11 till 2042. The projected population in line with required housing units and expected household size are given in the following table.

Table 20: Future Housing Demand – Charsadda Study Area

Year	Population	Proposed Household size	Increase in Population	Existing Housing Units	Carry Forwarded Housing Backlog	Replacement Demand	Future Requirement	Total Requirement
I	J	K	L	M	N	O	P	Q
			Future Projection Present Population	E + 50% of Total Requirement	50% of Backlog	M x 55% of Existing Housing Units	L/K	N + O + P
2027	273,703	6.84	32,926	34,380	408	1,616	4,815	5,223
2032	308,032	6.60	34,329	39,603	408	1,861	5,205	5,613
2037	343,133	6.35	35,101	45,216	-	2,125	5,524	5,524
2042	378,326	6.11	35,193	50,741	-	2,385	5,758	5,758

Source: Devised by Consultant

9.2. Proposed Housing Scenarios Charsadda

The study area of Charsadda has undergone significant growth in population over recent years, prompting a need for projections of future housing requirements to accommodate these increases. The future housing projections for the Charsadda study area have been carefully formulated, taking into consideration various factors, including the projected population, household sizes, existing plot sizes, land availability, conservation of agriculture land, and overall housing needs till 2042.

After thorough analysis, three housing scenarios have been discussed, each proposing a unique approach to housing development. These scenarios include all horizontal development, complete vertical development, and a horizontal cum vertical development scenario. Each scenario has been further divided into four phases designed to cover the total housing requirement till 2042 in equal intervals.

The timeline for each interval is set at five years, starting from 2022 and spanning until 2042. The carefully designed phases and intervals will ensure that the housing requirements are met effectively and efficiently, without disrupting the existing infrastructure of the area.

To provide a brief summary of the proposed scenarios, the all-horizontal development scenario will focus on developing low-rise, spacious housing units, which are cost-effective and energy-efficient. The complete vertical development scenario proposes high-rise buildings, which can accommodate a greater population, while conserving land and providing a more sustainable housing option. Lastly, the horizontal cum vertical development scenario combines both the horizontal and vertical development models, to provide a unique and innovative housing solution, which is both spacious and sustainable.

Housing Scenarios

Scenario 1
- Horizontal Development

Scenario 2
- Vertical Development

Scenario 3
- Horizontal cum Vertical Development

9.2.1. Housing Scenario Analysis

Housing scenarios have been made based on the exiting plot size, building height analysis and several qualitative and quantitative factors. Following section highlights the detail of scenario analysis;

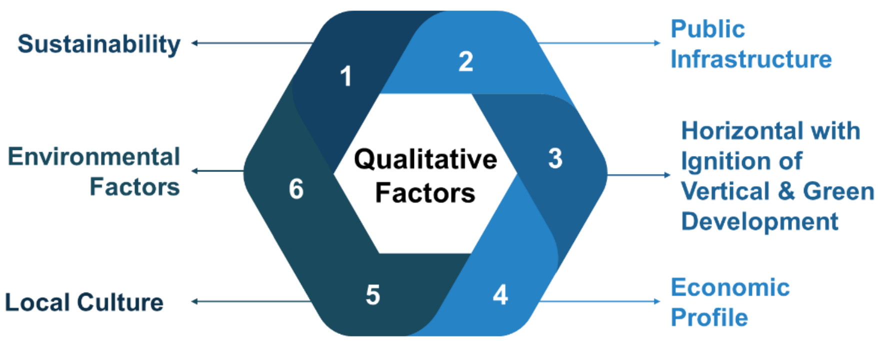
9.2.1.1. Building Height

Building height of residential parcels have been assessed to develop housing scenarios. The results show that out of total 38,432 residential parcels, almost 2766 parcels accommodate to triple story buildings that makes up 7% of the total residential buildings. On the basis of this analysis, a scenario accounting to 20% vertical and 80% horizontal residential development has been developed.

9.2.1.2. Qualitative Factors

When developing scenarios for the development of Charsadda, a range of qualitative factors alongside quantitative factors have been considered. These qualitative factors play a significant role in understanding the unique context of Charsadda and ensuring that development scenarios align with the specific needs and aspirations of the local community. Here are some key qualitative factors that have been considered for developing scenarios;

Figure 18: Qualitative Factors Considered For Housing Scenario



Source: Devised by Consultant

- **Sustainability**

The developed scenario aims to promote sustainability in its design and development. This includes the use of sustainable materials in construction, the integration of green spaces, the promotion of walking and cycling as transportation options, and the implementation of a waste management system. It encompasses various dimensions, including environmental, social, and economic sustainability.

- **Environmental Factors**

Charsadda is surrounded by natural beauty and resources that need to be protected and preserved. Considerations related to biodiversity, conservation of natural habitats, water and air quality, and climate change resilience are crucial. Integrating environmental factors into scenario development will help minimize environmental degradation and promote sustainable practices for the benefit of current and future generations.

- **Access to Public Infrastructure**

The accessibility of public infrastructure, such as public transportation, healthcare facilities, educational institutions, and recreational areas, are recommended to be considered in the scenario development. It is important to ensure that residents have easy access to these facilities, especially those living in vertical developments, which may require closer proximity to these amenities.

- **Accessibility to Social Infrastructure**

The accessibility of social infrastructure, such as community centers, religious institutions, and social services, has also be taken into account in the scenario development. The development ensures that residents have access to these social resources to promote community cohesion and well-being.

- **Horizontal with Ignition of Vertical & Green Development**

This approach combines the advantages of horizontal development, such as preserving natural areas and creating spacious dwellings, with the benefits of vertical and green development, such as efficient land use, social interaction, and environmental sustainability. By incorporating vertical development within horizontal projects, the city can optimize land use and accommodate a larger population without extensive urban sprawl. Vertical development allows for the construction of mid-rise buildings, which can house multiple housing units on a smaller footprint, thereby maximizing the utilization of limited land resources.

- **Economic Profile of the city**

Charsadda has the potential for economic growth and diversification. Economic factors to consider include employment opportunities, income distribution, and the stimulation of local industries. Development scenarios aims to create sustainable economic opportunities, attract investments, and empower local businesses to contribute to the economic development of Charsadda and improve the livelihoods of its residents.

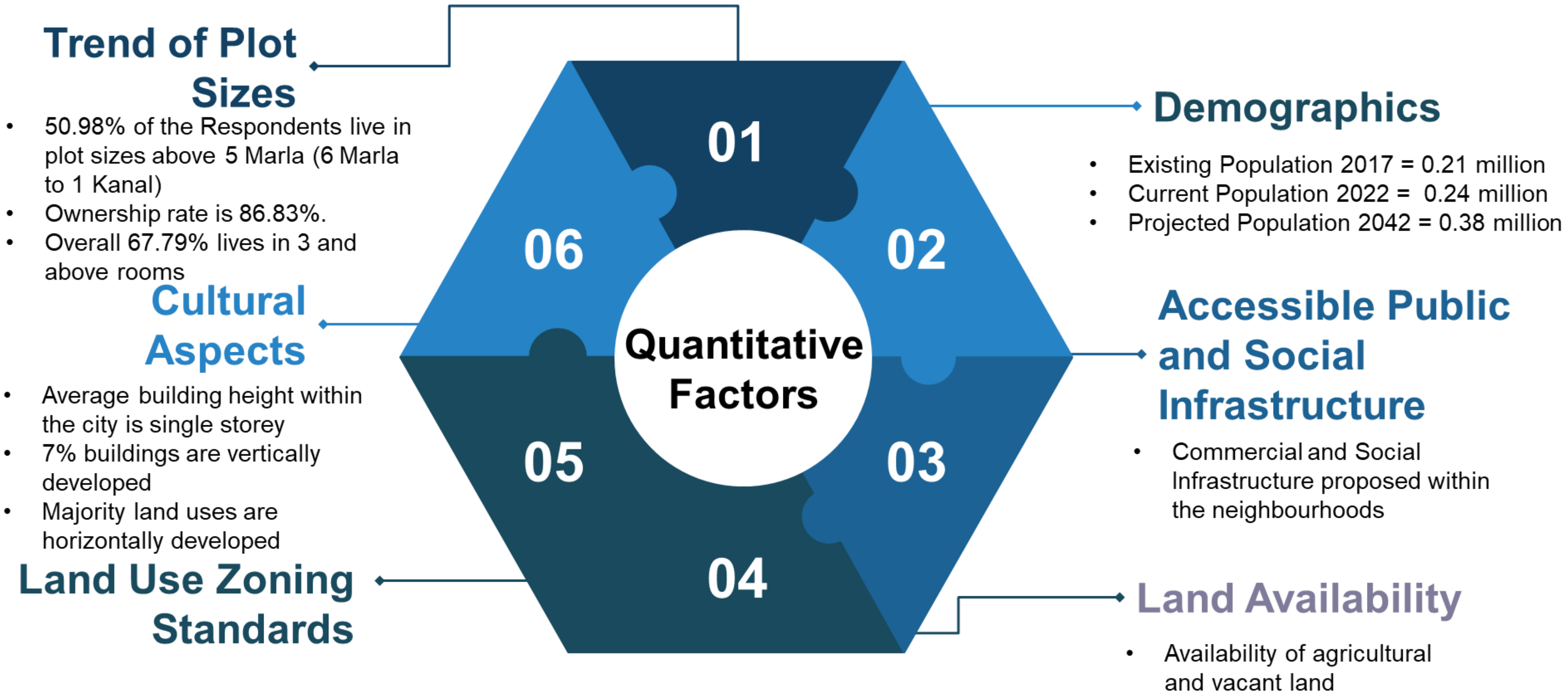
- **Local Culture**

Charsadda has a rich cultural heritage that must be valued and preserved. Cultural factors include architectural heritage, traditional practices, cultural events, and local customs. Incorporating cultural considerations into development scenarios helps maintain the distinct identity of Charsadda and promotes a sense of pride and belonging among its residents.

9.2.1.3. Quantitative Factors

While considering the qualitative factors, some quantitative factors have also been considered for scenario development. Following figures shows the quantitative factors considered for residential scenario development.

Figure 19: Quantitative Factors Assessed for Residential Scenario - Charsadda Study Area



Source: Devised by Consultant

9.2.2. Scenario 1 – Horizontally Harmonious: Building a Community Through Affordable Housing

Horizontal housing development is a type of residential development that involves spreading out horizontally across a large area of land. This type of housing typically takes the form of detached, semi-detached, and townhouses and can be found in both urban and rural areas. The appeal of horizontal housing lies in its ability to provide a more private, spacious, and quieter living environment for its occupants. Some of the benefits of horizontal housing include greater flexibility of use, a sense of ownership, and a more spacious living environment.

However, it is important to note that horizontal housing development can promote intensive land utilization and increase car dependency, which can have negative impacts on the environment. Unfortunately, in many urban areas of Pakistan, the trend towards horizontal housing development is quite extensive. This highlights a concerning mentality among people who prioritize the perceived benefits of living in a horizontal housing development without fully considering the impact it may have on the environment and future generations.

This trend has been further reinforced and encouraged by private developers who purchase large tracts of agricultural land at low rates, and subsequently carry out frenzied real estate development within or at the outskirts of urban areas. This rapid expansion of urban areas has resulted in the consumption of precious agricultural land, wildlife habitats, and orchards, without due consideration for the importance of these natural resources. This unsustainable approach to horizontal housing development has compromised the needs of future generations and the long-term well-being of the planet.

Keeping in view all the constraints associated with the horizontal development, the consultants have devised the first scenario based upon horizontal development approach for housing in the study area till 2042. Certain calculations were performed giving the area required to build such housing facilities in the city. For this purpose, housing units have been proposed of varying sizes from 3 Marla to 1 Kanal viewing socioeconomic limitations of the existing population of Charsadda city. These socioeconomic figures have been identified from the performed primary surveys in the study area. Furthermore, the scenario has been divided into four phases having five years interval. The total area required for horizontal housing development has been calculated about 1714.9.

9.2.3. Scenario 2 – Exploring the Potential of Vertical Housing – Redefining Urban Living

Vertical housing development includes the provision of residential facilities in form of multistorey apartment or condominiums. A smaller footprint of land is consumed adjusting more population is a key advantage of such housing provision. It allows more densified development certainly in urban areas and can accommodate large number of people without utilizing larger amount of land. Furthermore, greater access to transportation facilities, proximity to employment and public amenities are some of the benefits which could be achieved through such development. Although there are also some issues attached with the vertical housing development, i.e., less access to natural light and outdoor space, more utilization of shared infrastructure and lack of ownership, still it can be highlighted as a more economical and smart way for providing housing in any area.

Throughout the country, the trend towards vertical housing has been observed to be slow as people prefer to live in individual housing units rather than shared ones. With rapid urban growth in cities, however, it will eventually become necessary to develop alternative housing options, such as vertical development, to make more efficient use of land and cater to the needs of future populations in a more justifiable way. To address these issues, a second housing scenario has been proposed for the entire housing development in the city, based on the vertical development approach. The plan includes 1-, 2-, and 3-bedroom apartments for housing development in the area until 2042. These apartments also attain areas for inner circulation within the building and for mandatory open spaces being 40% and 20% respectively to build these units with all the necessary uses. 45% additional area for allied uses is also provided for the entire zone to promote sustainable and environment friendly development. The total area calculated for vertical housing development in the area is about 285.4 acres in total.

9.2.4. Scenario 3 – Horizontal cum Vertical Housing Development

One of the most important factors in developing sustainable, livable communities is balancing vertical and horizontal housing development. Cities may maximize the effective use of land by combining the two while also fostering community, outdoor space, and affordability. Vertical housing has certain benefits, like increasing living area per square meter of land and decreasing urban sprawl and the related long commutes. But it can also lead to a feeling of seclusion and cutoff from the neighbourhood. Horizontal housing, on the other hand, can be expensive and promote urban expansion but offers a sense of neighbourhood, outdoor space, and a more typical neighbourhood feel.

In order to create more diverse and welcoming communities, it is important for cities to strike a balance between vertical and horizontal housing options. This approach can help to avoid some of the negative consequences of relying too heavily on one type of housing, such as sprawling suburbs or cramped apartment living. Additionally, offering a variety of housing options can help to ensure that the needs of different socioeconomic groups are met.

With these goals in mind, the third scenario for housing development in city of Charsadda has been developed that includes 20% vertical and compact development in the form of five-storey (G+4) apartment buildings, and 80% horizontal development with plot sizes ranging from 3 Marla to 1 Kanal. The city plans to expand in a balanced way between horizontal and vertical development, but even with this approach, the overall amount of horizontal development will still be greater than vertical. The total area calculated for such housing development is around 1301.5 acres.

9.3. Selected Housing Scenario

The selected housing scenario for Master plan of Charsadda City 2042 is Scenario III, that accounts for 80% horizontal and 20% vertical development. The major reason behind selecting this scenario is the land availability and housing affordability in Charsadda city. The primary motivation for introducing vertical development is to increase the standard of living for most of the population and to stop the horizontal spread of cities. With positive environmental benefits, vertical development can elevate the standard of living for the country's population and become an effective solution to decreasing informal settlements. The plot sizes in the selected scenario are devised with respect to the prevailing socioeconomic characteristics of the population. The details of the proposed plot sizes are given in the following table.

Table 21: Plots and Apartment Size for Housing Scenario III

Low Income Class		Middle/High Income Class	
Horizontal Development			
Plot Size	Percentage	Plot Size	Percentage
3 Marla	45	7 Marla	35
5 Marla	35	10 Marla	30
7 Marla	---	1 Kanal	15
Total for Horizontal Development	80	Total	80
Vertical and Compact Development			
Apartment Type	Percentage	Apartment Type	Percentage
1 bedroom	15	2 bedrooms	15
2 bedrooms	5	3 bedrooms	5
Total for vertical Development	20	Total for vertical Development	20
Total for Low Income class	100%	Total for Middle/High Income Class	100%

Source: Devised by Consultant

9.3.1. Phase Wise Development of Selected Scenario

For this housing scenario, horizontal development of housing accounts for 80% of the total residential development. The total area required for each phase for this scenario has been calculated in a similar method adapted for other scenarios. Following table shows the calculations for phase I (2022-2027).

Table 22: Phase 1 Horizontal + Vertical Housing calculations for Selected Scenario

Low-Income Residential											
Housing Type	Size of Apartment (sq ft)	Size of Apartment / Housing Unit (Marla)	Percentage	Population	Housing Units	Number of Storeys	Housing units Accommodated in	Area Required (Marla)	Area into Acres	Area Required for Allied Uses	Total Area Required
	A	A1	F	F1	F2	G	H	I	I1	I2	J
		A*0.00367309		Pop*F	HU*F		B*G	(F2/H) *A	I*0.00625001	(I1/65) *35	
3 Marla House	N/A	3	45%	8194	1198	1	1	3594	22.5	10.1	32.6
5 Marla House	N/A	5	35%	6373	932	1	1	4658	29.1	13.1	42.2
1 bedroom	720	2.6	15%	2731	399	5	20	384	2.4	1.1	3.5
2 bedrooms	1000	3.7	5%	910	133	5	20	178	1.1	0.5	1.6
Total	100 %	49930	100 %	18208	2662			8814	55.1	24.8	79.9
Medium to High-Income Residential											
Housing Type	Size of Apartment (sq	Size of Apartment /Housing Unit (Marla)	Percentage	Population	Housing Units	Number of	Housing units Accommodated	Area Required (Marla)	Area into Acres	Area Required for Allied Uses	Total Area Required
	A	A1	F	F1	F2	G	H	I	I1	I2	J
		A*0.00367309		Pop*F	HU*F		B*G	(F2/H) *A	I*0.00625001	(I1/65) *35	
7 Marla	N/A	7	30%	5252	768	1	1	5375	33.6	15.1	48.7
10 Marla	N/A	10	30%	5252	768	1	1	11518	72.0	32.4	104.4
1 Kanal	N/A	20	20%	3502	512	1	1	10239	64.0	28.8	92.8
2 bedrooms	1200	4.4	15%	2626	384	5	20	616	3.9	1.7	5.6
3 bedrooms	1600	5.9	5%	875	128	5	20	274	1.7	0.8	2.5
Total			100 %	17508	2560			28022	175.1	78.8	253.9

Source: Devised by Consultant

Similar to the aforementioned calculations for phase I, the area required for each phase has been calculated in the following table. Hence total area required for 80% horizontal and 20% vertical development in phase I is 333.9 acres. The detailed phase wise calculations of the selected scenario are given in the housing section of annexure III. Further calculations for area requirement of each phase based on the allocated percentages have been carried out in the similar way mentioned as follows;

Phases	Duration	Low Income Class		Total Area (Acres)
		Horizontal – 80%	Vertical-20%	
Phase – 1	2022-2027	320.7	13.2	333.9
Phase – 2	2022-2032	307.1	14.1	321.2

Phases	Duration	Low Income Class		Total Area (Acres)
		Horizontal – 80%	Vertical-20%	
Phase – 3	2022-2037	302.6	13.9	316.5
Phase – 4	2022-2042	315.3	14.5	329.8
Total area Required		1245.7	55.7	**1301.4**

The above table depicts that total 1,301.4 acres of the area is required to accommodate projected incremental population as per the third scenario. As stated in the detailed calculation table of Phase 1 residential above, the total residential area includes 55% area for the housing units and 45% for the allied uses. Following table shows the calculations for allied uses;

Figure 20: Details of Allied Uses

Residential Area Required
- 1301.4 Acres

Housing
- 55%
- Area Required (Acres)
  715.77

Allied Uses
- 45%
- Overall Area Required (Acres)
  585.63

Details of Allied Uses
- Health
  4%
  52.056 acres
- Education
  4%
  52.056 Acres
- Commercial
  2%
  26.028 Acres
- Civic Amenities
  2%
  26.028 Acres
- Parks and Playground
  10%
  130.14 Acres
- Roads
  23%
  299.322 Acres

Source: Devised by Consultant

As per KP Urban Policy 2023, the percentage for civic amenities in a residential zone is 10-20%, 30-50% for residential use and 30-40% for transportation network including parking. In accordance with the prescribed land use percentages outlined in the KP Urban Policy 2023, the consultant has made necessary amendments to the percentages of allied uses to suit the requirements of the study area. Notably, the allocation for public amenities and civic facilities within residential zones has been set at an overall 10%. These facilities encompass primary and secondary level schools, as well as healthcare centers. However, it is important to mention that distinct zones dedicated to health, education, and civic facilities have been proposed separately and will be discussed in subsequent chapters.

Furthermore, it is recommended that commercial areas constitute 2% of the residential zones. This allocation will serve to accommodate neighborhood-level shops, convenience stores, and corner shops. Similar to institutional zones, major commercial zones intended to meet the overall needs of the city have been proposed outside the residential zones.

Additionally, the recommended ratio for parks and playgrounds stands at 10% of the residential zones. This allocation will include the provision of pocket parks and neighborhood parks situated within residential areas. As for the transport network, which encompasses roads and parking facilities, the consultant has assigned a weightage of 23% of the residential zones.

9.3.2. International Examples for Scenario Justification

Winnipeg is the capital city of the province of Manitoba, located in the central part of Canada. Winnipeg is situated at the eastern edge of the Canadian Prairies, where the Red and Assiniboine Rivers meet. It is approximately 110 kilometers north of the Canada-U.S. border and 1,600 kilometers west of Toronto.

Winnipeg, Manitoba has a transportation system that includes various modes of transportation to facilitate the movement of people within the city and beyond. Winnipeg Transit operates the city’s public bus system. It provides an extensive network of bus routes that cover the entire city, including regular and express routes. The buses are equipped with accessibility features, such as ramps or lifts, to accommodate passengers with disabilities. Winnipeg is working on incorporating transit-oriented development principles in certain areas. This approach involves developing high-density housing, commercial, and recreational spaces in close proximity to public transit nodes, encouraging residents to rely less on personal vehicles.

The development pattern of Winnipeg, Manitoba has evolved over time and is characterized by several key aspects. Winnipeg features a mix of land uses throughout the city. While there are residential areas, there are also commercial and industrial zones, as well as areas designated for institutional and recreational purposes. The city has designated specific areas for concentrated commercial activity, such as the downtown area and major corridors.

Winnipeg, Manitoba also has a strong focus on affordable housing, with a number of programs and initiatives aimed at ensuring that low-income residents have access to safe, affordable housing. The provincial government of Manitoba operates the Rent Assist program, which provides financial assistance to low-income individuals and families to make rental housing more affordable. Rent Assist helps bridge the gap between a household's income and the cost of rent.

Overall, Winnipeg's housing development pattern emphasizes sustainability, accessibility, and affordability, with a focus on creating livable, walkable communities that are well-connected to the wider city. It has become possible just due to indulging vertical housing interventions in the ongoing and future developments which is counted for 20% of the total development. Although the set percentage target could not be achieved at full but still an extent is covered by limiting the housing facilities in terms of percentage for vertical development in the city.

9.3.3. Proposed Residential Zones for selected housing scenario

As per area requirement of housing scenario III, the proposed zone in the scenario will be used to cater the incremental population over the next 20 years (2022-2042). The total area allocated for 80% horizontal development and 20% vertical development in Charsadda city is 1610.47 acres falling in infill, and zone 1 selected for the housing development.

Proposed Housing Zones		
Sr. No.	Residential Zone	Area (Acres)
1	Infill Residential	645.03
2	Residential Zone 1	965.44
Total	Total	1610

9.4. Housing Affordability Analysis

The term "housing affordability" relates specifically to a person's financial capability of people to purchase or rent a home. It is often influenced by a variety of social circumstances, such as income level, cost of housing, cost of building supplies, etc. Low-rise, low-income urban communities are unintentionally and quickly evolving into high-rise, high-density communities, with all the associated physical, social, and environmental issues. Meanwhile, the city's ecological assets are being threatened by speculative low-density elite construction.

According to the primary data analysis, urban housing demand in Charsadda is of 34,975 units. The following table shows the housing affordability analysis as per primary data;

Table 23: Housing Affordability Analysis – Charsadda Study Area

Household Income Scale (Primary Survey)	%age of HH	Cumulative %age of HH	Average HH Income (PKR monthly)	Housing Affordability (PKR monthly)
< 20,000	28	28	10,000	35,000

Household Income Scale (Primary Survey)	%age of HH	Cumulative %age of HH	Average HH Income (PKR monthly)	Housing Affordability (PKR monthly)
20,001 to 35,000	28	56	27,500	96,250
35,001 to 50,000	24	80	42,501	114,753
> 50,000	20	100	> 50,000	N/A
Total Number of Respondents (N) = 357				

Source: Devised by Consultant

The above table shows that the housing affordability of middle-income group having monthly income 42,501 PKR is 114,753 PKR per month. In Charsadda city, the housing affordability issues have been identified affecting the people's ability to afford a house for living a reasonable life. Seeing the income distribution, the situation is so worse that even people with higher incomes in comparison to all socioeconomic classes in the city appear to be unable to afford a house due to high prices. According to some property evaluation resources, per marla rates are higher near to the main city i.e., 15 to 20 lacs per marla. Although prices are comparatively low in peripheral areas, still its costs are much extensive that a normal person cannot dare to buy one. Viewing the situation, it is inevitable for the government bodies to provide the residents of the city with affordable housing schemes to cater the individual households housing needs. However, since July 2020, the State Bank of Pakistan has taken a number of actions to aid in the financing of the affordable housing such as "Mera Pakistan Mera Ghar" (MPMG) markup subsidy Scheme. Based on different interest rate tiers, following table shows the affordability scenario for Charsadda City;

Table 24: Housing affordability Criteria – Charsadda Study Area

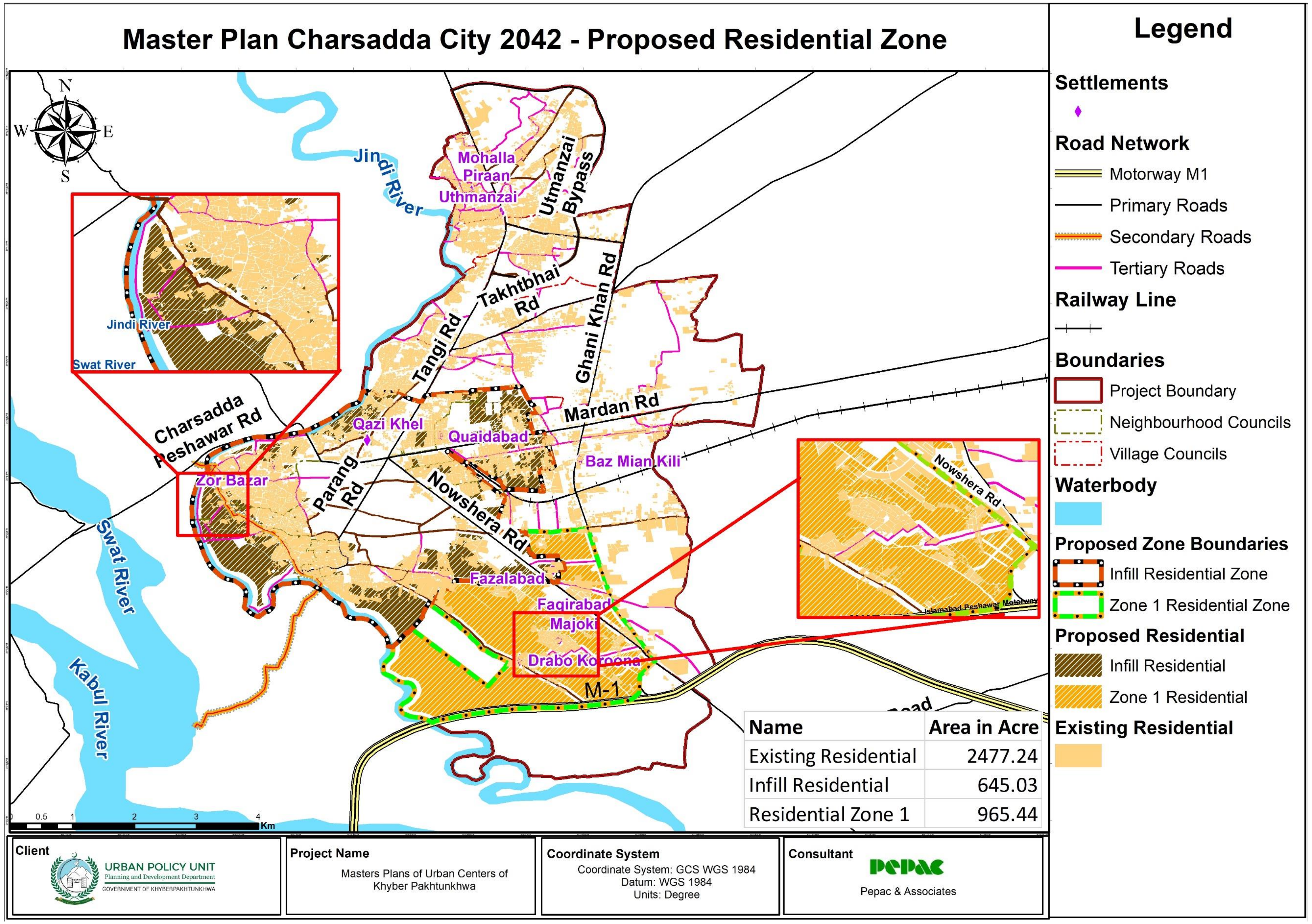
Different Types of Loans Offered	Loan Size	Basic Interest Rate without Kibor			at 3%, monthly payment			at 5%, monthly payment			at 7%, monthly payment		
		3%	5%	7%	5 years	7 years	10 years	5 years	7 years	10 years	5 years	7 years	10 years
Tier 0	2,000,000	60,000	100,000	140,000	35,937	26,427	19,312	37,742	28,268	21,213	39,602	30,185	23,222
Tier 1	2,700,000	81,000	135,000	189,000	48,515	35,676	26,071	50,952	38,162	28,638	53,463	40,750	31,349
Tier 2	6,000,000	180,000	300,000	420,000	107,812	79,280	57,936	113,227	84,803	63,639	118,807	90,556	69,665
Tier 3	10,000,000	300,000	500,000	700,000	179,687	132,133	96,561	188,712	141,339	106,066	198,012	150,927	116,108

Source: State bank of Pakistan

The capacity to finance down payments on mortgages is a significant aspect in determining how affordable a house is because a substantial portion of the population lacks sufficient funds to contribute significant sums of money towards establishing a home. The affordability of a house is influenced by the quantity of accessible finances, outstanding obligations, and loan amount.

On the basis of above-mentioned affordability criteria, the consultant has carried out the aforementioned housing demand calculations. The calculations made by the consulting team for Charsadda's master planning illustrated the city's future housing demand in light of three distinct scenarios. The housing projections showed how many homes would be needed in the region at the most during the master planning phase. Keeping in view the housing affordability, the selected housing scenario for master plan is scenario III that is 80% horizontal and 20% vertical and compact development of the Charsadda City. While vertical development can be more cost-effective in terms of land use and infrastructure, it can also be more expensive to build and maintain. In contrast, horizontal development can be more affordable to construct and maintain, although it requires more land.

Map 19: Proposed Residential Zone Charsadda Study Area



Name	Area in Acre
Existing Residential	2477.24
Infill Residential	645.03
Residential Zone 1	965.44

Source: Devised by Consultants

9.4.1. Permitted, Permissible Land Uses

Table 25: Permitted, Permissible Land Uses of Residential Area

Sr. No.	Land Use Zone	Permitted Land Uses	Permissible Land Uses
1	Low Density residential	Detached/semidetached dwellings Mosques Primary/High Schools Clinics/Dispensaries Social/Cultural Institutions Local Shopping Areas/Retail Shops Offices of Professionals with adequate parking facilities Parks and Playgrounds Local Recreational Uses Non-commercial vegetable gardens and nurseries	Commercial Offices and Service Shops of Local Character Raising of poultry for noncommercial purposes Petrol pump, gas filling station. Taxi/rickshaw stand
2	Medium Density Residential	Detached/semidetached dwellings Mosques Primary/High Schools Clinics/Dispensaries Social/Cultural Institutions Local Shopping Areas/Retail Shops Offices of Professionals with adequate parking facilities Parks and Playgrounds Local Recreational Uses Non-commercial vegetable gardens and nurseries	All uses permissible on appeal in low-density residential zone. Restaurants and hotels Hospitals Petrol and Gas filling stations
3	High Density Residential	All uses permitted in Medium Density Zone Public Utilities and Buildings Recreational Uses Taxi and Rickshaw Stands	All uses permitted on appeal in medium density zone.

Source: Devised by Consultant

Chapter 10: Commerce and Trade Comprehensive Proposals

Commerce and trade centers are essential for supporting economic activities in a city. These can be physical places, such as a marketplace or shopping mall, or in the present world it could be a virtual platform like online marketplaces or e-commerce websites etc. These areas influence several factors associated with the economic development of individuals living in an area and the society as a whole.

With respect to land use, the main commercial markets identified in Charsadda city are Charsadda Bazaar, Ghafoor Market, and Durrani Market, with Farooq Azam Chowk serving as the central business district. These commercial markets have a plethora of commercial activities related to retail and wholesale including clothing, electric and general stores, banks, petrol pumps, shopping malls, furniture shops, bakeries, poultry shops, mobile repair and other accessories shops, fruit, and vegetable shops, etc. The total commercial area occupied by these commercial activities, as identified in the land use survey are 290.47 acres comprising 162.79 acres of retail, 66.72 acres of wholesale, and others taking up 60.96 acres. As per the standard of 1,000 people per acre of commercial land, these commercial activities have employed approximately 290,400 people.

Charsadda city has a diverse range of industries, including cement, grain, and ice manufacturing, among others, and overall, 30 small to medium industries have been identified. The land use analysis has shown that these 30 industries, collectively, make up 25 acres of land. Using the population-industry standard of 70 people per acre, this suggests that approximately 1,700 people are working in the industrial sector. The city is also connected to three economic zones, Rashakai, Jalozai, and Charsadda, via the Islamabad-Peshawar Motorway and N5 and N45 highways. These industrial zones provide job opportunities and business possibilities for Charsadda city residents. However, the city lacks planned commercial markets with adequate parking, resulting in a mixed land use pattern in many residential areas and along major highways. It is important to consider Charsadda's diverse land uses, physical, economic, and cultural aspects, in future land use policies to preserve the city's distinctive character. While complete land use segregation is not desirable, uncontrolled land use conversion can lead to traffic congestion, which is not an issue at present within the city, an unlivable environment, and excessive load on infrastructure and public services.

Also, the analysis performed for Charsadda study area shows that a significant portion of the population earns between 20,000 and 35,000 PKR per month, while 24% earn 30,000 to 50,000 PKR per month, and 20% earn over 50,000 PKR per month. Food expenses account for 46% of the monthly costs, followed by education (17%) and health (13%). The average monthly expenses calculated are around 84,000 PKR, which is a considerable amount considering that earning over 50,000 PKR does not necessarily equate to a monthly income of over 100,000 PKR.

10.1. Proposed Commercial Zone

The proposed zones for commercial development in the study area are given along the primary, secondary and tertiary road networks in form of buffers having certain width i.e., 11-50m for primary roads, 6-50m for secondary roads and 3-50m for tertiary roads. However, the final proposal has been given catering both scenario A and B commercial proposals giving a total area of 657 acres in total. The following table delineates the total area proposed for commercial facilities in Charsadda city till 2042.

Table 26: Proposed Commerce and Trade Zone Charsadda Study Area

Proposed Zone for Commercial Development		
Sr. No.	Zone	Area (acres)
1	Commercial	657
Total Area		657

Source: Devised by Consultants

10.2. Proposed Grain Market

Grain markets is a physical marketplace where farmers bring their crops for selling. Most commonly known grains include wheat, corn, soybeans, and rice, etc. Grain markets are important for the agricultural industry, as they provide a mechanism for producers to sell their crops and for buyers to purchase the grains they need for their businesses. Grain prices are influenced by a variety of factors, such as supply and demand, weather conditions, and government policies. As a result, grain markets can be volatile and subject to rapid price fluctuations.

In Charsadda city, a certain zone has been allocated for development of a grain market to promote trade related to general grains ploughed in the agricultural lands of the city. This zone is located in the area of village council administratively and total area provided for the zone has been highlighted in the table given below.

Table 27: Proposed zones for Grain Market

Proposed Zone for Grain Market		
Sr. No.	Zone	Area (acres)
1	Grain Market	24.29
Total Area		24.29

Source: Devised by Consultant

10.2.1. Permitted, Permissible Land Uses for Commercial

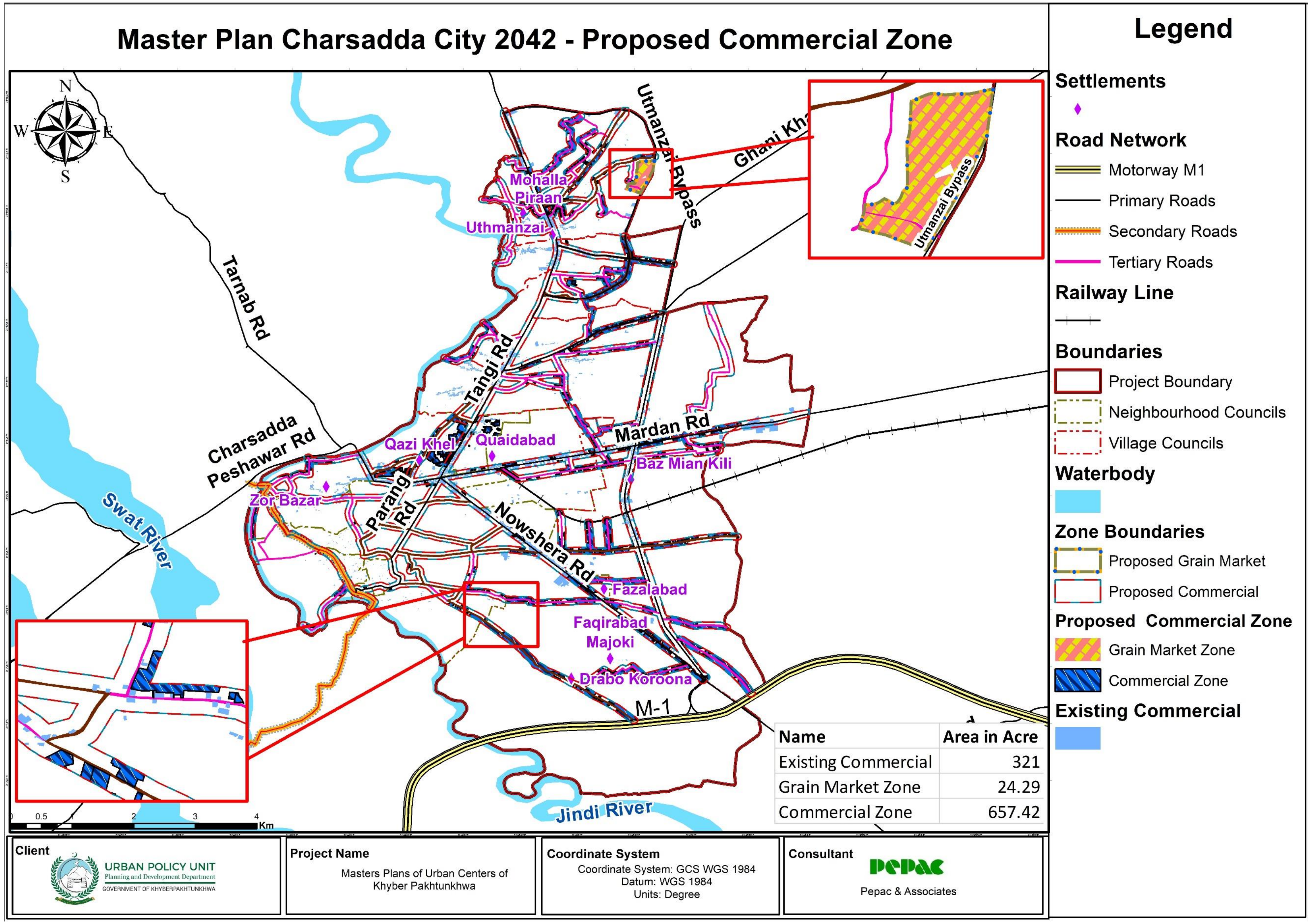
For the proposed commercial areas, the following table defines the permitted and permissible land uses which will be allowed from minimum to maximum extent for certain development within the provided commercial zones. These include;

Table 28: Permitted, Permissible Land Uses for Commercial

Sr. No.	Land Use Zone	Permitted Land Uses	Permissible Land Uses
1	Major Commercial Areas	Shopping plazas, Shops and commercial centers, Educational institutions, Recreational places, Parks and open spaces, Public and religious buildings Service industries and firefighting arrangements governed by the building and space regulations	Petrol filling stations, Hospitals, Residences, Transport terminals, Cinemas, Clubs and all sort of storage.

Source: Devised by Consultants

Map 20: Proposed Commercial Zone Charsadda Study Area



Name	Area in Acre
Existing Commercial	321
Grain Market Zone	24.29
Commercial Zone	657.42

Source: Devised by Consultants

10.3. Proposed Industrial Zone

Industry in cities refers to the various manufacturing and production activities that take place within urban areas. These industries are typically involved in the production of goods such as textiles, machinery, automobiles, electronics, and chemicals, among others.

Cities offer many advantages to industries, including access to a large labor force, proximity to transportation infrastructure such as ports, airports, and highways, and access to raw materials and supplies. Additionally, many cities offer tax incentives and other benefits to attract businesses to their area.

Industrialization in cities has played a significant role in the economic development of many countries, contributing to job creation, technological advancement, and overall economic growth. However, it has also brought with it challenges such as pollution, congestion, and environmental degradation. As a result, many cities have implemented policies and regulations to mitigate these negative impacts and promote sustainable industrial development.

Charsadda, primarily an agricultural city, relies on its farming sector for revenue. Nonetheless, it holds potential for various industries. Charsadda's industrial prospects mainly encompass small-scale cottage industries specializing in cloth production (Khaddar) and Charsadda chappal, handicrafts, and agro-based processing industries such as flour mills, sugar mills, and dairy processing. The city also possesses untapped livestock potential, which can support the development of cotton ginning.

In the District Land Use Plan of Charsadda, a proposed Industrial zone spanning over 400 acres was designated at the intersection of Takhbai Road and Ghani Khan Road. However, this proposed zone lacks direct connectivity to the expressway. Instead, it is connected via Ghani Khan Road to Mardan Road and M1 (Islamabad-Peshawar Motorway), which in turn provide access to Mardan, Islamabad, Peshawar, Lahore, and Nowshera through GT Road. Moreover, the proximity of the proposed industrial zone to the proposed housing and residential zone raises concerns regarding transportation and environmental compatibility.

The lack of direct connectivity to the expressway can pose challenges for transportation logistics. Industries typically require efficient transportation routes for the movement of goods, materials, and equipment. Without a direct connection to the expressway, transportation to and from the industrial zone may face delays and increased costs. This can hamper the overall productivity and competitiveness of the industries based in the zone.

Furthermore, the proposed industrial zone is situated in close proximity to the proposed housing and residential zone. This proximity raises environmental concerns. Industrial activities, such as manufacturing and processing, can generate noise, air pollution, and waste. Placing the industrial zone in such close proximity to residential areas can lead to negative impacts on the quality of life for residents. It can result in increased pollution levels, noise disturbances, and potential health hazards.

To address these transportation and environment incompatibilities, it is suggested that the industrial zone be relocated to a more suitable location. This new location should ensure better transportation access, such as being situated along the M1 motorway. By doing so, heavy traffic associated with industrial activities can be routed directly to the industrial zone without passing through the city. This reduces congestion within the city and improves overall transportation efficiency.

Additionally, relocating the industrial zone away from residential areas mitigates the potential negative environmental impacts. Placing the industrial zone outside the city boundary and adjacent to the motorway ensures a separation between industrial and residential areas. This helps minimize pollution and disturbances to nearby communities, maintaining a healthier and more sustainable environment for both industrial operations and residents.

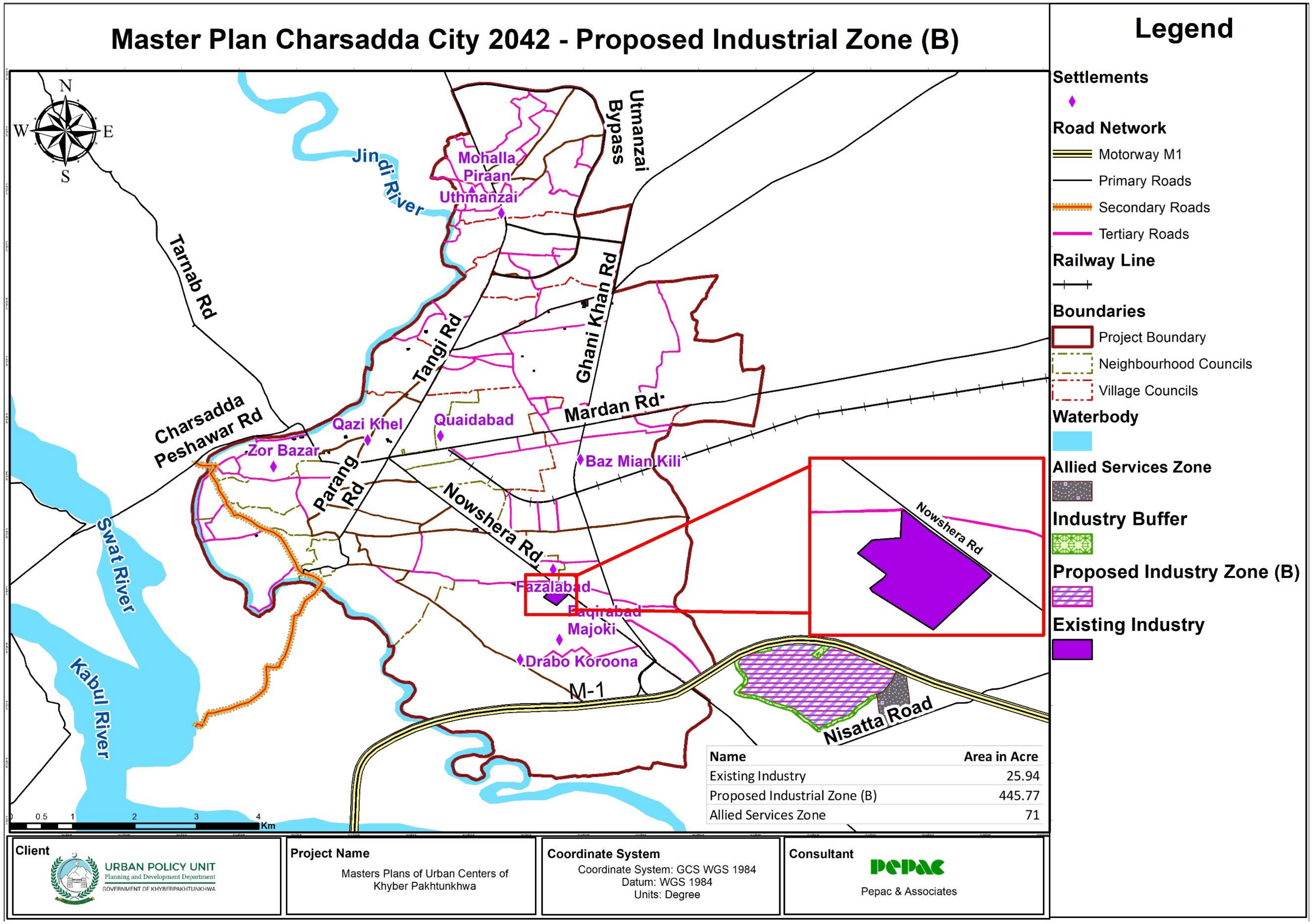
Considering the incompatibilities present in the proposed industrial zone within the Charsadda District Land Use Plan, it has been recommended to relocate the industrial zone to a location devoid of transportation, environmental, and land use conflicts. As an alternative, a new industrial zone has been proposed along the M1 motorway, covering an area of XYZ acres. This new zone offers convenient access via the motorway, connecting Charsadda to multiple cities. Additionally, since the zone is situated outside the city boundary and adjacent to the motorway, it ensures that heavy traffic bypasses the city and directly reaches the industrial zone. Furthermore, a separate zone for allied services, including warehouses, truck terminals, and cold storage, has been designated next to the industrial zone to facilitate their development

Table 29: Proposed zones for Industrial Development

Sr. No	Industrial Zone	Area Acres	Area Sq. Km,
1	Proposed Industry	445.77	1.80

Source: Devised by Consultants

Table 30: Proposed Industrial Zone Charsadda Study Area



Source: Devised by Consultants

Chapter 11: Health, Education and Civic Facilities

11.1. Proposed Health Care Facilities

The KP government is the main supplier of healthcare services in Charsadda city. One of the most essential needs of any person is access to health services. By providing skilled staff, a sufficient supply of medications, and the creation of health services units, efforts have been undertaken in Charsadda to enhance the health of the population. The idea of health encompasses both the availability of maternity and childcare services as well as the absence of infectious and other illnesses. The construction of hospitals, dispensaries, basic health units, and centers for maternity and child health care, as well as the hiring of enough physicians and other medical professionals to staff them, are all included in the infrastructure of the health sector. In Charsadda, diarrhea hepatitis, malaria, and pneumonia are the most prevalent illnesses.

In Charsadda MC, the data about satisfaction level of health facilities suggested 61% showed their satisfaction towards the existing facilities while 28% showed dissatisfaction and remaining expressed indifference. For a population of 209,745 in 2017, the city has three Basic Health Units, one dispensary, one DHQ, and 206 beds in all health facilities. For such a population, the city should have at least 8 Basic Health Units. There should be at least 14 Dispensaries in Charsadda but there is only one. The city has not any rural healthcare, however, the required RHC for the population is 3.

The National Reference Manual's population requirement guidelines were used to determine the city of Charsadda future healthcare needs. According to the criteria, one MCH is needed for 75,000 people and one civil dispensary for every 15,000 people.[13] Also, a Basic Health Unit serves up to 25,000 people. Based on the projected population of 2042, additional 2 RHC are required, however, the total required RHC is 5. Applying the standards, the gross number of beds required at the end of 2042 is 1032 while the existing number of beds is 206. The additional 826 beds are required for the projected population. The city required 9 civil dispensaries and 5 Basic Health Units (BHU) till 2042.

As per the National Reference Manual, the size of DHQ should be 5-8 hectares but the size of DHQ Hospital Charsadda is 1.69 hectares. So DHQ hospital should be expanded area-wise. The size of the BHU of Charsadda is 11.51 Marla but according to National Reference Manual, the size of BHU should be between 49.42-98.84 Marla. This means that along with DHQ Hospital, the BHU also needs to be expanded. The total area required for dispensary is 40 Marla approximately according to the standards mentioned in National Reference Manual. The table below lists the future requirements for healthcare institutions with area based on the NRM criteria.

[13] Primary Healthcare service delivery system in Punjab, Semal Farid, Accessed from mpo.lums.edu.pk, Accessed on 16 November 2022

Table 31: Future Requirement of Health Facility-Charsadda

Sr. No	Health Institute Type	Area Required by One (acre)		No. of Health Institutes										2022-2042	Total Area Req. (acre)
		Min	Max	2022	Area	2027	Area	2032	Area	2037	Area	2042	Area		
1	CD	0.02	0.05	2	0.1	2	0.1	2	0.1	2	0.1	2	0.1	9	0.45
2	BHU	0.3	0.6	1	0.6	1	0.6	1	0.6	1	0.6	1	0.6	5	3
3	RHC/ MCH	2.47	2.47	0	0	0	0	0	0	0	0	0	0	2	4.94

Source: Calculated by Consultant based on NRM Standards

The total required areas for civil dispensary, Basic health unit and Rural health care are 8.39 acres. The area will be located within existing Village Councils viewing the availability of suitable land and to ensure easy accessibility for the community. This is an important consideration, as it is essential for the community to have access to quality healthcare services. The proposed facilities are a move towards assuring the community's sustainable growth, meeting the population's healthcare needs, and advancing the community's general wellbeing. To ensure that these proposed healthcare facilities are implemented successfully and in a sustainable way addressing the healthcare requirements of the community.

In the study area, health care zones are explicitly proposed covering an area of 30.67 acres in total. The details of these proposed zones are given in the table below.

Table 32: Proposed zones for Health care Facilities-2042

Proposed Health Care Zones		
Sr. No	Zone	Area (acres)
1	Health	30.67
Total Area		30.67

Source: Devised by Consultan

11.2. Proposed District Head Quarters Hospital

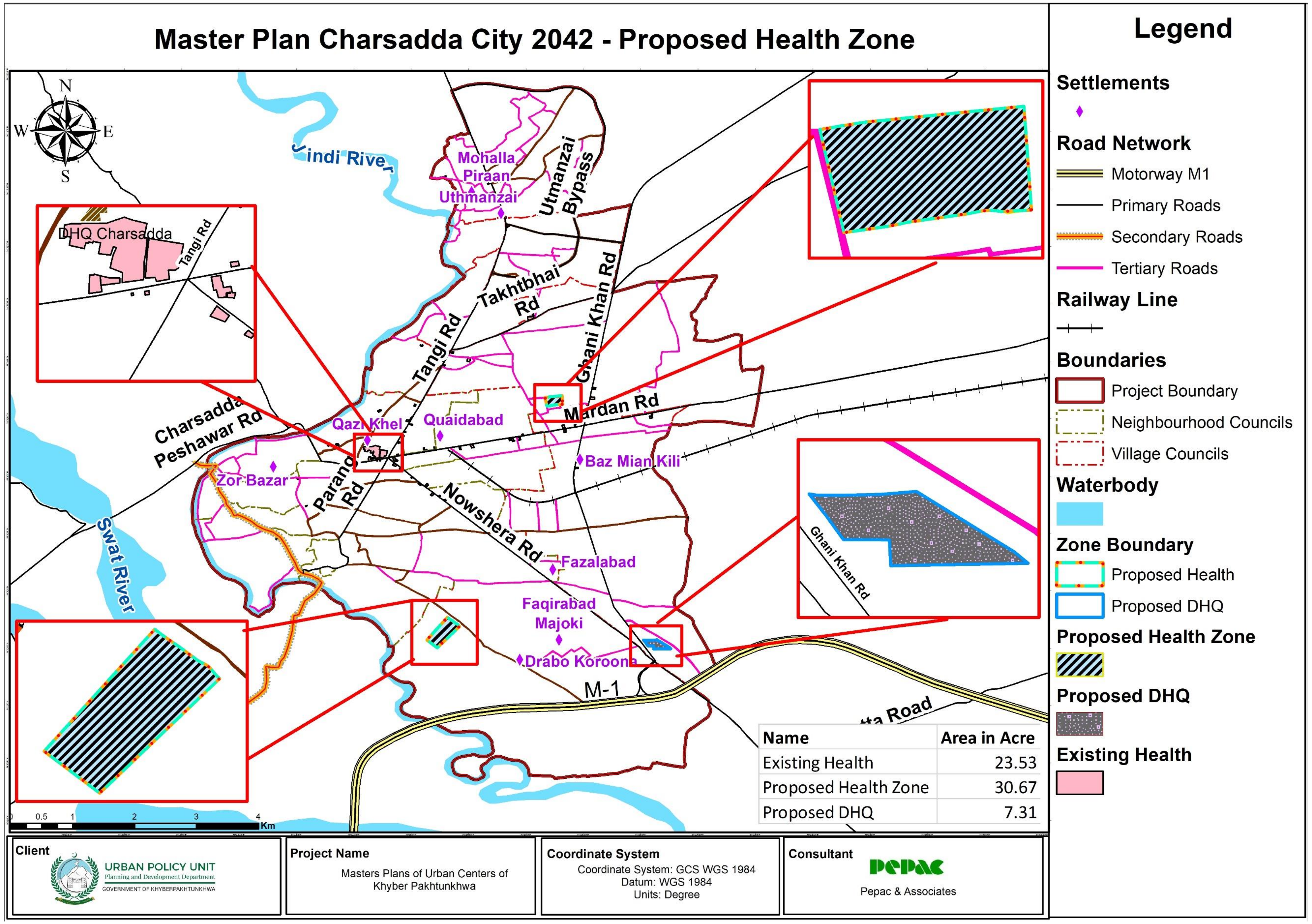
Viewing the problems of current DHQ both area and location wise, a new zone for development of district head quarter hospital has been proposed in the master plan which is supposed to cater the requirements of the current DHQ of the city. However, the old DHQ will not be replaced entirely and will still serve its initial purpose. The new proposed DHQ will also facilitate the medical education for the city residents willing to study in medical field. The total area allocated for the development of DHQ is 7.31 acres. The area details and proposed zone for the DHQ are given in the section below.

11.2.1. Permitted Permissible Land Uses for Health Zone

For the proposed zones, the allowed permitted and permissible uses which could be built within the zone areas are given in the following table.

Sr. No.	Land Use Zone	Permitted Land Uses	Permissible Land Uses
1	Health Zone	Hospital and Medical Centers Psychiatric Center Burn Unit Medical Training Institute Diagnostic Centers Administrative Offices Support Facilities: (banks, petrol pumps, bus stops, parking lots, clinics and small green open spaces)	Residential Facilities for medical staff Rehabilitation Centers Retail Centers

Map 21: Proposed Health Zone Master Plan Charsadda 2042



Name	Area in Acre
Existing Health	23.53
Proposed Health Zone	30.67
Proposed DHQ	7.31

Source: Devised by Consultants

11.3. Proposed Educational zone

Education is a fundamental necessity of each individual living in an area. One approach for people to accomplish their goals is through education. The primary purpose of a school is to facilitate in learning and teaching process. Following the new requirements of the educational system, however, the emphasis on education quality must be increased in the educational system, particularly with regard to facilities and infrastructure.

The data about literacy rate, literate people and education attainment in regard to Charsadda MC suggests that overall, 66% people are literate in the study area according to the census of 2017, while according to primary survey 2022, 79% is literate population. In terms of degree wise education attainment, the census shows that 21,524 people have education below matriculation level, 18,607 people are educated above matriculation level but do not possess a bachelor level degree and 6,876 people have education above degree level.

According to the District Land Use Plan of Charsadda, there are 76 primary schools in district Charsadda out of which 14 exist in Charsadda city. Further, there are 15 middle schools, 8 high schools and 5 colleges in the study area. The requirement is 28 primary school, 12 middle school, 3 high school and 1 college. According to NRM standard, One is required for a population of 7500. A middle school is required for a population of 17000 and a high school is required for a population of 74000. For a college, a population of 170,000- 400,000 is required.

Applying the criteria, total required number of primary schools in the study area is 18 and based on the projected population of 2042, there is a requirement of 8 middle schools and 2 high schools. The college is not required for the population, as 5 existing colleges are more than the requirement for projected population. In addition, 98.1 acres are required for education proposals.

Table 33: Future Requirement of Educational facilities-Charsadda Study Area

Education Institute Type	Required Educational Facility (NRM) **2022-2042**	**Total Area Req.**
Primary	18	44.46
Middle	8	41.44
High	2	12.2
College	0	0

Source: Calculated by Consultant based on NRM Standards

To fulfill the need, proposals have been put forward for the establishment of new education institutes. These facilities will be located in both Neighborhood and Village Councils, ensuring accessibility by foot and by car. The proposed facilities have been planned while keeping in view the existing educational institutes to ensure that the education needs of the community are met.

Six zones have been proposed in the study area for future demand accommodation. The details of these zones along with the proposed areas are given in the table below;

Table 34: Proposed Area for Education Zone - 2042

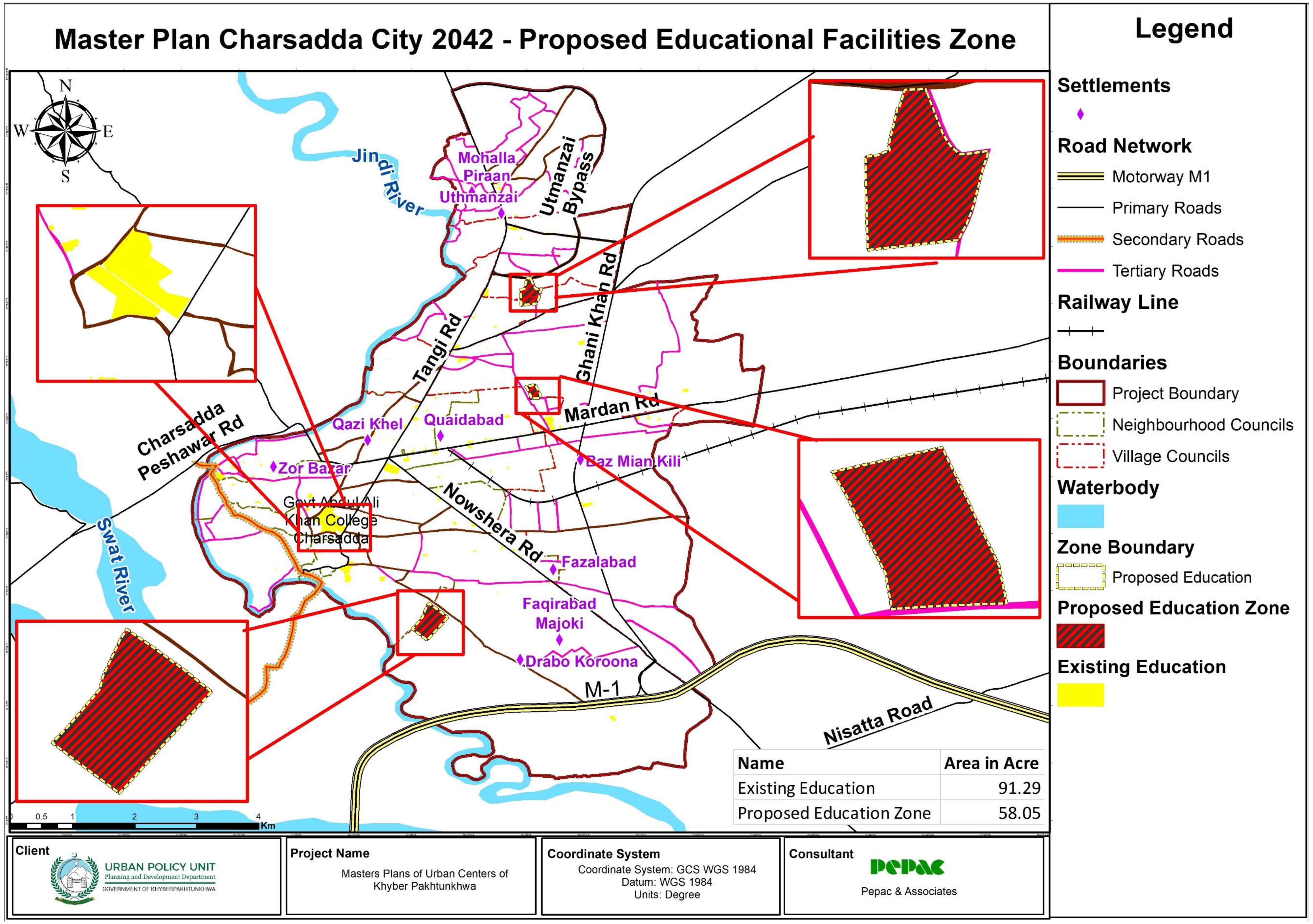
Proposed Educational Zone		
Sr. No	Zone	Area (acres)
1	Education	58.05
Total Area		58.05

Source: Devised by Consultant

However, simply establishing new schools is not enough. Along with the establishment of new facilities, it is also essential to improve the quality of education, training of teachers, and availability of educational resources. The proposed education institutes must be equipped with modern technology and resources to enable students to compete with the rest of the world. Additionally, the role of parents in the education of their children must be emphasized, and initiatives to encourage parental involvement in their children's education must be implemented.

Furthermore, vocational and technical education must be used to satisfy the city's requirement for a skilled labor force. Vocational and technical education can assist students gain real-world skills and information that they can apply in the workplace, enhancing the city's economic prospects. Overall, Charsadda may move towards a more sustainable and affluent future by building additional educational institutions, enhancing the quality of education, and offering vocational and technical training. Task D - Action Plan will go into considerable detail on these points.

Map 22: Proposed Educational Zone Master Plan Charsadda 2042



Source: Devised by Consultants

11.3.1. Permitted Permissible Land Uses

For proposed educational zones, highlighted permitted and permissible land uses are given the table below.

Sr. No.	Land Use Zone	Permitted Land Uses	Permissible Land Uses
1	Educational Zone	Educational and Research Institutions Primary Schools Secondary Schools Higher Secondary Schools Colleges Parks, Memorials and Monuments Arts Councils and Auditoriums	Offices of Social and Cultural Organizations Restaurants Religious Institutions Government Offices Approved Parking Provisions Taxi Stands, Bus Halts

11.4. Civic and Community Facilities

As Charsadda is district headquarter of Charsadda District, therefore in the future with the rising activities more space for different public offices, community centers, and religious building. The establishment of public buildings is crucial for the social and economic well-being of the community. Accessible civic zone facilitates the delivery of services and improve the quality of life for citizens. The proposed civic zones are a step towards ensuring sustainable development by addressing the needs of the community and providing access to vital services.

The Civic & Community Facilities Zone is vital to every area. They serve as the center of the community, where neighbors congregate, children play and learn, and real life occurs. Therefore, it is even more crucial that these structures to be sustainable, as they serve as a means of educating the public. For Charsadda city, there is an already developed civic zone in the eastern side of the study area containing multiple facilities, i.e., government departments, public buildings, etc. and is seemed to be covering the civic demand of the city at utmost.

However, an extension for this existing civic zone has been proposed to cater the future needs of the city till 2042. In this extension, the land uses will comprise of town halls, GPO, fire stations, exhibition center, public administration offices, women gymnasium, libraries and theatres, etc. The proposed area along with the area measurement and visual mapping has been given in the section below.

Table 35: Proposed Civic Zone Area

Zone for Civic Facilities		
Sr. No.	Type of Area	Area (acres)
1	Existing Area	87.11
2	Extended Area	83.84
Total area for Civic Zone		170.95

Source: Calculated by Consultants

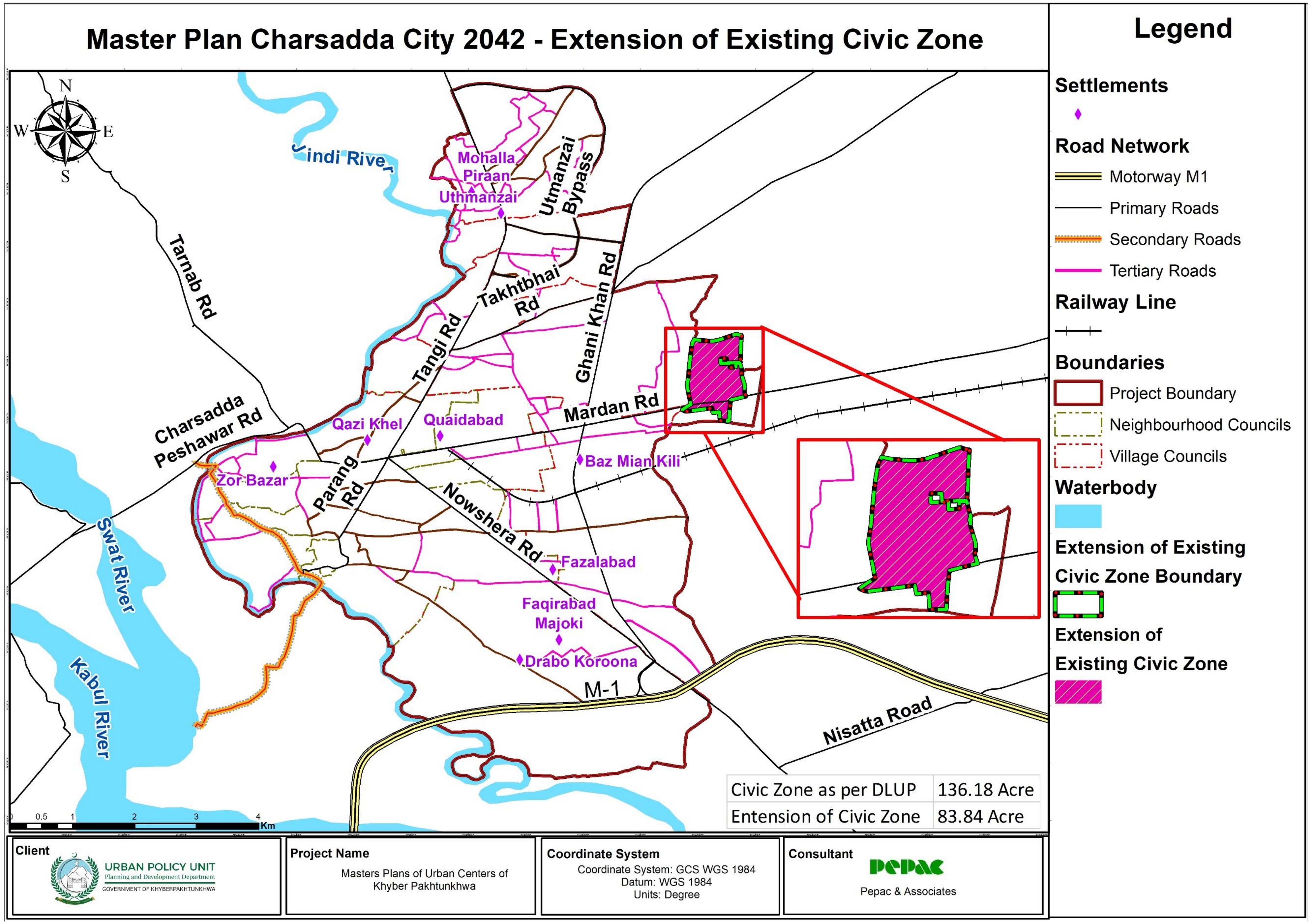
11.4.1. Permitted Permissible Land Uses

For the proposed zones, the allowed permitted and permissible uses which could be built within the zone areas are given in the following table.

Sr. No.	Land Use Zone	Permitted Land Uses	Permissible Land Uses
1	Civic Zone	General Post Office Town halls Fire station Police Station Exhibition centre Public Administration Ladies Club Offices	Residential Units Recreational areas Health Clinic Petrol Pump/filling station

Sr. No.	Land Use Zone	Permitted Land Uses	Permissible Land Uses
		Religious Building Libraries Theatres Food Streets Handicraft Markets Bus stop	

Map 23: Proposed Civic Zone Master Plan Charsadda 2042



Source: Devised by Consultants

11.5. Proposed Mixed-Use Development

Mixed-use development refers to a type of urban development that combines different types of land uses within a single project. These different uses can include residential, commercial, office, institutional, and/or industrial spaces, often integrated with public spaces, such as parks or plazas. Mixed-use developments are designed to create a more walkable, livable, and sustainable community, where people can live, work, and play in the same area. They can range from small-scale projects to large-scale urban districts and are becoming increasingly popular in cities around the world as a way to promote smart growth and efficient land use.

For Charsadda city, a specific mixed-use zone has been proposed in the study area facilitating the mixed-use development in the area. Details of the area allocated for this purpose is given in the table below.

Table 36: Proposed zones for Mixed-Use Development

Proposed Mixed Use Zone		
Sr. No.	Zone	Area (acres)
1	Mixed Use	134.3
Total area proposed for Mixed Use Zone		134.3

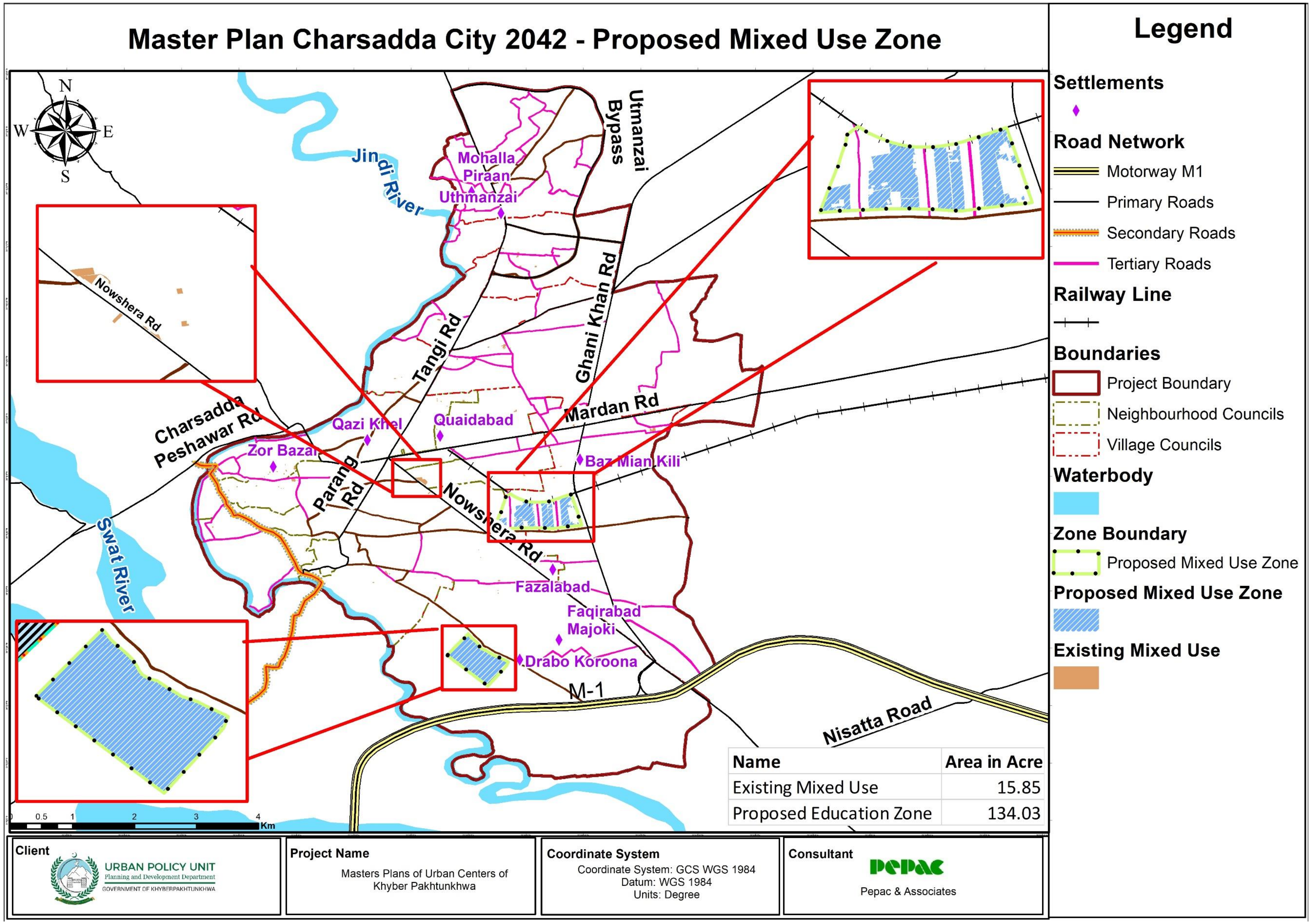
Source: Devised by Consultants

11.5.1. Permitted Permissible Land Uses

For the proposed zones, the allowed permitted and permissible uses which could be built within the zone areas are given in the following table.

Sr. No.	Land Use Zone	Permitted Land Uses	Permissible Land Uses
1	Mixed Use Zone	Apartment building Detached House Semi-Detached House Residential cum Commercial Cinemas Office Buildings Wedding Marquees Parks Urban Forest Public Buildings Religious Buildings Commercial	Farm Houses Universities Petrol Pumps Shopping Malls

Map 24: Proposed Mixed-Use Zone - Charsadda Study Area



Name	Area in Acre
Existing Mixed Use	15.85
Proposed Education Zone	134.03

Source: Devised by Consultant

Chapter 12: Environment & Urban Forestation

12.1. Current Environmental Situation and Analysis

Based on the project's terms of reference (TORs), a methodology has been developed for testing air quality, noise quality, soil quality as well as water and surface water quality. The findings from these tests were then utilized to formulate proposals for a sustainable future environment. The details of parameters and their respective detailed methodology is outlined in the table below.

Table 37: Details of Testing / Monitoring Parameters

Type of Sample	Parameters
Drinking Water	Temperature (During Sample Collection), Colour, Taste, pH, Turbidity, Total Hardness as $CaCO_3$, Total Dissolved Solid (TDS), Fluoride (F), Chloride (Cl), Nitrate (NO_3), Nitrite (NO_2), Odour, Manganese (Mn), Boron (B), Arsenic (As), Zinc (Zn), Aluminium, Antimony, Cadmium (Cd), Mercury (Hg), Nickel (Ni), Selenium (Se), Barium (Ba), Chromium (Cr), Copper (Cu), Cyanide (CN), Lead (Pb), Residual chlorine, Total Coli forms, Faecal Coli forms (E. Coli).
Surface Water	Temperature, pH, COD, BOD_5, Total Suspended Solids (TSS), TDS, Chloride, Fluoride (F-), Oil & grease, Phenols (Total Phenolic Compounds), Cyanide (CN-), Anionic Detergents as MBAS, Sulphate (SO_4^{-2}), Sulphide (S), Ammonia NH_3, Cadmium (Cd), Chromium (Cr) as Hexavalent & Trivalent, Copper (Cu), Lead (Pb), Nickel (Ni), Zinc (Zn), Iron (Fe), Manganese (Mn), Selenium (Se), Silver (Ag), Arsenic (As), Barium (Ba), Boron (B), Mercury (Hg), Chlorine (Cl), Total Toxic Metals
Ambient Air Monitoring	SO_2 (Averaging Period: 24 hours)
	NO (Averaging Period: 24 hours)
	NO_2 (Averaging Period: 24 hours)
	NO_x (Averaging Period: 24 hours)
	CO (Averaging Period: 1 hour & 8 hours)
	O_3 (1 hour)
	Suspended Particulate Matter (Averaging Period: 24 hours)
Noise Level Monitoring	dB(A) (hourly)

The sampling methodology was in compliance with National Environmental Quality Standards (NEQS), Environmental Sample Rules, 2001, Statutory Notification S.R.O.527(1)/2001, and USEPA. The engineer's Representative supervised the sampling process at the site.

The monitoring methodology for all the parameters was in accordance with the requirements of the NEQS SRO Notification dated 18th October 2010 and USEPA. The sampling methodology was approved by Engineer's Representative before mobilization to the site. Whereas the Analytical procedures were in accordance with ASTM, APHA, and USEPA methods. The results of the analysis are compared with NEQS limits. Error-free and up-to-date equipment were used for air, noise, water quality, and surface water quality testing.

12.1.1. Ambient Air Monitoring

The selection of ambient air monitoring sites was carefully considered with regards to the emission sources present in the project area. KP- Environmental profile 2017 was also considered to select the monitoring points. The Consultant conducted ambient air monitoring to evaluate the quality of air and its impact on the environment and sensitive receptors. The monitoring was conducted in compliance with the National Environmental Quality Standards (NEQS).

The monitoring methodology for ambient air quality involved assessing the concentration of priority pollutants, including Carbon monoxide (CO), Oxides of Nitrogen (NOx), Sulphur dioxide (SO2), PM2.5, PM10, TSP, Lead (Pb) and Ozone (O3). The selection of sampling locations was based on environmental factors such as wind direction and the level of turbulence in the air on a particular day.

The measurements were conducted using reference methods, which are detailed in the following table, while the description is provided in subsequent sections.

Table 38: KP, EPA Methodology for Air Quality Monitoring

Air Pollutants	Monitoring Techniques	Method
Carbon Monoxide (CO)	Cross Flow Modulation, non-dispersive infrared (NDIR) absorption technology.	US EPA Designated Method RFCA-0981-054.
Sulphur Dioxide (SO_2)	UV fluorescence (UVF)	US EPA Designated Method EQSA-0486-060.
Nitrogen Dioxides (NO_x)	Crossflow modulation type, reduce pressure chemiluminescence (CLD).	US EPA Designated Method RENA-1289-074.
Particulate Matter ($PM_{2.5}$)	β-Ray Absorption Method	40 CFR 50, App. B (US-EPA)
Particulate Matter (PM 10)	β-Ray Absorption Method	40 CFR 50, App. B (US-EPA)
TSP	β-Ray Absorption Method	40 CFR 50, App. B (US-EPA)
Lead (Pb)	ASS Method after sampling using Glass Fibre Filter Paper	40 CFR 50, App. B (US-EPA) Followed by SMWW 3114 B.
Ozone (O_3)	Non-Dispersive UV Absorption Method.	US EPA Designated Method EQOA-0515-225.

a) Details of Instruments Used for Ambient Air Quality Monitoring

i. AQM – 09

AQM-09 monitoring station was utilised to check the air quality of the study area at selected monitoring locations. The AQM-09 Air Quality Monitoring Station can measure ambient air pollutants in real-time, measuring data quickly and accurately. High precision electrochemical sensors are used for the determination of Nitrogen Oxides, Sulphur Oxides, Carbon Monoxide and Ozone. AQM 09 is capable to detect low levels of nitrogen oxides, Sulphur Oxides, Carbon Monoxide and Ozone from 0-2000 ppb, 0-2000 ppb, 0-200 ppm and 0-2000 ppb respectively. The AQM-09 Air Quality Monitoring Station can also measure PM10 & PM2.5 in real-time, measuring data accurately through light scattering technique. Measuring ranges for both PM10 & PM2.5 is 0~1000ug/m3.

ii. Weather Station

A weather station was installed on each point measurement to assess the environmental parameters like Ambient Temperature, Relative Humidity, Wind Speed & direction and other weather conditions.

12.1.2. Ambient Noise Monitoring

A noise level monitoring was conducted at identified locations using BSWA Noise Meter. All noise monitoring was conducted in accordance with the guidance set out in BS 7445:2003. Measurements were made using Class 1 Integrating-Averaging Sound Level Meters as defined in IEC 61672:2003. Meters were calibrated and checked before and after each measurement period by using Sound level calibrator.

12.1.3. Soil Sampling Analysis

12.1.3.1. Soil Sampling Analysis

To have in depth understanding of the quality of soil in the project area, various secondary data sources were examined. The 2017 KP Environmental Profile was consulted to assess the different soil parameters in Charsadda. Additionally, the Soil Survey of Pakistan Soil profiles were also reviewed and analyzed for this purpose14.

12.1.3.2. Parameters and Testing Methods

Soil quality is a crucial factor for achieving high crop yields and agricultural productivity in Charsadda. With reference to the available date, the tests conducted, and relevant procedure is given in the table below;

Table 39: Soil Quality Parameters and Testing Methods

Sr. No	Soil Test	Test Method
1.	pH	ICARDA Manual
2.	Textural class	

[14] District Soil Survey Reports, Soil Survey of Pakistan (2018).

3.	Electrical Conductivity	
4.	Organic matter (%)	
5.	Nitrogen (%)	
6.	Phosphorous (mg / Kg)	
7.	Potassium (mg / kg)	

12.1.4. Water Quality Analysis

To check the quality of water in the project area, the detailed methodology which was adopted for water sampling and analysis is given below. Groundwater samples are collected from different land uses to develop groundwater profile of the project city. Analytical parameters of ground water have been performed to evaluate the chemical nature of water in different land uses, as follows:

a. Agricultural areas.
b. Industrial areas.
c. Commercial Areas.
d. Streams; and,
e. Residential areas.

a) Sampling Methodology

Following methodology was adopted for water sampling and analysis.

Drinking Water / Ground Water Sampling

i. Sampling Procedure

- **Step One**
  - Spray spirit on hands up to arms for disinfection purpose.
- **Step Two**
  - Removed any attachments from the tap such as pipes, filters etc. Open the tap for 5 minutes to flush out the stand water, closed the tap and cleaned with tissue paper. Spray a small quantity of spirit on surface of tap and flame it with matchstick and let it cool down.
- **Step Three**
  - After flaming, open the tap again to turn the water down to a thin stream (about the width of a pencil) and let it run for one minute.
- **Step Four**
  - To avoid contamination while taking the sample, hold the bottle near the bottom with one hand, hold the top of the cap with the other, and then unscrew the cap. Do not place the cap on the ground. Sampling will be more reliable if performed near flame.

- **Step Five**
  - Hold the bottle under the stream of water, being careful not to let the bottle touch the sample tap. Fill the bottle to the neck (leave 1" from top) but do not allow it to overflow. Remove the bottle from the water flow and replace the cap.
- **Step Six**
  - Label the bottle with permanent marker and kept in insulated ice box having sterilized coolants (under controlled condition of 40C). Sample should be delivered to laboratory as soon as possible.

Surface Water Quality

ii. Procedure

- **Determination of sampling Frequency**
  - The sampling frequency was established in consultation with client's representative.
- **Representative Sampling**

For obtaining representative samples, guidelines given below are followed:

- Divide the channel cross section into different vertical sections so that each section had equal width. Took a representative sample in each vertical section. Collect the sample where in the Centre of the channel above the bottom of the channel where the velocity of flow is average or higher than average and chances of solids settling is minimum. This depth avoids bottom bed loads and top floating materials such as oils and grease.
- Force sampling vessel through the entire cross section of the stream wherever possible.
- When sampling, it was necessary to fill the bottles completely because of the samples were to be analyzed for NH3, Sulfide, residual chlorine, pH, hardness, SO4-, Fe, oil and grease. Collect sufficient volume to allow duplicate analysis and quality assurance testing.

Samples were preserved at 4°C in icebox as per standard procedures & protocols

Table 40: Preservation Methods

Analysis	Min. Volume	Container	Preservative	Holding time
Acidity	100	P, G	Cool, ≤6°C	14 d
Alkalinity, bicarbonate	200	P, G	Cool, ≤6°C	14 d
Ammonia	100	P, G	Analyze ASAP, or Add H_2SO_4 to pH<2; Cool ≤6°C	28 d
Bromate	100	P, G	None required	28 d
Bromide	100	P, G	None required	28 d
Calcium hardness	100	P, G	Add HNO_3 or H_2SO_4 to pH<2	6 M
Chlorate	100	P, G	None required	28 d
Chloride	50	P, G	None required	28 d
Chlorine	500	P, G	Analyze immediately	0.25 h
Cyanide	1000	P, G	Analyze within 15 min. Add NaOH to pH>12 if sample is to be stored, Cool ≤6°C, in dark. Add thiosulfate if residual chlorine present	14 d
Dissolved Oxygen	300	G, BOD bottle	0.25 h	0.25 h
Fluoride	100	P	None required	28 d
Hardness, total	100	P, G	Add HNO_3 or H_2SO_4 to pH<2	6 M
Nitrate	100	P, G	Analysis ASAP, Cool ≤6°C Boric acid addition	48 h
Nitrite	100	P, G	Analysis ASAP, Cool ≤6°C	48 h
Phosphate	100	G(A)	For dissolved PO_4^{3-} filter immediately, Cool ≤ 6	48 h
Phosphorus, total	100	P, G	Add H2SO4 to pH<2 and cool	28 d

Analysis	Min. Volume	Container	Preservative	Holding time
			≤ 6°C	
Sulfite	100	P, G	None	Immediate
Sulfate	100	P, G	Cool ≤6°C	28 d
Sulfide	100	P, G	Cool ≤6°C	7 d
TDS	200	P, G	Cool ≤6°C	7 d
BOD	1000	P, G	Cool, ≤6°C	48 h
COD	100	P, G	Analyze ASAP, or Add H_2SO_4 to pH<2; Cool ≤6°C	28 d
Color	500	P, G	Cool, ≤6°C	48 h
Conductivity	100	P, G	Cool, ≤6°C	28 d
pH	50	P, G	Analyze immediately	Immediately
TSS	200	P, G	Analysis	7d
Turbidity	100	P, G	Cool ≤6°C	48 h
Metals	1000	P(A), G(A)	Add HNO_3 to pH<2	6 M
Chromium VI	250	P(A), G(A)	Cool ≤6°C, pH 9.3-9.7, ammonium sulfate buffer preservative	28 d
Mercury	500	P(A), G(A)	Add $HNO_3$to pH<2, Cool ≤6°C	

iii. Methods of Analysis

Table 41: Drinking Water Testing Methods

Parameters for Microbiological Analysis

Sr. No.	Parameters	Reference Method
1.	Total Coliforms	SMWW:9222 B
2.	Fecal Coliforms (E. Coli)	SMWW:9222 D
3.	Total Plate Count	SMWW: 9215 B

Parameters for Chemical Analysis

Sr. No.	Parameters	Reference Method
1.	Color	SMWW 2120 C
2.	Taste	SMWW 2160 C
3.	Odor	SMWW 2150 B
4.	Turbidity	SMWW 2130 B
5.	Total Hardness (as $CaCO_3$)	SMWW 2340 C
6.	Total Dissolved Solids (TDS)	SMWW 2540 C
7.	pH	SMWW 4500 H^+ B
8.	Aluminum (Al)	SMWW 3111 B
9.	Antimony (Sb)	SMWW 3114 B
10.	Arsenic (As)	SMWW 3114 B
11.	Barium (Ba)	SMWW 3113 B
12.	Boron (B)	SMWW 3113 B
13.	Cadmium (Cd)	SMWW 3113 B
14.	Chloride (Cl^-)	SMWW 4500 Cl^- B
15.	Chromium (Cr)	SMWW 3113 B
16.	Copper (Cu)	SMWW 3111 B
17.	Cyanide (CN^-)	SMWW 4500 CN^- F
18.	Fluoride (F^-)	SMWW 4500 F^- C
19.	Lead (Pb)	SMWW 3114 B
20.	Manganese (Mn)	SMWW 3113 B
21.	Mercury (Hg)	SMWW 3114 B
22.	Nickel (Ni)	SMWW 3113 B
23.	Nitrate (NO_3^-)	SMWW 4500 NO_3^- B
24.	Nitrite (NO_2^-)	SMWW 4500 NO_2^- B
25.	Selenium (Se)	SMWW 3114 B
26.	Residual Chlorine (Cl_2)	SMWW 4500 Cl^- B
27.	Phenolic Compounds (as Phenols)	SMWW 5530 D
28.	Zinc (Zn)	SMWW 3113 B

12.2. Results of Environmental Baseline Studies

The city is affected by a range of environmental factors including air pollution, water pollution, waste management, deforestation, and changes in land use. However, technological advances have also contributed to global challenges such as soil, water, and air degradation. To assess the current state of these environmental factors in the city, a monitoring survey was conducted. Addressing these issues is critical for preserving the local ecosystem and improving the quality of life for residents. The survey was conducted with the aim of developing concepts and strategies to improve the environment in Charsadda. Monitoring was carried out for water, air, soil, and noise, and the results are presented below.

The city's environment is impacted by the factors such as air pollution, water pollution, waste management, deforestation, and changing land use patterns. However, many worldwide challenges, like soil, water, and air degradation, are the result of technological developments. A monitoring survey was carried out in the city to determine the current state of the aforementioned environmental factors. It is important to address the environmental issues to maintain the health of the local ecosystem and improve the quality of life for residents. The monitoring was carried out solely to generate concepts and strategies for enhancing the Charsadda environment. During the survey, monitoring of the water, air, soil, and noise was carried out, and the results are presented below.

12.2.1. Drinking/Ground Water Quality

After reviewing the literature and existing environmental profile of KP, 10 locations from Charsadda city were selected for water quality testing. The samples were selected and analyzed for different parameters of NEQs. The lab testing results reveals that the current ground water quality within city boundary is satisfactory and is in compliance with the National Environmental Quality Standards (NEQS).

Owing to lab results, it could be said that the water is safe for human consumption and other uses. Moreover, it is important to regularly test drinking water to ensure that it continues to meet safety standards and to take action to address any potential issues. By prioritizing access to safe drinking water, improve public health and support sustainable communities could be achieved. However, given Charsadda's growing population and recent advances, it is possible to foresee that the water may get contaminated due to human activity; as a result, some anticipated actions must be taken to guarantee long-lasting high quality of drinking water.

Table 42: Drinking Water Quality of Charsadda City

Sr. No	Parameter	NEQS	Unit	Average	No of Contaminated Samples	No of Samples
1.	Color	≤ 15	TCU	0	0	10
2.	Taste	Non-Objectionable		Non-Objectionable-Salty	0	

Sr. No	Parameter	NEQS	Unit	Average	No of Contaminated Samples	No of Samples
3.	Odor	Non-Objectionable		Non-Objectionable	0	
4.	Turbidity	< 5	NTU	0	0	
5.	Total Hardness (as $CaCO_3$)	< 500	mg/L	162.4	1	
6.	Total Dissolved Solids (TDS)	< 1000	mg/L	283.2	1	
7.	pH	6.5- 8.5		7.93	0	
8.	Aluminum (Al)	≤ 0.2	mg/L	<0.005	0	
9.	Antimony (Sb)	≤ 0.005	mg/L	<0.005	0	
10.	Arsenic (As)	≤ 0.05	mg/L	0.01	0	
11.	Barium (Ba)	0.7	mg/L	<0.0035	0	
12.	Boron (B)	0.3	mg/L	<0.02	0	
13.	Cadmium (Cd)	0.01	mg/L	<0.006	0	
14.	Chloride (Cl^-)	< 250	mg/L	79.1	1	
15.	Chromium (Cr)	≤ 0.05	mg/L	<0.004	0	
16.	Copper (Cu)	2.0	mg/L	<0.164	0	
17.	Cyanide (CN^-)	≤ 0.05	mg/L	0	0	
18.	Fluoride (F^-)	≤ 1.5	mg/L	0.024	0	
19.	Lead (Pb)	≤ 0.05	mg/L	<0.005	0	
20.	Manganese (Mn)	≤ 0.5	mg/L	<0.015	0	
21.	Mercury (Hg)	≤ 0.001	mg/L	<0.001	0	
22.	Nickel (Ni)	≤0.02	mg/L	<0.02	0	
23.	Nitrate (NO_3^-)	≤ 50	mg/L	0.133	0	
24.	Nitrite (NO_2^-)	≤ 3.0	mg/L	0.0002	0	
25.	Selenium (Se)	0.01	mg/L	<0.01	0	
26.	Residual Chlorine (Cl_2)	0.5	mg/L	0	0	
27.	Phenolic Compounds (as Phenols)	NGVS		0	0	
28.	Zinc (Zn)	5.0	mg/L	0.0525	0	

Source: Primary Data Collected from Field Survey, (2022)

12.2.2. Surface Water Quality

Surface water quality testing is the process of measuring and analyzing the chemical, physical, and biological characteristics of water in rivers, lakes, and other water bodies that are open to the atmosphere. The measurement and analysis of water quality were conducted in line with National Environmental Quality Standards NEQs). It is important to check the quality of water because the city water bodies are served as sources of drinking water, recreation, and habitat for aquatic species, and also play a crucial role in the ecosystem by supporting plant and animal life. Poor water quality has negative impacts on human health, the environment, and the economy, making it important to regularly monitor and test surface water to ensure it is safe and suitable for its intended use.

A survey was carried out to collect water samples from KPEPA certified laboratory from surface water bodies in order to monitor the quality of Charsadda's surface water. There are no surface water quality standards available in Pakistan, that is why FAO Surface water quality criteria is used for comparative study. The findings of the lab analysis are shown in the table below. The results lead to the conclusion that there is no contamination have been observed and that Charsadda's surface water quality is within the allowed limits established by the FAO guidelines.

Table 43: Surface Water Quality of Charsadda city

Sr. No	Parameter	FAO Standard	Average	No of Samples	No of Contaminated Samples
1.	pH**	-	7.8	6	0
2.	Total Suspended Solids (TSS)*	NGVS mg/L	76.16		
3.	Biochemical Oxygen Demand (BOD_5) *	NGVS mg/L	32.33		
4.	Chemical Oxygen Demand (COD)**	NGVS mg/L	68.16		
5.	Total Dissolved Solids (TDS)**	NGVS mg/L	225.83		
6.	Phenolic Compounds (as Phenols) *	NGVS mg/L	0		
7.	Grease and Oil*	NGVS mg/L	0		
8.	Chloride (Cl^-)**	NGVS mg/L	27.16		
9.	Fluoride (F^-)**	1.0 mg/L	0.0033		
10.	Cyanide (CN^-)*	NGVS mg/L	0		
11.	An-ionic Detergents (as MBAs) *	NGVS mg/L	0		
12.	Sulfate (SO_4^{2-}) *	NGVS mg/L	16.17		
13.	Sulfide (S^{2-}) *	NGVS mg/L	0		
14.	Ammonia (NH_3) *	NGVS mg/L	0		
15.	Aluminum (Al)	5.0 mg/L	0.005		
16.	Antimony (Sb)	NGVS mg/L	<0.005		
17.	Cadmium (Cd)	0.01mg/L	<0.006		
18.	Chromium (Cr)	0.1 mg/L	<0.004		
19.	Copper (Cu)	0.2 mg/L	0.167		
20.	Lead (Pb)	5.0 mg/L	<0.005		
21.	Mercury (Hg)	NGVS mg/L	<0.001		
22.	Selenium (Se)	0.02 mg/L	<0.02		
23.	Nickel (Ni)	0.2 mg/L	<0.02		
24.	Silver (Ag)	NGVS mg/L	<0.02		
25.	Total Toxic Metals	NGVS mg/L	0.265		
26.	Zinc (Zn)	2.0 mg/L	0.052		
27.	Arsenic (As)	0.1 mg/L	0.008		

Sr. No	Parameter	FAO Standard	Average	No of Samples	No of Contaminated Samples
28.	Barium (Ba)	NGVS mg/L	<0.0035		
29.	Iron (Fe)	5.0 mg/L	0.052		
30.	Manganese (Mn)	0.2 mg/L	<0.015		
31.	Boron (B)	0.75 mg/L	<0.02		
32.	Residual Chlorine (Cl_2) *	NGVS mg/L	0		

Source: Primary Data Collected from Field Survey, (2022)

Based on the aforementioned facts, it is concluded that Charsadda's surface water isn't particularly contaminated and is safe to drink. However, there is still a chance that its rivers and other surface water resources could get contaminated owing to a range of activities, such as the mixing of industrial waste, sewage discharge, the mixing of solid waste into surface water, etc. As a result, stringent precautions need to be taken to protect the cleanliness of these surface water bodies.

12.2.3. Ambient Air Quality

Ambient air quality monitoring involves measuring air pollutants according to National Environmental Quality Standards (NEQs). Monitoring is crucial because air pollution has severe consequences on human health, the environment, and climate change. Prolonged exposure to contaminated air can result in respiratory issues, heart disease, and other illnesses. Additionally, air pollution contributes to climate change, deteriorates air quality, and harms wildlife and ecosystems. Through monitoring, environmental departments, policymakers, and individuals can take steps to reduce pollution and safeguard public health.

In reference to the project's terms of reference (TORs), Charsadda's air quality has been assessed and analyzed, and it has been determined to be satisfactory and within NEQs limits. The pollutant levels are acceptable, except for PM2.5 and PM10 at some locations, ensuring that residents can inhale fresh and healthy air.

Table 44: Ambient Air Quality of Charsadda City

Sr. No	Parameter	NEQS	Unit	Average	No of Contaminated Samples	No of total Samples
1.	NO2	80.0	µg/m3	53.71	0	11
2.	NO	40.0	µg/m3	23.60	0	
3.	NOx	120	µg/m3	77.31	0	
4.	SO2	120	µg/m3	84.73	0	
5.	CO	05.0	µg/m3	2.87	0	
6.	O3	130	µg/m3	59.21	0	
7.	PM10	150	µg/m3	121.58	1	
8.	PM2.5	35	µg/m3	31.17	3	
9.	TSP	500	µg/m3	228.73	0	

High levels of PM10 and PM2.5 can have significant impacts on human health and the environment. The health effects include respiratory and cardiovascular problems, such as asthma, bronchitis, heart disease, and stroke. Long-term exposure to high levels of PM2.5 can even lead to premature death. Whereas, the environmental effects of PM10 and PM2.5 include visibility reduction, harm to wildlife and ecosystems, and contribute to climate change by affecting the atmospheric processes that regulate the Earth's temperature.

It is important to monitor and reduce the levels of PM10 and PM2.5 in order to protect public health and the environment. This can be achieved through various measures, including reducing emissions from transportation and industry, improving waste management practices, and promoting the use of clean energy sources. Continued monitoring of air quality is necessary to sustain this progress and promptly identify and address any potential threats to air quality. Industrial activities, manufacturing, and transportation are some of the potential sources that may contribute to air pollution. Effective planning, monitoring, and execution are necessary to maintain the current air quality and prevent future contamination.

12.2.4. Ambient Noise Quality

Continuous monitoring and analysis of sound levels in a city, known as ambient noise monitoring, is crucial as excessive noise pollution can have detrimental effects on human health, the environment, and overall quality of life. Long-term exposure to high noise levels can lead to hearing loss, stress, sleep disturbance, and other health problems.

Continuous ambient noise level monitoring in a city can be extremely useful for policymakers and relevant departments to take necessary actions to reduce noise pollution and improve the quality of life for residents. For instance, the data collected from noise monitoring can help in urban planning, such as the placement of new transportation routes, industrial facilities, and residential areas. It can also aid in identifying the sources of noise pollution and targeting interventions to reduce their impact. Ambient noise monitoring plays a crucial role in enhancing the health, environment, and quality of life in a city by providing data that informs decisions and actions to reduce noise pollution.

To conduct ambient noise level monitoring in Charsadda city, different locations were chosen based on literature review and considering the noise pollution hotspots in the city.. The monitoring was conducted for 24 hours as explained in NEQs. The monitoring results are shown in the table below;

Table 45: Ambient Noise Quality of Charsadda City

Sr. No	Day/Night	NEQS	Unit	Average	No of Samples	No of Contaminated Samples
1	Day	75	dB	62.52	11	4
2	Night	65		58.36		0

Source: Primary Data Collected from Field Survey, (2022)

According to monitoring, the average noise level in the city adheres to National Environmental Quality Standards (NEQ_s). This indicates that the level of noise in the city is within permissible limits and is not excessive. The study also notes that noise levels during both the day and night are below the threshold limits, which implies that noise pollution is not a significant concern in the city.

Based on the noise monitoring survey findings, the paragraph concludes that the noise levels in Charsadda City do not have any adverse effects on the health of its residents. This is good news as excessive noise pollution can cause various health problems such as hearing loss, sleep disturbance, and stress. The study's results imply that the current noise levels in Charsadda City are not a significant threat to public health.

12.2.5. Soil Quality

To test the quality of Soil in Charsadda city, Secondary data e.g., KP – Environmental Profile (2017), government agencies, research institutions, academic journals, and online databases was used. These sources provided information about the soil characteristics and quality. The literature survey and available data on soil quality of Charsadda city reveals that the soil quality is not contaminated.

The mean results of all samples of soil are shown in the table below along with their statistical analysis. So far, Pakistan has not developed and promulgated any standards for Soil quality. Hence, the obtained values were obtained and compared with international standards.[15]

Table 46: Statistical Analysis of Soil Fractions

Sr. No.	Parameter	Value (%) (Mean)
1	pH	6.2-10.4
2	Total P (%)	1 – 45 (Low)
3	Total K (%)	50 – 830 (Low)
4	Total N (%)	0.034
5	Electrical Conductivity	0.04 – 5.88 (Slightly Saline)
6	Organic Matter	0.1 – 2.72 (Low)

Source: Soil Survey of Pakistan - 2019

12.3. Environmental Proposals

12.3.1. Agriculture

Charsadda has a great potential of agriculture production. Currently, it is one of the major cities of KPK producing many cereal and cash crops. The land of Charsadda is very fertile. There are three rivers flowing in Charsadda: The River Jindi, the Kabul River, and the Swat River; these are the main source of irrigation for Charsadda. The three rivers then merge and join the Indus River. It is an agriculturally rich region that produces a variety of crops. The total agricultural area of Charsadda city is 5291.31 acres.[16]

[15] KP Environmental Profile 2017.
[16] Khyber Pakhtunkhwa Board of Investment & Trade

To promote sustainable agriculture in Charsadda city, the goals include integrating livestock, minimizing soil disturbance, creating job opportunities, promoting environmentally friendly practices, and lowering the prices of fertilizers. Proposals to meet these goals include raising awareness, providing subsidies and commodities, promoting public-private partnerships, transforming unproductive lands, establishing model vegetable farms, promoting communal garden spaces, encouraging eco-friendly practices, and providing education and training opportunities. By adopting these proposals, Charsadda can create a paradigm shift in the agricultural sector and ensure long-term sustainability. It is crucial to implement sustainable agriculture proposals to ensure productive yields and a self-sustained Charsadda city. The details of areas of the proposed agriculture zone are given in the table below;

Table 47: Proposed Agriculture Zone - Charsadda Study Area

Sr.	Zone	Area (Acre)
1	Agriculture Zone	5291.31

Source: Devised by Consultants

Here are the guidelines developed for agricultural zone development:

Permitted Uses	Allied Permitted Uses	Prohibited Uses
• Allow the development of land designated for agriculture. • Incentives for farmers to adopt modern technologies and practices to enhance productivity. • Promote the development of farmers' markets and direct marketing channels for agricultural products to consumers. • Encourage agricultural research and development activities for sustainable agriculture production.	• Allow agro-processing industries, such as food processing and textile manufacturing, within the agricultural zone. • Generation of renewable energy, e.g. the installation of solar panels on farms. • Encourage rural tourism, such as farm stays and guided tours, within the agricultural zone. • Allow forestry and agroforestry activities in the agricultural zone. • Provision of accommodation for farmers and laborers in association with the relevant authority.	• Conversion of agricultural land to non-agricultural uses, e.g. residential, commercial, or industrial development. • Use of harmful agrochemicals or practices that degrade soil quality or pollute water sources. • Cultivation of crops or raising of livestock that are not appropriate for the region or that require excessive amounts of water or other resources. • Any activities that are illegal or harmful to the environment or public health.

Agriculture, when practiced sustainably, can have positive impacts on air, water, soil, and noise. Here are some of the benefits:

1. Air Quality Improvement: Sustainable agricultural practices such as agroforestry, crop rotation, and reduced chemical inputs can contribute to improved air quality. By minimizing the use of chemical fertilizers and pesticides, the release of harmful pollutants into the ai2r is reduced, leading to a healthier environment for both humans and wildlife.

2. Water Conservation: Sustainable agriculture focuses on efficient water management techniques, such as drip irrigation and rainwater harvesting. These practices help conserve water resources by minimizing wastage and reducing the need for excessive water extraction. By maintaining healthy water levels in rivers and aquifers, sustainable agriculture supports the overall ecosystem and ensures a reliable water supply for both agricultural and domestic purposes.

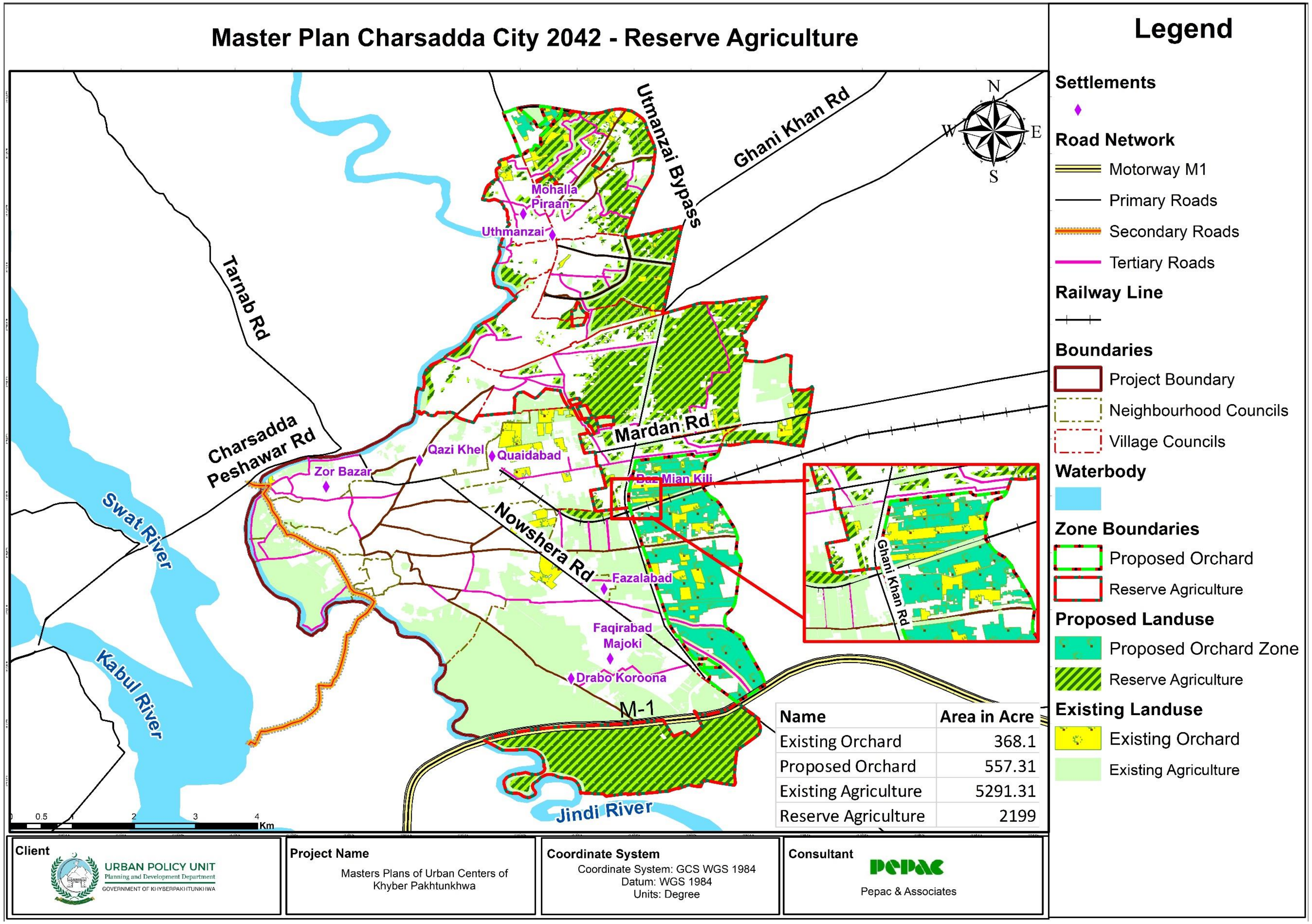
3. Soil Health Enhancement: Sustainable agriculture emphasizes soil conservation and improvement. Techniques like cover cropping, composting, and organic farming practices help prevent soil erosion, enhance soil fertility, and promote the growth of beneficial microorganisms. Healthy soils can retain water more effectively, minimize nutrient runoff, and support the growth of robust crops, leading to increased agricultural productivity and long-term sustainability.

4. Biodiversity Preservation: Sustainable agriculture practices encourage the preservation of natural habitats and the promotion of biodiversity. By maintaining diverse cropping systems, preserving hedgerows, and creating wildlife-friendly landscapes, agriculture can provide habitats for beneficial insects, birds, and other wildlife. This contributes to the overall ecological balance, helps control pests naturally, and supports pollination, thus ensuring a sustainable food production system.

5. Noise Reduction: Sustainable agricultural practices can help minimize noise pollution. By adopting eco-friendly technologies and practices, such as using electric or low-noise machinery, minimizing the use of loud equipment, and implementing precision farming techniques, the overall noise levels in agricultural areas can be reduced. This benefits both farmers and nearby communities, providing a more peaceful environment.

It is important to note that realizing these positive impacts requires the adoption of sustainable agricultural practices and the active participation of farmers, policymakers, and the community. Continuous efforts to raise awareness, provide education and training, and incentivize sustainable practices can further enhance the benefits of agriculture on air, water, soil, and noise in Charsadda and beyond.

Map 25: Reserved Agriculture Map – Charsadda Study Area



Source: Devised by Consultants

12.3.2. Fisheries

The fishing industry provides economic support and food security to many people worldwide, including in Charsadda. To maximize the potential of the fish industry, local and provincial governments need to develop a strategy for sustainable fish stock management, biodiversity conservation, economic benefits, environmental protection, and compliance with fisheries regulations. Proposed actions include developing a fisheries management plan, encouraging appropriate fishing practices, investing in research and monitoring, promoting education and outreach, adopting new and green technologies, establishing protected areas, and implementing and monitoring a fisheries management program. These actions will help preserve fish populations, protect the environment, and ensure compliance with regulations, while contributing to economic growth and food security.[17]

The fishing industry, when managed sustainably and with appropriate practices, can have several positive impacts on air, water, soil, and noise pollution. Here are some of the potential benefits:

1. Air Pollution:

- Reduced carbon emissions: Sustainable fishing practices, such as using efficient engines or transitioning to alternative energy sources.
- Reduced air pollutants: Properly maintained fishing vessels and responsible handling of fuel and chemicals can minimize the release of air pollutants, such as volatile organic compounds and particulate matter.

2. Water Pollution:

- Decreased marine debris: Implementing proper waste management practices, including recycling, reducing plastic use, and ensuring proper disposal of fishing gear, can help reduce marine debris and prevent water pollution.

3. Soil Pollution:

- Minimized chemical runoff: Promoting responsible use of chemicals, such as fertilizers or pesticides in aquaculture operations, can help prevent soil pollution through minimized runoff and leaching into water bodies.

4. Noise Pollution:

- Reduced vessel noise: Encouraging the adoption of noise-reduction technologies and promoting awareness among fishermen about the impacts of excessive noise can help minimize underwater noise pollution, which can disturb marine life and their habitats.

[17] Khyber Pakhtunkhwa Board of Investment & Trade

It's important to note that these positive impacts can only be achieved through proper management, adherence to regulations, and the active involvement of the fishing industry, government bodies, and local communities.

12.3.3. Tree Plantation and Ecological Corridors

Tree plantation is important for sustainability and improved environmental conditions of any city. The benefits of tree plantation and as a result, ecological corridors development is given hereunder;

- Conserve and preserve indigenous species of plants and animals in the city.
- Absorb carbon dioxide from the atmosphere and helps to mitigate the effects of climate change.
- Prevent soil erosion, conserve soil moisture and fertility, and reduce the impact of natural disasters such as floods.
- Regulating the water cycle by absorbing and releasing water vapor, reducing runoff and soil erosion, and maintaining aquifers.
- Provide livelihood opportunities, food, fuel, and non-timber forest products and restore degraded landscapes, create green spaces, and provide recreation and tourism opportunities.

The Irrigation and Forest departments jointly launched mass tree plantation at the Lift Irrigation Scheme in Charsadda during the reign of the Pakistan Tehreek-e-Insaaf government. According to this, they set the target of Around 1.8 million trees is the plantation target for Charsadda as part of the Billion Tree Tsunami Project.[18] The tree plantation is helpful for the provision of ecosystem services including carbon storage, carbon sequestration. The major goal for tree plantation is soil conservation, climate impact mitigation, water resource management, reduce urban heat Iceland effect, promotion of human health and well-being, community engagement and urban livability enhancement. These goals can be achieved through a combination of preserving existing green spaces and plantations, creating new green spaces, and incorporating green infrastructure such as green roofs, rain gardens, and urban parks into city planning and development.

We can achieve sustainable and environmentally friendly ecosystem by imposing following proposals against the set goals. Proposals includes, ban on unauthorized housing projects, emission reduction by promoting public transport, afforestation campaigns by creation of urban forests, establishment of policies and their enforcement, climate resilience planning followed by community engagement and collaborative efforts.

[18] https://tribune.com.pk/story/1055142/tsunami-cometh-1-8-million-trees-to-be-planted-in-charsadda

Table 48: Riparian and Tree Plantation Zonal Calculations

Sr. No.	Zone	Area (Acre)
1	Riparian Zone	78
2	Tree Plantation	657.42

Source: Devised by Consultants

The urban forestation proposal has been developed by incorporating transportation considerations. The current road network spans a total length of 70.02 kilometers, while the proposed roads cover a distance of 33.98 kilometers in the existing road network. According to the studies conducted, it is recommended to plant trees along the sides of the road at intervals of three meters, following the standards set by the National Highway Authority (NHA). The existing areas alongside the roads accommodate a total of 23,340 trees, while the proposed areas will be able to accommodate 11,326 trees.

Here are the guidelines developed for Urban Forestation zone development:

Table 49: Guidelines for Urban Forestation Zone Development

Permitted Uses	Allied Permitted Uses	Prohibited Uses
• Land designated for horticulture, landscaping, plantation, green belt, or forestation purposes. • Areas developed for walking and cycling trails, picnic spots, and other recreational facilities that do not harm the natural environment. • Places where stormwater management practices are implemented using vegetation to minimize runoff and enhance water quality. • Installation of green infrastructure, like green roofs or walls, that support urban forestation and natural resource conservation. • Land allocated for agricultural research and development.	• Provision for temporary accommodation of labor and security personnel. • Designated parking areas for emergency situations like accidents in forestry and agroforestry. • Accommodation for farmers and labor. • Eco-tourism and recreational activities, like guided nature walks, bird-watching, and photography, promote the conservation of natural resources and the benefits of urban forestation. • Installation of renewable energy systems, such as solar panels or wind turbines, that are compatible with preserving the natural environment.	• Conversion of the zone for non-forest uses, such as commercial, industrial, or residential development. • Use of harmful agrochemicals or practices that degrade soil quality or pollute water sources. • Dumping of waste materials, including construction debris or hazardous waste, in the urban forestation zone. • Establishment of any illegal or environmentally harmful activities that may pose risks to public health.

Tree plantation and the development of ecological corridors have numerous positive impacts on air, water, soil, and noise pollution. Here are some of the benefits:

1. Air Pollution:
   - Trees absorb carbon dioxide (CO_2) from the atmosphere through the process of photosynthesis, reducing the concentration of this greenhouse gas that contributes to climate change.

- They also absorb other harmful air pollutants such as ozone, nitrogen dioxide, and particulate matter, improving air quality.
- The presence of trees in urban areas can create a buffer against vehicular emissions and industrial pollution, helping to mitigate the negative effects of air pollution.

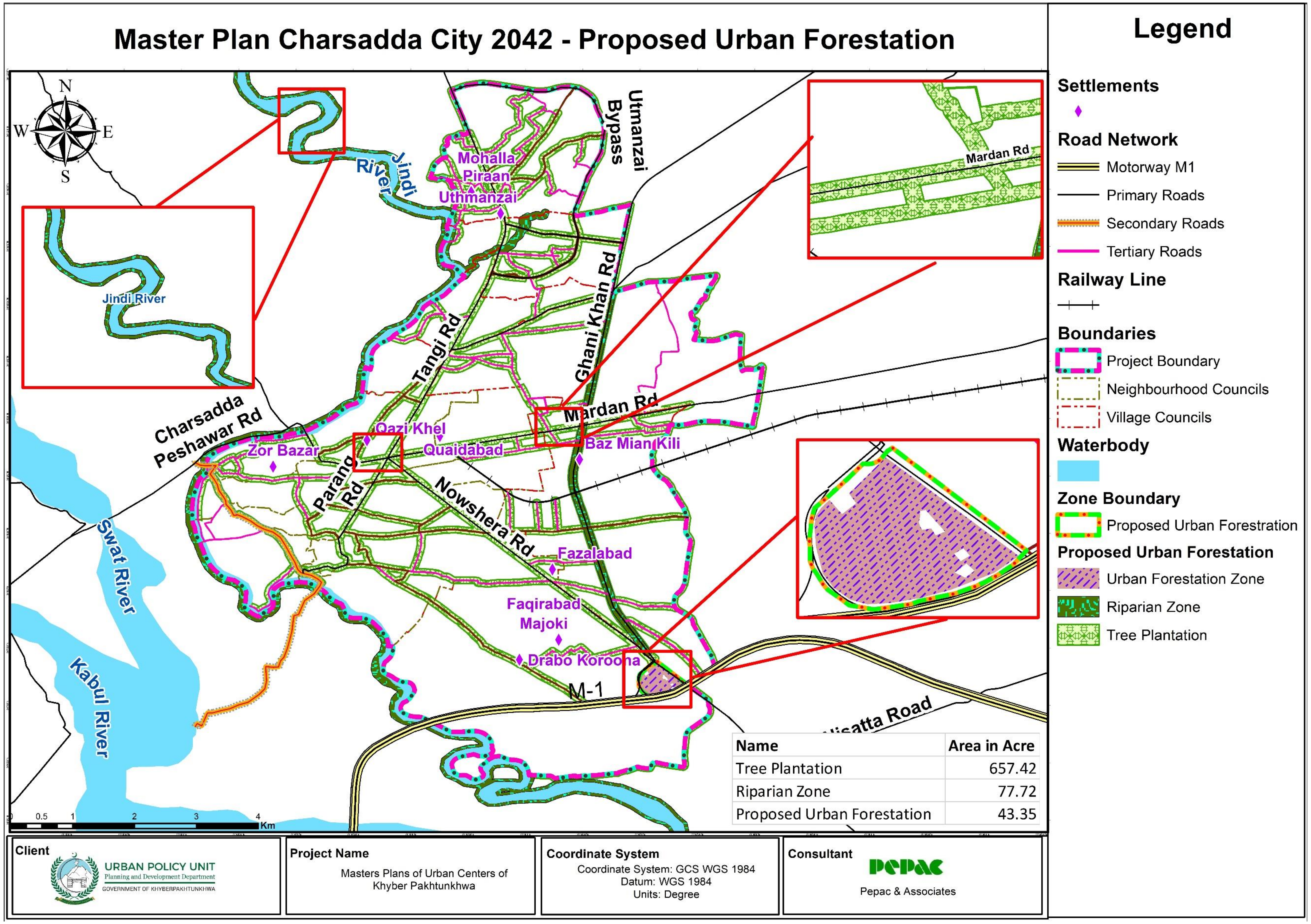
2. Water Pollution:
- Tree plantation and ecological corridors help regulate the water cycle by absorbing and releasing water vapor, reducing the intensity of rainfall and preventing stormwater runoff.
- The root systems of trees act as natural filters, intercepting and reducing the flow of pollutants into rivers, lakes, and underground water sources.
- Trees can also help control soil erosion, preventing sediment and other pollutants from entering water bodies and reducing the risk of water pollution.

3. Soil Pollution:
- The roots of trees bind the soil, preventing erosion and promoting soil stability. This helps to retain valuable topsoil and reduces the risk of sedimentation in nearby water bodies.
- Tree plantation enhances soil fertility by increasing organic matter content through the decomposition of fallen leaves and other plant material.
- Trees can also absorb and store certain contaminants, reducing their concentration in the soil and preventing their migration into groundwater.

4. Noise Pollution:
- Trees act as natural sound barriers, absorbing and diffusing noise from traffic, construction, and other sources.
- The dense foliage and branches of trees help to break up sound waves and reduce noise levels, creating a more peaceful and serene environment.
- Ecological corridors that incorporate tree cover can create wildlife habitats and promote biodiversity, which contributes to a more balanced ecosystem and reduces human-induced noise.

Overall, tree plantation and the establishment of ecological corridors play a vital role in improving air quality, reducing water and soil pollution, and mitigating noise pollution. These initiatives contribute to the creation of sustainable and environmentally friendly cities, fostering healthier and more livable environments for both humans and wildlife.

Map 26: Urban Forestation Map – Charsadda Study Area



Name	Area in Acre
Tree Plantation	657.42
Riparian Zone	77.72
Proposed Urban Forestation	43.35

Source: Devised by Consultants

12.3.4. Wildlife

In Charsadda, an alarming decline in the indigenous animal, plant, and bird species has been noticed. This is unquestionably a result of illicit wildlife and bird hunting as well as deforestation19. To guarantee the security and protection of the wildlife of the city, however, there is an urgent need for specific and practical actions. The major objectives are to conserve wildlife, safeguard wildlife from harm, and impose a prohibition on all forms of hunting of endangered animals.20

The wildlife population in Charsadda city is limited due to urbanization and human development. Some common urban wildlife species that may be found in Charsadda include birds, squirrels, and possibly some small mammals such as hedgehogs or mongooses. The goals to protect the present wildlife in the city are minimizing habitat destruction, reduce human-wildlife conflict, promote wildlife friendly urban planning, increase public awareness, enforcement of wildlife friendly protection laws by supporting research, monitoring and proper implementation. These goals can be achieved by creation of wildlife designated areas, imposition of sanctions for non-compliance with legal regulations, enhance research and monitoring, control of invasive species, stringent measures to avoid deforestation, minimize dependence on hunting, establishment of indigenous flora through afforestation & deforestation and development of urban forests within local government jurisdiction.

Wildlife plays a crucial role in maintaining a healthy ecosystem, and its presence can have positive impacts on various forms of pollution. Here are the potential benefits of wildlife on air, water, soil, and noise pollution:

1. Air Pollution:

- Carbon Sequestration: Forests and vegetation, which are habitats for wildlife, act as natural carbon sinks. They absorb carbon dioxide through photosynthesis, helping to mitigate greenhouse gas emissions and reduce air pollution.
- Oxygen Production: Trees and plants release oxygen during photosynthesis, improving air quality and providing fresh oxygen for humans and other organisms.
- Filtering Airborne Pollutants: Some wildlife species, such as birds and bats, consume large numbers of insects that may carry harmful pollutants or diseases. By controlling insect populations, they contribute to reducing the spread of airborne pollutants.

2. Water Pollution:

[19] WWF-PAK
[20] Forestry, Environment & Wildlife Department Govt of Khyber Pakhtunkhwa

- Nutrient Cycling: Wildlife, such as fish and aquatic organisms, play a vital role in maintaining the balance of nutrients in aquatic ecosystems. They help in breaking down organic matter, preventing excessive nutrient buildup and reducing the risk of water pollution.
- Biofiltration: Wetlands and riparian areas inhabited by wildlife act as natural water filters. They help remove pollutants like sediments, nutrients, and contaminants, improving water quality.
- Algae Control: Certain wildlife species, such as waterfowl and herbivorous fish, feed on algae, preventing excessive algal growth that can lead to water pollution and oxygen depletion.

3. Soil Quality:

- Nutrient Cycling: Wildlife, particularly small mammals and insects, contribute to nutrient cycling by consuming organic matter and excreting nutrient-rich waste. This aids in the decomposition of organic material and the enrichment of soil fertility.
- Soil Aeration: Burrowing animals like earthworms and certain rodents help aerate the soil through their digging activities. This enhances soil structure, water infiltration, and nutrient availability for plants.

4. Noise Pollution:

- Predation Control: Wildlife, especially predators, help regulate populations of other animals, preventing overpopulation that can lead to excessive noise and disturbances.
- Natural Soundscapes: The presence of diverse wildlife contributes to the creation of natural soundscapes, which can have a calming effect and counteract human-induced noise pollution in urban areas.

12.3.5. Aggregate Resources

Aggregate extraction can have several environmental repercussions, including changes to the landscape, habitat loss, noise, dust, erosion, and sedimentation. While most environmental effects related to mining for aggregate are mild, extracting aggregate from some locations can alter the local geology, which could disrupt the ecosystem's equilibrium. Therefore, the primary objective of an aggregate resource study and plan is to protect Charsadda's natural aggregate resources.21

Aggregate resources play a crucial role in economic growth and infrastructure development. However, their rapid depletion and increasing demand raise concerns about their

[21] Khyber Pakhtunkhwa Board of Investment & Trade

sustainability. To ensure their long-term availability, it is essential to establish appropriate goals and strategies for their extraction and use.

As Charsadda expands, the demand for aggregate resources also increases. However, extracting these resources is not without challenges, including environmental degradation, land-use conflicts, and safety concerns. To ensure sustainable resource management, it is crucial to set appropriate goals and strategies that balance the community's needs with environmental preservation. Therefore, stakeholders from the public and private sectors, including government agencies, industry leaders, and local communities, must collaborate to establish policies and practices that protect Charsadda's aggregate resources for future generations.

The goals to protect these resources include conservation, sustainable extraction, a ban on illegal extraction, economic viability through reuse and recycling, enforcement of regulations, and the establishment of protected zones to preserve natural resources. These goals could be achieved by prohibiting illegal mining, conducting EIA studies of extraction, establishing health and safety regulations, monitoring, evaluation, research and development, providing financial incentives, increasing public awareness, supporting community engagement, encouraging innovative technology, and developing regional plans.

Impacts of Aggregate Resources on air, water, soil, and noise pollution include:

a. Air Pollution Reduction: The use of aggregate resources, such as gravel and crushed stone, in construction projects can reduce air pollution. By substituting aggregate for traditional materials like clay or sand, construction activities can minimize dust generation, which is a common source of air pollution. The use of aggregates in road construction can also lead to smoother surfaces, reducing vehicle emissions and improving air quality.
b. Water Pollution Prevention: Proper management of aggregate extraction and construction activities can help prevent water pollution. Well-designed aggregate pits and quarries can incorporate sedimentation ponds and containment measures to prevent sediment runoff into nearby water bodies. By implementing erosion control measures, such as silt fences and vegetative buffers, the potential for soil and chemical contaminants to enter water sources is reduced.
c. Soil Conservation: Aggregate resources, when used in construction projects, can contribute to soil conservation. By utilizing aggregates in road construction or building foundations, it reduces the need for extensive earthwork, minimizing soil disturbance and erosion. This helps to preserve the integrity of the soil and maintain its ability to support vegetation and ecological functions.
d. Noise Pollution Reduction: Aggregate resources, particularly in the form of sound-absorbing materials like gravel or crushed stone, can help mitigate noise pollution.

When used as a base or surface material for roads, aggregates can absorb and reduce traffic noise, creating quieter environments for surrounding communities. Additionally, well-planned extraction and processing operations can implement noise control measures to minimize the impact on nearby residential areas.

12.3.6. Environmental Conservation Areas and Floodplains

Charsadda city, like many cities in the world, faces challenges with environmental protection and flood management. Effective environmental protection in the city requires addressing a range of issues including air pollution, water pollution, solid waste management, deforestation, and conservation of biodiversity. For flood management, the city can implement measures such as building flood protection structures such as levees and flood walls, improving drainage systems, and creating early warning systems. Additionally, urban planning and land use management play a critical role in reducing the risk of floods by avoiding development in flood-prone areas, preserving natural drainage ways and wetlands, and promoting sustainable land use practices. It is important for the government, local organizations, and the community to work together to find solutions to these challenges and ensure a sustainable and livable environment.

The goals which are identified for the same are green space development, flood protection infrastructure, water conservation, renewable energy and sustainable transportation, community education, and engagement. These goals can be met by the establishment of protected areas, implementation of restoration programs, promote sustainable land use practices, develop floodplain management plans in flood-prone areas, promote water quality monitoring, promotion of research and innovation, development of partnership and collaboration followed by promotion of sustainable transport.

The proposal entails the implementation of water recharge zones within the existing parks. A portion of 2% of the total park area has been designated for water recharge purposes. Specifically, this equates to a proximate area of 46422.47 sq. ft, which is distributed across 4 different locations within the parks.

Here are the guidelines developed for Environmental Conservation zone development:

Table 50: Guidelines for Environmental Conservation Zone Development

Permitted Uses	Allied Permitted Uses	Prohibited Uses
• Non-invasive recreational pursuits, such as hiking, birdwatching, and camping, that does not disturb the local ecosystem or cause harm to the natural environment. • Low-impact agricultural practices, including organic farming and agroforestry, to support sustainable land use practices that promote conservation and reduce environmental impact. • Flood-resistant agricultural practices, such as the utilization of contour farming techniques or crops that are adapted to wet conditions, to support productive land use and protect against potential flood damage. • The floodplain can be utilized for flood control and prevention activities, including the construction of flood control structures and the planting of vegetation that helps to stabilize riverbanks and reduce erosion. • Research and educational activities related to environmental conservation and floodplain management to promote the protection of the natural environment and support sustainable land use practices.	• The construction of hiking trails or campgrounds to support non-destructive recreational activities • The construction of research facilities or education centers to support research and education activities related to environmental conservation and floodplain management. • The construction of eco-lodges or other tourist accommodations to support ecotourism and nature-based tourism. • The construction of flood control structures or planting of vegetation that helps stabilize riverbanks and reduce erosion to support flood control and prevention activities.	• Industrial activities that produce pollution or degrade the environment and floodplain are strictly prohibited, to ensure that the natural ecosystem and water quality are preserved. • Any form of mining, logging, or other extractive activities that could create harm or cause soil erosion are prohibited to preserve the natural resources. • The development of large-scale commercial or residential buildings that could harm the natural habitats or increase the risk of flooding is strictly prohibited to maintain the natural environment and reduce the likelihood of flood damage. • Activities that damage the floodplain, such as filling, grading, or excavation to preserve the natural ecology of the area and protect it against potential environmental damage.

To protect the environment and conserve biodiversity the following criteria could be followed;

- Ensuring environmental sustainability by restricting the discharge of waste and pollutants.
- Restoring and maintaining ecological cycles.
- Rehabilitating degraded ecosystems and creating environmental awareness.
- Overcoming environmental challenge such as land degradation, watersheds, deforestation, waste management, pollution control, and climate change, require attention. These challenges can be addressed through sustainable practices, policy interventions, and investments in research and development.

Reduce emissions with plantation of tree species that are viable with local climate to achieve safe, healthy and sustainable environment. Plantation of trees to reduce carbon emissions and improve air quality. Additionally, afforestation can provide additional benefits, such as water conservation and reducing soil erosion.

Environmental Conservation Areas and Floodplains can have several positive impacts on air, water, soil, and noise pollution. Here are some of the benefits:

1. Air Pollution:

- Vegetation in Conservation Areas and Floodplains acts as natural air filters, absorbing pollutants and releasing clean oxygen into the atmosphere.
- Trees and plants in these areas help reduce the concentration of airborne particulate matter, such as dust and pollutants, by capturing and trapping them on their leaves and stems.
- Preservation of natural habitats encourages the presence of wildlife, which helps maintain the ecological balance and contributes to a healthier air quality.

2. Water Pollution:

- Conservation Areas and Floodplains play a crucial role in maintaining the quality of water sources. Wetlands, for example, act as natural water filters, removing pollutants and sediment before the water enters rivers, lakes, or groundwater.
- Vegetation in these areas helps to stabilize soil, reducing erosion and the subsequent runoff of sediment and pollutants into water bodies.
- Conservation Areas can protect the riparian zones along rivers and streams, preventing contamination from agricultural or industrial activities and preserving the water quality.

3. Soil Pollution:

- Conservation Areas and Floodplains protect and maintain healthy soil by preventing erosion and sedimentation, which can carry pollutants and degrade the soil quality.
- The presence of vegetation and organic matter in these areas improves soil structure, promotes nutrient cycling, and enhances soil fertility.
- Protection of these areas also prevents the accumulation of contaminants in the soil, preserving its natural composition and reducing the risk of pollution.

4. Noise Pollution:

- Conservation Areas and Floodplains provide natural buffers against noise pollution by absorbing and diffusing sound waves. The vegetation, trees, and natural topography act as barriers, reducing the impact of noise from surrounding urban or industrial areas.
- These areas can also provide peaceful and serene environments, promoting a sense of well-being and reducing the negative effects of noise pollution on human health.

Overall, the establishment and preservation of Environmental Conservation Areas and Floodplains contribute significantly to mitigating air, water, soil, and noise pollution

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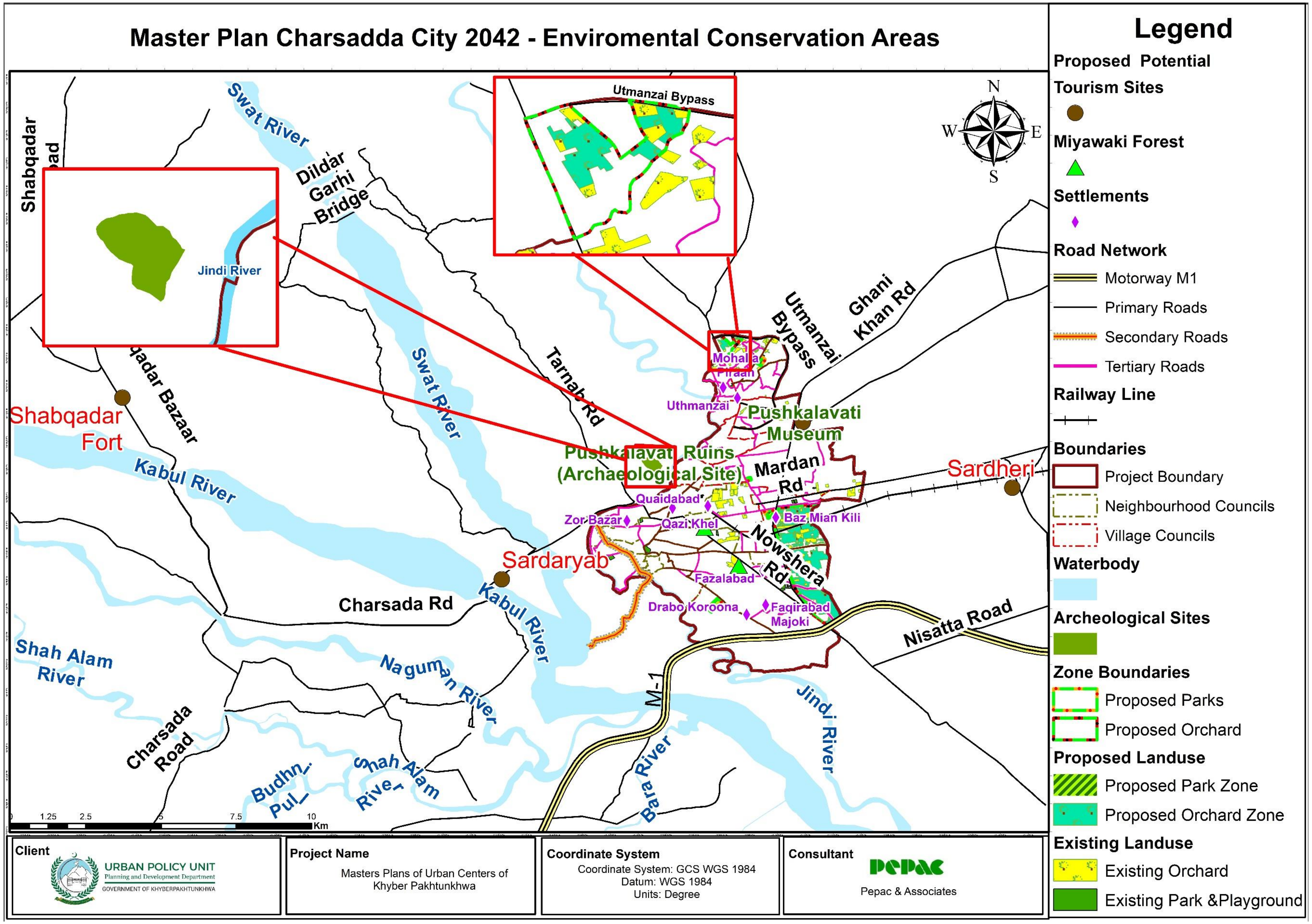
Map 27: Environmental Conservation Map – Charsadda Study Area



Source: Devised by Consultants

12.3.7. Mitigation measures for sustainable environment

Environmental Conservation Areas and Floodplains can have several positive impacts on air, water, soil, and noise pollution. Here are some of the benefits:

1. Air Pollution:

- Transition to Renewable Energy Sources: Promotion towards use of renewable energy will be implemented, such as solar and wind power, this will reduce reliance on fossil fuels and decrease air pollution from power generation.
- Improve Industrial Emissions Controls: Stricter regulations and standards for industries will be implemented to reduce emissions of pollutants like particulate matter, sulfur dioxide, and nitrogen oxides through the use of scrubbers, filters, and cleaner production technologies.
- Encourage Sustainable Transportation: The use of electric vehicles, public transportation, and active modes of transportation like cycling and walking will be introduced to reduce emissions from vehicles and alleviate air pollution in urban areas.

3. Water Pollution:
- Implement Proper Waste Management: Effective waste management systems will be established to prevent the discharge of untreated or improperly treated wastewater into water bodies, reducing pollution from industrial, agricultural, and residential sources.
- Enhance Agricultural Practices: Sustainable farming techniques will be imposed that minimize the use of pesticides, fertilizers, and herbicides, reducing agricultural runoff and contamination of water sources.
- Protect Riparian Zones: Preservation and restoration will be done for riparian zones, the areas along rivers and streams, these will act as natural buffers, filtering runoff and preventing pollutants from entering water bodies.

Soil Pollution:

- Adopt Organic Farming Practices: Encouragement will be given to organic farming methods to minimize the use of synthetic fertilizers and pesticides, promoting soil health and reducing contamination.
- Implement Soil Erosion Control Measures: Implementation on measures such as terracing, contour plowing, and cover cropping will be done to prevent soil erosion and the subsequent loss of topsoil and contamination of water bodies.
- Remediate Contaminated Sites: Identification and remediation will be done on contaminated sites to prevent the spread of pollutants into the soil and groundwater, ensuring the long-term health and productivity of the land.

Noise Pollution:

- Design Noise Barriers: Construction of physical barriers, such as noise walls and green belts, near highways, airports, and industrial areas to reduce the transmission of noise and protect nearby communities will be done.
- Implement Urban Planning Strategies: Noise-reducing measures will be taken under consideration in urban planning, such as zoning regulations that separate residential areas from noisy sources, and design buildings with soundproofing materials.
- Promote Public Awareness and Education: Awareness will be given about the impacts of noise pollution and encouragement of individuals to adopt practices such as reducing noise levels from personal activities and using quieter equipment and machinery.
- By implementing these mitigation methods, it will be made possible to significantly progress in reducing air, water, soil, and noise pollution, leading to a healthier and more sustainable environment.

By implementing these mitigation methods, it will be made possible to significantly progress in reducing air, water, soil, and noise pollution, leading to a healthier and more sustainable environment.

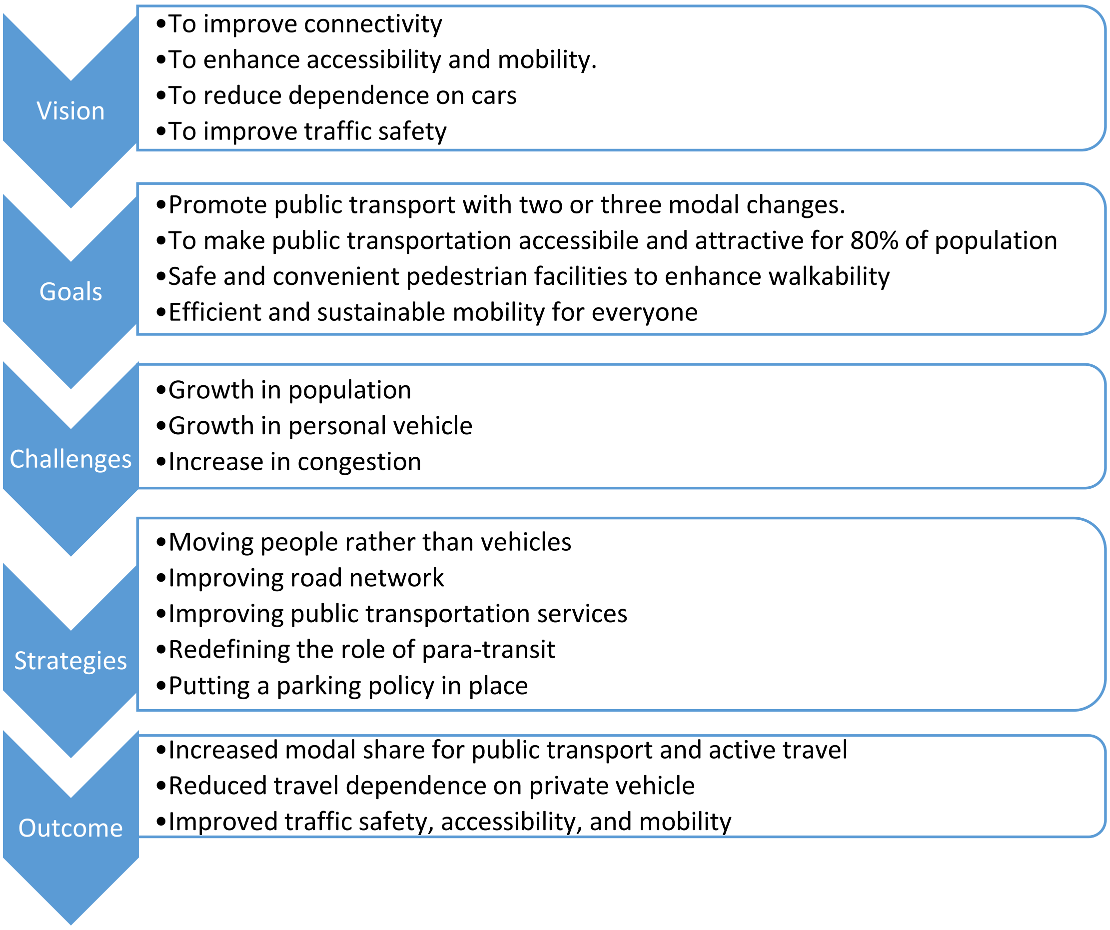
Chapter 13: Transportation & Mobility

The existing traffic condition in Charsadda city poses traffic congestion problems and travel time delays for people commuting to the Central Business District (CBD). The core area of the city is connected by major corridors such as Tangi Road, Mardan Road, Nowshera Road, and Charsadda Road surrounded by various administrative offices and commercial centers near Farooq-e-Azam Chowk. The vehicle mix observed on major corridors of Charsadda mostly include of cars, motorcycles, and rickshaws and few local public transport vehicles such as Suzuki and Hiace. Most people are concerned about poor traffic conditions in the city owing to increase in private vehicles, driving behavior of motorcyclists, and lack of enforcement of traffic bylaws which cause traffic bottlenecks and interrupts smooth traffic flow on the primary corridors. Moreover, lack of pedestrian facilities, traffic signage, lane marking, presence of hawkers, encroachments and illegal parking is also observed on these primary corridors which hinders overall mobility. To address these issues, a comprehensive mobility plan is prepared to attain a People Centric Urban Transportation System and improve accessibility to the central city area. This can be done by promoting multimodal transportation on major corridors, improving public transportation systems, and managing parking demand generated by the core city area. Considering existing traffic and transportation problems, the interventions are proposed for improvement of mobility and traffic management in Charsadda.

13.1. The Comprehensive Mobility Plan Approach

The approach used to achieve a comprehensive mobility plan addressing all transportation needs of Charsadda city is based on five components. These components are Vision, Goals, Challenges, Strategies, and Outcome. To comprehend the current traffic and transportation situation of Charsadda, the existing challenges are highlighted, and a vision is defined followed by listing achievable goals. Afterwards, a well-defined strategy is laid out to achieve the desired outcome for the transportation system. Key components of this five-step methodology are summarized below.

Figure 21: Comprehensive Mobility Plan Approach



Source: Developed by Consultant

13.2. The Comprehensive Mobility Plan Methodology

The comprehensive mobility plan approach needs a well-laid out methodology to achieve its vision and goals for the horizon year of 2042 for Charsadda study area. The methodology comprises of Travel Demand Management (TDM) measures which helps in analyzing the existing situation and propose necessary interventions to improve the transportation network in Charsadda study area. The key components of TDM include identifying the exiting road network shortcomings and highlighting the required interventions to improve the road network. Moreover, based on land use zoning, new roads are proposed to complement the existing road network. This is done by estimating the Trip Generation from proposed residential zones and predicting the future traffic volume and no. of lanes required for ease of traffic flow towards commercial, health, educational, and industrial areas. The major intersections of Charsadda study area are also considered to improve accessibility and mobility for commuters. Public transportation improvements are also suggested to focus on enhancing its attractiveness as a mode choice to cater transportation needs. For that purpose, mode choice analysis is done to predict the most convenient travel mode for the horizon year 2042. Moreover, parking management and traffic signage improvements are also considered for improving overall mobility. The detailed explanation for each component i.e., road network improvements, junction geometry improvements, signage improvements, public transportation service improvements, and parking management are discussed later in the report.

13.3. Road Network Improvements

The traffic flow in a city is governed by trips attracted towards major land uses. The major corridors of Charsadda are Mardan Road, Nowshera Road, Tangi Road, and Charsadda Peshawar Road. The Manual Classified Count (MCC) Survey was conducted to access the LOS of these roads at the entry/exit points of the study area. Moreover, considering the land use and strategic importance of these primary corridors, interventions are proposed to improve the overall traffic mobility within the Charsadda city. The sections below discuss the interventions proposed for existing primary and secondary roads. Similarly, new structural roads are also proposed to provide access and cater traffic demand for proposed industrial, commercial, and housing areas of 2042.

13.3.1. Capacity Improvement of Existing Roads based on Vehicle Growth Trend

The primary corridors of Charsadda city were analyzed for existing traffic volume in the Background Study Report (BSR). To determine whether these corridors will be sufficient to cater the traffic demand of horizon year 2042, an average of individual growth rate for each vehicle type was taken to project the future traffic volume. This growth rate comes out to be 5% for Charsadda study area. The following two scenarios are considered for comparison:

I. Future traffic demand with current geometry

II. Future traffic demand with interventions (improved geometry)

The analysis results for these roads with their respective traffic volumes, peak hours and required interventions to improve the LOS in 2042 are shown in the following table.

Table 51: Manual Classified Count results for Future Scenario

Cordon Point	Cordon Point ID	Direction	Duration	Current Demand with Existing Geometry - 2022					Future Demand with Existing Geometry - 2042					Future Demand with Interventions - 2042					Remarks
				Existing No. of Lanes	Road Capacity (pcu/hr) C	Peak Hour Volume (pcu) V	V/C Ratio	LOS	Existing No. of Lanes (Single Approach)	Road Capacity (pcu/hr) C	Peak Hour Volume (pcu) V	V/C Ratio	LOS	Proposed No. of Lanes (Single Approach)	Road Capacity (pcu/hr) C	Peak Hour Volume (pcu) V	V/C Ratio	LOS	
Sardaryab Bridge	MCC-1	Inflow	AM	2	3,200	602	0.19	A	2	3,200	1597	0.50	A	2	3,200	1597	0.50	A	LOS is fine in current lane configuration. So, no interventions are required.
			PM	2	3,200	852	0.27	A	2	3,200	2259	0.71	C	2	3,200	2259	0.71	C	LOS is fine in current lane configuration. So, no interventions are required.
		Outflow	AM	2	3,200	672	0.21	A	2	3,200	1783	0.56	A	2	3,200	1783	0.56	A	LOS is fine in current lane configuration. So, no interventions are required.
			AM	2	3,200	818	0.26	A	2	3,200	2171	0.68	B	2	3,200	2171	0.68	B	LOS is fine in current lane configuration. So, no interventions are required.
Motorway Interchange	MCC-2 (a)	Inflow	AM	2	3,200	799	0.25	A	2	1,600	2120	1.32	F	3	4,800	2120	0.44	A	1 additional lanes are required for smooth flow of traffic
			PM	2	3,200	956	0.30	A	2	1,600	2536	1.58	F	3	4,800	2536	0.53	A	1 additional lanes are required for smooth flow of traffic
		Outflow	AM	2	3,200	799	0.25	A	2	1,600	2120	1.33	F	3	4,800	2120	0.44	A	1 additional lanes are required for smooth flow of traffic
			PM	2	3,200	732	0.23	A	2	1,600	1943	1.21	F	3	4,800	1943	0.40	A	1 additional lanes are required for smooth flow of traffic
Ghani Khan Road	MCC-2 (b)	Inflow	AM	2	3,200	696	0.22	A	2	3,200	1847	0.58	A	3	4,800	1847	0.38	A	1 additional lanes are required for smooth flow of traffic
			PM	2	3,200	776	0.24	A	2	3,200	2060	0.64	B	3	4,800	2060	0.43	A	1 additional lanes are required for smooth flow of traffic
		Outflow	AM	2	3,200	922	0.29	A	2	3,200	2446	0.76	C	3	4,800	2446	0.51	A	1 additional lanes are required for smooth flow of traffic
			PM	2	3,200	1303	0.41	A	2	3,200	3457	1.08	F	3	4,800	3457	0.72	C	1 additional lanes are required for smooth flow of traffic
Mardan Road	MCC-3	Inflow	AM	2	3,200	920	0.29	A	2	3,200	2441	0.76	C	3	4,800	2441	0.51	A	1 additional lanes are required for smooth flow of traffic
			PM	2	3,200	1092	0.34	A	2	3,200	2899	0.91	E	3	4,800	2899	0.60	A	1 additional lanes are required for smooth flow of traffic
		Outflow	AM	2	3,200	912	0.28	A	2	3,200	2419	0.76	C	3	4,800	2419	0.50	A	1 additional lanes are required for smooth flow of traffic
			PM	2	3,200	1077	0.34	A	2	3,200	2859	0.89	D	3	4,800	2859	0.60	A	1 additional lanes are required for smooth flow of traffic
Takhtbhai Road	MCC-4	Inflow	AM	2	1600	448	0.14	A	1	1,600	1189	0.74	C	2	3,200	1189	0.37	A	1 additional lanes are required for smooth flow of traffic
			PM	2	1600	470	0.15	A	1	1,600	1247	0.78	C	2	3,200	1247	0.39	A	1 additional lanes are required for smooth flow of traffic
		Outflow	AM	2	1600	335	0.10	A	1	1,600	889	0.56	A	2	3,200	889	0.28	A	1 additional lanes are required for smooth flow of traffic
			PM	2	1600	379	0.12	A	1	1,600	1006	0.63	A	2	3,200	1006	0.31	A	1 additional lanes are required for smooth flow of traffic
Tangi Road	MCC-5	Inflow	AM	2	1600	826	0.26	A	1	1,600	2190	1.37	**A**	2	3,200	2190	0.68	B	1 additional lanes are required for smooth flow of traffic
			PM	2	1600	656	0.20	A	1	1,600	1739	1.09	**A**	2	3,200	1739	0.54	A	1 additional lanes are required for smooth flow of traffic
		Outflow	AM	2	1600	614	0.19	A	1	1,600	1629	1.02	**A**	2	3,200	1629	0.51	A	1 additional lanes are required for smooth flow of traffic
			PM	2	1600	491	0.15	A	1	1,600	1302	0.81	A	2	3,200	1302	0.41	A	1 additional lanes are required for smooth flow of traffic

Source: Developed by Consultant

The expected peak hour traffic volume on Mardan Road and Ghani Khan Road for horizon year 2042 is 2899 and 3457 PCU/hr respectively. Additional lanes for Mardan Road & Ghani Khan Road are proposed to improve capacity to 4800 PCU/hr. Other than that, the LOS results for future demand for most of the roads are satisfactory. However, these results are only applicable to a certain road section as they depict the vehicles entering or exiting the study area. The traffic situation within the city can be better depicted by the junction connected by these primary corridors. The Farooq-e-Azam Chowk and Utmanzai Chowk analysis for future scenario will be addressed later in the report. The LOS calculations in previous table were computed by estimating the traffic with growth rate derived from the Vehicle Registration trend. However, to promote public transportation and active travel, private mode share shall be reduced. For this purpose, new growth rates for private and public modes have been computed in the following section.

13.3.2. Mode Choice

Mode choice represents the travel mode people commonly use to travel to their desired location. The common travel modes to fulfil daily travel needs include car, bike, public transport, and walk. To determine the mode choice, various factors which influence the choice of travel mode are considered. These factors include socio-economic characteristics of trip makers, characteristics of the trip, characteristics of the transportation system. There are various modal split models to determine mode choice, but for this study Utility Function modal is used to compute modal split for horizon year of 2042 for Charsadda study area.

The utility function measures the degree of satisfaction that people derive from their travel choices. The magnitude of utility depends on the characteristics of alternative mode choices, transportation network, and the decision of individual trip maker. A typical Utility function is expressed as the linear weighted sum of the independent variables as shown in equation below.

$$\mathbf{U} = \mathbf{a_0} + \mathbf{a_1 X_1} + \mathbf{a_2 X_2} + \cdots + \mathbf{a_r X_r}$$

where, “U” is the utility derived from a choice defined by the magnitudes of the attributes “X” in the choice weighted by the model parameters “a”.

For the modal split Utility function, two travel modes are considered for analysis i.e., public mode and private mode. The model choice parameters which influence the decision are listed in the table below for both modes. These parameters are further broken down and assessed for their utility for both modes for base year as per the results derived from Household Interview questionnaire survey (HIS) and Public Transport User Interview survey. Afterwards, considering the overall transportation proposals, the magnitude for these attributes is assumed as per engineering judgement for the assessment of horizon year of 2042.

Table 52: Mode Choice Parameters and Influencing variables for Utility Function

Mode Choice Parameters	Influencing variables	
	Public Mode	**Private Mode**
1. Travel time & distance	1. Operating hours 2. Headway 3. Punctuality 4. Accessibility 5. Convenience of Transfer 6. Operational routes & Infrastructure	1. Traffic Congestion 2. Roadside Encroachments 3. Parking availability 4. Road network & Infrastructure
2. Travel Cost	1. Travel fare	1. Fuel costs 2. Vehicle maintenance costs 3. Vehicle fitness costs 4. Parking fee
3. Safety	1. On-board security 2. Waiting condition 3. Traffic safety	1. Accidents or injuries 2. Traffic safety 3. Driving behavior 4. Traffic rules enforcement
4. Convenience	1. Convenience of transfer 2. On-board comfort 3. Waiting condition 4. Bus stop facilities	1. Traffic mobility 2. Vehicle condition 3. Flexibility of time

Source: Developed by Consultant

The Utility function-based mode choice analysis based on selected parameters and their influencing variables is illustrated in tabular form below.

Table 53: Utility Function for Modal Split Analysis of Public and Private modes

Assumed Magnitudes to access utility of Public & Private Travel Modes							Weightages by Mode (%)						Influencing Variables								*****Assumption Range
Mode Choice Parameters	Public Mode			Private Mode			Public Mode			Private Mode			Public Mode	**Existing Situation	***After Implementing Short-term strategies	****After Implementing Long-term Strategies	Private Mode	**Existing Situation	***After Implementing Short-term strategies	****After Implementing Long-term Strategies	
	Existing Situation	After Implementing Short-termstrategies	After Implementing Long-term Strategies	Existing Situation	After Implementing Short-termstrategies	After Implementing Long-term Strategies	Existing Situation	After Implementing Short-termstrategies	After Implementing Long-term Strategies	Existing Situation	After Implementing Short-termstrategies	After Implementing Long-term Strategies									
Column No.	a	b	c	d	e	f	g	h	i	j	k	l		m	n	o		p	q	r	s
Formulas	magnitude based on range mentioned in column 's'						*Average (m)	Average (n)	Average (o)	Average (p)	Average (q)	Average (r)									
Travel Time & Distance	5	7	8	3	5	8	58.33	79.17	93.33	61.3	23.3	11.7	operating hours headway punctuality accessibility 1. convenience of transfer Operational routes & infrastructure	1. 47% (Satisfactory) 66% (Normal) 52% (Occasionally 68% (Walking Distance) 67% (Average) 50% (3/6 Routes: No dedicated infrastructure)	1. 70% (Fixed Stops) 80% (Increased vehicles) 70% (Fixed Stops) 80% (New Proposed Stops) 85% (Redefining the role of Paratransit & Fixed Stops) 90% (New Routes & Dedicated Bus Routes)	1. 90% (Fixed Stops, New Buses, Increased Attraction) 95% (Increased vehicles, New Buses) 90% (Fixed Stops, New Buses, Increased Attraction) 95% (Regulated stops) 95% (Integrating & Subsidizing Fares) 95% (Increased Attraction & Ridership)	1. Traffic Congestion 2. Roadside encroachments 3. parking availability 4. Road network & Infrastructure	1. 37% (Same congestion as 5 years ago) 2. 80% (Encroached Roads: Primary Survey) 3. 66.8% (No Parking Availability)	1. 20% (Reduced attraction towards private modes due to high maintenance cost, signalized junctions, reduced encroachments, lane markings, traffic bylaws enforcement) 2. 30% (reduced encroachments, strict bylaws enforcements) 3. 20% (Repulsive travel mode due to high ownership and maintenance costs)	1. 10% (Reduced attraction towards private modes due to high maintenance cost, signalized junctions, reduced encroachments, lane markings, traffic bylaws enforcement) 2. 15% (reduced encroachments, strict bylaws enforcements) 3. 10% (Repulsive travel mode due to high ownership and maintenance costs)	
Travel Cost	2	5	7	8	4	2	67	70	90	80	90	95	1. Travel fare	1. 67% (Reasonable)	1. 70% (High vehicle ownership costs, Increase attraction towards Public Transportation)	1. 90% (Integrated & Subsidized Fares)	1. fuel costs, vehicle maintenance costs, vehicle fitness costs, parking fee	1. 80% (Assumption: High fuel costs and vehicle maintenance costs)	1. 90% (High fuel costs and vehicle maintenance costs, vehicle fitness costs)	1. 95% (High fuel costs and vehicle maintenance costs, vehicle fitness costs, parking fee)	
Safety	5	7	8	3	5	5	48.33	63.33	90.00	50	49.17	48.33	1. on-board security 2. waiting condition 3. Traffic Safety	1. 63% (Average) 2. 36% (Satisfactory) 3. 46% (Normal)	1. 70% (Regulation of Public Transportation Services) 2. 60% (Maintenance and Regulation of Schedule & Designated Bus Stops) 3. 60% (Regulated and Well-maintained Services)	1. 90% (New Buses, Increased capacity, Regulation of Public Transportation Services) 2. 90% (Maintenance and Regulation of Schedule & Designated Bus Stops) 3. 90% (Dedicated Bus Lane marking for smooth and safe travel experience)	1. Accidents or injuries 2. Traffic Safety for motorcycles 3. Traffic Safety for cars 4. Driving Behavior for motorcycles 5. Driving Behavior for cars 6. Traffic rules enforcement	1. 85% (No Traffic Accidents) 2. 60% (Normal for motorcycles) 3. 49% (Safe for Cars) 4. 43% (Bad for motorcycles) 5. 46% (Bad for Cars) 6. 17% (Lack of Traffic enforcement)	1. 90% (No Traffic Accidents) 2. 80% (Less private motorcycles, strict bylaws enforcements, so less accidents) 3. 80% (Less private motorcycles, strict bylaws enforcements, so less accidents) 4. 20% (less motorcycles, narrow lanes, strict bylaws enforcements) 5. 15% (less Cars, narrow lanes, strict bylaws enforcements) 6. 10% (Improvement in Traffic enforcement)	1. 90% (Less Traffic Accidents) 2. 90% (Less private motorcycles, strict bylaws enforcements, so less accidents) 3. 90% (Less private motorcycles, strict bylaws enforcements, so less accidents) 4. 10% (less motorcycles, narrow lanes, strict bylaws enforcements) 5. 5% (less Cars, narrow lanes, strict bylaws enforcements) 6. 5% (Improvement in Traffic enforcement)	1 = Lowest value 5 = Middle value 10 = Highest value
Convenience	5	7	8	8	7	7	61.75	67.50	88.75	54	76.67	90	1. Convenience of transfer 2. on-board comfort 3. waiting condition	1. 67% (Average) 2. 67% (Average) 3. 36% (Satisfactory)	1. 75% (Redefining the Role of Para-transit)	1. 90% (Redefining the Role of Para-transit) 2. 90% (New Buses,	1. Traffic Convenience or mobility 2. Vehicle Condition 3. Flexibility	1. 54% (Same convenience as 5 years ago)	1. 70% (Increased Mobility & Accessibility) 2. 80% (Certified Vehicles) 3. 80% (Flexibility to use private modes for travel purposes)	90% (Increased Mobility & Accessibility) 90% (Certified Vehicles)	

Assumed Magnitudes to access utility of Public & Private Travel Modes							Weightages by Mode (%)						Influencing Variables								*****Assumption Range
Mode Choice Parameters	Public Mode			Private Mode			Public Mode			Private Mode			Public Mode	**Existing Situation	***After Implementing Short-term strategies	****After Implementing Long-term Strategies	Private Mode	**Existing Situation	***After Implementing Short-term strategies	****After Implementing Long-term Strategies	
	Existing Situation	After Implementing Short-termstrategies	After Implementing Long-term Strategies	Existing Situation	After Implementing Short-termstrategies	After Implementing Long-term Strategies	Existing Situation	After Implementing Short-termstrategies	After Implementing Long-term Strategies	Existing Situation	After Implementing Short-termstrategies	After Implementing Long-term Strategies									
Column No.	a	b	c	d	e	f	g	h	i	j	k	l		m	n	o		p	q	r	s
Formulas	magnitude based on range mentioned in column 's'						*Average (m)	Average (n)	Average (o)	Average (p)	Average (q)	Average (r)									
													4. bus stop facilities	4. 38% (Satisfactory)	2. 75% (Increased Wagons/Hiace, New Routes) 3. 60% (Maintenance and Regulation of Schedule & Designated Bus Stops) 4. 60% (Regulated and Well-maintained Services)	Increased Vehicles) 3. 85% (Maintenance and Regulation of Schedule & Designated Bus Stops) 4. 85% (Regulated and Well-maintained Services)				90% (Flexibility to use private modes for travel purposes)	
Utility	9.76	18.20	28.07	14.06	12.59	11.55															
Fomula	a*g/100	b*h/100	c*i/100	d*j/100	e*k/100	f*l/100															
Preffered Mode		Public Mode	Public Mode	Private Mode																	
% difference between modes	30.57	30.82	58.85	-	-	-															
% decrease in Private mode	-	-	-	-	-10.43	-8.27															
% increase in Public mode	-	86.46	54.21	-	-	-															

Source: Developed by Consultant

**For existing situation, average of highest rated parameters for survey results are taken to portray the weightage of existing situation*
***Existing situation of influencing variables for both public & private mode is based on results from HIS & Public transport User Interview survey*
****Weightages are assigned based on short term improvements strategies against each influencing variable (detail explanation & proposals are provided section-wise)*
*****Weightages are assigned based on long term strategies against each influencing variable (detail explanation & proposals are provided section-wise)*
******Magnitude values are assumed based on engineering and planning judgement whilst considering city specific context and people perception*

The results extracted from modal split analysis portrays that that private mode is more preferred for base year of Charsadda study area. However, due to proposed interventions based on short-term and long-term strategies (explained in following sections), public transport mode is more attractive than private mode. This prediction is based on the improvement in public transport services and its increased ridership attraction. Results from this mode shift are utilized to decide the required ROW to cater future traffic of 2042 and propose cross-sections for each primary road. The modal shift analysis shows that for the horizon year 2022, the difference in utility of private and public mode is 30.57%. However, after the implementation of short-term strategies, this difference slightly increases to 30.82% and highly increases to 58.85% after implementation of long-term strategies. Similarly, the increase in public mode is predicted as 86.46% and 54.21% after the implementation of short-term and long-term strategies respectively. Conversely, the decrease in private mode is predicted as 10.43% and 8.27% after the implementation of short-term and long-term strategies respectively.

These percentage increase and decrease values are utilized in determining the future traffic volume and propose road cross-sections. For this purpose, the Peak Hour Volumes (PHV) for base year 2022 obtained through Turning Movement Count Survey of Farooq-e-Azam Chowk which connects Parang Road, Nowshera Road, Mardan Road, Tangi Road, and Charsadda Road are shown in table below for each road. The traffic volume is represented in three categories namely public, private, and freight vehicles. These are added to find the total vehicular volume.

Table 54: Traffic Volumes for Base year 2022

Road Name	Public Vehicles PHV	Private Vehicles PHV	Freight Vehicles PHV	Peak Hour Vehicular Volume
Parang Road	47	793	13	852
Nowshera Road	138	1418	109	1665
Mardan Road	105	1701	23	1828
Tangi Road	74	1442	14	1530
Charsadda Road	40	1126	31	1197
Ghani Khan Road	138	302	146	586

Source: Developed by Consultant

Similarly, the percentage increase and decrease of public mode and private mode respectively is used to predict the traffic volumes for intermediate year (2027) and horizon year (2042) as shown in tables below.

Table 55: Predicted Traffic Volume (based on Mode Choice) for Intermediate year 2027.

Road Name	Public Vehicles PHV	Private Vehicles PHV	Freight Vehicles PHV	Peak Hour Vehicular Volume
Parang Road	87	710	14	811
Nowshera Road	258	1270	117	1645
Mardan Road	195	1524	24	1743
Tangi Road	138	1291	15	1444
Charsadda Road	74	1009	33	1116
Ghani Khan Road	257	270	157	

Source: Developed by Consultant

Table 56: Predicted Traffic Volume for Horizon year 2042 (based on Mode Choice)

Road Name	Public Vehicles PHV	Private Vehicles PHV	Freight Vehicles PHV	Peak Hour Vehicular Volume
Parang Road	134	651	17	803
Nowshera Road	398	1165	146	1709
Mardan Road	301	1398	31	1729
Tangi Road	213	1185	19	1416
Charsadda Road	114	925	41	1080
Ghani Khan Road	397	248	197	842

Source: Developed by Consultant

The predicted traffic volumes of horizon year 2042 are converted into PCUs for LOS analysis. Due to various road network, junction, and parking management proposals, lane capacity is assumed as 1800 PCU/hr. The Ideal Lane capacity for multilane highways is 2300 PCU/hr and depends on various factors such as

(a) 12 ft (3.65 m) lane widths.
(b) 6 ft (1.82 m) clearance between the edge of the travel lanes and the nearest obstructions or objects at the roadside or in the central reservation.
(c) 70 mile/h (112 km/h) design speed for freeways and multilane roads and 60 mile/h (96 km/h) for two-lane roads.
(d) level terrain, and
(e) all passenger cars in the traffic stream.

Due to non-compliance of most of the aforementioned factors, the lane capacity used for LOS calculations is considered as 1800 PCU/hr as shown in table below.

Table 57: Predicted Traffic Volume (PCU) for Horizon year 2042 (based on Mode Choice) & LOS Calculation

Road Name	Public Vehicles PHV	Private Vehicles PHV	Freight Vehicles PHV	Peak Hour Vehicular Volume	Existing ROW	Proposed ROW	*Proposed Lanes (one-directional)	*Ideal Lane Capacity (PCU/hr/ln)	V/C	LOS
Parang Road	403	651	52	1106	30	30	1	1800	0.61	B
Nowshera Road	1194	1165	438	2798	60	60	2	1800	0.78	C
Mardan Road	902	1398	92	2391	80	80	2	1800	0.66	B
Tangi Road	638	1185	56	1878	60	60	2	1800	0.52	A
Charsadda Road	341	925	123	1390	60	60	2	1800	0.39	A
Ghani Khan Road	1190	248	590	2028	80	80	2	1800	0.56	A

Source: Developed by Consultant

**Service lane is not included for LOS analysis because it caters less capacity than carriageway lanes but it can improve mobility for carriageway lanes by increasing accessibility for traffic attracted towards abutting land use*

**Lane capacity is taken as 1800 PCU/hr due to lane width of 10 feet. This is reduced from Ideal Lane capacity for Multilane highways which is 2300 PCU/hr (Source: Highway Capacity Manual, 2000)*

The proposed lanes on all roads based on modal shift from private mode to public mode in horizon year 2042 aligns with the proposed cross sections of roads provided in Road Network Improvement section. Therefore, the proposals of road network improvements and proposed road geometry cross-sections are justified.

13.3.3. Proposed Geometry Improvements of Roads

For better traffic management within the city, the geometry of primary and secondary roads shall be improved to develop an integrated transportation network. As per **Institute of Transportation Engineers (ITE) Planning Handbook** guidelines, the urban roadways systems should be planned such that individual roads serve multimodal transportation. This multimodal network of primary and secondary roads shall cater private cars, motorbikes, transit vehicle, trucks, and pedestrians. For this purpose, the roadway network shall complement the surrounding land-use patterns and serve traffic volumes safely, and efficiently.

The improved geometry of primary and secondary roads is discussed below to cater the future traffic demand.

Primary Roads

In Charsadda, the primary roads such as Tangi Road, Mardan Road, Nowshera Road, and Charsadda Road are major corridors carrying traffic volume within the Charsadda city and also from incoming commuter traffic of nearby cities such as Mardan, Peshawar, and Nowshera. The traffic volume within the city is attracted to major Commercial markets, Bazaars, Industries, Plazas, Retail shops, Education Institutes, Restaurants, Public buildings, administrative buildings, and Government offices. These major developments predominantly exist along these primary roads which causes traffic congestion problems as no service lanes exist for accessing these land uses without interrupting through-moving traffic. This results in illegal parking, mobile encroachments, reduced ROW for through-moving traffic and traffic conflicts also arise at the unsignalized intersection with secondary roads or tertiary roads. Similarly, no footpaths exist for accessing the abutting land use for pedestrians. If no suitable interventions are proposed to ensure multimodal transportation, then increased no. of vehicles will worsen the traffic congestion, travel time, and traffic accidents on these primary roads for the horizon year of 2042. For better traffic and access management on these major corridors, the following interventions are proposed with two different scenarios.

Scenario 1: Short-term Strategy

- Short term strategy for improving the capacity of roads along major commercial activity centre, is to remove all kind of mobile and permanent encroachments to restore the designed capacity of road. This includes encroachments by shop owners, hawkers, and vendors which should be restricted at least 400 meters away from commercial area.
- Footpaths shall be provided near the building line on both sides for easy pedestrian access to adjacent land use along the road. As per KPK Urban Policy, footpaths shall be provided on all primary and secondary roads.
- Another strategy should be to incorporate a dedicated bus & bike lane to promote public transportation in Charsadda City.
- Lanes should be marked throughout the running length of the road to avoid weaving conflicts among drivers. These roads are Nowshera Road, Charsadda-Peshawar Road, Tangi Road, Parang Road, and all secondary roads. For marking, lane width should be considered as 10 feet to reduce operational speed and instilling cautiousness in drivers' perception.
- Hard Shoulder shall be provided for temporary or emergency parking.
- Strict traffic bylaws and parking policy enforcement measures can help improve safety and reduce congestion on primary roads. This can include increased police patrols, smart cameras.

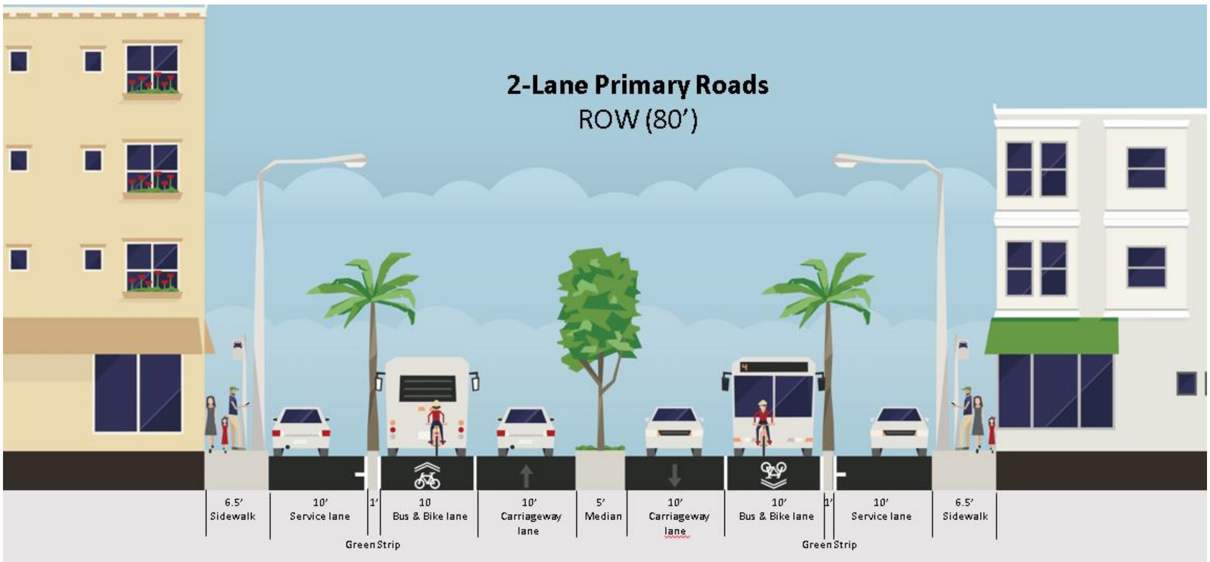
- The carriageway shall be separated by central median of minimum 1 foot and shall be extended where linked with unsignalized secondary roads and force traffic to take the specified U-turn for travelling on opposite lane.

Scenario 2: Long-term Strategy

- For medium or long-term strategy, dedicated one-way service lanes separated by kerb stone from carriageway lanes shall be provided on both sides of Primary roads with adequate ROW such as Mardan Road and Ghani Khan Road. These roads shall serve as frontage roads with low-speed traffic volume for accessing the adjacent land use.
- Other than off-street parking, temporary parallel parking may be allowed on these service lanes for nearby commercial and business activities. However, parking fee must be charged to discourage parking on service lanes. On-street parking should be completely avoided during peak hours.
- For minor secondary roads directly linking with primary roads, a T-intersection shall be provided by extending the kerb stone of service lane and forcing a turn for better access management towards the primary road. A speed table shall also be provided at the ends of minor secondary roads to safely access the service lane.

The tentative cross section for Mardan Road for long term improvements are shown below:

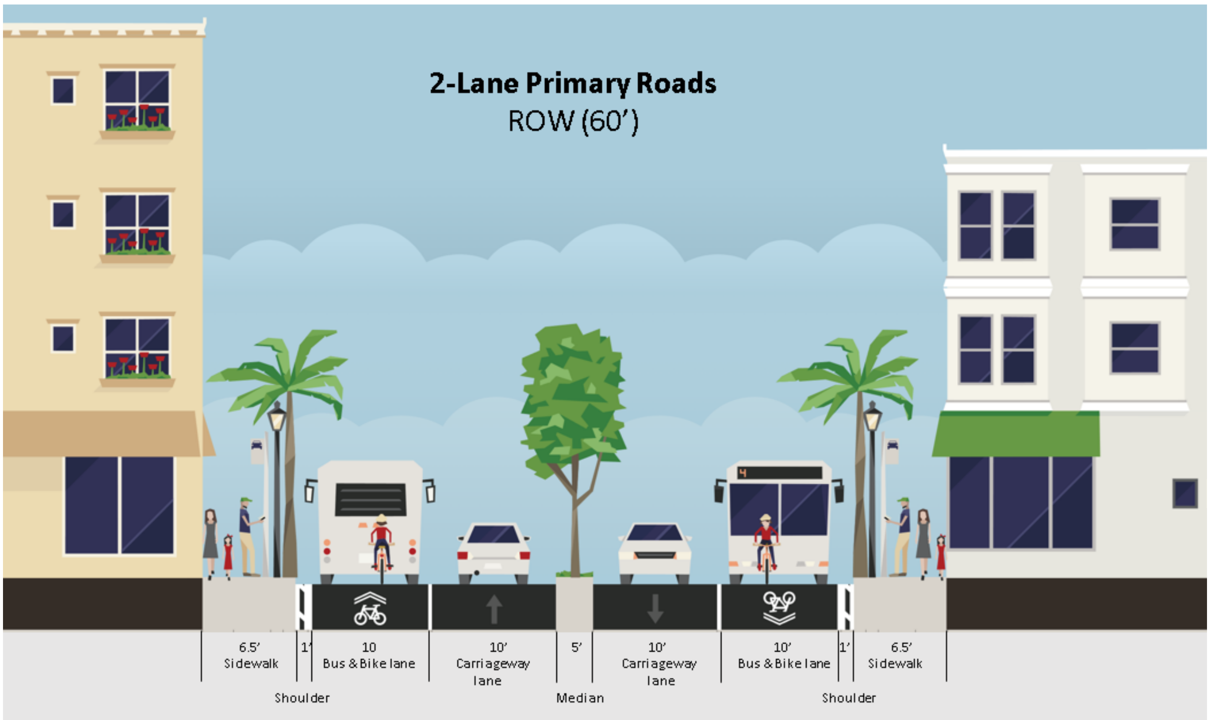
Figure 22: Cross-Section of 2-Lane Primary Roads (80' ROW)



Source: Developed by Consultant

The tentative cross section for Tangi Road, Nowshera Road, Takhtabai Road and Charsadda-Peshawar Road for long term improvements are shown below:

Figure 23: Cross-Section of 2-Lane Primary Roads (60' ROW)



Source: Developed by Consultant

The tentative cross section for Parang Road for long term improvements are shown below:

Figure 24: Cross-Section of Singe-Lane Primary Roads (Minimum 30' ROW)

Source: Developed by Consultant

Improving mobility is a critical goal for many communities as it is essential to create a more efficient and sustainable transportation system. To achieve this goal two scenarios were suggested. The short-term strategy presented in Scenario-1 can help improve transportation efficiency and reduce congestion on primary roads. For instance, improving pedestrian safety can reduce the number of accidents involving vulnerable road users. This can be achieved by installing dedicated pedestrian crossings, improving street lighting, and enforcing speed reduction in urban areas. Promoting and developing a public transportation network and providing footpaths along primary roads can also improve safety for pedestrians, as it encourages more people to walk and reduces the number of vehicles on the road. However, if traffic congestion and safety issues are still not addressed, then long term strategies must be employed to cater to the needs of the growing population and increasing traffic in Charsadda City. Therefore, the long-term strategy presented in Scenario-2 can provide additional measures to improve the primary roads' capacity, safety, and sustainability. The long-term strategy focuses addition of extra lanes, investment in active transportation infrastructure, and provision of dedicated one-way service lanes separated by curb stone from carriageway lanes can significantly improve traffic flow and reduce congestion. Scenario-2 also suggests temporary parallel parking along service lane to access abutting land use without hindering mobility on through-moving carriageway lanes. However, parking fees must be charged to discourage the use of private vehicles and promote public transportation & active mode to improve traffic situation & ensure mobility.

In conclusion, while the short-term strategy presented in Scenario-1 can provide immediate improvements in transportation efficiency, the long-term strategy in Scenario-2 is more comprehensive and can better address the future needs of the growing population and increasing traffic in Charsadda City.

Secondary Roads

The secondary roads joining primary roads at intersections shall be improved to effectively manage the traffic flow at the primary road. These roads shall also serve multimodal transportation and be equipped with footpaths. In this way, the active and motorized traffic from secondary roads shall be diverted towards service lanes to access adjacent land uses without interrupting the traffic moving at the primary roads.

Some of the secondary roads in Charsadda study area are listed below and also highlighted in the traffic mobility section.

- Rajjar Bypass Road
- Abdullahabad Deputy Kili Road
- Parang Road
- Chitral Korona Road
- Other un-named Roads

The following interventions are proposed for the secondary roads.

- Footpaths shall be provided near the building line on both sides for easy pedestrian access to adjacent land use along the road.
- Lanes should be marked throughout the running length of the road to avoid weaving conflicts among drivers. For marking, lane width should be considered as 12 feet.
- Clear and visible signage and road markings can improve driver awareness and reduce the risk of accidents.
- On-street parking must be avoided on secondary road for improving overall mobility
- Regular maintenance of secondary roads, such as patching potholes, repairing cracks, and fixing drainage issues, can improve road conditions and reduce accidents.
- Implementing speed limits and traffic calming measures, such as speed humps can reduce vehicle speeds and improve safety.
- Increased police patrols and enforcement of traffic laws can reduce speeding and reckless driving, improving safety on secondary roads.
- Collaborating with local stakeholders, such as community groups and businesses, can help identify and address specific safety concerns on secondary roads.

Figure 25: Cross-Section of Secondary Roads

Source: Developed by Consultant

Table 58: Summary of Improved Roads

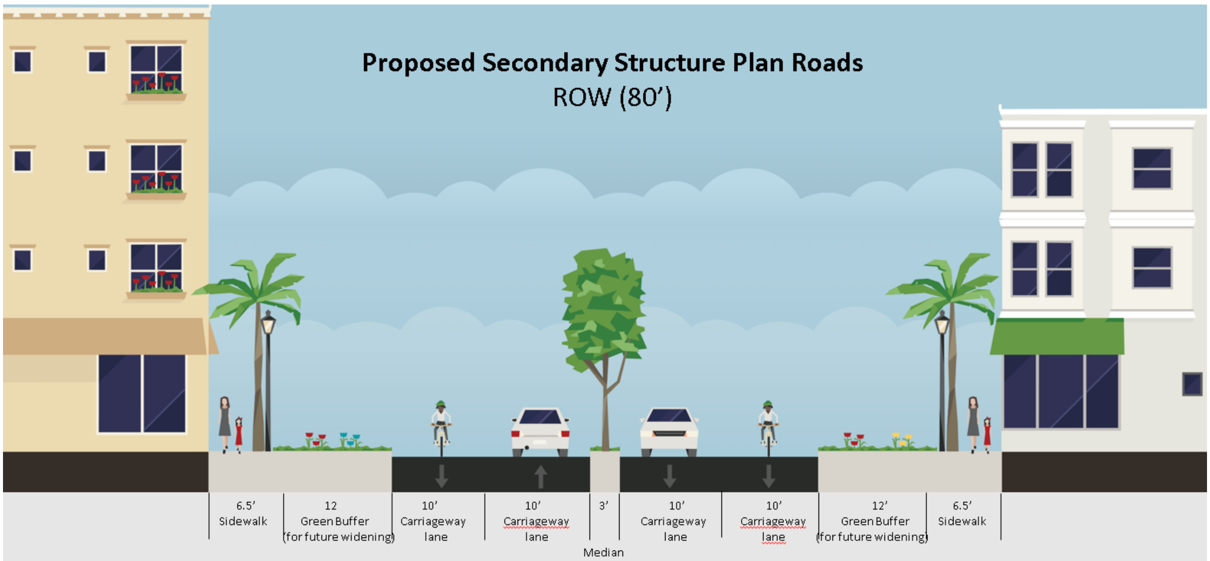
Road Category	Road Name	Existing ROW (feet)	Proposed ROW (feet)	Existing No. of Lanes	Proposed No. of Lanes	Proposed Interventions
Primary Roads	Charsadda-Peshawar Road	60	60	2	2	• Dedicated Bus & Bike Lane. • Service lane & Footpaths on both sides • Lane markings • Extended median with dedicated U-turns • Regulate & remove encroachments. • Introduce temporary paid parking. • Traffic calming strategy for tertiary roads.
	Tangi Road	60	60	2	2	
	Nowshera Road	60	60	2	2	
	Mardan Road	80	80	2	2	
	Ghani Khan Road	80	80	2	2	
	Takhtabai Road	60	60	2	2	
Secondary Roads	Rajjar Bypass Road	30	30	1	1	• Provision of Footpaths • lane markings • Avoid on-street parking
	Parang Road	30	30	1	1	
	Chitral Korona Road	30	30	1	1	
	Abdullahabad Deputy Kili Road-Sadatabad Kandrai Road	30	30	1	1	
	Other Un-named Roads	30	30	1	1	

Source: Developed by Consultant

13.3.4. Newly Proposed Roads

After Land Suitability Analysis (LSA), vacant areas within the Neighborhood Councils (NCs) are proposed as an infill residential zone and others are considered as residential zone 1. Roads are proposed as primary and secondary roads which will carry traffic towards the primary roads such as Mardan Road, Nowshera Road, Charsadda-Peshawar Road, Tangi Road, and Ghani Khan Road. Moreover, to establish connectivity with civic & trade zones, mixed-use zone, education & health zones with proposed infill residential areas, several unpaved roads have been identified to serve as a link between these land uses. The ROW and carriageway lanes of these roads are proposed after calculating trip production by residential zones using standard ITE Trip Generation Rates. The detailed calculation and proposed roads with their cross sections & geometry is shown in table below.

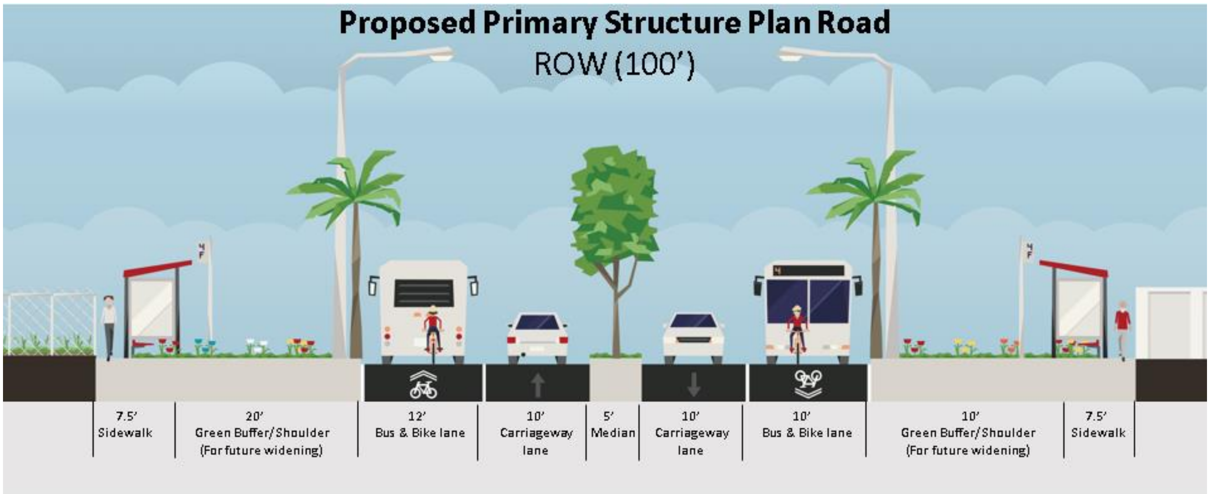
Figure 26: Proposed Roads with 80ft ROW



Source: Developed by Consultant

The ROW of proposed Roads have an adequate shoulder width for future widening, if required, as shown in figure below.

Figure 27: Proposed Structure Plan Road with 100ft ROW



Source: Developed by Consultant

In the following table, the trip generation step was used as per **Institute of Transportation Engineers (ITE) Trip Generation Manual 9th Edition.** The input data required to estimate trips from each residential zone is the total residential units proposed in the respective zone. After estimating the directional volume produced from each zone, the volume is used to propose the lanes and ROW of secondary and primary roads provided to complete the network and cater the traffic generated from these proposed land uses. These calculations are explained in tabular form attached herewith.

Table 59: Trip Generation Calculation for Proposed Residential Zones

Code	LU	Type	Day	Directional Distribution	Average Trip Rate per Day	Total Plots		Trips Produced per PM Peak Hour		Total Trips		Zone 1				(Infill Development)				Zone 1		(Infill Development)	
												Trip Volume by Mode per PM Peak Hour			PCU	Trip Volume by Mode per PM Peak Hour			PCU	Inflow Volume	Outflow Volume	Inflow Volume	Outflow Volume
												Personal Vehicles		Public Transport Vehicles		Personal Vehicles		Public Transport Vehicles					
						Zone 1	Infill	Zone 1	Infill	Zone 1	Infill	Motorcycles	Cars	Bus/ MiniBus		Motorcycles	Cars	Bus/ MiniBus					
a						b	d	e	g	h	j	k	l	m	n	s	t	u	v	w		y	
1	2	3	4	5	6			b*a6	d*a6	sum(e)	sum(g)	share*h				share*j				n*0.5		v*0.5	
210	Single HH unit	Avg Vehicle Trip Ends vs Dwelling Units	Weekday, PM Peak Hour	50% entering, 50% Exiting	1.02	5146	5913	5,249	6,031	8,697	9,993	8,241	302	153	4,883	9,469	348	176	5,611	2,442	2,442	2,806	2,806
220	Apartments	Avg Vehicle Trip Ends vs Dwelling Units	Weekday, PM Peak Hour	50% entering, 50% Exiting	0.67	5146	5913	3,448	3,962														

Source: Developed by Consultant

**Taken from Institute of Transportation Engineers (ITE) Trip Generation Manual 9th Edition*

Table 60: Vehicle Registration Table used to determine growth rate of vehicles in the Residential Areas

Year	Total	Motor Cycle & Scooter	Motor Cars, Jeeps & Taxi	Tractors	Buses/ Mini Buses	Motor Cabs Rickshaws	Delivery Vans/ Pick-up	Public Carrier (Trucks)	Other Vehicles
	Growth Rate	25%	1%	2%	1%	7%	3%	1%	0.40%
2023	31,640	23,867	876	765	127	4,293	235	84	1,392

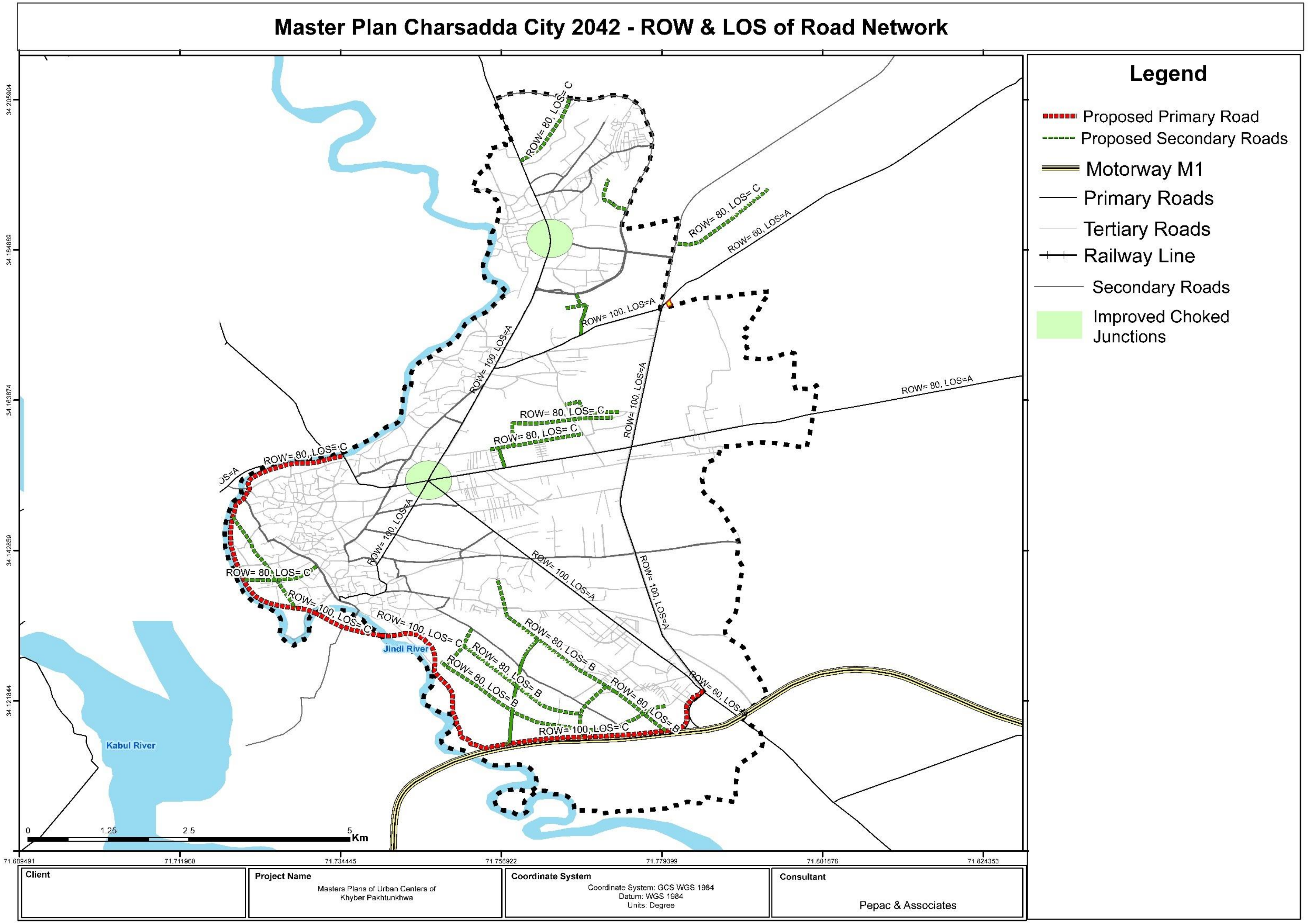
Source: Developed by Consultant

Table 61: Growth rate of vehicles used for Trip Generation for Residential Areas

Year	Growth Rate after Mode Choice		Registered Vehicles (2023)			Growth Rate from Vehicle Registratrion			Vehicular Volume (2042) Computed from Mode Choice Growth Rate			Mode Share (2042) Computed from Mode Choice Growth Rate		
	% increase in Public mode	% decrease in Private mode	Bus/Minibus	Cars	Motorcycles	Bus/Minibus	Cars	Motorcycles	Bus/Minibus	Cars	Motorcycles	Bus/Minibus	Cars	Motorcycles
2027	86.46	10.43	127	876	23,867	1%	1%	25%	365	720	19609	1.8	3.5	94.8
2042	54.21	8.27												

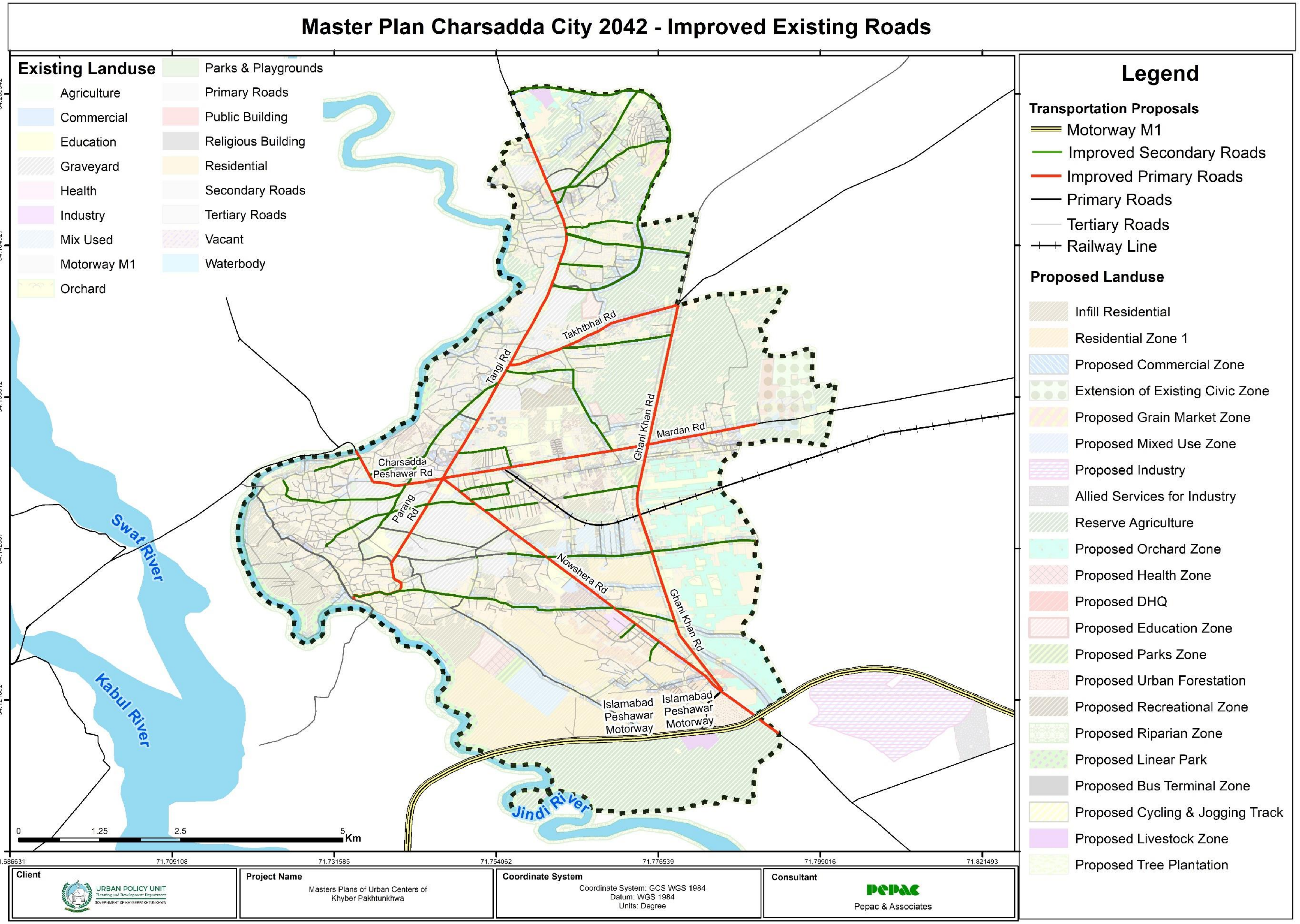
Source: Developed by Consultant

Map 28: ROW & LOS Map for Road Network Charsadda



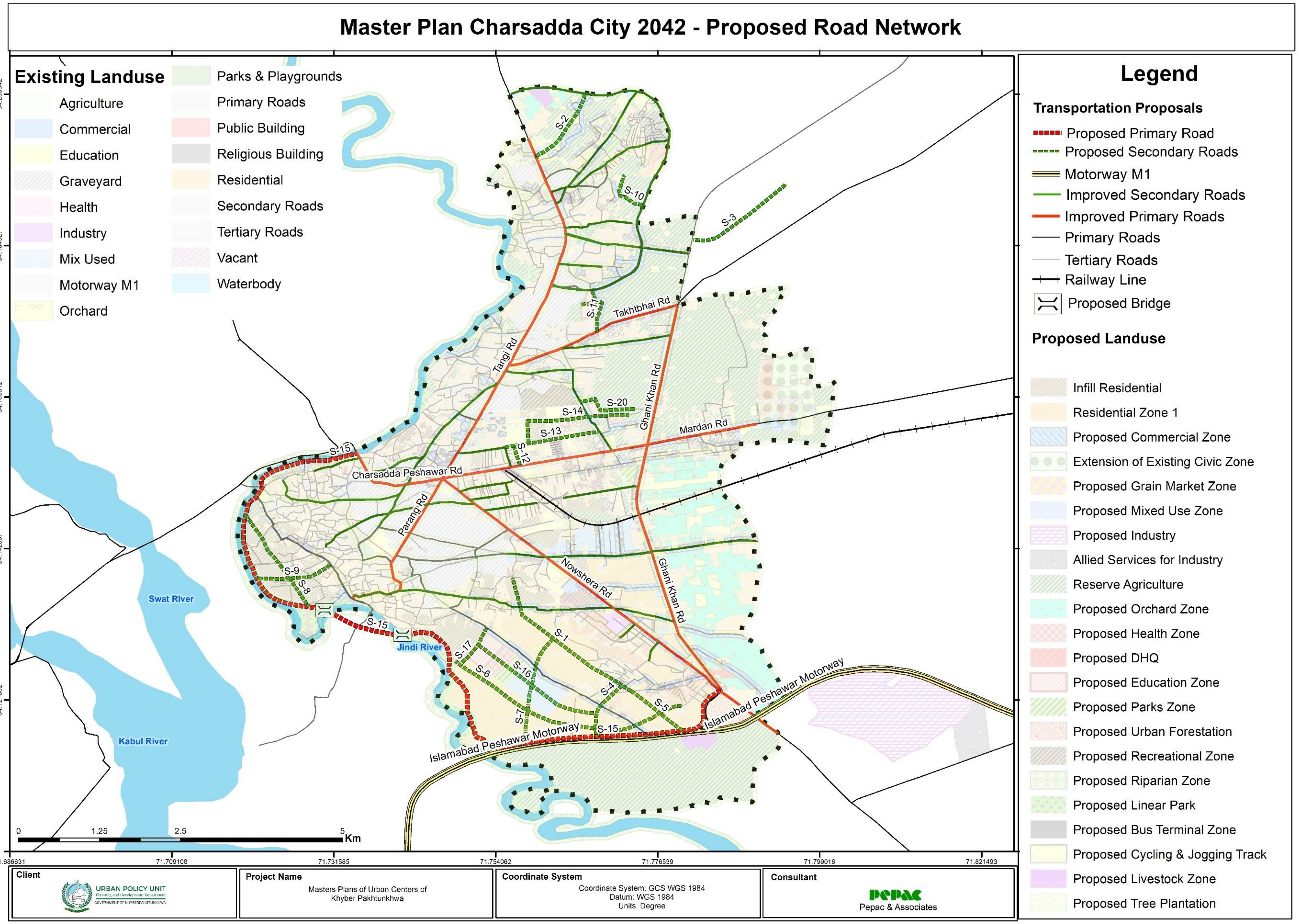
Source: Developed by Consultant

Map 29: Improved Road Network Charsadda



Source: Developed by Consultant

Map 2: Proposed Road Network Charsadda



Source: Developed by Consultant

Table 62: Proposed Roads in Charsadda

Name	Length (Km)	Expected Traffic from Residential Zones	Inflow Volume (PCU)	Outflow Volume (PCU)	Existing ROW	Proposed ROW (ft)	Proposed Lanes (Single Approach)	Saturation Ratio V/C	LOS	Existing Surface Type
S-1	2.42	Zone 1	2,442	2,442	0	80	2	0.68	B	Existing Barren Land
S-2	1.21	Infill	2,806	2,806	0	80	2	0.78	C	Existing Barren Land
S-3	1.52	Infill	2,806	2,806	0	80	2	0.78	C	Existing Barren Land
S-4	0.91	Zone 1	2,442	2,442	0	80	2	0.68	B	Existing Barren Land
S-5	0.89	Zone 1	2,442	2,442	0	80	2	0.68	B	Existing Barren Land
S-6	3.33	Zone 1	2,442	2,442	0	80	2	0.68	B	Existing Barren Land
S-7	1.73	Zone 1	2,442	2,442	0	80	2	0.68	B	Existing Barren Land
S-8	1.64	Infill	2,806	2,806	10'	80	2	0.78	C	Existing Unpaved Road + Existing Barren Land
S-9	1.02	Infill	2,806	2,806	10'	80	2	0.78	C	Existing Unpaved Road + Existing Barren Land
S-10	0.66	Infill	2,806	2,806	10'	80	2	0.78	C	Existing Unpaved Road + Existing Barren Land
S-11	0.48	Infill	2,806	2,806	10'	80	2	0.78	C	Existing Unpaved Road + Existing Barren Land
S-12	0.31	Infill	2,806	2,806	10'	80	2	0.78	C	Existing Unpaved Road + Existing Barren Land
S-13	1.23	Infill	2,806	2,806	15'	80	2	0.78	C	Existing Unpaved Road + Existing Barren Land
S-14	1.65	Infill	2,806	2,806	0	80	2	0.78	C	Existing Barren Land
S-15	11.12	Zone 1 + Infill	2,624	2,624	10'	100	2	0.73	C	Existing Unpaved Road + Barren Land
S-16	1.89	Zone 1	2,442	2,442	10'	80	2	0.68	B	Existing Barren Land
S-17	0.67	Zone 1	2,442	2,442	0	80	2	0.68	B	Existing Barren Land
S-18	0.28	Infill	2,806	2,806	0	80	2	0.78	C	Existing Barren Land
S-19	0.19	Infill	2,806	2,806	0	80	2	0.78	C	Existing Barren Land
S-20	0.83	Infill	2,806	2,806	10'	80	2	0.78	C	Existing Unpaved Road + Existing Barren Land

Source: Developed by Consultants

In the horizon year of 2042, due to proposed residential, commercial, institutional, and other proposed development, the road network capacity shall be increased. This is why in the capacity improvement of existing road section, the growth rate of traffic is applied to predict the future traffic expected on each road. By computing the LOS and ROW required in the future, a map has been prepared which portrays the LOS of existing improved roads and newly proposed roads and the key junctions considered for improvement.

13.4. Junction Geometry Improvements

Turning Movement Counts (TMC) Survey was conducted to access the existing LOS of major intersections in Charsadda study area. The selected intersections are Farooq-e-Azam Chowk and Utmanzai Chowk as they are very busy due to their central location and people from nearby residential areas such as Qazi Khel, Ghari Hameed Gul Mian, Faqirabad, Umarabad travel through these intersections to visit commercial markets, retail shops, commercial plaza, and major educational centers. Currently, these intersections do not have any footpaths or service lanes on the adjoining roads. Moreover, illegal parking is also observed near the intersection on Mardan Road, Nowshera Road, Charsadda Peshawar Road, and Tangi Road which causes extreme congestion during peak hours. If this trend continues in the future, then travel time delays due to congestion and road accidents due to traffic conflict will hinder traffic mobility for commuters passing through these junctions.

To reduce the travel time delays and for effective and safe traffic management within a city, intersections-both large and small-need to function safely and efficiently. A good intersection design shall bring people together and invigorate cities all while making traffic flow mobile, seamless and as smooth as possible. For this purpose, short-term & long-term strategies are suggested to efficiently tackle with the future demand on these intersections.

13.4.1. Scenario 1: short term strategy

The short-term strategies for junction improvement are as follow:

- To ensure a smooth flow of traffic, it is highly recommended to signalize junctions. By installing a traffic signal movement of vehicles and pedestrians at Farooq-e-Azam Chowk & Utmanzai Chowk will be regulated. By doing so, drivers and pedestrians are provided with clear indications of when to proceed or stop, thereby reducing confusion and minimizing the risk of accidents.
- Clearly marked lanes can help drivers to navigate a junction safely and efficiently. Adding lane arrows, turning lanes, and other markings can help to guide traffic flow and reduce the risk of accidents.
- Clear signage can help to direct drivers to their destination and reduce confusion at a junction. Adding signs to indicate turn lanes, parking, and other relevant information can improve the overall flow of traffic.
- Providing safe and accessible pedestrian crossings can improve safety for pedestrians and reduce congestion at a junction.

Intersection shall be considered as public spaces which promotes both motorized and non-motorized traffic for efficient and safe mobility. For this purpose, lane marking, dedicated bus & bike lanes, provision of sidewalks to promote pedestrian activity are proposed interventions to ensure mobility & accessibility of people at the selected junctions. If this people centric planning approach does not improve the traffic situation at the junction, then long term approach shall be to increase capacity of roads adjoining the intersection by providing additional lanes. This strategy is explained in the following section.

13.4.2. Scenario 2: Long term strategy

For long term strategy, the LOS analysis of these junctions was performed on SIDRA Intersection software by considering a growth rate of 5% as mentioned earlier. The following two scenarios are considered for comparison:

I. Future traffic demand with current geometry

II. Future traffic demand with interventions (improved geometry)

To improve the junction geometry to cater the future traffic demand of 2042, the following interventions are proposed on Farooq-e-Azam and Utmanzai Chowk

Table 63: Turning Movement Count results for Future Scenario

Sr.	Junction Name	Current Demand with Current Geometry (2022)				Future Demand with Current Geometry (2040)				Future Demand with Interventions (2040)			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS
1	Farooq-e-Azam Chowk	1971.4	F	1961.7	F	220819	F	279779.1	F	1529.6	F	1571.0	F
2	Utmanzai Chowk	23.2	C	15.2	C	16057.9	F	16687	F	32.8	C	26.9	C

Source: M/S PEPAC Pvt Ltd & Associates

As apparent from the results, the LOS of Utmanzai Chowk has somewhat improved. However, Farooq-e-Azam Chowk has failed even after adding multiple lanes in each direction.

There are multiple factors which affect the level of service of a road such as operating speed, travel time, encroachments, freedom to maneuver, road condition and driving comfort. The most common factor affecting the Level of service is roadside encroachments which most commonly exists in the form of illegal roadside parking. To eradicate roadside encroachments, dedicated service lanes have been proposed along primary roads and junctions. Therefore, one lane shall be reserved for the proposed improved geometry of the Utmanzai Chowk and Farooq-e-Azam Chowk.

By calculating future demand for year 2042, it has been estimated that junction will not serve adequately with current geometry. Therefore, interventions will be required in future which are as follow:

Proposed geometry of selected junction is explained below and for AM & PM Peak with movement summary is show in the annexure.

1. Farooq-e-Azam Chowk

The projected volume of both AM and PM Peak hour for year 2042, is shown in table below:

- **Projected Volume for AM Peak**

Table: 6 Projected Volume of Farooq-e-Azam Chowk for AM Peak

Year	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19	D20
2022	755	1459	1082	902	2935	2864	1933	1764	1559	3120	1857	1392	1553	1451	1186	1131	1400	713	891	1275
2040	2003	3871	2871	2393	7787	7599	5129	4680	4136	8278	4927	3693	4121	3850	3147	3001	3715	1892	2364	3383

Source: Developed by Consultant

- **Projected Volume for PM Peak**

Table 64: Projected Volume of Farooq-e-Azam Chowk for PM Peak

Year	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19	D20
2022	656	1633	1072	1010	2631	2102	2437	1983	2200	2528	2503	2303	1512	2303	1604	1249	2103	803	832	1498
2040	1741	4333	2844	2680	6981	5577	6466	5261	5837	6708	6641	6111	4012	6111	4256	3314	5580	2131	2208	3975

Source: Developed by Consultant

After using the projected volume and conducting Intersection analysis for horizon year, the junction serves at Level of Service (LOS) 'F' for both AM and PM Peak with maximum delay of 1529.6 sec for AM and 1571.0 sec for PM Peak Hour. Thus, for Farooq-e-Azam Chowk, a few alternate interventions are proposed.

1. Improvement of Current Geometry

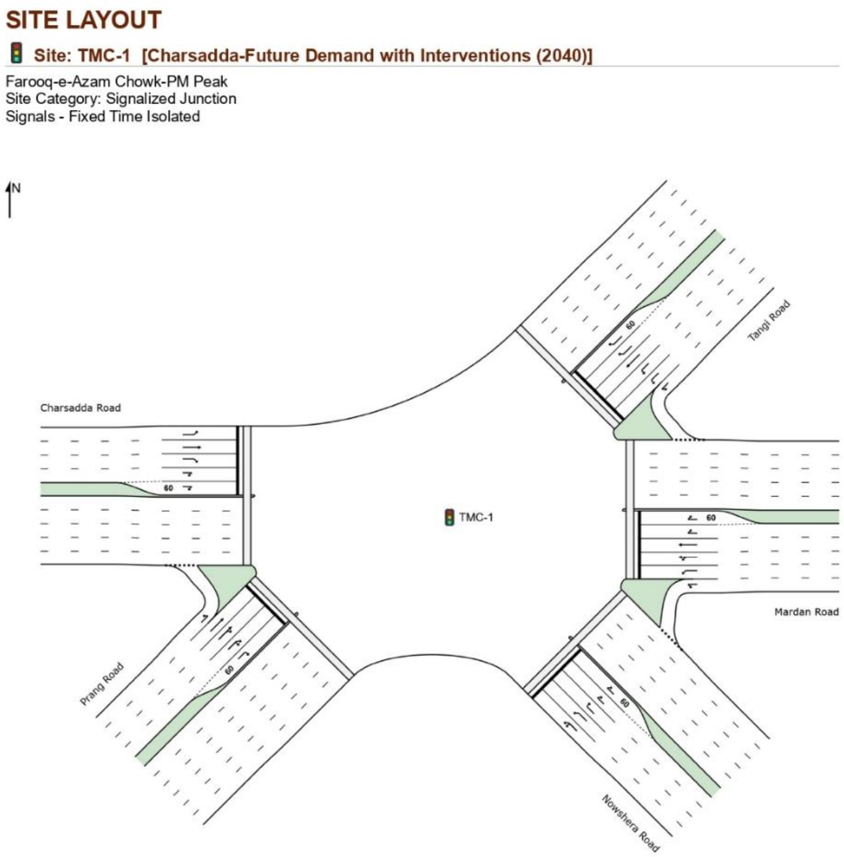
   - Signalize the intersection by providing a four-phased signal.
   - Addition of 1 slip lane and 1 short lane at the junction on Charsadda Road
   - Addition of 2 carriageway lanes, 1 slip lane, and 1 short lane at the junction on Parang Road
   - Addition of 2 carriageway lanes, 1 slip lane, and 1 short lane at the junction on Tangi Road
   - Addition of 1 carriageway lane, 1 slip lane, and 1 short lane at the junction on Nowshera Road
   - For smooth pedestrian movement, zebra crossing is required on each side.
   - Strip Island (low angle) is required on all legs for letting one direction of traffic to flow easily.
   - Central Medians of at least 3ft width is suggested on every road to distinguish between app and exist lanes.

2. Provision of Gradation Structure

- Provision of an underpass with two lanes to accommodate two-way traffic on Mardan-Peshawar Road.
- Signalize the intersection by providing a four-phased signal for traffic above the underpass.
- Provide at least one lane on Mardan Road and Peshawar Road on each side of underpass for access to signalized intersection.
- For smooth pedestrian movement, zebra crossing is required on each side.

Both aforementioned proposals can improve the Farooq-e-Azam Junction. However, for both proposals, sufficient land must be acquired in the future to improve the junction geometry. For short term strategy, signalization, lane marking, and all temporary and permanent encroachments shall be removed along the road to improve the capacity of junction. For long-term strategy, the proposed underpass could be built to aid in smooth traffic flow. Due to the central location of Farooq-e-Azam Chowk, the junction must be upgraded to accommodate smooth traffic flow on all primary roads such as Mardan Road, Peshawar Road, and Tangi Road. The proposed geometry for future is explained below:

Figure 28: Proposed Geometry of Farooq-e-Azam Chowk-Charsadda Study Area



Source: Developed by Consultant using SIDRA Intersection 8.0

2. Utmanzai Chowk

Table 65: Projected Volume of Utmanzai Chowk

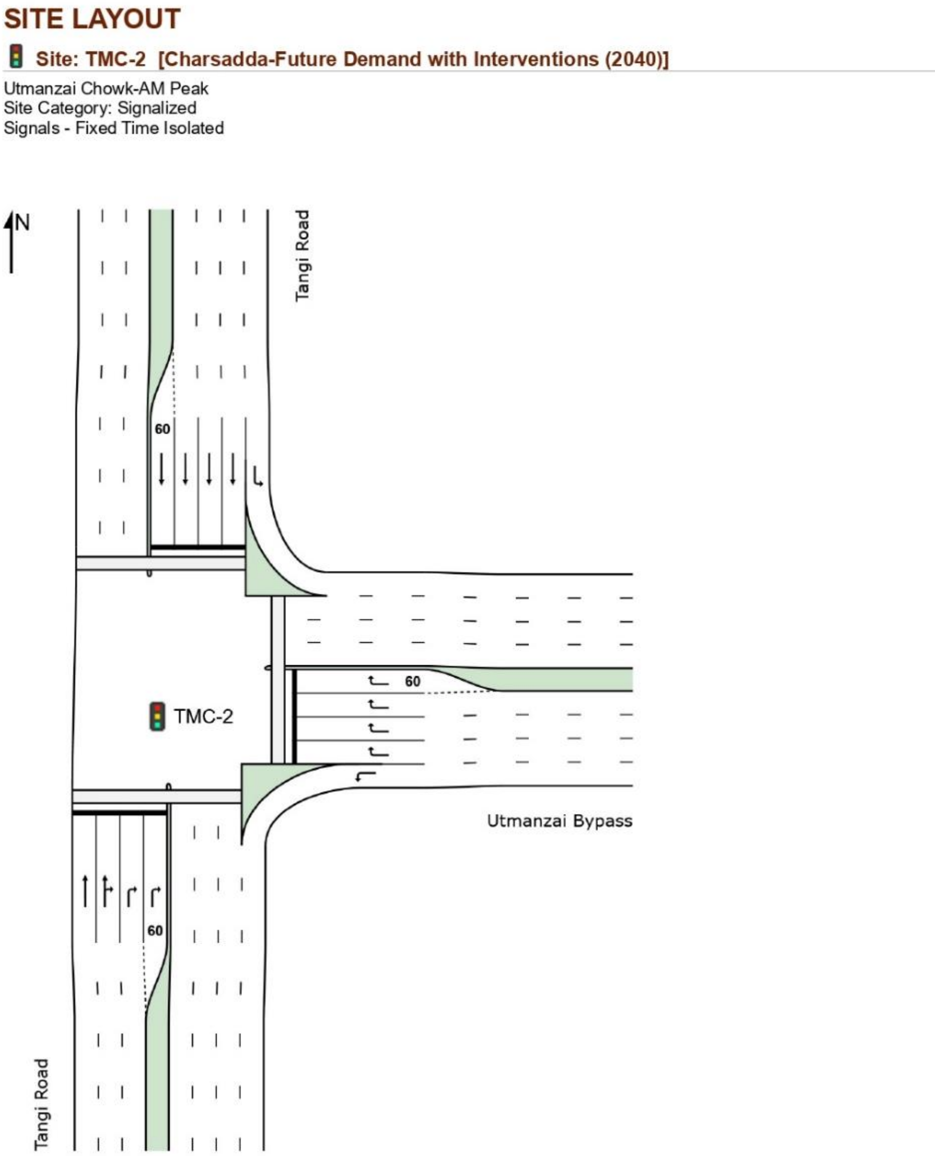
Year	AM						PM					
	D1	D2	D3	D4	D5	D6	D1	D2	D3	D4	D5	D6
2022	864	559	798	231	291	396	714	510	776	240	243	403
2040	2292	1483	2117	613	772	1051	1894	1353	2059	637	645	1069

Source: Developed by Consultant

After using the projected volume and conducting Intersection analysis for horizon year, the junction serves at Level of Service (LOS) 'C' for both AM and PM Peak with maximum delay of 32.8 sec for AM and 36.9 sec for PM Peak Hour. Thus, the proposals for Utmanzai Chowk are listed below.

- Signalize the intersection by providing a four-phased signal.
- Addition of 1 carriageway lane and 1 slip lane is required on each approach of Utmanzai Bypass Road
- Addition of 1 lane is required on Tangi Road for traffic flowing towards Farooq-e-Azam Chowk
- Addition of 1 lane is required on Tangi Road for traffic flowing towards Utmanzai
- For smooth pedestrian movement, zebra crossing is required on each side.
- Strip Island (low angle) is required on all legs for letting one direction of traffic to flow easily.
- Central Medians of at least 3ft width is suggested on every road to distinguish between app and exist lanes.

Figure 29: Proposed Geometry of Utmanzai Chowk-Charsadda Study Area



Source: Developed by Consultant using SIDRA Intersection 8.0

In comparison, the short-term strategies focus on improving the existing infrastructure by enhancing traffic flow, improving safety for both drivers and pedestrians, and reducing confusion at junctions. These strategies can be implemented quickly and efficiently and are suitable for addressing immediate transportation challenges. On the other hand, the long-term strategies focus on adding new infrastructure to improve traffic flow and reduce congestion. These strategies may require a significant amount of land and resources, and their implementation may be subjected to fiscal & physical constraints. In conclusion, short-term strategies are quick and efficient, but long-term strategies may be employed to cater to the traffic demand of 2042. Long-term strategies require more resources and may take longer to implement, but they have the potential to provide more significant benefits in the long run.

13.5. Other Intersections

Traffic signals play a crucial role in achieving safe, smooth, and efficient performance at intersections. They can maintain an orderly movement of traffic and can be coordinated to provide for continuous or nearly continuous movement at a definite speed along a given route. In Charsadda city, various cross overs of secondary roads with primary roads are unsignalized and thus present traffic conflicts and mobility issues on primary roads. To enhance traffic mobility on primary corridors, unsignalized crossovers shall be converted to signalized corridors for safe and efficient movement of people. In this way, motorized traffic shall be allowed to change directions to and from commercial activity centers, all while providing safe and easy access to pedestrians. Thus, to efficiently manage the traffic volume in Charsadda city, especially during peak hours, some key intersections are considered for signalization based on engineering judgement and warrants mentioned in **Manual of Uniform Traffic Control Devices**. These warrants are listed below.

1. Minimum Vehicular volume

Interruption of continuous traffic
Minimum pedestrian volume
School crossings
Progressive movement
Accident experience
Systems warrant.
Combination of warrants

Since most of the traffic signals are proposed along arterial or primary roads of Charsadda city, the warrant no. 1, 3, 7 are satisfied. Some of the key characteristics which fulfil the warrant conditions at these intersections are listed below.

- For warrant 1, minimum traffic volume on major roads (total of both approaches) is 600 vehicles per hour.
- For warrant 3, a minimum of 600 vehicles per hour (total of both approaches) on major road enter the intersection.
- For warrant 7, major primary roads which serve high volumes for through traffic flow and connects areas of principal traffic generation shall be signalized.

As per the **Manual of Uniform Traffic Control Devices**, there may be some exceptional cases where signals occasionally be justified even if no warrant is satisfied. Therefore, considering these guidelines the intersections considered for signalization are shown in the map attached in the Improved Traffic Mobility Section and the coordinates are attached below.

Table 66: Proposed Intersections to be Signalized in Charsadda City

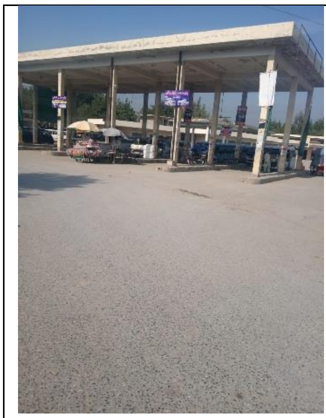
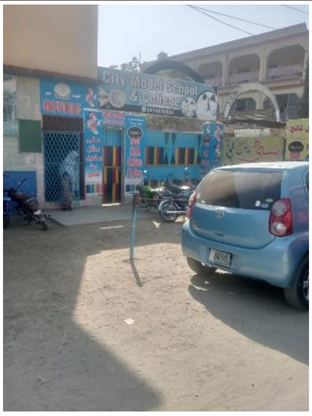
Junction ID	Coordinates		Junction Type	Ajdoining Roads
	Longitude	Latitude		
J-1	71.761	34.142	4-Leg	Nowshera Road- Major (Eastbound & Westbound) Secondary Roads- Minor (Northbound & Southbound)
J-2	71.775	34.157	4-Leg	Mardan Road- Major (Eastbound & Westbound) Ghari Khan Road-Minor (Northbound & Southbound)
J-3	71.741	34.152	4-Leg Staggered	Charsadda-Peshawar Road- Major (Eastbound & Westbound) Rajar Bypass & Zor Bazar Road-Minor (Northbound & Southbound)
J-4	71.737	34.152	3- Leg	Charsadda-Peshawar Road- Major (Eastbound & Northbound) Zor Bazar Road-Minor (Westbound)
J-5	71.749	34.156	3-Leg	Tangi Road-Major (Northbound & Southbound) Secondary Road-Minor (Eastbound)
J-6	71.754	34.166	5-Leg	Tangi Road & Rajar Bypass-Major (Northbound & Southbound) Secondary Roads-Minor (Eastbound & Westbound)
J-7	71.756	34.168	3-Leg	Tangi Road-Major (Northbound & Southbound) Takhtbai-Minor (Eastbound)

Source: Developed by Consultants

13.6. Proposed Signage Improvements

Traffic signs, signals, and road markings are crucial to guide commuters with desired speed and safety. They illustrate the right of way at points of conflict and provide necessary information about traffic conditions prevailing ahead to prepare drivers to take timely action to avoid any hazard. Along the primary corridors of Charsadda city, there are many junctions and road segments where necessary traffic signage is missing. Upon provision, it would aid drivers to navigate smoothly and safely on the road rather than asking for informational or directional instructions from other people. The following table shows the coordinates and type of signs that are currently missing to further assist the movement of people along main roads such as Mardan Road, Parang Road, Farooq-e-Azam Chowk.

Table 67: Proposed Traffic Signage in Charsadda City

	
Informational Signage: Charsadda Bus Adda **Coordinates:** 34°09’25.5” N, 71°43’56.8” E	**Informational Sign & Regulatory Singage:** Farooq-e-Azam Chowk **Coordinates:** 34°09’09.3”, 71°44’48.7”E
	
Informational Signage: At Mardan Road **Coordinates:** 34°09’16.8”N, 71°45’34.7”E	**Informational Signage:** At Mardan Road **Coordinates:** 34°09’41”N, 71°47’28.19”E
	
Informational Signage: At Mardan Road **Coordinates:** 34°09’12.0”N, 71°45’01.0’’E	**Informational Signage:** At Parang Road **Coordinates:** 34°09’04.5’’N, 71 °44’45”E

Source: Field Survey Conducted by Consultants

The purpose of signage and other traffic control devices is to promote highway safety and efficiency by providing for the orderly movement of all road users. Other than installing signs on existing infrastructure, adequate signs should also be considered for new proposals. The following signs shall be considered for improved mobility in Charsadda city.

1. At Intersections:

- Destination and Distance Signs: to be installed on Farooq-e-Azam Chowk and Utmanzai
- U-turn allowed sign at Major intersections.

2. Along Primary Roads:

- Stop signs and Yield Signs
- No Parking Sign
- Junction Ahead Sign
- Slow speed signs: before health, educational and other major land uses
- Parking Area Guide Sign
- Speed Limit Signs

Some of these signs are illustrated in the Improved Traffic Mobility Map shown in following section.

13.7. Improvement of Public Transportation Services

A well-planned public transportation system improves mobility and accessibility in cities. Due to the high occupancy of public transport vehicles, it can efficiently carry more trip volumes to central business districts than any other mode of transportation and simultaneously reduce traffic volume and need for parking along roads. The public transportation user interview survey was conducted on general bus stand/ terminal to gain an insight on user opinion regarding public transportation services. Most of the users belong to low-income group and are students, shopkeepers etc. travelling to their workplace. The most common public transport vehicles operating in Charsadda city are wagons such as Suzuki and Hiace. These vehicles operate on Tangi Road, Charsadda Road, and Mardan Road but randomly stop at intermediate points. Moreover, remote areas do not have access to public transportation services and thus are bound to travel to their destinations by using personal vehicles. To improve the public transport services and ensure last mile connectivity to meet future demand of 2042, the following short-term and long-term interventions are proposed.

- For improving existing public transportation services in short timeframe, wagons such as Hiace and Suzuki shall only operate on a fixed route on all primary roads i.e., Tangi Road, Charsadda Road, Mardan Road, Ghani Khan Road and Nowshera Road. Therefore, adding new routes would enhance public transportation accessibility and convenience of transfer for passengers.

- The public transport vehicles shall only drop off passengers on fixed stops near major commercial and business centers such as near Farooq-e-Azam Chowk to promote active transportation among people i.e., walking towards their destinations. This would also improve operating hours and the punctuality of the public transportation service, which eventually increases its attraction as a reliable transportation mode.
- Flexible transit service vehicles such as qinqchi, rikshaw should only operate on secondary roads, especially in low density areas and drop off passengers to the stop location to ensure last mile connectivity of public transportation.
- Introducing strict policies for vehicle fitness certificates, imposing high vehicle registration taxes, and charging high parking fee would discourage people from using private modes and increase attractiveness and ridership of public transport.
- For long term plans, public transportation buses shall be introduced and operate on all primary roads i.e., Tangi Road, Charsadda Road, Mardan Road, and Nowshera Road.
- These buses shall be prioritized and made to travel on dedicated bus lanes to avoid congestion delays and maintain its routine schedule.
- For improving public transport services and increase ridership, the travel fares shall be subsidized and integrated for all modal changes.
- Another long-term strategy should be to regulate the bus stop facilities for strict schedule following, secure and safe waiting conditions to maintain and improve the public transport services.

13.7.1. Proposed Bus Stops/Terminals

In the existing situation of city, there are two terminals, an Intercity Bus terminal on Mardan Road near Farooq-e-Azam Chowk and the other on Peshawar Charsadda Road named as General Bus Stand Charsadda. Currently, mini wagons such as Suzuki & Hiace operate on Tangi Road, Mardan Road, and Charsadda Road and serve residential & commercial areas such as Ghari Hameed Gul Mian, Umarabad, Muslimabad, Qazi Khel, Mohallah Piraan, Uthmanzai. To improve public transport services and ensure first mile-last mile connectivity, the public transport shall operate on all primary roads. Moreover, feeder services shall operate on secondary roads and roads to drop passengers on stop location to increase ridership. Adding new bus stops and redefining the role of para-transit vehicles would enhance accessibility to public transportation services. The proposed bus stop locations are decided by considering the density of residential and commercial areas which are the key traffic generation sites in Charsadda city as per the Transit capacity and Quality of Service Manual, 2nd edition. The proposed coordinates of public transport stops are shown in the table below and locations are shown on the map.

Table 68: Proposed Bus Stop in Charsadda City

Stop ID	Coordinates	Location

	Longitude	Latitude	
PBS-1	71.73561656070	34.15466532740	On Charsadda Road
PBS-2	71.74193748410	34.15184456060	On Charsadda Road
PBS-3	71.73561656070	34.15466532740	On Charsadda Road
PBS-4	71.78093343700	34.18487887400	On Ghani Khan Road
PBS-5	71.77847061530	34.17365872950	On Ghani Khan Road
PBS-6	71.77675320300	34.16579276000	On Ghani Khan Road
PBS-7	71.77593331950	34.14123286570	On Ghani Khan Road
PBS-8	71.77933821780	34.13130626460	On Ghani Khan Road
PBS-9	71.77369897020	34.15163947840	On Ghani Khan Road
PBS-10	71.77847061530	34.17365872950	On Ghani Khan Road
PBS-11	71.75530546900	34.15392504700	On Mardan Road
PBS-12	71.76799006400	34.15613376400	On Mardan Road
PBS-13	71.76799006400	34.15613376400	On Mardan Road
PBS-14	71.76799006400	34.15613376400	On Mardan Road
PBS-15	71.76799006400	34.15613376400	On Mardan Road
PBS-16	71.75530546900	34.15392504700	On Mardan Road
PBS-17	71.75968550230	34.14271020680	On Nowshera Road
PBS-18	71.77011691650	34.13481223110	On Nowshera Road
PBS-19	71.75285245440	34.14780616790	On Nowshera Road
PBS-20	71.77731575090	34.12947285080	On Nowshera Road
PBS-21	71.77731575090	34.12947285080	On Nowshera Road
PBS-22	71.77011691650	34.13481223110	On Nowshera Road
PBS-23	71.75285245440	34.14780616790	On Nowshera Road
PBS-24	71.74082483600	34.14309075400	On Parang Road
PBS-25	71.74082483600	34.14309075400	On Parang Road
PBS-26	71.77731575090	34.12947285080	On Proposed Structure Plan Road
PBS-27	71.77731575090	34.12947285080	On Proposed Structure Plan Road
PBS-28	71.77731575090	34.12947285080	On Proposed Structure Plan Road
PBS-29	71.77731575090	34.12947285080	On Proposed Structure Plan Road
PBS-30	71.77731575090	34.12947285080	On Proposed Structure Plan Road
PBS-31	71.77731575090	34.12947285080	On Proposed Structure Plan Road
PBS-32	71.77731575090	34.12947285080	On Proposed Structure Plan Road
PBS-33	71.77731575090	34.12947285080	On Proposed Structure Plan Road
PBS-34	71.77731575090	34.12947285080	On Proposed Structure Plan Road
PBS-35	71.77731575090	34.12947285080	On Proposed Structure Plan Road
PBS-36	71.75001300100	34.15805133300	On Tangi Road
PBS-37	71.75001300100	34.15805133300	On Tangi Road
PBS-38	71.75487376600	34.16651710700	On Tangi Road
PBS-39	71.76283830110	34.18259170910	On Tangi Road
PBS-40	71.76175318910	34.19221872650	On Tangi Road
PBS-41	71.75487376600	34.16651710700	On Tangi Road

Source: Developed by Consultant

The bus stops are proposed to provide a fixed route for public transport vehicles operating on each primary road. The existing General Bus Stand on Charsadda-Peshawar Road is inadequate both in terms of capacity and cost for operating and maintaining schedules for an efficient public transportation system operational on all primary roads. Therefore, a transport hub is proposed is proposed near Ghani Khan Road which would cater to the need for an Intercity Bus Terminal, General Bus Stand, and a Truck Terminal. The proposed General Bus Stand would suffice the public transportation need for efficient routine operation on Ghani Khan Road, Nowshera Road, and proposed Primary Circular Structure Plan Road (S-15). On the other hand, the existing General Bus Stand on Charsadda-Peshawar Road, is sufficient for routine operation on Mardan Road, Tangi Road, Parang Road, and Charsadda-Peshawar Road. A detailed and efficient public transport network will be developed by implementing the proposed bus stops. The sidewalk widths required to cater for the expected pedestrian volume comprising of alighting or boarding public transport users are calculated in the table below.

Table 69: Sidewalk width calculation

Roads	Peak hour Bus volume	No. of stops (Proposed)	Average Alighting Passengers Volume (ped/hr)	Walking Speed (Km/hr)	Target LOS	Space (ped/m2)	Sidewalk width required (ft)	Average Expected Pedestrian Volume Served (ped/hr)
	*a	b	**c	***d	****e	f	g	*****h
			a*30*b					d*g*304.8/f
Charsadda-Peshawar & Mardan Road	14	6	2,520	4.8	B	3.7	6.5	2,570
Nowshera Road	13	6	2,340	4.8	B	3.7	6.5	2,570
Tangi & Parang Road	14	4	1,680	4.8	B	3.7	5	1,977
Ghani Khan Road	13	6	2,340	4.8	B	3.7	6.5	2,570
Proposed Primary Road	13	7	2,730	4.8	B	3.7	7.5	2,966

Source: Developed by Consultant

**The Peak hour Bus Volume is taken from table: Population served by Public Transport Network attached in the following table. No. of buses required on each route is factored as per the length of route to determine peak hour count.*
***Assuming that all passengers alight & new passengers fill up the seating capacity (30 seats) of bus at each stop*
****The average walking speed is taken as 4.8km/hr as per (Transportation Research Board, 2016).*
*****The target LOS is set and calculations to compute sidewalk width are done as per methodology defined by Highway Capacity Manual (HCM 2000)*

****** Assuming all buses remain in full capacity throughout the peak hour, average expected passengers served are computed*

The proposed public transport network is expected to make people shift from private mode to public mode for their travel needs. Therefore, about 80% of the total population is targeted to use public transport services. The following table shows the calculation for No. of buses required and population served by proposed public transport network. Similarly, the proposed public transport network consisting of main bus routes and feeder routes for para-transit vehicles are also identified and highlighted on the map.

Table 70: Population served by Public Transport Network

Description	Value	Units
Target ridership of Public Transport	70%	
Expected Population 2042	378,326	people
Target population	264,828	people
Seating Capacity of Medium Bus	30	per bus
Length of routes for one complete round		
1. Charsadda-Peshawar & Mardan Road	10.98	km
2. Nowshera Road	9.32	km
3. Tangi & Parang Road	15.08	km
4. Ghani Khan Road	12.40	km
5. Proposed Primary Road	22.24	km
Total Length	70.02	km
Time required for one bus to complete one round		
1. Charsadda-Peshawar & Mardan Road	22.0	minutes
2. Nowshera Road	18.6	minutes
3. Tangi & Parang Road	30.2	minutes
4. Ghani Khan Road	24.8	minutes
5. Proposed Primary Road	44.5	minutes
*No. of buses required on each route		
1. Charsadda-Peshawar & Mardan Road	5	units
2. Nowshera Road	4	units
3. Tangi & Parang Road	7	units
4. Ghani Khan Road	5	units
5. Proposed Primary Road	9	units
Total Buses required	30	units
Residential density of city 2022	86	people/acre
**Existing residential area accessing Bus Stop	2003.96	acre
**Existing Residential Population served by Public Transport Network	172,341	people
Proposed Residential area density 2042	105	people/acre
**Proposed residential area accessing Bus Stop	1310.19	acre
**Proposed Residential Population served by Public Transport Network	137,570	people

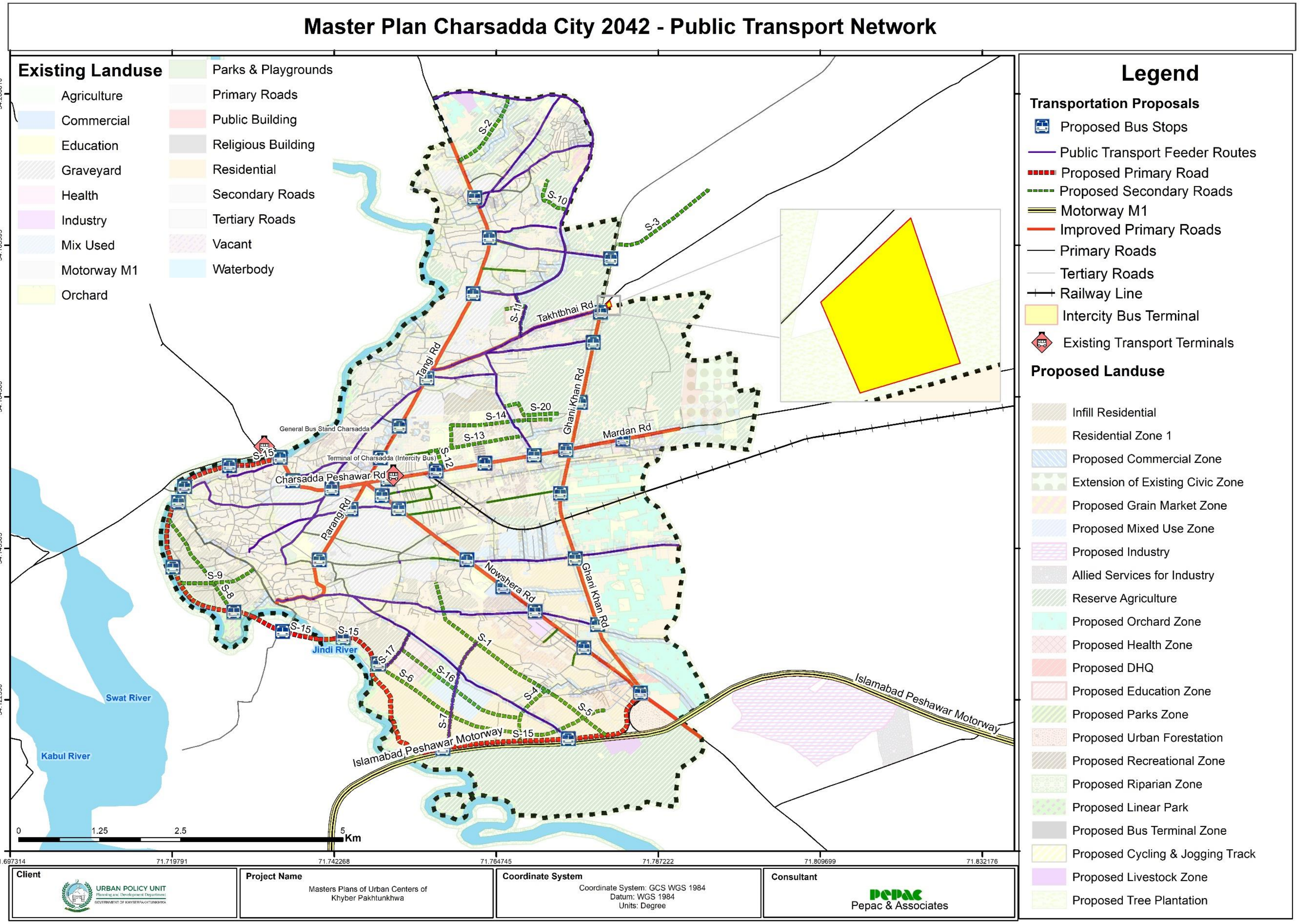
Description	Value	Units
Total people served by Public Transport Network	309,911	people
Percentage of population served	82%	

Source: Developed by Consultant

**Population served in Peak Hour is calculated by dividing the Target Population with Average Expected Passengers Served from Sidewalk Width Calculation Table.*

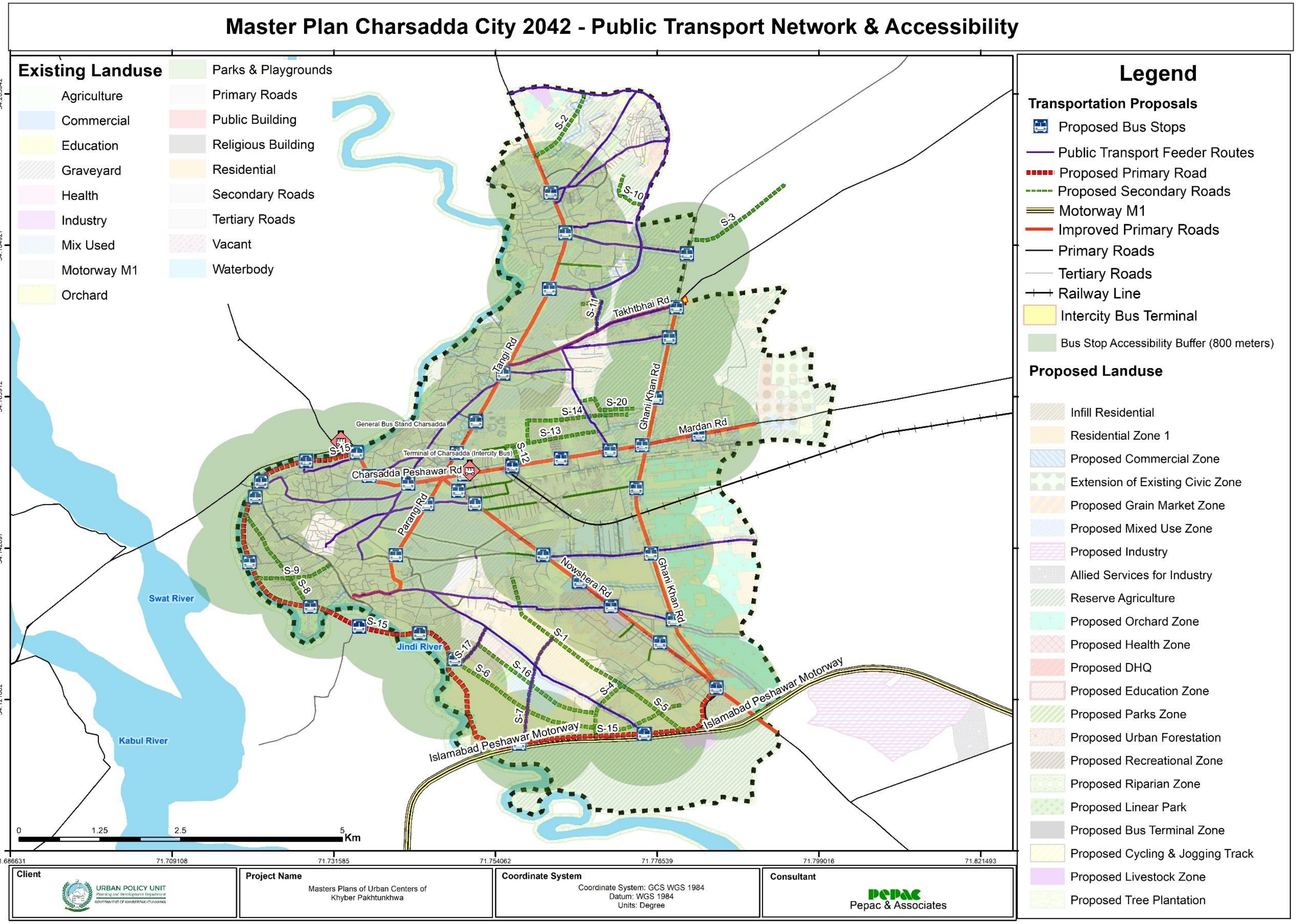
***The existing and proposed residential area and population accessing bus stop represents the area and no. of residential units which can access the bus stop within 10 minutes of walking 800-meter distance as shown in Public Transport Network Accessibility Map.*

Map 30: Proposed Public Transport Network



Source: Developed by Consultant

Map 31: Accessibility of Proposed Bus Stops of Public Transport Network by walk within 10 minutes



Source: Developed by Consultant

13.8. Parking Management

Parking is a significant component of a city transportation system. The number and use of parking spaces vary widely among activities in different zones of a city. The parking demand is influenced by the size, intensity, and location of specific land uses; availability of alternate means of travel; attitude of people regarding environmental quality, and economic development. Both detailed and observed parking survey was conducted on major corridors of Charsadda city to gain insight into parking behavior of commuters towards commercial, industrial, public buildings and educational institutions along the roads. In transportation planning, the conventional perception still holds that adequate and convenient parking must be provided near commerce and business-related activities for a city to thrive. However, it has been observed that non-compliance of traffic bylaws has encouraged people to park illegally on primary corridors of Charsadda city reducing ROW of road and hindering smooth traffic flow. Moreover, the availability and price of parking are also key factors affecting the mode choice of people. Therefore, considering all the factors, the following interventions are proposed to efficiently manage parking demands in Charsadda city.

13.8.1. Scenario-1: Short-Term Parking Management Strategies

Short-term parking management strategies are actions that can be implemented to address immediate parking challenges in Charsadda. Here are some strategies that can help:

- Parking fee shall be introduced for temporary parking along primary roads such as Mardan Road, Nowshera Road, Peshawar-Charsadda Road, and Tangi Road. Heavy fee shall be charged to discourage on-street parking if the vehicle is parked for longer duration. Charging a higher parking fee will discourage use of private vehicles and would enhance public transportation services.
- Parking demand of existing commercial plazas, institutional buildings, and public buildings shall be met by its own private parking space.
- Make it easier for drivers to find available private & public parking spots by improving signage in the city. This can reduce congestion and improve the overall parking experience.
- Parking fee should be regulated and maintained by authorities implementing a new parking fee structure in busy roads such as Mardan Road, Nowshera Road, Peshawar-Charsadda Road, and Tangi Road. The authorities could set new parking rates based on location, with higher rates for commercial areas along primary roads and lower rates along secondary roads. Temporary Parking signs on Primary roads and No Parking signs on secondary roads must be installed and parked vehicles must be issued a ticket for regulation and enforcement of policy by police officer or parking enforcement officer.

13.8.2. Scenario-2: Long-Term Parking Management Strategies

The goal of the parking management plan is to find the correct balance between providing adequate parking to support the requirements of an emerging planned commercial development while minimizing the negative aspects of excessive land area or resources devoted to parking.

- For efficient parking management, parking plazas are proposed at suitable locations. However, temporary parking may be permitted on service lanes along major corridors such as Mardan Road, Nowshera Road, Peshawar-Charsadda Road, and Tangi Road
- Parking fee shall be introduced for temporary parking along these primary roads. Heavy fee shall be charged to discourage on-street parking if the vehicle is parked for longer.
- Parking demand generated by any new construction in horizon year shall introduce basement parking to cater its own parking needs.
- For efficient parking management, existing vacant land shall be used as a parking plaza along major corridors such as Mardan Road, Nowshera Road, and Tangi Road to accommodate parking demand of adjacent land uses.
- Parking sensors can be installed in individual parking spaces to detect the presence or absence of vehicles. This data can then be used to determine real-time parking availability, direct drivers to open spots, and optimize parking lot usage.
- License plate recognition cameras can be used to monitor vehicles on road and in parking lots and enforce parking regulations. By capturing license plate information, parking managers can detect parking violations and issue tickets more efficiently.

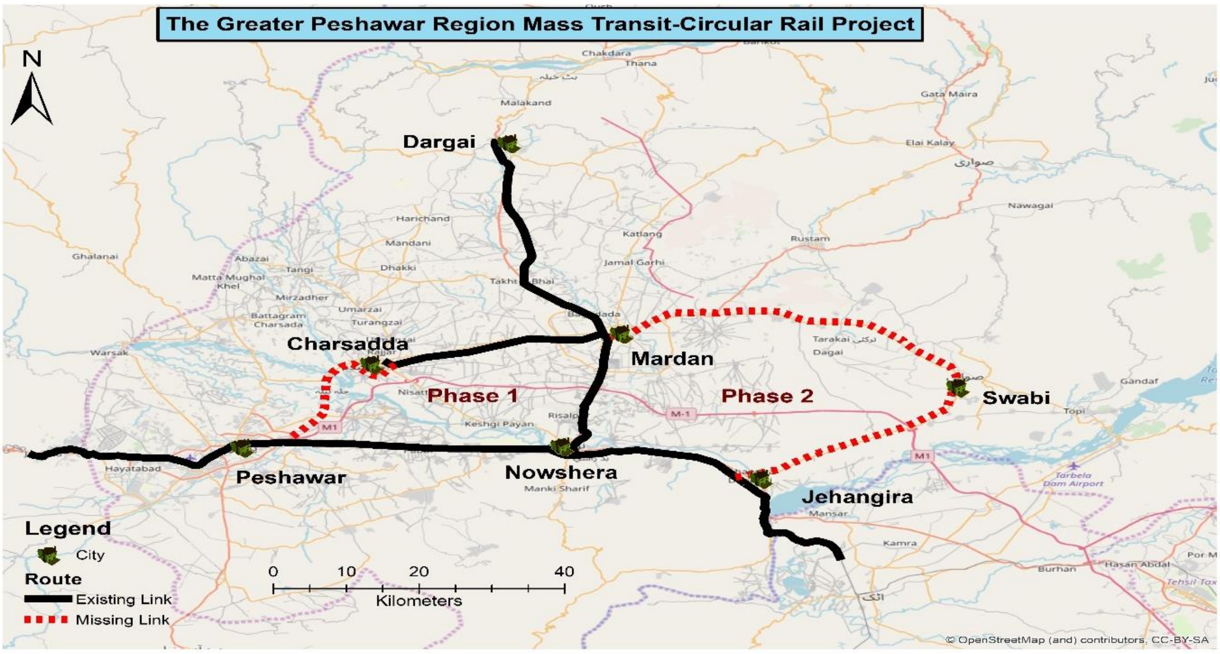
13.9. Non-Motorized Transport Strategy

Non-motorized transport strategy in Charsada is aimed at enhancing pedestrian connectivity to promote active travel mode. For this purpose, footpaths along all primary and secondary roads have been proposed. This would enable pedestrians to safely commute to their destinations specially near Rajjar bazar, Utmanzai bazar, and Zor bazar. Moreover, the presence of sidewalks would enable pedestrians to travel on foot to nearest bus stops for first-mile last mile connectivity of public transport network in Charsadda.

13.10. The Greater Peshawar Circular Railway Project

The Greater Peshawar Circular Railway Project is proposed to connect **Peshawar-Nowshera-Mardan-Charsadda** in **Phase-I** while **Swabi, Jahangira and Dargai** in **Phase-II** using the existing/Laying new infrastructure where necessary. It is a CPEC approved project which would enhance connectivity of the aforementioned regions and attract commuters towards rail transit. This would greatly shift the freight and public transport service load on the road network. The existing link and missing links of the circular railway is shown in image below

Figure 30: Proposed Greater Peshawar Circular Railway Project



Source: Transport Department, KPK

A single-story parking lot can be considered for intended use which can be upgraded as a multi-story parking plaza if required in the future. The location for provision of a parking plaza shall be well-planned and complement the surrounding land use. The intercept model for parking is proposed to efficiently manage the parking demand and promote use of active transportation modes to reach destined land uses. The concept of intercept parking suggests that a parking facility shall be available near the perimeter of major activity center. In this way, the activity center shall be kept congestion free and pedestrian friendly. For an efficient parking plaza, the roadway access shall be clear, safe, and congestion free and thus, is to be provided from secondary roads. To encourage the use of intercept parking, high parking fee for long term parking on primary and commercial bazaar roads has been proposed. The tentative most suitable location for parking plaza is shown in map attached in the Improved Traffic Mobility Section.

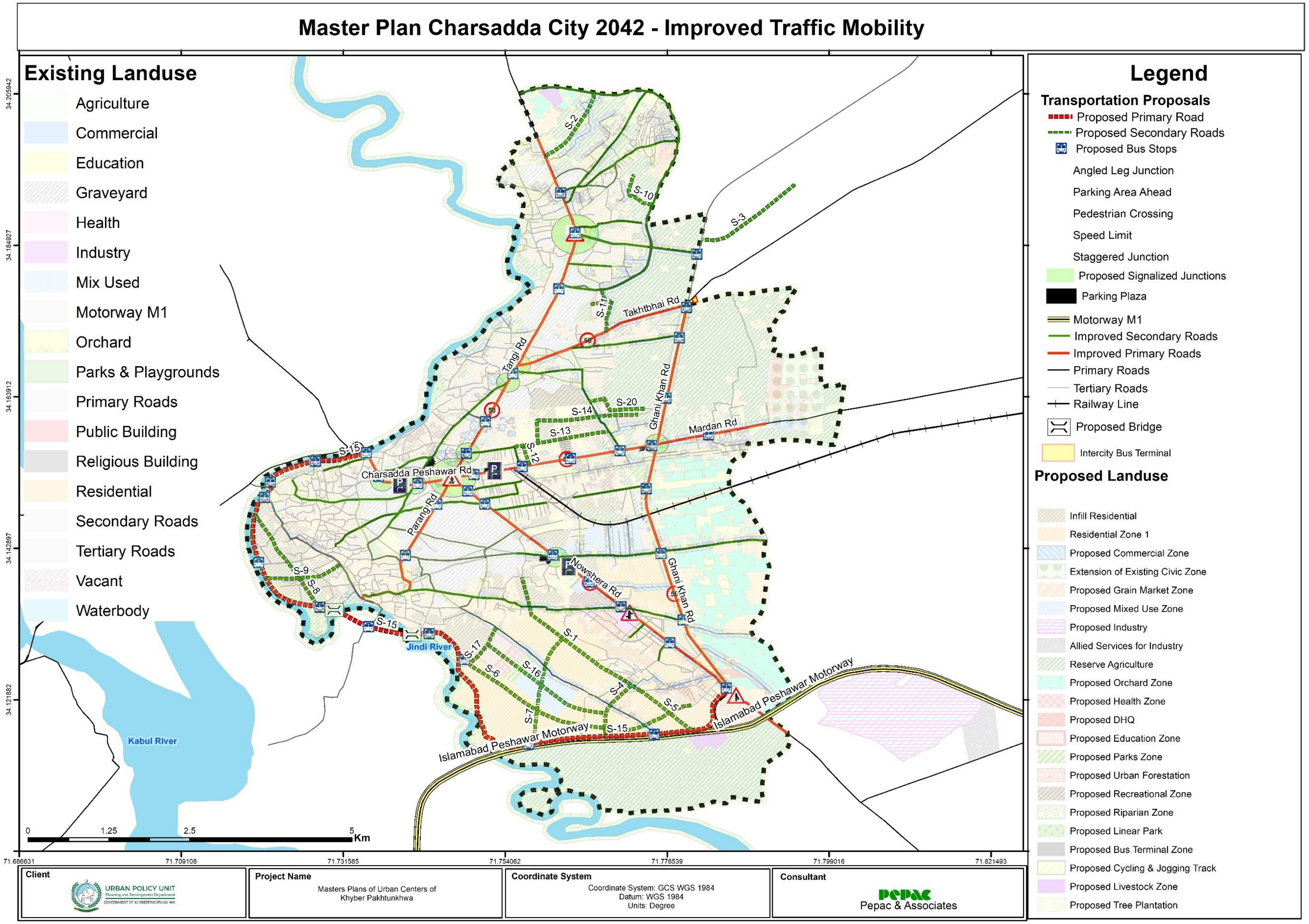
In conclusion, both short-term and long-term parking management strategies have their advantages and can be implemented simultaneously to achieve the best results. However, in the context of improving mobility in Charsadda, the long-term parking management plan seems to be more comprehensive and effective. The plan considers not only the immediate parking challenges but also aims to find a balance between providing adequate parking and minimizing the negative aspects of excessive land area or resources devoted to parking. The introduction of service lanes with parking facilities and the charging of parking fees can help reduce congestion and discourage on-street parking, leading to a more efficient use of available parking spaces. Additionally, the plan suggests that existing and future activities such as administrative, government and commercial plazas should cater to their own parking demand. Moreover, an intercept model for parking plaza is proposed near primary roads which will ensure that the parking demand is distributed more evenly throughout the city, reducing the burden on primary roads, and promoting alternative modes of transportation. Overall, the long-term parking management plan appears to be a more sustainable and effective solution for improving mobility in Charsadda.

13.11. Improved Traffic Mobility

Comprehensive mobility planning is based on land use and urban design strategies to increase accessibility and mobility of a city. To complement land use with transportation network, short term and long-term strategies have been suggested to improve traffic and transportation in Charsadda city. A balanced and well-planned roadway network is proposed with removal of encroachments, widening of primary roads, addition of service lanes and footpath to serve both active and motorized traffic accessing the adjacent land with ease. Lane marking at 10 feet width, dedicated lane intended for bus and bicyclists/ motorcyclists, cars, and public transport vehicles shall reduce traffic speed, instill cautiousness in drivers' perception, ensure traffic safety and improve mobility on primary roads. For better traffic management and connectivity of primary roads, certain crossovers with secondary roads shall be signalized to maintain orderly movement and regulate traffic volume approaching major junctions such as Farooq-e-Azam Chowk and Utmanzai Chowk. Similarly, to further improve traffic mobility on primary roads, forced turns at cross over with some secondary roads, and specified U-turn at major junctions is proposed for management of traffic. Footpaths shall be available on all primary and secondary roads for easy access to commercial markets, retail shops, plazas, educational centers, and banks. Moreover, a well-planned public transportation hierarchy with local wagons and rickshaws operating on secondary roads feeding passengers to main bus operational with fixed stops on all major corridors and serving majority of passengers travelling to and from major commercial, industrial, and educational institutions. This would attract enhance Public Transport ridership and people would be able to reach their destinations with two or three modal changes. To efficiently manage parking demand for major commercial and industrial land use, existing vacant land on prime locations along Mardan Road, Nowshera Road, and near Charsadda Road have been identified on the perimeter of activity center. The availability of a parking lot would encourage people to park their vehicles for free and walk to their nearest destination or bus stops to ride farther away. Similarly, paid temporary parking is suggested on primary roads to discourage long-term illegal roadside parking and promote the use of public transport. The installation of traffic signage along primary roads, intersections, and tertiary roads have been proposed to guide vehicles throughout their commute. These signs include slow speed signs, destination & distance signs, parking plaza ahead signs, and other signs to guide people on the road. In conclusion, the roadway network improvements in Charsadda city are proposed to enhance accessibility to adjacent land use, provide multimodal transportation option to reduce average trip time, congestion and improve overall mobility.

The improved traffic mobility with all the proposals incorporated are shown in map below.

Map 32: Improved Traffic Mobility



Source: Developed by ConsultantS

Chapter 14: Water, Sanitation & Solid Waste

In Charsadda city, water supply system mainly relies on groundwater sources. Tehsil Municipal Administration (TMA) is mainly responsible for providing municipal water in urban areas of Charsadda while Public Health Engineering Department (PHED) is responsible for supplying water services in the rural/ village councils. There are 19 tube wells out of which 6 are not functional and 3 storage reservoirs out of which only one is functional. The non-functional OHWT had technical issues during construction which caused leakage and did not get repaired afterwards. For the six non-functional tube wells, most of them drew sand mixed water which could not be filtered and used for domestic purposes. The people nearby these tube wells use hand pumps and privately bored wells. Most of the people also resist paying bills for municipal tap water which also hinders improvement of non-functional tube wells. Moreover, many people have complained about bad odour and taste in municipal tap water. Therefore, a request letter to replace old, rusted pipelines with new water supply pipes has been sent to provincial government from TMA.

In this report, the proposal for Charsadda water supply, sewerage and drainage systems are presented and discussed.

14.1. Methodology

The methodology adopted for the preparation of proposals for water supply and sanitation systems of the project area are discussed below:

I. Desk Study

After the award of project, based on TOR, all information regarding water supply system and sanitation in the project area or similar areas were collected. Based on the data, strategy for the household survey was prepared. Further, the data needs to be collected from the relevant departments and directly from ground, was also listed and documented.

II. Surveys

Once strategy of survey and list of data required has been prepared, teams were mobilized in the project area for household survey. These surveys include water supply and sanitation serviceability, type of water source, type of sanitation facility, quality of water, satisfaction with water supplies and sanitation facilities, water and sanitation charges etc.

III. Collection of Secondary Data

Teams were also mobilized to collect secondary data from relevant departments such as PHED, UPU etc. These data include location and discharge of layout maps of water supply, sewerage and drainage systems, tubewells, depth and quality of groundwater, outfall location of wastewater, identification of waterlogged areas (if any), size and location of water tanks and location and discharge of filtration plants, etc.

IV. Baseline Study Report

After the collection of household surveys, primary data and secondary data, all the data was compiled and scrutinized before any kind of analysis. Detail analysis was performed to access the existing water supply and sanitation situation. In the end, separate maps were prepared to depict existing water supply and sanitation situation.

V. Proposals

After the preparation of baseline study report, based on future population and future demand proposals for existing 2022 scenario and 2042 scenario has been prepared for water supply and sanitation. The proposals include water supply and sewerage and drainage layouts, proposals to meet water supply and sanitation flows, identification of new water sources, location of new facilities etc.

14.2. Existing Water Supply and Sanitation Situation

14.2.1. Existing Water Supply

Water supply situation in Charsadda city is worst in the region. Not only 10% of population is getting municipal water supplies but water has also been contaminated in different parts of the city as well mainly areas near Jindi river where people are using private bores which are shallow and have contaminated by sulphates and lead etc. The satisfaction level of Charsadda city is also very alarming as 41% of population is dissatisfied with the water supply services of MC. About 96% of population are deprived of basic water infrastructure necessary for the sustainability and growth of the city. MC is supplying water, three times a day, to the major of service area and about only 1% of population is getting only once a day.

14.2.2. Existing Water Supply Distribution System

The existing water supply distribution system contains of 3 Water tanks and 19 tube wells in the study area and within the jurisdiction of TMA and PHED. The Tube well and tank coordinates, areas/ population served, status and yield/ capacity are listed in the Annexure J. The water is supplied to nearest population through main distribution GI/HDPE pipes with diameter ranging from 3 to 18 inches. The individual household connection is provided from the main distribution line through pipes of 2” or 1.5”. The location of tube wells and water tanks, capacity, and main distribution pipelines are shown on water supply network map.

The common cause of sand-mixed water from tube well could be because of the pump being too powerful to pull in sand from the surrounding aquifer which may have clogged pump valves. Moreover, the casing of well could also have been damaged which allows infiltration of sand in the pumped water.

14.2.3. Existing Drainage System

A drainage system allows the safe disposal of wastewater from house or even an entire area. Thus, it is important to have a sufficient and satisfactory drainage system, from single dwelling to urban level. A proper drainage system is lacking in most areas of Charsadda city. There is no sewerage treatment plant available in project area and the wastewater is eventually discharged into Jindi River without any treatment.

For the case of Charsadda city, the satisfaction of population with the provided drainage facilities in the area is shown in figure below. The gathered data showed that 37% of the surveyed population was satisfied with the current drainage provision in the area. Similarly, 26% of this sample responded in negative terms with respect to said provision. Furthermore, 94% of people have their house accessible to drainage system. On the other hand, 4% do not have any connection of drainage system.

As for the 94% of the people with drainage system connection in their house, the washroom, kitchen and laundry waste disposal are done mostly through open drains (kacchi and pakki). Only 10% of people have soakage pits from which waste is absorbed into the ground and could potentially pollute the ground strata and affect the quality of dug wells in that area. The houses connected with open drains (21%) of rectangular cross-section creates blockage and unhygienic environment. Meanwhile 32% of people have connection to covered drains. On the other hand, 37% of people have their houses connected with underground drains.

14.2.4. Existing Groundwater Conditions

In Charsadda, only one filtration plant exists which has a capacity of 800 litres. The rest of the areas are provided with unfiltered water from direct pumping. Upon interviewing the local tube well operators, they reported that the groundwater is clean and fresh. However, It may be free from any contamination and impurities where water table is located as deep as 100 m. For areas near the Jindi river water table is shallow up to 30 m depth and may get contaminated when mixed with wastewater. Some of the areas under TMA jurisdiction are not supplied with municipal water due to resistance of people regarding payment of bills. Those people use private shallow bored wells without following the governmental guidance for installation. The water from those wells is contaminated and is not satisfactory.

14.2.5. Design Criteria of Water Supply and Sanitation services

This section provides the minimum design criteria and standards required for the water supply network, sewerage collection, disposal and treatment systems. Major aspects will include:

- To design water supply and sewerage systems, these can be operated with minimum operation and maintenance cost up to the planning horizon;
- Hydraulically the system should be capable of handling anticipated water demand and sewage load up to the planning horizon;
- The proposed wastewater treatment plant should deliver an effluent that will meet the National Environmental Quality Standard (NEQS) and WHO standards for reuse for irrigation purpose; and
- The entire system would be designed in a cost-effective manner.

14.2.6. Design Criteria Water Supply System

The design criteria for the water supply system have been based on "Technical and Service Delivery Standards for Water Supply and Sanitation Sectors" by PHED KPK guidelines. Design criteria for major components of the water supply system are described in this section.

a. Design Period

As per PHED KPK guidelines design life/period of different components of water supply are as follows:

- ***The design period adopted for civil works is 25 years***
- ***Mechanical works will be designed for a design period of 10 years.***

b. Water Demand

Sufficient potable water is required to fulfil the requirement of domestic and various non-domestic consumptions. Water is also required for the purpose of firefighting and horticulture requirement. Therefore, water demands for various usages in the project area (Charsadda) is described here.

Water demand of the project area has been established to fulfil the water requirements up to horizon year of 2042. This section discusses the computation of water demand for Charsadda City.

c. Water Demand

Population projection has been performed considering growth rate trend and calculated as below:

Projection Using Different Methods	Base Year	Projection					
	2017	*2022*	*2027*	*2032*	*2037*	*2042*	*Average*
Average Population Increase	209,745	240,777	273,703	308,032	343,133	378,326	N/A
Average Growth Rate Increase	1.44%	3.37%	2.65%	2.4%	2.17%	1.96%	2.33%

Design population (2042) of Charsadda is 378,326 persons. The water demand for the design population will be calculated using 25 gpcd as unit water demand. The unit water demand, in addition to residential demand, will include commercial, firefighting, horticulture and unaccounted for water as well. Year-wise water demand of Charsadda City is given below:

Sr. No.	Year	Population	Unit Water Demand (GPCD)	Average Water Demand (GPD)
1	2022	240,777	25	6,019,425
2	2027	273,703	25	6,842,575

Sr. No.	Year	Population	Unit Water Demand (GPCD)	Average Water Demand (GPD)
3	2032	308,032	25	7,700,800
4	2037	343,133	25	8,578,325
5	2042	378,326	25	9,458,150

Source: Calculated by Consultant

d. Water Supply Source

The water in Charsadda City will be supplied by installing tube wells. The location of tube wells will be finalized as per computer hydraulic modelling of water supply system. However, preference of location will be near the canals, green areas and government owned land etc. in the project area and considering the land available with Charsadda administration.

e. Demand Fluctuation Factors

As per PHED KPK, demand fluctuation factors i.e., Maximum day demand is 1.5 times the average day demand and Peak hour demand will be calculated as 1.5 times the maximum day demand.

f. Design Flows

The distribution network will be analyzed against following design flows:

- Peak Flows
- Diurnal Flows
- Peak Flows + Fire
- Night Flows

g. Pressure in the Network

The pressure in the distribution network shall be at least 12 m (40 ft.) as per PHED KPK in all parts of the network including the remotest and highest points, to deliver sufficient quantities of water. In case of fire, pressure in the network shall be maintained as a minimum positive value i.e., negative pressure shall not be developed in the network.

h. Tube wells

Tube well plays a pivotal role in catering the water requirement of the area. Wells must be properly located to avoid the drawdown of groundwater. According to Groundwater Study Report, a distance of 1500ft shall be maintained between proposed 0.10 cusecs (4500 gph) tube wells. A tube well typically consists of a pump, bowl assembly, strainer, blind pipe and electrical panel. Pump is the major part of tube well. There are four basic types of pumps commonly installed which include:

- Submersible Pump
- Centrifugal Pump
- Jet Pump
- Progressive Cavity Pump

In most cases, the type of pump selected for a particular installation depends on the cost and site conditions. However, in many instances the physical limitations of the well may restrict the type of pump that can be considered. Regardless of which type of pump is selected, it should be capable of delivering the required daily demands at adequate pressures. However, pump capacity should not be greater than the yield capability of the well.

The following general factors will be considered in selecting a pump for maximum performance and service life. Technical comparison of different types of pumps is provided in **Table 43.**

The pump should be capable of producing water at the "desired flow" and "total head" while operating near its peak efficiency. The total head includes the vertical distance from the lowest pumping water level to the highest point in the distribution system, anticipated friction losses in the piping, and the desired minimum pressure at the highest outlet or faucet.

- Water quality should be considered.
- The initial cost, operating expense, and expected maintenance costs should be considered.

Table 71: Comparison of Different Types of Pumps - Charsadda

Pump Type	Operation	Head (m)	Cost	Efficiency	Size	Maintenance	Suction Lift
Submersible Pump	Continuous	200	Medium to High	Medium to High	Medium to Large	Difficult	Yes
Jet Pump	Continuous	20	Medium	Low to Medium	Medium to Large	Difficult	No
Centrifugal Pump	Continuous	200	Medium to High	Medium to High	Medium to Large	Easy	Yes
Progressive Cavity Pump	Cyclic	45	Low	Low to Medium	Small	Easy	No

Source: Market Survey Conducted by Consultant

Centrifugal pumps provide high head and maintenance is relatively easy. Therefore, centrifugal pumps (Vertical Turbine Pumps) are recommended.

i. Elevated Water Reservoirs

- Overhead Reservoirs (OHRs) are key component of water distribution system. In water supply system OHRs serve the following functions:

- Store water for use during electric load-shedding and during maintenance works of tube-wells/pumps.
- Provide balancing of flow and pressure during peak hours.
- They are elevated enough to provide the required pressure for the end-user. According to Punjab Devolved Social Services Programme (PHED KPK) criteria, OHRs are sized to store about a 1/10th of water demand. One of the advantages of an OHR is that it helps to optimize the performance of pumps by avoiding pump overloading, which will increase the life of pumps. It also helps during load shedding hours.

According to PHED KPK criteria, overhead storage of 1/10th based on diurnal water demand will be provided for balancing the reservoir.

j. Pipe Materials

The following pipe materials, commonly used in service connection, distribution systems and pumping mains, have been considered.

i. Galvanized Iron (GI)
ii. High Density Polyethylene (HDPE)
iii. Unplasticized Polyvinyl Chloride (uPVC)
iv. Asbestos Cement (AC)
v. Ductile Iron (DI)
vi. Mild Steel (MS)
vii. Glass Reinforced Pipe (GRP)

The principal advantages and limitations of the different pipe materials are presented table below. It also shows typical pipe sizes and pressure ranges, which are locally available. If necessary, pipes of other pressure ratings and sizes may be obtained for a particular application by special arrangement with the manufacturers.

Description	Galvanized Iron (GI)	High Density Polyethylene (HDPE)	Unplasticized Polyvinyl Chloride (U-PVC)	Asbestos Cement (AC)	Ductile Iron (DI)	Mild Steel (MS)	Glass Reinforced Plastic (GRP)
Technical Considerations							
1. Range of available diameters	25-300 mm	20-1200 mm	20-250 mm	80-1000 mm	100-1000 mm	80-1000 mm	350-2400 mm
2. Operating Pressures Availability to withstand hammer	12-30 bar	3.2-40 bar	6-15 bar	6-14 bar	12-51 bar	12-30 bar	1-32 bar
3. Inside lining requirement	Required	Not Required	Not Required	Not Required	Required	Required	Required
4. Outside coating / Wrapping requirement	Not Required	Not Required	Not Required	Not Required	Not Required	Required	Not Required
5. Cathodic protection requirement	Required	Not Required	Not Required	Not Required	Not Required	Required	Not Required
6. Coefficient of friction in 10years for William Hazen Formula	120	150	150 140	140	130	120	150
General Structural Design Considerations							
1. Minimum cover required	1.0 m	1.0 m	1.0 m 1.0 m	1.0 m	1.0 m	1.0 m	1.0 m

Description	Galvanized Iron (GI)	High Density Polyethylene (HDPE)	Unplasticized Polyvinyl Chloride (U-PVC)	Asbestos Cement (AC)	Ductile Iron (DI)	Mild Steel (MS)	Glass Reinforced Plastic (GRP)
2. Flexible / Brittle/	Brittle	Flexible pipe	Flexible pipe	Brittle	Brittle	Brittle	Brittle
3. Bedding requirement	Sand Bedding Required	Sand Bedding Required	Sand Bedding Required	Granular Bedding Required	Sand Bedding Required	Sand Bedding Required	Sand Bedding Required
Ground / Soil Considerations							
1. Type of terrain suitable	Plain, rolling and mountai n	Plain, rolling and mountain	Plain and rolling	Plain	Plain and rolling	Plain and rolling	Plain and rolling
2. Stability of ground requirement	Not required	Not required	Required	Required	Not required	Not required	Requir ed
Cost Considerations							
1. Carriage cost	High	Low	Low	Low	High	High	Low
2. Laying procedure	Skilled	Simple	Simple	Simple	Simple	Skilled	Simple
3. Jointing procedure	Skilled	Skilled	Simple	Simple	Simple	Skilled	Simple
4. Testing procedure	Skilled	Skilled	Skilled	Skilled	Skilled	Skilled	Skilled
5. Repairing procedure	Skilled	Skilled	Simple	Simple	Skilled	Skilled	Skilled
6. Life	40-50 years	>50 years	>50 years	50 years	20-40 years	40- 50 years	50 years
Operational Considerations							

Description	Galvanized Iron (GI)	High Density Polyethylene (HDPE)	Unplasticized Polyvinyl Chloride (U-PVC)	Asbestos Cement (AC)	Ductile Iron (DI)	Mild Steel (MS)	Glass Reinforced Plastic (GRP)
1. Compatibility with existing network	No	Yes	Yes	Yes	Yes	Yes	No
2. Compatibility with repair procedures	No	Yes	Yes	Yes	Yes	Yes	No
3. Past operational and maintenance experience	Satisfactory	Good	Good	Satisfactory	Good	Good	Satisfactory

Source: Market Survey Conducted by Consultant

k. Velocity of Flow

Velocity of 0.5 to 2 m/s (1.65 ft/s to 6.5ft/s) will be used for design of water distribution network and 0.3 to 1.5 m/s (0.98 ft/s to 4.92 ft/s) for design of transmission mains as per PHED KPK criteria.

l. Transmission Main

According to PHED KPK criteria, water transmission mains will be designed on Maximum Day Demand.

m. Distribution Pipe Lines

According to PHED KPK criteria, water distribution lines will be designed on peak hourly demand.

n. Minimum Pipe Size

According to PHED KPK criteria, the minimum pipe size for distribution network pipe will be Ø3".

o. Water quality

The proposed water supply source to be used for water of domestic needs should be of acceptable quality in accordance with the guidelines of World Health Organization (WHO) which is presently being followed in Pakistan. Following table**Error! Reference source not found.** shows the WHO Guidelines for Potable Water Quality.

Table 72: WHO Guidelines for Portable Water Quality

Sr. No	Parameter	W.H.O. Desirable levels	W.H.O Maximum permissible levels
1	Temperature o C	-	-
2	pH	7.0-8.0	6.5-8.5
3	Odour	Unobjectionable	Unobjectionable
4	Colour	5 Units	50 Units
5	Taste	Unobjectionable	Unobjectionable
6	Turbidity N.T.U.	5 Units	25 Units
7	Total dissolved solids	500	1500
8	Calcium	75	200
9	Magnesium	50	150

Sr. No	Parameter	W.H.O. Desirable levels	W.H.O Maximum permissible levels
10	Total Hardness mg/l as CaCO3	100	500
11	Sulphates	200	400
12	Chlorides	200	250
13	Iron	0.1	0.3

Source: World Health Organisation (WHO)

14.2.7. Water Disinfection and Treatment System

Water treatment or disinfection varies depending on the source and quality of water. Municipal water supplies need to be treated to make the water potable (safe to drink) and palatable (aesthetically pleasing) and to ensure an adequate supply of water to meet the needs of the community at a reasonable cost.

Chlorination

Water chlorination is a process of adding chlorine or hypochlorite to water. This method is used to kill certain bacteria and other microbes in water as chlorine is highly toxic. In particular, chlorination is used to prevent the spread of waterborne diseases such as cholera, dysentery, typhoid etc. Chlorination is the most commonly used method to eliminate disease causing microorganisms in water today.

Chlorine readily combines with chemicals dissolved in water, microorganisms, small animals, plant material, tastes, odors, and colors. These components "use up" chlorine and comprise the chlorine demand of the treatment system. It is important to add sufficient chlorine to the water to meet the chlorine demand and provide residual disinfection.

The chlorine that does not combine with other components in the water is free (residual) chlorine, and the breakpoint is the point at which free chlorine is available for continuous disinfection. An ideal system supplies free chlorine at a concentration of 0.3-0.5 mg/l.

The disadvantage of chlorination is the generation of by-product i.e., TriHaloMethanes (THMS). THMS are chemicals that are formed, primarily in surface water, when naturally occurring organic materials (humic and fulvic acids from degradation of plant material) combine with free chlorine. Groundwater does not contain naturally occurring organic materials therefore, there is a low probability for the generation of THMS.

Field survey reveals that wastewater of the project area is usually discharged into soakage wells which are affecting shallow ground water rapidly at the moment and may have also penetrated into deep ground water which shall be hazardous as for as contamination and its related serious issues. Complete revamping of sewerage system is required considering local topography, sub-surface soil, sanitary and industrial wastewaters etc.

14.2.8. Design Criteria Sewerage & Disposal System

i. Minimum Pipe Size

A minimum diameter for sanitary sewers is usually specified in order to avoid clogging by large objects. In conventional systems in the United States, the house connections are usually 6 inches in diameter, but smaller sizes have been used. As per PHED criteria, for conventional sewerage, the minimum diameter commonly specified for street sewers in many countries is 8-9 inches. In the simplified system, smaller sizes are recommended because, in the upper reaches of a system where flow is low, the use of smaller-diameter sewers results in greater depths off low and higher velocities, and improves cleansing.

The minimum pipe size will be as under:

- RCC Pipe 9”
- Plastic Pipe 8”

ii. Peaking Factor

Multiply the average daily flow by the Peak factor to calculate the peak flow. Peak Factor depends upon the population; it decreases with increase in population. Following table has been provided in PHED KPK criteria to decide peak factor for calculating peak flow.

Table 73: Variation in Peak Factors - Charsadda

Population	Peak Factor
5000	4.5
5000-10,000	4
10,000-25,000	3.5
25,000-50,000	3
50,000-100,000	2.5
More than 100,000	2

Source: Punjab Devolved Social Services Program (PHED KPK)

iii. Infiltration Rate

Infiltration rate into the sewerage depends upon size of the pipe line, rainfall in the area, situation of sub soil water table and others. The manufacturing of pipes under local situation does not meet the required norms and standards for jointing; the grooves are invariably not in the true form line and shape.

Accounting for the local situation, following criteria is suggested, which is in sequence with engineering practices:

- Above sub-soil water level 350 gallons/day/inch dia/mile

- Below sub-soil water level 700 gallons/day/inch dia/mile

A more rational approach is to relate infiltration with pie size / quantity of follow which is usually taken 10% of the flow. However, if plastic pipe is adopted, this allowance may be taken as zero.

iv. Wastewater Flow Estimation / Average Daily Flow

Normally about 80% to 90% of water supplied is received in sewers. As per standards and guidelines, the minimum per capita consumption shall be 17 gallons per day. The sewage quantity will be taken as 85% of average water consumption. The sewage quantity thus calculated will cover domestic & commercial use including infiltration. The average sewage flow in the design will be based on 80% of water consumption as above.

v. Trench Width

The trench widths for laying of pipes of various sizes in the network is shown in the following table:

Table 74: Proposed Trench Width - Charsadda

Pipe Diameter (mm)	Trench width (mm)
150	650
200	700
250	750
300	850
350	900
400	950
450	1050
500	1100
600	1250
700	1400

Source: Design Criteria as per Public Health & Engineering Department (PHED)

vi. Design Flow

Design flow is equal to the sum of peak flow and storm water allowance.

vii. Friction Formula and Minimum Gradients

Hydraulic design of pipes mainly concerns; resistance to flow in relation to available and required pressure/head and required and allowable velocity of flow.

Manning's formulae in the following form are the usual hydraulic tool:

$$V = 1 / n \times R\ 2 / 3 \times S\ 1 / 2$$

Where,

V = Velocity, ft/sec

R = Hydraulic Radius, D/4 (In case of circular x-section)

n = Friction co-efficient which is 0.013, when flowing full

The co-efficient of friction varies with internal surface of pipe, diameter of pipe and velocity.

For the project area, Manning's formula will be practiced. The minimum adopted slopes to lay the sewer are mentioned in table given below:

Table 75: Minimum Slope Requirements

Size of Sewer (Inches)	Minimum Slope
9	0.00150
12	0.00095
15	0.00070
18	0.00054
21	0.00044
24	0.00037
27	0.00032
30	0.00028
33	0.000243
36	0.000215

Source: Design Criteria as per Public Health & Engineering Department (PHED)

viii. Velocity of Flow

Gravity sewer has been designed for a minimum velocity of 2.0 feet/sec and where falls are available; the velocity may be increased with maximum velocity of 7 feet/sec, when running full.

The design velocity of flow in the sewerage system as per PHED criteria is:

- Minimum (in difficult situations) 2.0 feet/second,
- Desirable minimum 2.5 feet/second
- Maximum in hilly area 7.0 feet/second (for plastic pipes, may be more than this velocity)

ix. Minimum Cover over Sewer

Pipes will be laid at a depth to give a minimum cover of 3.0 ft over top of the pipe as per PHED criteria. Where minimum pipe cover is not available, the pipe shall be encased in cement concrete so as to provide adequate structural strength against load impacts. However, for a street where traffic load is not so significant and a shallow sewer is the requirement, this minimum cover shall be reduced to 2 ft.

The suggested cover over pipes is as under:

- Narrow streets with remote possibility of heavy traffic 2 ft
- Other locations 3 ft

x. Pipe Roughness Coefficient

The pipe roughness coefficient shall be as under:

RCC Pipes

- New Lines 0.013
- Old Lines 0.015

Plastic Pipes

- New Lines 0.009
- Old Lines 0.009

The roughness coefficient varies with the depth of flow whereas in the criteria it is stated to be constant. More practical approach is to vary the coefficient with the depth of flow.

Following are the recommendations for roughness coefficient:

- New Lines, RCC 0.013, when flowing full
- New Lines, Plastic 0.009, when flowing full
- Old Lines, RCC 0.015, when flowing full

xi. Class of Pipe

The applicable criteria will be as under:

Reinforced Cement Concrete: Pipes manufactured according to ASTM pipes Class II (C-76) are used locally. Higher classes are specified only for locations where excessive backfill and live loads are expected.

Plastic Pipe: Pipes manufactured as per applicable specifications i.e., polyethylene pipe shall be of high density and uPVC conforming to Class-B.

xii. Permissible Loads on Sewers

Permissible loads on different classes of sewers for various types of bedding are essentially should be part of the criteria so as to provide guidance to engineers for selection of certain class of pipe for a particular situation and for a type of bedding. As per depth of laying pipeline and type of bedding, the class of pipe to be used will be decided.

xiii. Bedding for Sewers

Usually, above sub-soil water level and for sewers 9-12 inches diameter, sand bedding is adopted whereas for larger sewer sizes crushed stone bedding is used. The bedding is to be decided as per individual case taking into account the depth of sewer, traffic loads, soil condition, and class of pipe. Normally, following types of sewer bedding are in practice:

Type of Bedding	Load Factor
Shaped Bedding	1.5
Sand Bedding	1.7
Gravel Bedding	1.7
Crushed Stone Bedding	1.9

xiv. Jointing of Pipes

Usual practice for RCC sewer pipe jointing is either by bell and spigot or tongue and groove with rubber ring. This practice has successfully performed in the sewerage schemes since decades. Present practice of covering of joint with cement concrete is not favoured.

The recommendation is as under:

a. RCC Pipes

Up to 24" dia Bell and Spigot with Rubber Ring Beyond 24" dia Tongue and Groove with Rubber Ring

b. Plastic Pipes

As per recommendation of the manufacturer/applicable specifications.

xv. Design Depth of Flow

Sewers will be designed to flow at 0.75 of full depth under peak flow conditions to provide requisite air gap under which condition the sewer will flow up to 90% capacity at peak flow. Thus, the design flow will be calculated by multiplying peak flow with a factor of 2.0.

xvi. Manholes

Manholes are an expensive component. They are now among the most familiar features of a sewer system, but they were not widely used in early sewers. They came into wide use with combined systems where they facilitated removal of grit. The criteria for manhole use have gradually become more conservative and have contributed significantly to the high cost of sewerage. The cost of manholes is a function of depth, spacing, and strength of design. The use of shallower depths is one way to reduce these costs.

Cement concrete manholes are usually adopted in the location and will be proposed for the project area. Following design criteria for manhole spacing is suggested: Not over 100' - For sewer up to 8" size.

Not over 200' - For sewers 12" size and above.

Pipe connections to Manholes

To allow for limited differential settlement between manholes and the connecting pipelines, there will be a flexible pipe joint located at the external face of the manhole and a second flexible joint approximately 30 inches from the face of the manhole.

Adjustment for Height of Manholes

Manholes will be constructed with a minimum of two and maximum of three courses of concrete blocks between the manhole cover slab and manhole cover to allow for future adjustment of the top level to suit changes in final road or ground level but manhole neck will not exceed 30 inches.

Change in Sewer Diameter at Manholes

To minimize the risk of blockage in sewers, the diameter of the outgoing sewer must not be less than the diameter of the largest incoming sewer. The top of smaller sewers entering a manhole will normally be at the same level as that of the outgoing sewer.

Slope of Pipe Channel within Manholes

All manhole invert levels used in the sewer calculations will be the centre of the manhole and all distances and gradients will be calculated between centres of manholes. Where the incoming and outgoing pipes are of the same gradient and diameter the pipe gradient will be continued through the channel in manhole.

Drop Connections to Manholes

The drop connections to manholes will be provided if the difference in pipe invert elevation is greater than 2 ft otherwise no drop connection will be provided.

Manholes Material

Manholes will be constructed in Brick Masonry in general, whereas for special conditions it will be of reinforcement cement concrete.

Ventilation

Ventilation of sewers is necessary to avoid the build-up of noxious gasses and to minimize septicity. In developed areas sewers will naturally ventilate through the ventilation stacks provided as part of each building sanitary system. Therefore, there is no need of additional ventilation stacks. If necessary, ventilated cases will be provided.

Sewer and Water Main Separation

Water mains and water service lines shall be protected from sanitary sewers, storm sewers, combined sewers, house sewer service connections, drains, and sanitary sewer force main. In unavoidable circumstances, concrete encasement of the water lines will be adopted.

Horizontal Separation

Water mains shall be laid at least 3 ft horizontally from any existing or proposed drain, storm sewer, sanitary sewer, combined sewer or sewer service connection.

Water mains may be laid closer than 3 feet to a sewer line when:

- Local conditions prevent a lateral separation of ten feet.
- The water main invert is at least 18 inches above the crown of the sewer.
- The water main is either in a separate trench or in the same trench on an undisturbed earth shelf located to one side of the sewer.

When it is impossible to meet the conditions above, the drain or sewer shall be constructed of slip-on mechanical joint cast or ductile iron pipe, or PVC pipe meeting the requirements for water main. The drain or sewer shall be pressure tested to the maximum expected surcharge head before backfilling with no leakage allowed in the area of required water main protection.

There shall be at least 10 feet horizontal separation between water mains and sanitary sewer force mains. Water mains must be separated at least 25 feet from septic tanks, disposal fields, seepage beds, and sewage lift stations.

Vertical Separation

A water main shall be laid so that its invert is 18 inches above the crown of the drain or sewer whenever water mains cross storm sewers or sewer service connections. The vertical separation shall be maintained for that portion of the water main located within 10 ft horizontally or any sewer or drain crossed. A length of water main pipe shall be centered over the sewer to be crossed with joints equidistant from the sewer or drain. The sewer shall be constructed of slip- on or mechanical joint cast or ductile iron pipe, or PVC pipe, meeting the requirements for water main when:

- It is impossible to obtain the proper vertical separation as described above; or
- The water main passes under a sewer or drain.

A vertical separation of 12 inches between the invert of the sewer or drain and the crown of the water main shall be maintained where a water main crosses under a sewer. Support the sewer or drain lines to prevent settling and breaking of the water main. If the invert of the water main is not 12 inches above the crown of the sewer when the pipes cross, a casing pipe can be installed around either the water main or sewer in lieu of constructing the sewer with water main equivalent pipe. The casing pipe must be a material that is approved for use as water main. The casing must extend on each side of the crossing at least 10 feet as measured at right angles from the outside edge of water main pipe to the outside edge of the sewer pipe.

Pipe support shall be provided within the casing pipe and ends of the casing shall be filled with an approved non-shrink grout.

At crossings when the invert of the water main is not 18 inches above the crown of the storm sewer, and the sewer crossed the water main at right angles, the storm sewer can be constructed with reinforced concrete pipe using flexible gasket joints meeting ASTM C- 361 or ASTM C-443 instead of providing a casing pipe or constructing the storm sewer with water main equivalent pipe. If casketed storm sewer piping is proposed, it shall be installed between adjacent storm structures. The drain or sewer shall be pressure tested to the maximum expected surcharge head before backfilling with no leakage allowed in the area within 10 feet of the water main.

Construction shall extend on each side of the crossing until the distance from the water main to the sewer or drain line is at least 10 feet as measured at right angles from the outside edge of the water main pipe to the outside edge of the sewer pipe. Where a water main passes over an existing or proposed force main, an 18- inch vertical separation shall be provided at the crossing; a forced main shall not be allowed to be above the water main at the crossing.

Material Selection

Pipe Materials

Selection of material is to be made not only on technical grounds but other considerations are to be kept in view so as to receive best value for the money. It is likely that on technical grounds, two options may be available and only one is to be identified which is suitable for a particular condition. For determination of suitable pipe material, a selection procedure is devised for the choice of material.

The type of pipes to be used for sewerage system depends upon the following factors:

a) Corrosion resistance

b) Capital cost

c) Local availability

d) Ease of installation

e) Efficiency of joints

f) Load sustaining ability

g) Useful life

Due to strategic importance of pipelines and high capital investment involved, careful consideration is to be given in selection of pipe material so as to ensure reliable efficiency at appropriate cost. The selection procedure usually involves:

- Technical selection
- Operational considerations
- Structural design
- Cost comparison
- Implementation and monitoring

xvii. Sewage Pumping Station

Sewage pumping stations are provided for the following reasons:

1. To raise the hydraulic grade of sewers in the sewerage system
2. To dispose of the sewage in the receiving body
3. To introduce the sewage in WWTP

Commonly non-clogging centrifugal pumps are used. The impellers have two vanes so that waterways are large. Reciprocating and rotary pumps are not adopted to sewage pumping unless sewage is treated to remove suspended particles. Pumps are designed in positive suction to avoid priming. General design considerations for sewage pumping stations are as under:

1. The total Capacity of pumps should be equal to the peak sewage flow
2. More than one pump should be provided
3. One pump or one set of pumps should be for minimum flow. One for average flow and on set for peak sewage flow
4. Standby pump should be provided. Capacity depends upon local conditions. Ideally capacity of standby pumps should be peak sewage flow. But according to PHED its capacity should be 50% of max. flow.
5. Electric power from two sources for the pumping station is recommended
6. Pumps should be a self-priming type or should operate under positive suction head
7. Each pump should have an individual intake
8. The minimum size of suction should not be less than 4 inch
9. Screens should be provided to remove particles 50mm or layer
10. Two screens and two wet wells are preferable due to repair and maintenance
11. Vents should be provided for wet well and dry well
12. The sump pump should be provided in dry well to pump out the leakage
13. Size of the drywell should be adequate to accommodate all pumps

xviii. Design Criteria for Sewage Treatment Facilities

General Design Basis

a) The process design of the wastewater treatment plants (WWTPs) shall be carried out at average sewage flows and pollution loads, whereas the hydraulic design of all the sewage conveyance and transfer components shall be carried out at peak flows.

b) WWTPs shall be designed primarily to bring the pH, BOD and TSS values of wastewater/sewage within the NEQS limits.

c) Economy of costs, capital as well as operational, maximum dependence upon local resources and efficient performance are kept in view while designing proposed sewage/sewage treatment facilities.

d) The process designs of component facilities are, primarily, based upon the design guidelines and methods, laid down in the following references:

[1] Mara D., (2004), Domestic Sewage Treatment in Developing Countries, Earthscan, UK & USA.

[2] Mara D., (1997) Design Manual for Waste Stabilization Ponds in India, Lagoon Technology International, Leeds, United Kingdom.

[3] Punjab Devolved Social Services Programme, (2008) Technical and Service Delivery Standards for Water Supply and Sanitation Sectors, Govt. of the Punjab, Lahore.

xix. Design Criteria for Key Wastewater Treatment Facilities

Based on past experience of similar sewage/wastewater treatment plants projects, qualitative and cost comparison of available Treatment Technologies is presented in following table.

Table 76: Qualitative and Quantitative Comparison of Available Treatment Technologies

Sr. No.	Parameter	Activated Sludge	Trickling Filter	Aerated Lagoons	Waste Stabilization Ponds
1	**Qualitative Comparison**				
a)	Area Requirement	Minimum	Moderate	Moderate	Large
b)	Process Mechanical Equipment	Yes	Yes	Yes	No
c)	Capital Construction Cost	High	High	High	Moderate
d)	Operation and Maintenance Cost	High	Moderate	High	Minimum
e)	Process Energy Requirement	High	Moderate	High	Nil
f)	Operational Supervision & Control	High	High	High	Minimum
g)	Quantities of Sludge Produced	High	Moderate	High	Minimum
h)	Daily Waste Sludge Disposal	Yes	Yes	Yes	No
Cost Comparison					
a)	Capital Cost (Including Land Cost) - Million Rs.	11,550	10,164	9,240	2,400
b)	Annual Operation & Maintenance Cost – Million Rs.	570	456	460	33
c)	Area Requirement - Acres	70	91	100	199

Source: Desk Study by Consultant

To bring the pollution concentration of wastewater/sewage within National Environmental Quality Standards (NEQS) and to use for agricultural purposes as per WHO standards, treatment technology based on Waste Stabilization Pond systems are recommended for Sewage Treatment Plant (STPs) of Charsadda City on basis of above given comparisons. Waste stabilization ponds (WSPs) are large earthen basins in which raw wastewater is treated entirely by natural processes involving algae and bacteria. They are amongst the most important methods of wastewater treatment in hot climates. However, since the oxidation rate is slow, large areas are required for their construction. Their specific advantages are simple operation and low operation & maintenance costs.

In view of the above technical discussion of treatment technologies, it is proposed to locate Waste Stabilization Ponds (WSP) in the outskirts of the city and near the water body.

a. Design Flows

The process design of the key sewage treatment facilities i.e., Anaerobic, Facultative and Maturation Ponds, will be designed on average sewage flows. In contrast, hydraulic design of sewage conveyance and transfer components i.e., Distribution Chamber, Inlet Channel, Outlet Channel and Overflow Channel, will be designed on peak flows.

b. Design Temperature

Design temperature plays a critical role in the design and performance of WSPs. Design temperature plays a critical role in design and performance of WSPs. Mean temperatures of Charsadda are in the range of 1˚C – 35 ˚C.

c. Design Criteria for Anaerobic Ponds

Anaerobic ponds are provided for primary sewage treatment in the absence of oxygen. Anaerobic grow under such conditions and use organic matter to produce mainly biomass and Methane (CH4). Anaerobic ponds are generally employed for destabilization of high strength sewage and a good process control is required mainly for temperature and pH control. Anaerobic ponds are common in domestic sewage treatment and recommended for developing countries. Efficiencies comparable to Primary Settling Tanks (PSTs) may be achieved in Anaerobic Ponds at less operational costs.

Anaerobic ponds, primarily designed for BOD removal, receive such a high organic loading (usually >100 g BOD/m3d) that they contain no dissolved oxygen and no algae. Almost 50% BOD removal could be achieved in well-designed and well-maintained anaerobic ponds. Criteria for Anaerobic Ponds have been established keeping in view the international practices and Technical and Service Delivery Standards published by Government of Punjab.

Anaerobic Ponds will be designed based on volumetric loading rate. The volumetric loading rate has been calculated by the relationships in Table 8. BOD removal in anaerobic ponds varies for different design temperatures.

Table 77: Permissible Volumetric Loading Rates and % BOD Removal at Corresponding Temperatures (Mara et al, 1997)

Temperature (ºC)	Volumetric Loading (g/m day)	BOD Removal (%)	Adopted
< 10	100	40	-
10 – 20	20T – 100	2T + 20	√
20 – 25	10T + 100	2T + 20	-
> 25	350	70	

Source: Technical Studies of Water Resources in FATA, IUCN, 2019

Other Design Parameters/Criteria used for Anaerobic Ponds are presented in table as under:

Table 78: Other Design Parameters for Anaerobic Pond (Mara et al, 1997)

Parameter	Unit	Range	Adopted
Water Depth	m	2 - 5	5.0
Free Board	m	0.5 - 1	0.5
Length to Width Ratio	-	2 – 3:1	1.5-1.70
Hydraulic Retention Time (HRT)	Day	>1	1
Sludge Accumulation Rate	m3/capita/day	0.03 – 0.04	0.04
Side Slope	m	2 - 3	3.0

Source: Desk Study by Consultant

d. Design Criteria for Facultative Ponds

After primary treatment in Aerobic Ponds, sewage is carried to Facultative Ponds for secondary treatment.

Facultative Ponds are employed for medium organic loadings where a mutual relationship prevails between algae, which provide oxygen, and facultative bacteria, which provide nutrients for the algal growth. Organic matter is consumed primarily by facultative bacteria. Resulting effluent, thus, have very less BOD. Facultative ponds are provided after anaerobic ponds

Facultative ponds are designed for BOD removal on the basis of a relatively low surface loading (100 - 400 kg BOD/ha. d) to permit the development of a healthy algal population as the oxygen for BOD removal by the pond bacteria is mostly generated by algal photosynthesis.

The facultative ponds will be designed based on surface loading rate. The surface loading rate will be calculated by the following relationships (Mara, 1997):

SLR= 350 [1.107-0.002T] (T-25)

Where:

SLR = Surface Loading rate in kg BOD/ha/day

Other Design Parameters/Criteria used for Facultative Ponds are presented in Table 10 as under:

Table 79: Other Design Parameters for Facultative Pond

Parameter	Unit	Range	Adopted
Water Depth	m	1 - 2	2.5
Free Board	m	0.5 - 1	0.5
Length to Width Ratio	-	>1.5	5.9-7.0
Hydraulic Retention Time (HRT)	**Day**		8
a) For Temp < 20 °C	Day	> 5	-
b) For Temp > 20 °C	**Day**	> 4	-
BOD Removal Efficiency	%	70 – 90	76.75
Side Slope	m	2 - 3	3.0

Source: Desk Study by Consultant

e. Design Criteria for Maturation Ponds

Maturation Ponds receive sewage from facultative ponds and are used to remove the excreted pathogens and very little BOD. Removal of fecal coliform can be estimated by following relationship

$$\mathbf{Ne = Ni / [\{1+k.(HRTAP)\} + \{1+k.(HRTFP)\} + \{1+k.(HRTMP)\}]}$$

Where:

Ne = Fecal Coliform concentration in Effluent (FC/100ml)

Ni = Fecal Coliform concentration in Influent (FC/100ml)

k = Fecal Coliform Removal Rate (1/d)

HRTAP = Adopted Hydraulic Retention Time in Anaerobic Ponds

HRTFP = Adopted Hydraulic Retention Time in Facultative Ponds

HRTMP = Adopted Hydraulic Retention Time in Maturation Ponds

Other Design Parameters/Criteria used for Maturation Ponds are presented in Table 49 as under:

Table 80: Others Design Parameters for Maturation Pond

Parameter	Unit	Range	Adopted
Water Depth	m	1 – 1.5	2.0
Free Board	m	0.5 - 1	0.5
Length to Width Ratio	-	2 - 3	1.0 - 1.20
Hydraulic Retention Time (HRT)	Day	1	1.0
Side Slope	m	2 - 3	3.0

Source: Desk Study by Consultant

f. Design Criteria for Distribution Chamber (DC)

Design criteria for the Distribution Chamber is presented as follows:

- Distribution Chamber shall be designed at peak flow of each STP.
- The effective hydraulic capacity of the DC shall be such that hydraulic detention period at peak design flow is not less than 24 seconds. The least dimension of the DC in plan shall not be less than 10 ft.
- Minimum free board over the maximum hydraulic grade level (HGL) in the Distribution Chamber shall be 2 ft.

g. Inlet/Outlet Channel

Design criteria for the Inlet/Outlet Channels is presented as follows:

- Inlet and Outlet channels will be designed at peak design flow.
- Minimum flow velocity in channel shall not be less than 2.50 ft/s.
- Minimum free board over the maximum hydraulic grade level (HGL) in the Channels shall be 2.0 ft.

14.3. Water Supply and Sewerage Proposal

14.3.1. Water Supply

Water Supply demand of Charsadda is being satisfactory fulfilled by tubewells without affecting groundwater aquifers. So, it is recommended to install tubwells in the vicinity of water stream and also to look for reliable surface water from nearby dam or spring.

- **Unit Demand**

The water supply and sanitation facility for each person must be continuous and sufficient for personal and domestic uses. These uses ordinarily include drinking, personal sanitation, washing of clothes, food preparation and personal and household hygiene. According to the World Health Organization (WHO), between 50 and 100 litres of water per person per day are needed to ensure that most basic needs are met and few health concerns arise. The current unit water demand as used by PHED for Charsadda project area is 15 Gals/Capita/Day or 68 liter /capita/day. It is expected that in future Charsadda city will get more developed and life style of people living in the city will be upgraded. In light of this assumption, per capita water demand of Charsadda is increased to 25 Gals/capita/day. This demand will be used to calculate existing as well as future demand of Charsadda project area.

Current Water Demand = 25 x 240,777

= 6,019,425 gallons per day

- **Design Flow for 2042**

Average Design Flow = 378,326 x 25

= 9,458,150 gallons per day

Max. Design Flow = 9,458,150 x 1.5

= 14,187,225 gallons per day

Peak Design Flow = 14,187,225 x 1.5

= 21,280,837.5 gallons per day

14.3.1.1. Water Supply Proposal for 2022 Scenario

The existing water supplies have been checked against the current population demand and the gap has been identified. To overcome this gap a proposal to improve the existing water supplies has been prepared considering better unit demand and 100% serviceability to the existing population.

- **No. of tubewells for 2022 scenario**

The tubewells capacities in the Charsadda plain varies from 0.27 cusecs to 0.36 cusecs. Tubewell capacity of 0.31 cusecs has been assumed as average capacity of one tubewell.

Capacity of one tubewell = 0.31 cusec

= 7000 gallons per Consider

12 hrs of tubewell operation,

Capacity of one tubewell = 84,000 gallons per day

Detail calculation for number of tubewells for the 2022 scenario has been shown in **Table 54**.

Table 54: Number of Tubewells for 2022 Scenario

Sr. No.	Name of Administration Unit	NC/VC	Area (Acre)	Population 2022	Per Capita Water Demand (Gallons/Capita/Day)	Avg. Water Demand (Gallons/Day)	Max. Water Demand (Factor = 1.50) (Gallons/Day)	Number of Tubewells (1T/W Cap. = 0.084 MGD*)
Existing Urban Boundary								
1	Mama Khel	NC	303.1861348	5,610	25	140,248	210,372	3.0
2	Yasin Zai	NC	54.65110583	9,384	25	234,599	351,898	5.0
3	Main Kalli	NC	369.2574717	17,043	25	426,081	639,122	8.0
4	Babara	NC	154.1731196	7,484	25	187,100	280,651	4.0
5	Aziz Khel	NC	179.0636232	20,332	25	508,297	762,446	10.0
6	Mirzagan	NC	201.6040793	13,658	25	341,449	512,174	7.0
7	Umerabad	NC	1064.571541	18,097	25	452,429	678,643	9.0
8	Qazi Khel	NC	182.3836904	8,072	25	201,791	302,686	4.0
9	Ghari Hamid Gul	NC	215.9143689	10,804	25	270,103	405,155	5.0
10	Muslim Abad	NC	342.536931	8,155	25	203,870	305,804	4.0

Sr. No.	Name of Administration Unit	NC/VC	Area	Population 2022	Per Capita Water Demand	Avg. Water Demand	Max. Water Demand (Factor = 1.50)	Number of Tubewells
			(Acre)		(Gallons/Capita/Day)	(Gallons/Day)	(Gallons/Day)	(1T/W Cap. = 0.084 MGD*)
11	Islamabad	NC	216.3243772	10,082	25	252,042	378,063	5.0
Total of NCs			3,284	128,720		3,218,009	4,827,014	64.0
Proposed Urban Boundary for Year 2042								
12	Chak Nissata	VC	2,289.23	5,067	25	126,681	190,022	3.0
13	Mara Prang	VC	1,220.69	11,546	25	288,642	432,963	6.0
14	Ameer Abad Rajjar	VC	217.14	17,997	25	449,929	674,893	9.0
15	Salarzai	VC	399.88	13,273	25	331,815	497,722	6.0
16	Parich Khel	VC	127.26	7,995	25	199,881	299,821	4.0
17	Piran	VC	191.68	9,648	25	241,200	361,800	5.0
18	Haleem Abad	VC	557.51	7,157	25	178,927	268,390	4.0
19	Tariq Abad	VC	505.93	9,746	25	243,643	365,465	5.0
20	Chitral	VC	503.64	13,213	25	330,326	495,489	6.0
21	Sheikh Abad	VC	1,240.84	11,298	25	282,462	423,694	6.0
Total of VCs			7,254	106,940		2,673,505	4,010,258	54.0
Total						**5,891,514.3**	**8,837,271.4**	**118.0**

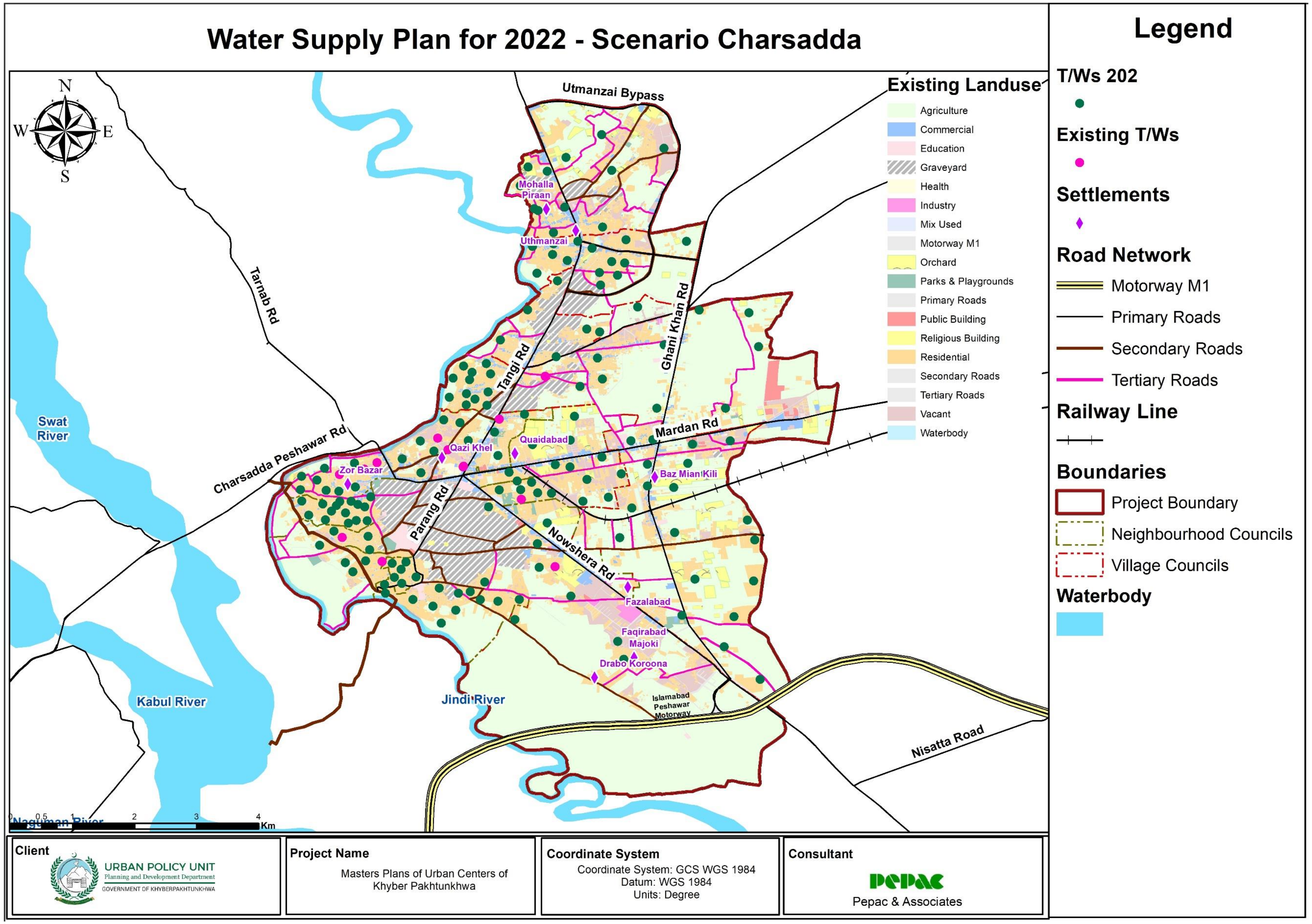
There are 12 existing tubewells operational in the Charsadda project area. So, to meet the water demands of Charsadda City, in the 2022 scenario, we need to install 118 – 13 = 105 new tubewells with capacity of each tubewell not less than 0.10 cusecs. Water Supply proposal for 2022 scenario is shown in **Figure 8.01.**

14.3.1.2. Water Supply Proposal for 2042 Scenario

For future three residential zones have been proposed namely Infill and Zone-1. It is predicted that all vacant lands available in NC will accommodate increase in population in NC areas. While further increase of population and increase of population of all VCs will be shifted to Zone-1.

In these residential zones private housing schemes will also going to develop. They will provide water supply to their residents by their own sources. The local government will only provide sewerage services to their residents. Looking at the current practices, 0% of future population will be residing in private housing schemes. So, in this proposal only 80% of projected future population will be considered for water supply

Map 33: Water Supply Map for 2022 Scenario



Source: Devised by Consultant

No. of tubewells for 2042 scenario

The tubewells capacities in the Charsadda plain varies from 0.27 cusecs to 0.36 cusecs. Tubewell capacity of 0.31 cusecs has been assumed as average capacity of one tubewell.

Capacity of one tubewell = 0.31 cusec

= 7000 gallons per Consider

12 hrs of tubewell operation,

Capacity of one tubewell = 84,000 gallons per day

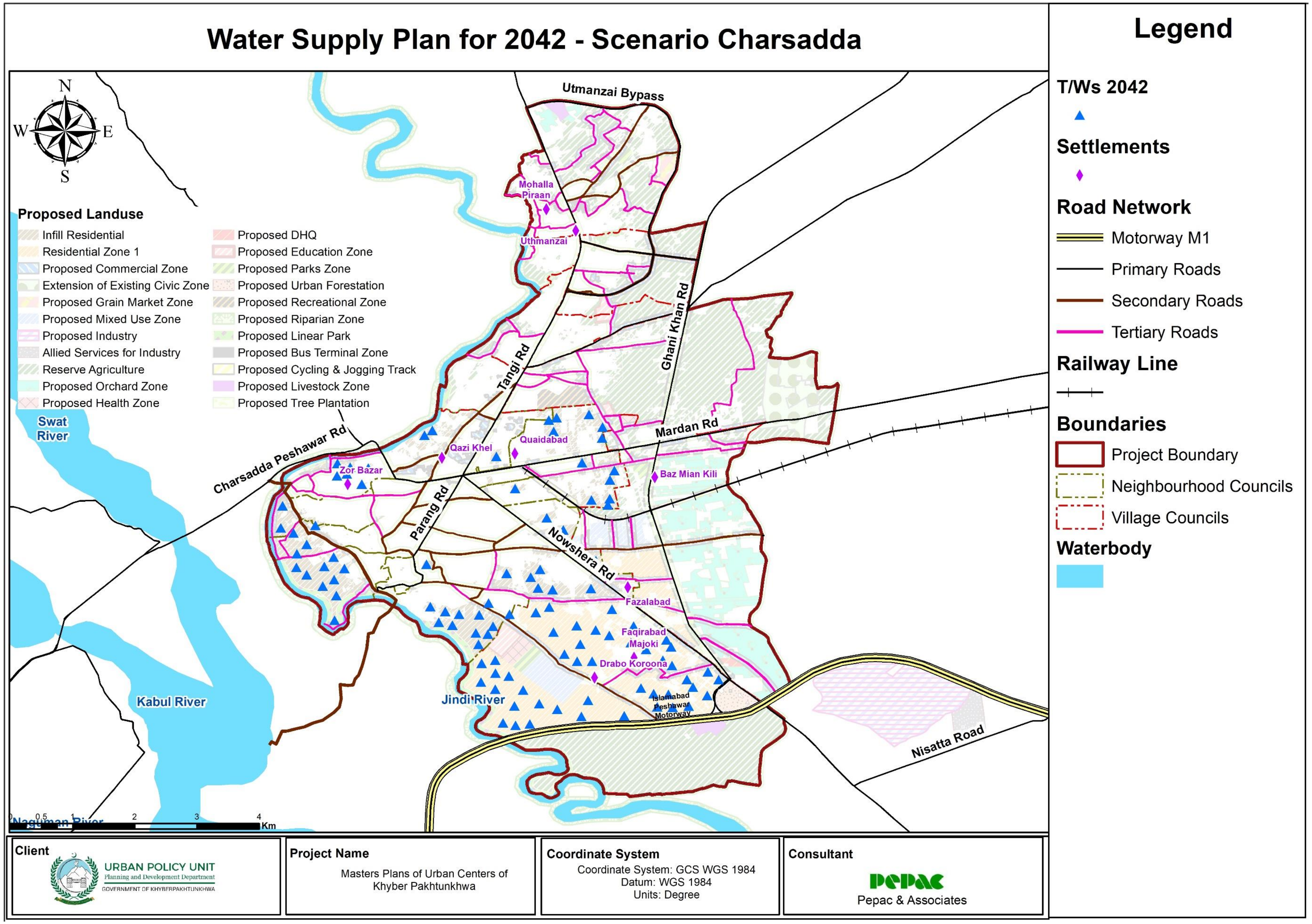
Detail calculation for number of tubewells for the 2042 scenario has been shown in **Table 55**.

Table 55: Number of Tubewells for 2042 Scenario

Sr. No.	Name of Administration Unit	Area (Acre)	Population 2042	Per Capita Water Demand (Gallons/Capita /Day)	Avg. Water Demand (Gallons/Day)	Max. Water Demand (Factor = 1.50) (Gallons/Day)	Number of Tubewells (1T/W Cap. = 0.084 MGD*)
1	Infill	634.93	2.57	79,056	25	1,976,400	2,964,600
2	Zone 1	857.32	3.47	63,976	25	1,599,400	2,399,100

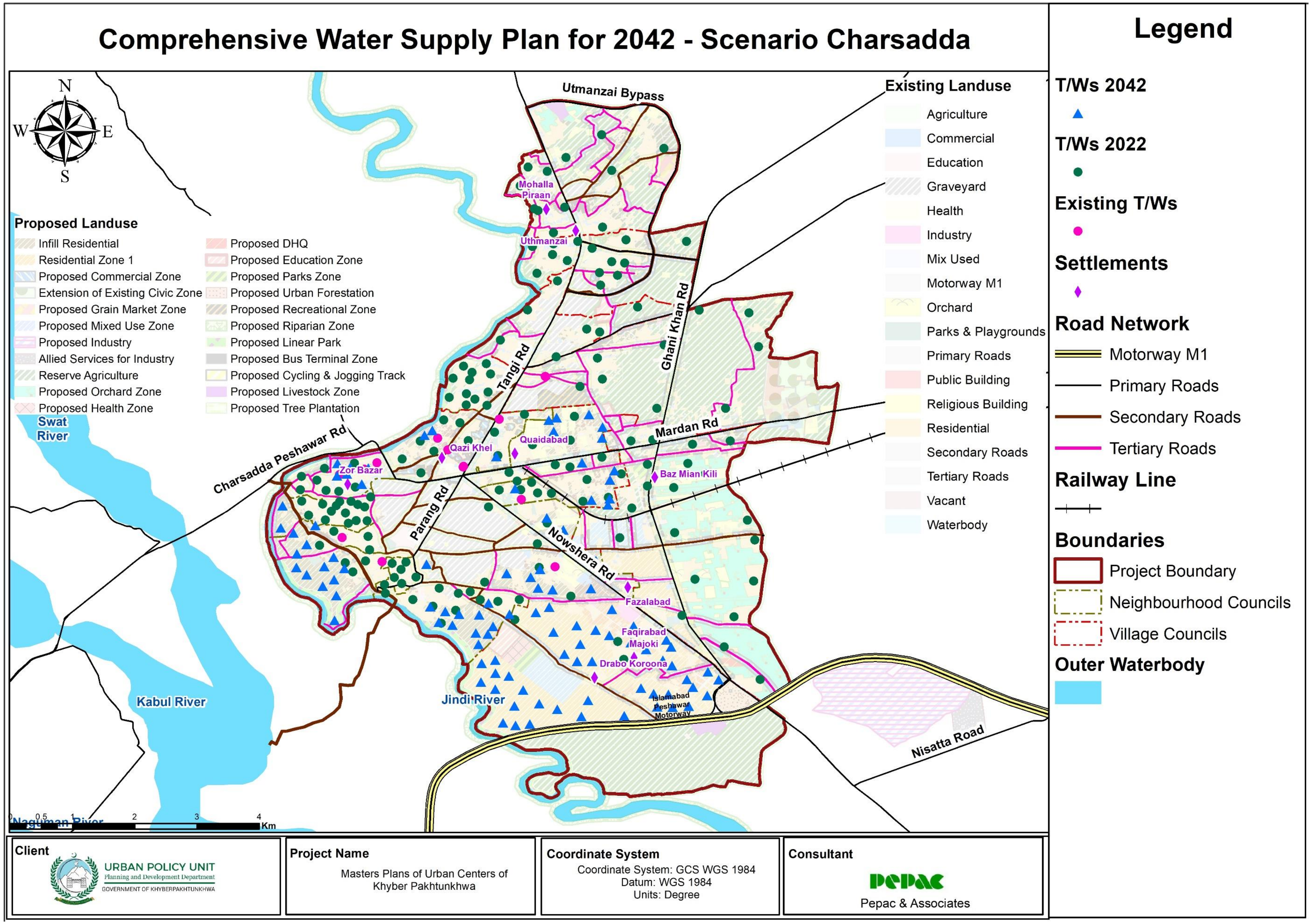
In order to meet the future demand of water supply of Charsadda project area further 104 tubewells need to be install in the proposed residential zones. Water Supply proposal for 2042 scenario is shown in map below. A comprehensive map combining both proposals have shown in below

Map 34: Water Supply Map for 2042 Scenario



Source: Devised by Consultant

Map 35: Comprehensive Water Supply Proposal



Source: Devised by Consultant

14.3.2. Sewerage System

As currently no piped sewerage system exists in Charsadda project area it is recommended to lay RCC pipes in the entire area and take all sewerage to a feasible treatment plant nearby water body before outfall.

- **Unit Flow**

Unit demand for sewerage is considered as 85% of unit water demand (25 gals/capita/day). So unit sewerage flow considered as 21 gals/capita/day.

- **Design Flow**

Current Sewerage Flow = 21 x 240,777

= 5,056,317 gallons per day

Proposed Average Design Flow = 383,809 x 21

= 8,059,989 gallons per day

Take 100% for stormwater and based on population peak factor of 2.0, the total design flow is:

Total Design Flow = 8,059,989 x 2.0 x 2.0

= 32,239,956 gallons per day

Sewage flows for 2022 scenario and 2042 scenarios has been calculated in **Table-56** and **Table -57.**

Table 81: Sewage Flows for 2022 Scenario

Sr. No.	Name of Administration Unit	NC/VC	Area (Acre)	Population 2022	Per Capita Wastewater Gen. (Gallons/Capita/Day)	Avg. Wastewater Discharge (Gallons/Day)	Peak Water Demand (P.F. = 2.0 + 100% Stormwater) (Gallons/Day)	Peak Water Demand (P.F. = 2.0 + 100% Stormwater) (Cusecs)
Existing Urban Boundary								
1	Mama Khel	NC	303.18	5,610	21	117,808	471,234	0.88
2	Yasin Zai	NC	54.65	9,384	21	197,063	788,252	1.46
3	Main Kalli	NC	369.257	17,043	21	357,908	1,431,632	2.66
4	Babara	NC	154.17	7,484	21	157,164	628,657	1.17
5	Aziz Khel	NC	179.06	20,332	21	426,970	1,707,879	3.17
6	Mirzagan	NC	201.60	13,658	21	286,817	1,147,269	2.13
7	Umerabad	NC	1064.57	18,097	21	380,040	1,520,160	2.82
8	Qazi Khel	NC	182.38	8,072	21	169,504	678,018	1.26
9	Ghari Hamid Gul	NC	215.91	10,804	21	226,887	907,547	1.69
10	Muslim Abad	NC	342.536	8,155	21	171,250	685,002	1.27
11	Islamabad	NC	216.32	10,082	21	211,715	846,861	1.57
Total of NCs			3,284	128,720		2,703,128	10,812,511	20.1
Proposed Urban Boundary for Year 2042								
12	Chak Nissata	VC	2,289.23	5,067	21	106,412	425,649	0.79
13	Mara Prang	VC	1,220.69	11,546	21	242,459	969,837	1.80

Sr. No.	Name of Administration Unit	NC/VC	Area	Population 2022	Per Capita Wastewater Gen.	Avg. Wastewater Discharge	Peak Water Demand (P.F. = 2.0 + 100% Stormwater)	
			(Acre)		(Gallons/Capita/Day)	(Gallons/Day)	(Gallons/Day)	(Cusecs)
14	Ameer Abad Rajjar	VC	217.14	17,997	21	377,940	1,511,760	2.81
15	Salarzai	VC	399.88	13,273	21	278,724	1,114,897	2.07
16	Parich Khel	VC	127.26	7,995	21	167,900	671,600	1.25
17	Piran	VC	191.68	9,648	21	202,608	810,431	1.51
18	Haleem Abad	VC	557.51	7,157	21	150,298	601,193	1.12
19	Tariq Abad	VC	505.93	9,746	21	204,660	818,642	1.52
20	Chitral	VC	503.64	13,213	21	277,474	1,109,895	2.06
21	Sheikh Abad	VC	1,240.84	11,298	21	237,268	949,074	1.76
Total of VCs			7,254	106,940		2,245,744	8,982,977	16.7
Total						**4,948,872.0**	**19,795,487.9**	**36.8**

Table 82: Sewage Flows for 2042 Scenario

Sr. No.	Name of Administration Unit	Area	Area (sq.km)	Population 2042	Per Capita Wastewater Gen.	Avg. Wastewater Discharge	Peak Water Demand (P.F. = 2.0 + 100% Stormwater)	
		(Acre)			(Gallons/Capita/Day)	(Gallons/Day)	(Gallons/Day)	(Cusecs)
Proposed Residential Zones								
1	Infill	634.93	2.57	79,056	21	1,660,176	6,640,704	12.34
2	Zone 1	857.32	3.47	63,976	21	1,343,496	5,373,984	9.99
Total		**1,492.3**	**6.0**	**143,032.0**		**3,003,672.0**	**12,014,688.0**	**22.3**

Map for sewerage system proposal for 2042 scenario has been prepared and shown in **Figure 8.04.**

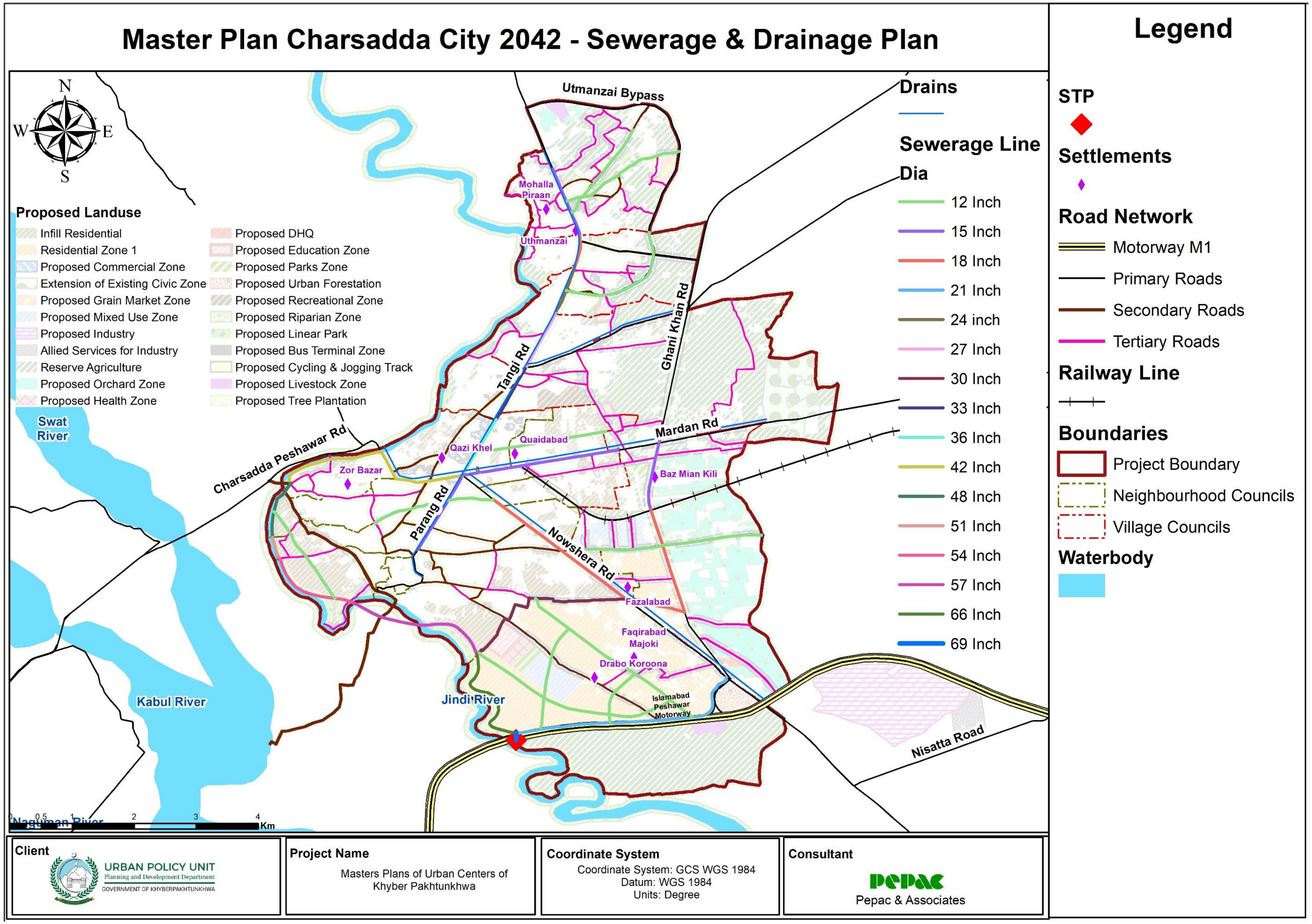
<u>Wastewater Treatment Plant</u>

One wastewater treatment plants (WWTP) would be required for the whole Charsadda City. Each having capacity of:

WWTP Design Capacity = 8,059,989 gallons per day

= 14.98

Map 36: Sewerage network of Charsadda- Study Area



Source: Devised by Consultant

14.4. Proposals for Solid Waste

Solid Waste Management (SWM), if not managed properly could be a major environment and health hazard for urban areas of Pakistan. Cities economies are fast growing, business activity and consumption patterns are driving up solid waste quantities. In Pakistan the collection of waste is sporadic and the disposal is poor. Despite the fact that solid waste services represent the single largest expenditure item, less than 50 percent of the waste generated is collected; and is mostly disposed at dumpsites or roadsides.

Additionally, recent history has shown that lifestyle is changing at a brisk pace in the city. Due to changing lifestyles and consumption habits, SWM has been increasingly recognized as one of the major environmental issues in the city. The rapid growth of many small to medium sized towns in KPK is causing unprecedented deterioration in the ecosystem. It is also placing enormous pressure on the capacity of these towns to provide adequate Solid Waste Management (SWM) services for their increasing populations.

In Charsadda, solid waste management has been a significant challenge because of no proper mechanism for waste disposal. Most of the waste is dumped in open spaces, causing health hazards for the residents. To tackle the issue of solid waste management, the local government has initiated several projects. However, due to the lack of awareness among the residents, they continue to dump waste in open spaces. The local government has also launched awareness campaigns to educate the public about the importance of proper waste disposal and the dangers of littering.

In addition to solid waste, Charsadda is also facing a problem with the disposal of charred biomass, known as char. The city is home to several brick kilns that burn wood and other biomass to produce bricks. The charred biomass is usually dumped in open spaces, causing environmental pollution and health hazards. To address this issue, the local government has introduced a project to use char as fuel for power generation. The project aims to reduce the environmental impact of char disposal while providing a sustainable energy source for the community.

14.4.1. Solid Waste Management in Pakistan

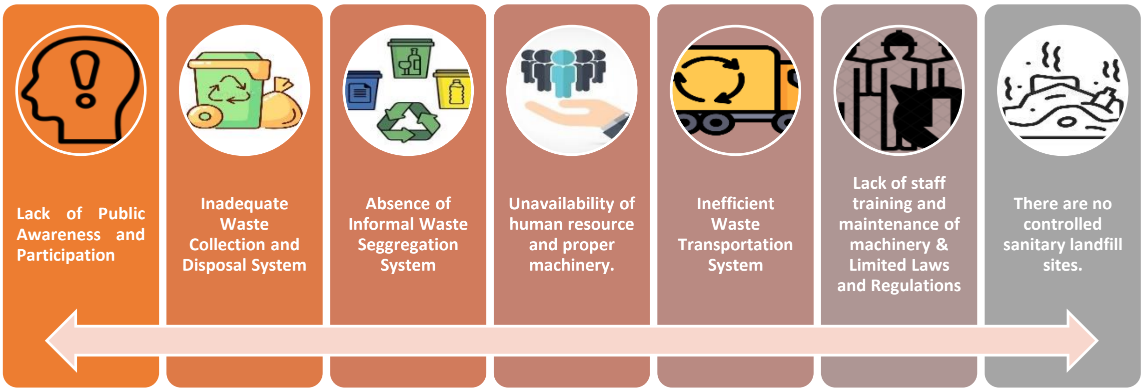
Most municipalities in developing countries spend a large proportion of their budgets on the collection, transport, and disposal of solid wastes. Most cities of developing countries, municipal SWM costs consume 20-50% of municipal revenues yet collection service levels remain low with only 50-70% of residents receiving service and most disposals being unsafe. The situation is likely to worsen due to continuing population growth and urbanization in developing countries.

Like other developing countries, Pakistan is also facing serious environmental problems. Developmental planning in the country has never focused on the poverty-environment nexus which has resulted in unregulated depletion of natural resources and has led to urbanization as well as unplanned agricultural and industrial proliferation. The combination of an overloaded local and national coping mechanism with a diminishing resource-base has resulted in a situation of uncontrolled pollution of water and other natural resources. Solid waste generation in Pakistan ranges between 0.283 to 0.612 kg per capita per day. Accordingly, a household generates 1.896 kg to 4.29 kg per day while the waste generation growth rate is 1% per year.

Unplanned urbanization, poor sanitation, ill-planned drainage systems, inadequate human and capital resources for collection and disposal of waste, unavailability of official dumping sites, absence of weigh bridges for exact measurement of waste received at these sites, and almost negligible presence of recycling processes have negatively impacted waste management in the country.

Accumulation and improper disposal of solid waste in urban and semi-urban centers plays a major contributing factor in this deteriorating environmental situation in the country. Solid waste collection by government owned and operated services in Pakistan's urban centers currently averages only about 50% of waste quantities generated. However, for cities to be relatively clean, at least 75% of these quantities should be collected. The rest of the waste remains uncollected or is disposed of by communities with unconventional and environmentally unsafe methods. The situation is deemed far worse in resource-deprived urban centers such as small towns/tehsil centers.

The following are the main problems regarding solid waste management in small urban centers of Pakistan:



14.4.2. Waste Hierarchy Process: 3Rs

In 1975's Waste Framework Directive (Directive 75/442/EEC) of the European Union formally adopted the waste hierarchy idea as a SWM policy for the first time. It emphasises the necessity of waste reduction, environmental protection, and human health as top concerns.

Often depicted in the form of a pyramid, the waste management hierarchy suggests an order of preference for actions to reduce and manage waste. The hierarchy illustrates the progression of a material or product through successive waste management phases and provides essential basic suggestions for the relative attractiveness of the various management methods.

The typical waste management hierarchy is (a) waste prevention, (b) waste minimization / source reduction, (c) recycling, (d) waste processing (with recovery of resources, i.e. energy) or waste transformation (without recovery of resources), and (f) land disposal (land-filling). This philosophy of minimizing waste, reusing resources, and recycling products is sometimes referred to as the "3Rs." Focusing largely on the first of the 3Rs, "reduce," is the most economical strategy to achieve waste minimization, followed by "reuse" and then "recycle.".

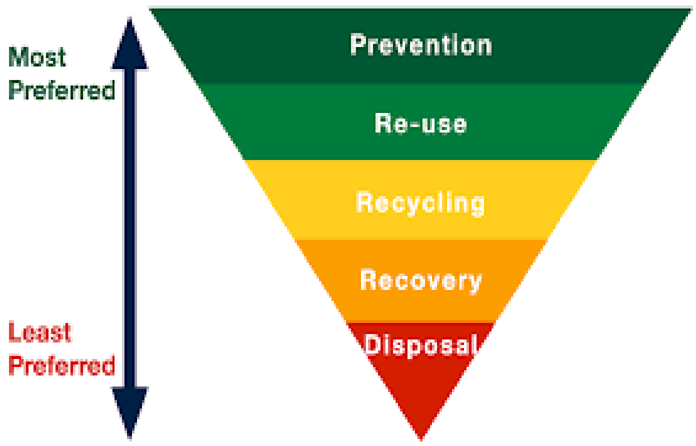
14.4.3. Why Manage Solid Waste?

The danger of improper solid waste handling and disposal to human health and the environment cannot be over-emphasized. When solid waste is disposed-off on land in open dumps or in improperly designed landfills (e.g., in low lying areas), it causes the following impact on the environment.

Open dumping of wastes creates unsightly and unsanitary conditions within municipalities, and causes unpleasant odours, which attract flies, stray animals, mice and other vectors. This increases the potential for vector-borne diseases and epidemics. Similarly, gathering of scavenging birds above the waste dump can affect aircraft flights and their safety. Such dumps also lead to pollution of ground and surface water through leachate as well as air through emission of noxious and offensive greenhouse gasses and methane. An increase in the acidity of surrounding soil leads to loss of agricultural potential.

Open solid waste dumps in urban localities are public health risk. Direct contact with refuse can potentially cause infectious diseases such as cholera and dysentery. Scavengers, especially, face a danger of direct exposure to hazardous waste. Fires within the waste dump may spread to surrounding homes and habitat.

Some categories of solid wastes block permeability of soils and drainage systems, including water courses, open drains and sewers, thus posing difficulties in the functioning and maintenance of such facilities. Inert waste may also cause erosion and stability problems in foundations of buildings, mountain slopes and road sides.



14.4.4. Legal and Institutional Framework regarding Solid Waste Management in Pakistan

Pakistan, like other developing countries, faces serious environmental problems. Rapid population growth has put enormous pressure on the country's natural resource base and significantly increased the levels of pollution. Pakistan has still not addressed the issues of sustainable development and environmental protection in a comprehensive manner and is consequentially facing huge resource gaps in dealing with the situation. Furthermore, with the advent of the 18th amendment of the constitution of Pakistan, legislation for environmental protection has become a provincial matter and the Pakistan Environmental Protection Act (1997) no longer holds legal status in the provinces. This situation now requires each province to come up with its own laws for protecting the environment; including those for transport and disposal of hazardous and waste materials.

14.4.5. Currently available legal framework regarding SWM in Pakistan

Presently the legal rules and institutional framework dealing with SWM in the country include:

KP Environmental Protection Act (KP - EPA) 2014	**Hazardous Substances Rules of 1999.**	**Guidelines for Hospital Waste Management since 1998**
Hospital Waste Management Rules 2005.	**Section 132 of the Cantonment Act 1924**	**Guidelines for Solid Waste Management (Draft), 2005**

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14.4.6. Institutional framework regarding SWM in Pakistan

Institutional frameworks are available but need strengthening to deal with the ever-increasing burden of SWM; both in the main cities as well as urban centres in rural areas. At the provincial level, the Local Government and Community Development Department (LG&CDD) has been mandated to support the Town/Tehsil Municipal Administrations (Tehsil Municipal Administrations) in developing the capacities, both institutional as well as human resource wise, to deal with their responsibilities in this regard.

14.4.7. Purpose of the Report

The proposed Integrated Waste Management System (IWMS) is a sectoral level plan for the improvement of solid waste management of the city, divided in to following sections:

Section 1: Review and inventory of existing Solid Waste practices in Charsadda City and its improvement.

Section 2: Provision of required resources for Improvement of future Solid Waste Management of TMA Charsadda till 2042.

Table 83: Authorities responsible

Execution	TMA Charsadda
Operation and maintenance	TMA Charsadda
Concern provincial department	Sanitation and Conservancy Department Environmental Protection Department

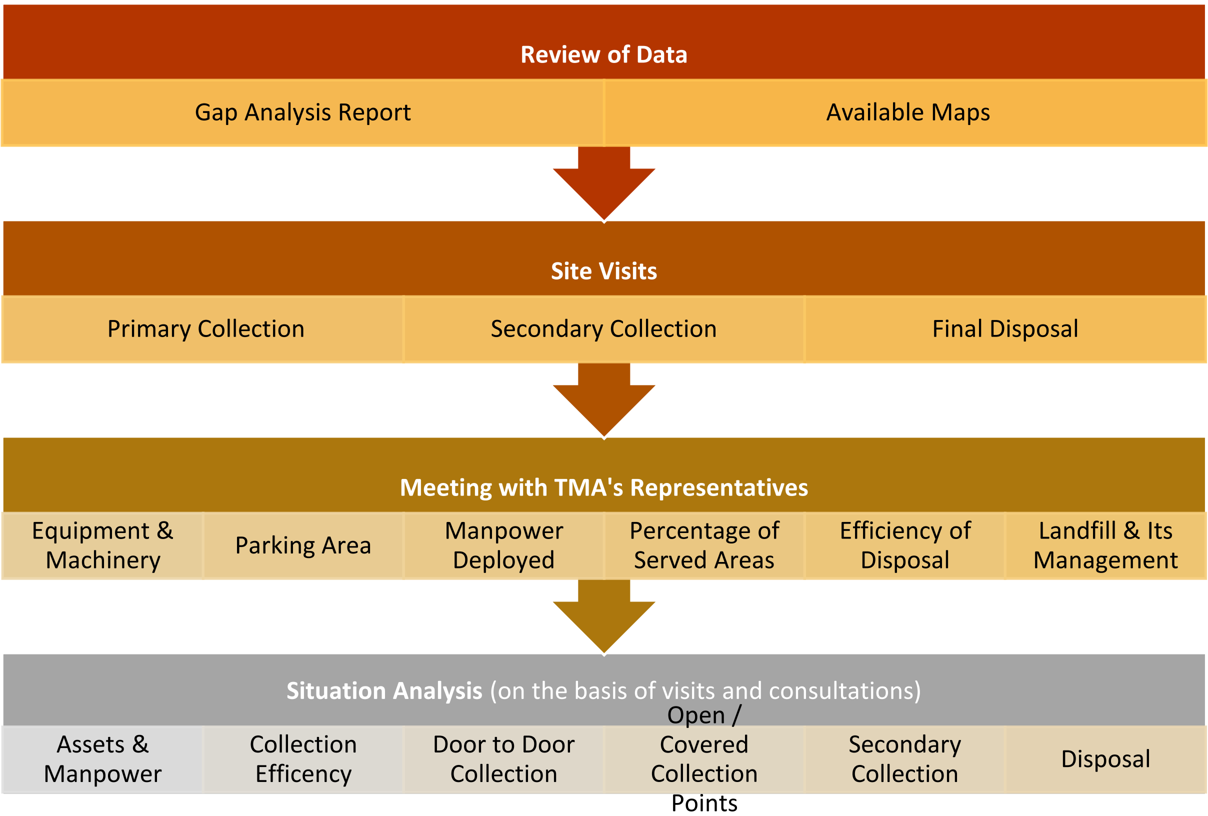
14.4.8. Existing Situation and Analysis

Charsadda city also lacks a proper landfill site for solid waste disposal, and the waste management authority doesn't have sufficient resources to manage waste effectively. The lack of public awareness regarding waste management practices leads to more waste production and land pollution, with open dumping being practiced in many areas of the city. This causes a nuisance to nearby communities and poses health and environmental risks due to the unsanitary conditions and the potential for vector-borne diseases.

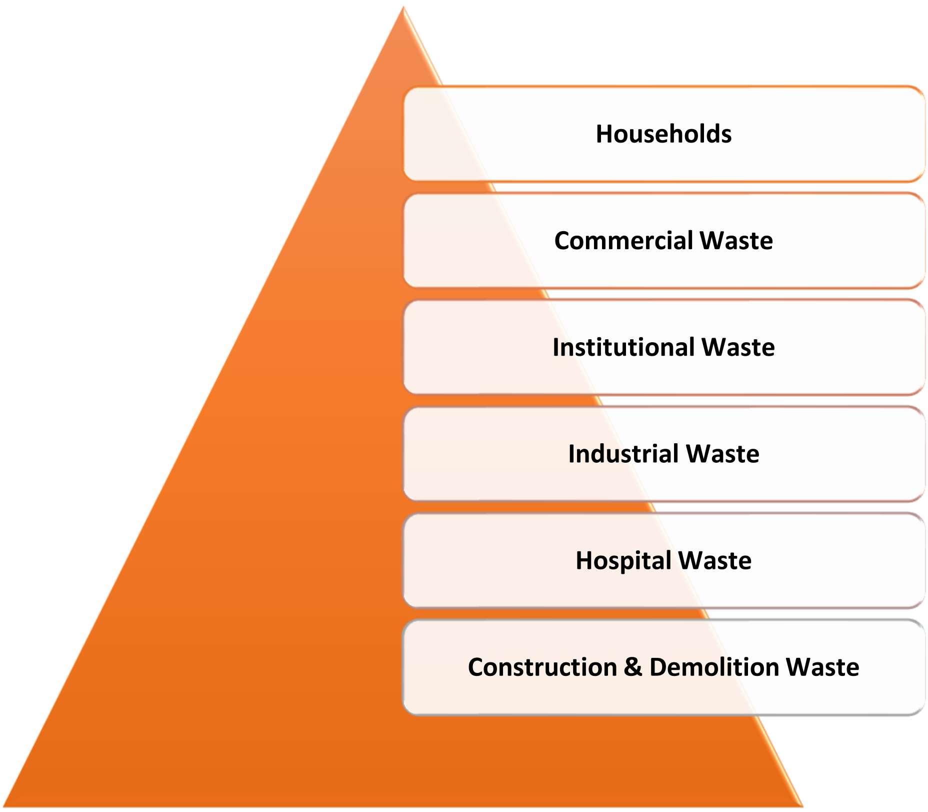
The bulk of waste generated in Charsadda is causing issues related to health and the environment, with the city's population growth, economic expansion, and urbanization leading to an increase in waste production. The waste composition varies depending on the lifestyle, economic situation, waste management regulations, and industrial structure.

Currently there is only one dumping site present in the city having an area of 20 Kanals to cater the demand of 240,545 population (2022). The existing dumping site is not being managed properly, affecting nearby communities and polluting the environment. The current dumping site is insufficient to cater to the existing demand for waste disposal, and open dumping is prevalent in the city. Sustainable landfill sites are needed for long-term waste disposal, with proper land acquisition rules and compensation for landowners. To address these issues, an integrated solid waste management system with sustainable planning is necessary for proper waste collection and disposal in the city.

Methodology for situational analysis is given below:



14.4.8.1. Classification of Solid Waste



14.4.8.2. Main Economic Activities

Agriculture | Forestry | Industries

14.4.8.3. Functions of TMA

TMA Charsadda provides collection, transportation, and disposal services for solid waste. The TMA shall provide SWM services within its jurisdictional boundaries. Owing to a lack of equipment and personnel, TMA Charsadda is incapable of serving the entire town. Containers, tractor loaders, arm rolls, garbage dumpers, front blade tractors, front end loaders, and water bowsers are included in the fleet. The TMA provides the following services:

- Managing, controlling, and monitoring the city's existing system directly or indirectly associated with solid waste management.
- Improvement and enhancement of the current organizational competence for solid waste management.
- Management and maintenance of machinery and equipment’s.
- Taking all actions necessary for appropriate solid waste management in order to protect public health. Also, ensure that garbage is managed in an environmentally responsible manner.
- Encouraging safety standards for generated garbage and delivering specific directives to individuals and Organisations.
- Raising public awareness of the significance of waste reduction, resource recovery, and solid waste management efficiency.
- Proposing and enforcing general standards, guidelines, and codes of practise pertaining to solid waste management.

14.4.8.4. Provisional Scoping Matrix for Solid Waste Management

The municipality's persistent struggle to maintain a clean town is primarily attributed to a general lack of civic awareness and public cooperation. Despite being crucial in developing an effective participatory solid waste management (SWM) system, the collaboration between civil society organisations, stakeholder groups and the municipality is still in its early stages. To enhance the capacity of the TMA and attain better outcomes in waste collection and disposal, the municipality has yet to formally engage any organisation or community group.

The critical role that stakeholders can play in educating and mobilising the community has not been adequately acknowledged. The community members, including women, children, and elders, are not sufficiently involved in designing and implementing the SWM system. As a result, the existing SWM system lacks depth and is non-participatory. The contribution of these community members as an essential component of waste generation is not recognised, further exacerbating the existing challenge of solid waste management in the town.

14.4.9. Solid Waste Generation

Generation of waste refers to the activities in which materials that are no longer regarded as having value (refuse from households and farms, non-hazardous solid waste from industrial, commercial, and institutional establishments including hospitals, market waste and garden waste, as well as street sweepings) are either thrown away or gathered together for disposal. The following tables detail the present population as well as the amount of waste produced:

Table 84: Solid Waste Generation

Sr. No.	Year	Rate of waste generation per capita/day	Population (2022)	Kg / day	Tons/day
1	2022	0.42	240,777	101126.34	101.13

*kg = kilogram. * Waste Sector Inclusion in the Revised Nationally Determined Contributions of Pakistan, 2022. (ADB Publication)*

14.4.10. Collection & Transportation

The operational modalities devised for successful implementation of this section are provided below:

The city currently has few vehicles for the transportation of waste from bins to dumping site. The condition of vehicles being observed were satisfactory. The existing system of SWM is a continuation of the traditional system that was being managed by the Municipal Administration. Equipment used for waste collection includes the collection bins, containers, arm roll trucks, trolleys, front blade tractors, front end loaders, water Bowsers, garbage dumpers. Below are the details of the Solid waste Generation & Disposal and Solid waste Coverage Detail for TMA Charsadda.

The table below provides the audit findings that was conducted to assess the existing activities being conducted from an environmental and social safeguards perspective and the required corrective measures that will be implemented.

Table 85: Current Situation Findings of the City

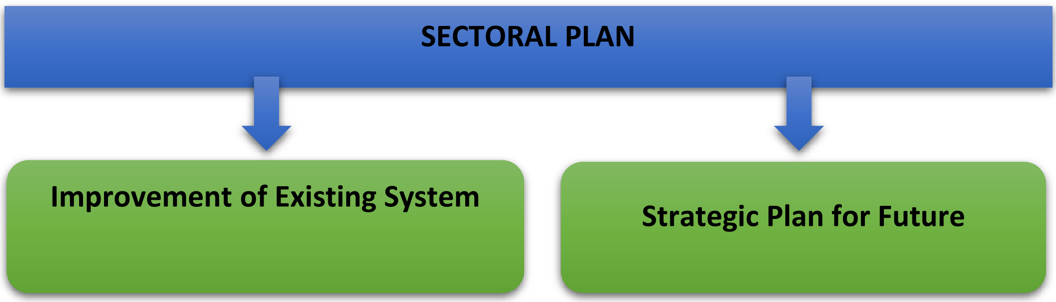
Sr. No.	Component	Existing Practice and Issues
1	Waste Generation	Solid waste generation in the tehsil is approximately 101 tons per day as per 2022 projection. Due to shortage of required resources, TMA Charsadda is not capable to serve the entire area of the town.
2	Storage of waste at source	Lack of public awareness, motivation, and education; Lack of civic sense and bad habits of people to litter; Lack of cooperation from households, trade, and commerce; Lack of litter bins in the city; Long distance between community bin;
3	Waste Collection	Citizens throw waste on streets instead of communalbins; Workers need to collect all scattered waste manually Multiple transactions of waste till disposal site; Lack of awareness and motivation; Maintenance and repairing of existing equipment and machinery Insufficient response from citizens.
4	Daily sweeping of streets	100% manual sweeping system makes difficult for the sanitary workers to cover TMA jurisdiction each day; Manual attendance management system is inefficient and leads to inefficiencies; No need to sweep on Sundays.
5	Communal Storage	Shortage of containers; Lack of financial resources leading to broken and illmaintained bins; Lack of planning for waste storage depots or temporarystorage locations; Inaccessible areas and narrow lanes that do not allow sufficient space for container.
6	Transportation	open vehicles for transport; Old vehicles that are difficult to replace; No scheduling for lifting of containers.
7	Waste Treatment	No Waste Treatment Facility is available.
8	Disposal of Waste	Lack of financial resources for a scientifically designedland fill site; Absence of proper land for landfill and technical personals

14.4.11. Proposed Strategic Approach/Sectoral Plan

Having established the priorities, the next step of the Plan is to provide broad guidelines to suggest measures to manage the growing solid waste of the town. This has been determined after assessing the potentials and constraints in the existing solid waste management of the city. The plan is prepared with from year 2022 to year 2042. This section of the report deals with an outline of proposals regarding;

Identifying gaps in exiting municipal services (already discussed) as well as identifying needs for the incremental population growth.

Capacity building for O&M of the municipal services is also proposed in these Action Plans.



14.4.11.1. Objectives of the waste management Plan

According to the developed vision, the following strategic objectives are to be achieved by 2042:

A comprehensive and sustainable approach towards improving waste collection, storage, transfer, disposal and treatment, including hazardous waste is implemented.

Provision of new, improved, economical, efficient and cost-effective solid waste collection and transportation machinery & equipment for the collection of primary and secondary collection and safe transportation of solid waste to dumping site.

14.4.11.2. Timeframe

Table 86 - Implementation Schedule

Tire 1	Improvement of Existing Solid Waste Management of The City
Tire 2	Provision of Solid Waste Management Resources for future solid waste management

14.4.11.3. Tire 1: Improvement of Existing Solid Waste Management of The City

Existing Solid Waste Management of the city require following corrective actions.

Sr. No.	Component	Required Corrective Action
1	Storage of waste at source	Door to Door collection would reduce littering in the streets; Strong behavior change communication programs would improve citizen's behavior; Removal of roadside communal bins would have a major impact on the street localities.
2	Segregation of recyclables	Segregation and materials recovery facilities would be developed; Refuse Derived Fuel (RDF), would be developed; Conversion of Organic component to organic compost; Efforts must be made to encourage segregation at source.
3	Collection	Improved citizens behavior throw communication; Collection vehicles pool All collection staff would have PPEs, in order to safeguard their health and safety; Citizens would hold the key to accountability, to ensure that the daily door to door collection is performed.
4	Daily sweeping of streets	With full Door to Door collection, the need for daily sweeping of all streets would be minimized to maximum twice a week.
5	Communal Storage	All unnecessary communal storage points in residential areas would be removed; No containers, no throwing by households into the streets; Commercial areas and institutions would have communal bins; User charges would be levied to induce financial sustainability.
6	Transportation	Waste would be carried in fully covered vehicles, in order to avoid any littering and pollution; Number of vehicles would be minimized, with transfer stations and larger hauling containers; Environment friendly transfer facilities with dust & odor control.
7	Waste Treatment	Materials Recovery Facility (MRF) would ne developed which will be an integral component of the treatment and disposal system; Options for Private sector participation would be explored in operations of the MRF centers; Specialized skilled workers would be operating the transfer stations, and MRF.
8	Disposal of Waste	Landfill would be properly designed and operated; Segregation, MRF and Composting facilities would enhance the useful life of Landfill;

14.4.11.4. Tier 2: Provision of Solid Waste Management Resources for future solid waste management

The future waste generation of the city can be calculated based on projected population (persons).

Solid waste projections were made by considering the current rate of waste generation in Charsadda city. Around 0.42 kg/capita/day standard was used to project the waste generation for the next 20 years in correlation with the rate of population growth. It is to get a glimpse of the future waste generation, disposal and management. The table below is showing the future estimations and projections, which are based on a compound method.

Table 87: SW Projection for 2020 - 2042

Year	Per Capita (Kg)	Population	Per Capita Waste Generation Per Day (tons)	Per Capita Waste Generation Per Year (tons)
2022	0.42	240,777	101.13	36911.11
2027	0.412	273,702	112.66	41119.35
2032	0.407	308,031	125.52	45813.96
2037	0.403	343,133	138.42	50524.39
2042	0.399	378,326	151.09	55149.3

Source: Projection by Consultant

14.4.12. Gap Identification

Various gaps have been identified from the existing situational analysis, in managing the solid waste such as inefficient collection of waste is varying from area to area where the door-to-door collecting is not done and due to the poor management of the waste, inadequate collection and unsuitable disposal of waste; such as waste collection, transport and disposal such as:

Table 88: Gap identification

Areas	Gaps
Waste Generation	According to 0.42 kg/capita/day, 101 tons/day waste is being generated as per 2022 population whereas for 2042 the estimated waste generation would be 191 tons/day. This shows that about 90 tons/day waste would increase in next 20 years.
Collection	According to 2022, the total waste collection efficiency is not satisfactory due to inefficient waste collection system. Inefficient collection of waste which may vary from area to area where the door-to-door collecting is not done. Lack of hand carts/motorbike/rikshaws for primary collection of waste from congested areas. Insufficient Tractor Trolley for secondary waste collection and hance collected waste is not being disposed-off at designated dump sites.
Transportation (Equipment and Machinery)	Due to low efficiency of equipment and machinery, there is large consumption of time and money in its operation. Survey showed that there is a need of mechanical instruments for proper management of waste. The tractors trolleys are slow moving and consuming large fuel & time but carry only one third of the waste to dumping sites as compared to the compactor trucks. The proposition of continued use of this equipment with enhanced number of manpower will not cure the problem. Rather it will increase the operation and maintenance cost with very little improvement of the

Areas	Gaps
	service delivery level.
Manpower	Presently, Charsadda city is short of manpower required for the collection and disposal of waste because of the ban imposed on the recruitment of staff since long. The population has increased whereas the man power has been reduced because of death and retirement of number of skilled and unskilled workers. There is a need of training of officers and workers for operation and maintenance of the machinery.
Disposal	After conducting survey of dumping site, it was determined that the existing one dumping sites under TMA jurisdiction is poorly managed. TMA has small but covered built-up parking area at present and the vehicles are parked in this area. This space is required to be converted in to proper parking area by construction of parking sheds, vehicles washing and service arrangements and other allied facilities.

Hence there is a large gap which needs to be bridged by

- Latest, more efficient collection and transportation equipment and machinery
- Delivering equivalent and satisfactory services to all parts of the city
- There is need to increase the present efficiency of waste collection to 90%.

Table 89- Total Estimated Machinery Requirement

HR	Additional Requirements				
	2022	2027	2032	2037	2042
Containers 0.8 m3	50	20	20	20	20
Handcarts Tripping Trolley 0.25 m3	15	5	5	5	5
Mini Tipper 01 m3	6	6	6	6	6
Arm Roll Containers 5.0 m3	2	2	2	2	2
Garbage Compactor 8.0 m3	11	3	3	3	4

14.4.13. Disposal of Solid Waste Management

14.4.13.1. Need

In Charsadda, the practice of at-source waste storage is non-existent, as the majority of residents dispose of their waste outside their premises, including on streets, in drains, open spaces, water bodies, and other inappropriate locations. Unfortunately, it is common practice of residents to discard waste into the running water bodies, including streams and canals, leading to the city's waterways becoming designated dumping sites. However, the TMA has taken proactive measures to address this challenge, including deploying containers and litter bins along main roads and streets. Additionally, after sweeping the streets, sanitary workers collect waste in handcarts and transport it to designated waste storage points in the area, typically containers.

To address the prevailing solid waste management issues in the city, the TMA has proposed a landfill site. The site's design seeks to establish a comprehensive and sustainable solution to waste disposal and management within Charsadda. The proposed landfill site would provide the necessary infrastructure for the proper disposal of waste and offer a long-term solution to the city's waste management challenges.

14.4.13.2. Transfer Stations

Currently, most waste collected by collection vehicles is taken to the dumping site directly. Smaller vehicles dump their waste at open collection points and this waste is lifted in bigger dump trucks etc. In order to improve the overall waste management system and urban environment, depending upon the waste generation rate, location of landfill and collection vehicles, a mini waste transfer stations can be proposed at suitable area.

14.4.13.3. Mini Transfer Station – Arm Roll vehicles containers of 5 m3 size, placed along a ramp in enclosures.

The primary reason for using a transfer station is to:

- Waste transfer stations help to reduce the cost of solid waste management operations by consolidating waste collection and transportation.
- They minimize the number of trips taken by waste collection vehicles, thereby reducing fuel consumption and associated costs.
- They provide a more efficient and centralized location for sorting and separating waste, making it easier to recycle and compost materials that are suitable for these processes.
- Waste transfer stations can extend the lifespan of landfills by reducing the amount of waste being deposited, thereby postponing the need for the construction of new landfills.
- They provide a safer working environment for waste management personnel as waste is transported to the transfer station rather than directly to the landfill site.
- Waste transfer stations can help to improve the aesthetic appearance of the surrounding environment by reducing the amount of waste that is stored or dumped in public spaces.
- They can also reduce the environmental impact of solid waste management by minimizing the distance traveled by waste collection vehicles and reducing greenhouse gas emissions associated with waste transportation.

14.4.13.4. Scenario Analysis for All Possible Treatment/Reduction Methods

Based on the quantum of waste and composition, there will be five possible scenarios which could be further ruled out through alternate technological comparative analysis. Landfill cannot be replaced because it would be needed in any case for the disposal of the reject and/or disposal of unsaleable compost and no single technology would be suitable for mixed waste.

Scenario-1-No Treatment: Can be without any intermediate treatment and 100% waste collected islandfilled as shown in **Figure** below.

Figure 31: Scenario-1-No Intermediate treatment

Table 90, Pros/Cons of Scenario-1

Pros	Cons
Most common method for ultimate treatment of the mixed waste in Asian countries. Less technicalities involved as comparedto advanced treatment options. Lower risk of technology failures.	Higher methane emissions in case of non-LFG capturing project. No remedy in case of landfill liner failure. Higher O&M and life cycle cost. 100% landfilling would require morelandfill.
Easy to operate and maintain, however, institutional competencies must be gauged for O&M of the landfills. Less capital investment required as compared to other technologies.	100% landfilling of the MSW is not in linewith the SGDs and National Action plan. Limited opportunities for harnessing economic potential of the waste.

14.4.14. Scenario-2-Composting, Recycling and Landfilling

Considers the recovery of the recyclables through sorting the mixed wastethrough mechanical means on conveyor belt after fine and coarse screening using trommels. Sorting may be done though magnetic separator and manual processes. Remaining organic fraction can be used for biological treatment using windrowcomposting (with sales of 50% of compost produced while using 50% as soil cover forlandfill).

Table 91- Pros/Cons of Scenario-2

Pros	Cons
• Suitable for mixed municipal waste withhigher organic fractions • Can recover recyclables • Composting helps to reduce the mass of the organic waste by 60-75% by volume. Even if there are limited compost sales, it's still economically and environmentally beneficial to convert the organic waste to the compost saving environmental emissions, landfill air space (improving the life of the landfill) and	• Without removal of the combustible fraction, the impurities (particularly plastic) may deteriorate the quality of the compost, Therefore, furthermore removal of combustible to prepare RDF will be beneficial but this would be a trade-off between the recyclablesand combustible for a better calorific value RDF. • Recyclables entering the mixed waste stream and collected by the compactors are low quality and therefore would have limited sales andrevenue potential.

Pros	Cons
reducing the O&M cost of the landfill. • Least expensive Option • Easy to operate and maintain the facility • Sorting facilities are available for manual to-semi-automatic to fully automatic.	• Composting process does not recovery the energy potential of the organic waste. It means, CO_2 produced during the aerobic composting process in emitted in theair, though CO_2 is 21 times less harmful than CH^4 • Feedstock management for composting might be challenging.

14.4.15. Scenario-3-Composting, RDF, Recycling, and Landfilling

Employ mechanical and biological treatment process for recovery of recyclables and compostable and conversion of the organic waste to the compost using biological process of windrow composting. Although, recovery of the recyclable would be low when targeting for high quality RDF however it is necessary for removingthe impurities from the organic waste stream.

Table 92: Pros/Cons of Scenario-3

Pros	Cons
• Suitable for mixed municipal waste with higher organic fractions • Can recover recyclables • Organic stream can be converted to compost which can be sold as soil enrichment material or can be used as soil cover for the landfill. Composting helps to reduce the mass of the organic waste by 60-75% by volume. Even if there are limited compost sales, it's still economically and environmentally beneficial to convert the organic waste to the compost saving environmental emissions, landfill air space • Least expensive Option • Easy to operate and maintain the facility • Sorting facilities are available for manual to-semi-automatic to fully automatic.	• Recyclables entering the mixed waste stream and collected by the compactors are low quality and therefore would have limited sales and revenue potential. • Composting process does not recovery the energy potential of the organic waste. It means, $CO2$ produced during the aerobic composting process in emitted in the air, though $CO2$ is 21 times less harmful than $CH4$ • Feedstock management for composting might be challenging • No or limited market for the compost sales • NO or limited market for the RDFsales. • Environmental emission due to direct burning of the RDF by the Cement • factories and brick kilns are not monitored.

Scenarios 3 is suitable options for Charsadda keeping in view the analysis done. However, it's recommended to adopt and implement the option-4 for sustainable waste management. Institutional arrangement, operational plan business model would be key factors for the

success of the proposed system. It’s therefore necessaryto review and develop an enabling environment for the implementation and success ofthe advanced treatment option.

14.4.16. Landfill Site Requirement

A landfill requirement is calculated based on 2017 census, per capita waste generated and percentage of collection efficiency. Population Projection is calculated through following Model:

$$\textbf{Population Projection} = \text{Population } (1 + \text{Growth Rate})^{\text{No of Years / 100}}$$

Per capita waste generation criteria are given below:

Table 93: Waste Generation Estimation Criteria

Criteria	Description
SWM Planning Horizon (2022-2042)	20 Years
Population	Projections based on 2017 Census
Per Capita Waste Generation	0.42 Kg/ca/person
Reduction in per capita waste generation by 2% after every 5 years interval	2%
Additional allowance (%)	25%
Loose waste density (kg/m^3)	500

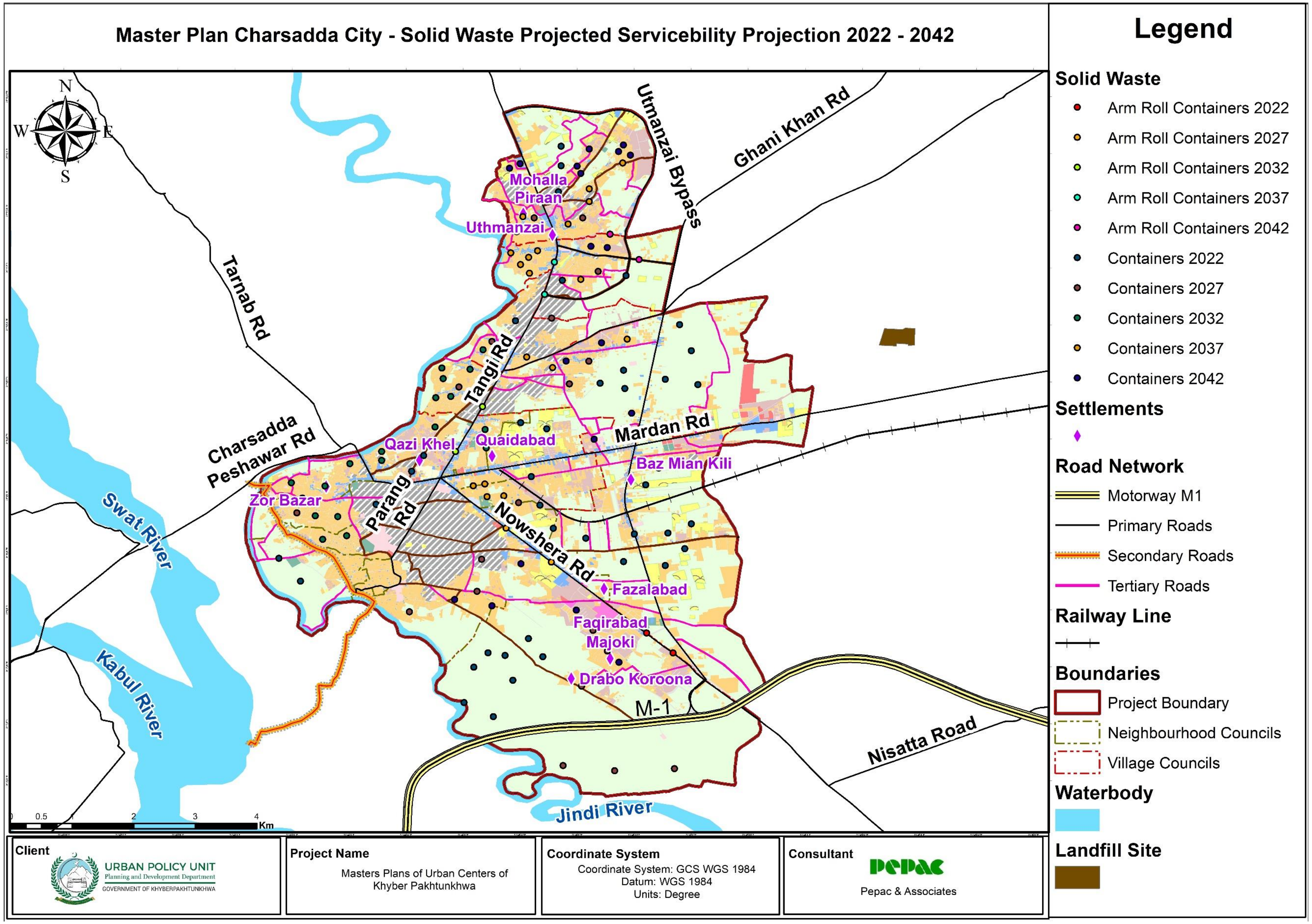
For waste projection in the future, a decrease by 2% is assumed in current waste generation rate in annual growth rate of 0.42 kg/ca/d as we will be implementing 4R strategy for waste management. Charsadda has a total waste generation rate of 101 tons per day in 2022. Keeping in view the infrastructure investment required for landfill, 10 years useful life of landfill is considered for Design. The proposed area for landfill site is 28.76 acres and its coordinates are 71 48.766171 34 10.405602.

Table 94: Landfill Requirement Over the Year

. Year	Population	Generation		Impact of 4Rs: reduction, reuse, recycling and recovery (20%)	Collection		Disposal		Landfill site requirement in acres
		Per Capita (Kg)	Total (Kgs)		Total Weight kg (W_T)	Total Volume, m3	Yearly volume m3	Accumulative volume m3	
2022	240,777	0.420	101126.34	80901.07	51777	103.55	37796.98	37796.98	0.93
2027	273,703	0.412	112655.74	90124.59	78859	157.72	57567.08	95364.07	2.35

. Year	Population	Generation		Impact of 4Rs: reduction, reuse, recycling and recovery (20%)	Collection		Disposal		Landfill site requirement in acres
		Per Capita (Kg)	Total (Kgs)		Total Weight kg (W_T)	Total Volume, m3	Yearly volume m3	Accumulative volume m3	
2032	308,032	0.407	125517.70	100414.16	94138	188.28	68720.94	164085.01	4.05
2037	343,133	0.403	138423.00	110738.40	110738	221.48	80839.03	244924.04	6.04
2042	378,326	0.399	151093.97	120875.18	128430	256.86	93753.81	338677.85	8.36

Map 37: Solid Waste Serviceability Projection Map



Source: Devised by Consultant

14.5. Conclusion

After analyzing the three proposed scenarios for solid waste management in Charsadda, it has been determined that **Scenario 3** is the most suitable option. However, it is recommended to adopt and implement **Option 4** for sustainable waste management. To ensure the success of the proposed system, key factors such as institutional arrangement, operational plan, and business model need to be developed. An enabling environment must be created to facilitate the implementation and success of the advanced treatment option. Municipalities in low-income, developing countries face significant challenges in SWM, and the situation is likely to worsen due to continuing population growth and urbanization.

This sectoral plan aims to provide a practicable and result-oriented solution to a long-standing predicament affecting almost all municipalities. The plan outlines a detailed strategy for transforming TMA Charsadda SWM sector and supporting its transition to a fully functioning, integrative, and sustainable system by 2042. The plan is guided by principles such as administrative and functional changes, documentation and evaluation, people's participation, stakeholder partnerships, recognition of the informal sector, waste minimization, affordability, and sustainability. It is important to recognize that lack of financial resources is not the main issue, and SWM must be seen in a wider context. Gradual minimization of landfill should be a priority.

Chapter 15: Parks and Recreational Spaces

Charsadda offers a diverse nature of active and passive recreational facilities including archeological and historical places. The district offers many traditional and cultural uniqueness such as Mra Dherai (MRA), Bala Hisar-Hisara Dherai, Ghani Khan Shrine, Ghani Dhere Museum etc. It plays a crucial role in sustainable development. They provide social, economic and environmental benefits that contribute to the well-being of individuals and communities. Many visitors from the entire district and peripheral areas come here to enjoy. However, due to rapid urbanization and ribbon development, the city is losing their agricultural beauty. The pressure on land is increasing because of competing Land Uses. Therefore, the consultants stress the need for reserving recreational spaces against many competing demands for land.

Parks and recreational spaces offer opportunities for physical activity and social interaction, promoting healthy lifestyles and community development. Tourists also seek out recreational spaces, contributing to the local economy. Hence, the proposed recreational activities in the master plan are segregated into two categories; active recreational spaces and passive recreational spaces. The existing number of active recreational space(playgrounds) and passive recreational spaces are 8 and 2, respectively, covering 83.11 acres. According to land demand calculation, the existing gap of recreation is 20.91 acres.

15.1. Proposals for Parks and Recreational Spaces

Viewing the demand for recreational facilities in the area, around 37.19 acres of land is proposed for recreational activities in the study area. The areas for the proposed recreational zone along with their administrative boundary is given in the table below.

15.1.1. Proposed Recreational Zone

The purpose of the proposed recreational zone is to provide a large, centralized area for recreational activities, sports, and events. It could include facilities such as sports fields, playgrounds, walking paths, picnic areas, and community gathering spaces. The recreational zone would provide a focal point for the community, promoting social interaction and community engagement. It is important to ensure the sustainable and responsible development of the recreational zone, taking into consideration the potential environmental and social impacts of such a development. Proper planning and management are necessary to ensure the long-term viability and success of the proposed recreational spaces. The recreational zone proposed in the study area is about 46.16 acres.

15.1.2. Proposed Parks

Parks are essential for fostering social cohesion, providing recreational opportunities, promoting physical and mental well-being, and enhancing the overall livability of neighborhoods. They serve as valuable community assets that bring people together, support healthy lifestyles, and create spaces for relaxation, learning, and celebration. Viewing this importance, zones for development of parks are proposed in the master plan covering a total area of 38.61 acres.

15.1.3. Proposed Linear Park

A linear park along a river offers a combination of scenic beauty, recreational opportunities, ecological value, and community gathering spaces. It provides a place for relaxation, exercise, and connection with nature, while also promoting environmental conservation and flood management. Such parks enrich the quality of life for residents, creating a unique and enjoyable public space along the water's edge. Falling within the recreational concern, a linear park has been proposed in the study area attaining area of 207.1 acres.

15.1.4. Proposed Cycling and Jogging Track

Cycling and jogging tracks provide a safe, convenient, and enjoyable environment for individuals to engage in physical activity, promote community engagement, and contribute to personal health and well-being. These dedicated tracks create spaces where cyclists and joggers can pursue their activities with ease while benefiting from the positive aspects of outdoor exercise. In Charsadda city, suck track has been proposed in the proposed master plan covering an area of 45.3 acres. Proposed areas for each dedicated zone for recreational spaces has been given in the table below.

Table 95: Proposed Civic Zone Area

Zone for Recreational Facilities		
Sr. No.	Zone	Area (acres)
1	Recreational Zone	46.16
2	Parks	38.61
3	Linear Park	207.1
4	Cycling and Jogging Track	45.3
Total area for Recreational Zone		337.17

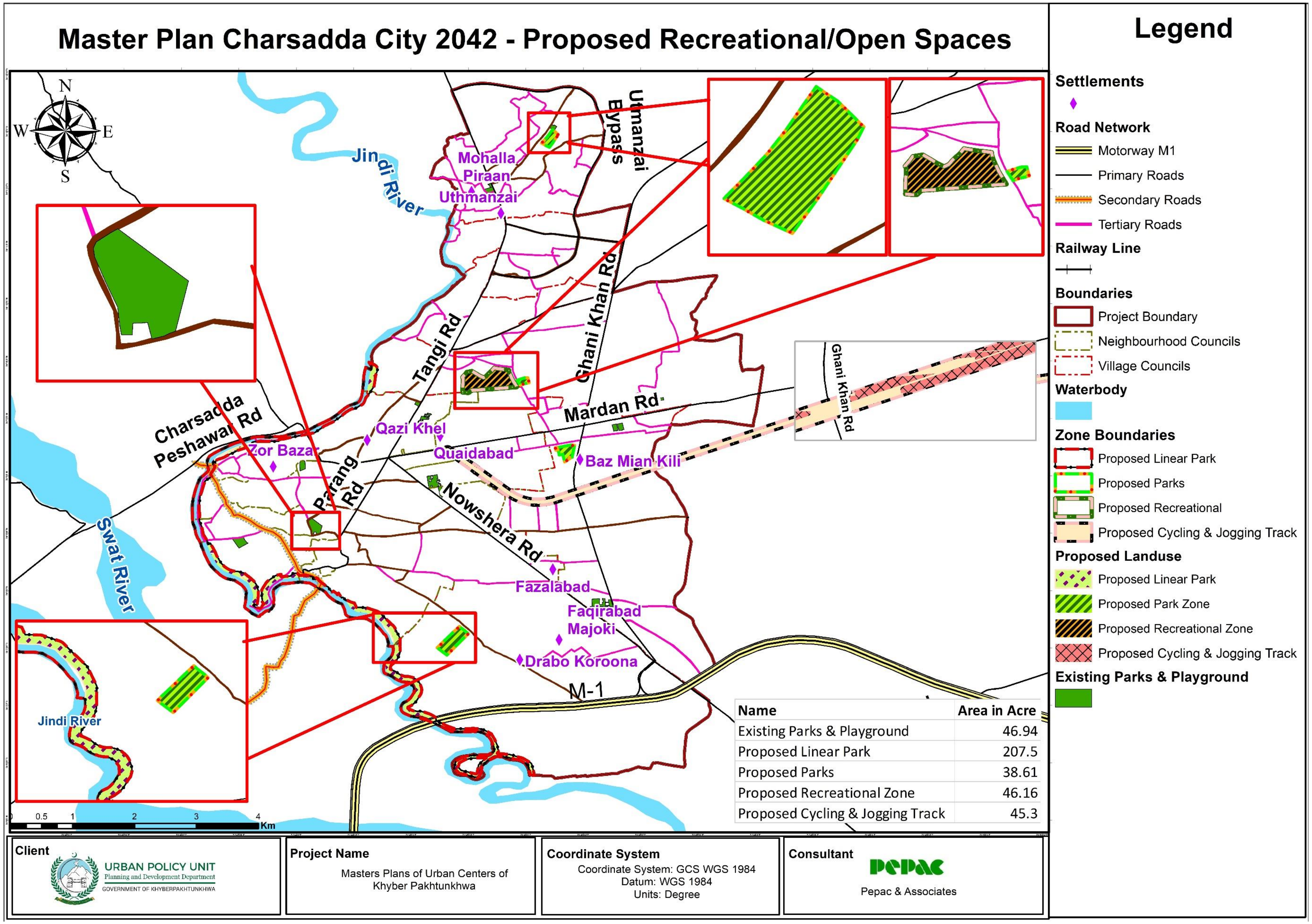
Source: Calculated by Consultant

13.11.1. Permitted Permissible Land Uses for Health Zone

For the proposed zones, the allowed permitted and permissible uses which could be built within the zone areas are given in the following table.

Sr. No.	Land Use Zone	Permitted Land Uses	Permissible Land Uses
1	Park Zone	Amusement Park Playgrounds Jogging Track Walking Trals Bycycling Tracks	Residential Uses Commercial Shops

Map 38: Proposed Recreational Zone - Charsadda Study Area



Name	Area in Acre
Existing Parks & Playground	46.94
Proposed Linear Park	207.5
Proposed Parks	38.61
Proposed Recreational Zone	46.16
Proposed Cycling & Jogging Track	45.3

Source: Devised by Consultant

Chapter 16: Proposed Livestock Zone

16.1. Proposed Livestock Zone

Livestock are domesticated animals which are raised in agricultural areas for providing labor and production of numerous associated goods i.e., milk, butter, etc. Examples of livestock include cattle, sheep, goats, horses, and poultry. These animals are usually domesticated and kept on farms or ranches, where they are fed, bred, and managed to ensure their health and productivity. Livestock plays an important role in many cultures and economies around the world, and provides a vital source of protein and other nutrients for human consumption.

The district has a potential of increasing the value of livestock, and a zone has been reserved for this purpose. Livestock in the District comprise cattle (40%), followed by goat (29%), buffaloes (19%) and sheep (8%); While 4% of the livestock is camels, horses, mules and donkeys. Additionally, there are 305 poultry farms 14 fish farms in District Charsadda. The livestock sector in Khyber Pakhtunkhwa, despite having great potential for poverty alleviation, has not developed on commercial lines because of paucity of funds, capacity and technology constraints. Another important benefit of livestock is the best utilization of the passive woman labor force which makes more than 50% of national population. Besides the above some Non-Governmental organizations are also working for improvement of the socio-economic status of the livestock farmers. The product of livestock especially goats both slaughtered and live are mostly exported to Afghanistan and Middle East, this potential shall be exploited to increase the provincial income and economic development of the region.

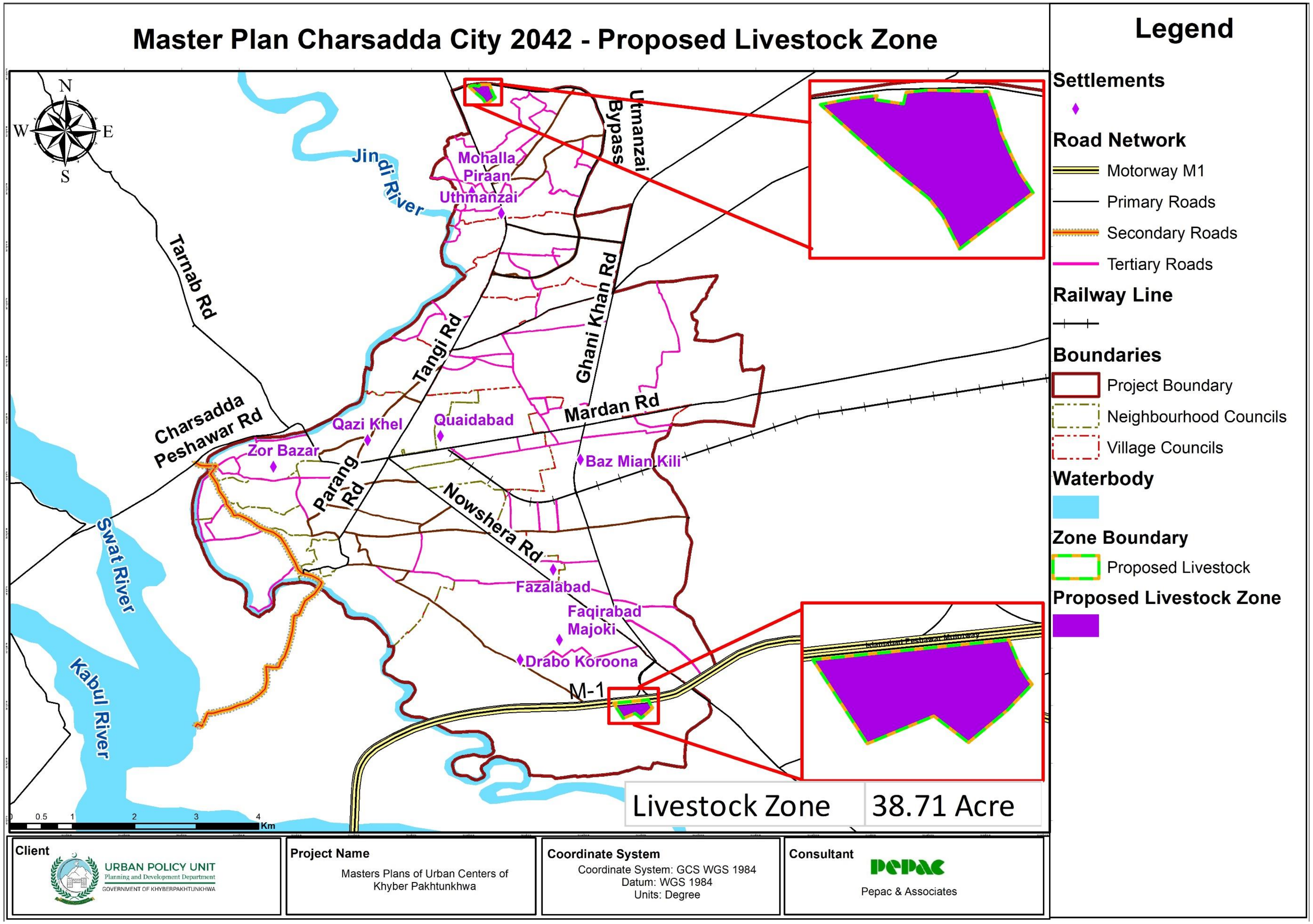
Viewing the untapped potential of livestock and other associated agricultural activities in Charsadda city, two livestock zones have been proposed in the master plan to promote livestock practices in the study area. The following table describes the measure of allocated areas for livestock provision is given in the table below.

Table 96: Proposed Zones for Livestock Facilities

Proposed Zone Area for Livestock Facilities		
Sr. No.	Zone	Area (acres)
1	Livestock	38.71
Total Area		38.71

Source: Devised by Consultants

Map 39: Proposed Livestock Zone - Charsadda Study Area



Source: Devised by Consultant

Chapter 17: Safety & Security

Cities around the world continue to face issues of insecurity, instability, violence, and corruption, despite economic development and social prosperity. These issues are due to personal vulnerabilities, unsafe environments, and local hazards that contribute to safety and security concerns. Safety refers to reducing or preventing risks that arise from human, material, and environmental interactions, while security aims to eliminate hazards entirely and provide a safe living environment for all. In case of Charsadda city, the next sections provide a detailed overview of the security situation in the area.

17.1. Existing Situation

A city is considered to be safe and secure when all of its inhabitants are able to live, work and participate in urban life without fear of bodily harm or intimidation.[22] It is difficult to determine safety and security of an urban environment because it is a mixture of several components and requires a separate in-depth study. For the purpose of this task, a brief analysis has been carried out at household level to understand the how people perceive their city and its different areas in terms of safety and security.

There are 43 police stations that fall within the boundary of District Charsadda while only 9 police stations/chowkies are within the boundaries of Charsadda city. The number of police chowkies have decreased over the period of 13 years as in 2009 the number of police chowkies were 37 in Charsadda district which now have fallen to 30. The number of police stations have stayed the same.

There is no standard regarding police stations for a certain number of people residing in an area. The requirement for police force for each station and number of police stations in an area depends upon several factors including rate of crime, social and economic situation of an area, unemployment rate and existing government and institutional environment. Furthermore, for the population of approximately 122,000, there is only one rescue station. Similar to police stations, there is no standard concerning how many rescue stations should there for a certain number of people, however, the emergency response time, internationally, is set to be maximum 8 (WHO Standard) to 10 (US EMS Standard) minutes for a radius of one mile. The list and map of these facilities is as follows:

Table 97: Police and Rescue Facilities in Charsadda Study Area

Sr. No.	Police/Rescue Facility Name	Latitude	Longitude
1	District Police Office Charsadda	34.162572	71.794387
2	Police Station Utmanzai	34.189183	71.762920
3	City Police Station	34.153801	71.744979
4	Prang Police Station	34.142933	71.735967
5	Police Line Charsadda	34.136062	71.764629
6	Police Chowky Manga	34.147403	71.753794

[22] Based on the New Urban Agenda. United Nations (2016). Available at: http://habitat3. org/wp-content/uploads/N1639668-English.pdf

Sr. No.	Police/Rescue Facility Name	Latitude	Longitude
7	Police Chowky Tarlandai	34.147016	71.754519
8	Police Station Takhtbai	34.181039	71.783421
9	Railway Police Station	34.152129	71.757202
10	Rescue Station Charsadda	34.161927	71.753994

Source: Secondary Data Collected from TMA Charsadda

17.2. Crime Rate in Study Area

The primary survey had indicated that most of the people i.e., 57% think that crime rate in the city had been increasing while remaining were of the opposite view. The 57% people were further asked about the specific crimes that they had thought were increasing. In response to that majority of the people had stated robberies as the most common crime followed by theft and then harassment.

This increase in crime rate was then further related to reporting of crime to police officials. 75% respondents have stated that they reported the crime to police. In comparison with the overall provincial reporting statistics, a smaller number of people in Charsadda are reporting crime to police as 92.2% people in overall KP have reported crime like robbery and assault to police while only 75% in Charsadda have done so.[23] Out of those 75%, 85% people were of the opinion that some action was taken by the police in response to their complaints.

Table 98: Crime Rate in Charsadda Study Area

Increase in Crime Rate	
Response	Percentage of Respondents
Crime rate has increased	57%
Crime rate has not increased	43%
No Response	0%
Total	100%
Total Number of Respondents (N) = 357	
Type of Crime That Has Increased	
Type of Crime	Percentage of Respondents
Theft	28%
Robberies	39%
Harassment	24%
Other (Drugs)	3%
No Response	2%
Total	100%
Total Number of Respondents (N) = 211	
Reported to Police	
Response	Percentage of Respondents
Have reported to police	75%
Have not reported to police	24%
No response	1%
Total	100%
Total Number of Respondents (N) = 204	

[23] Parameter 6.4: reporting of robbery and assault in the last one year, MICS 2019, GoKP.

Did Police take any steps in response?	
Response	Percentage of Respondents
Police took steps in response to complaint	85%
Police did not take steps in response to complaint	14%
No response	1%
Total	100%
Total Number of Respondents (N) = 153	

Source: Primary Data Collected from Field Survey

17.3. Proposals to improve security situation

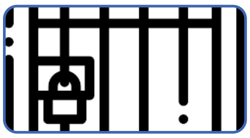
Safety and security proposals are essential for maintaining a safe and secure environment in a community. safety and security proposals are crucial for maintaining a safe, secure, and prosperous society. By implementing effective safety and security measures, citizens can live in a community where they feel safe and protected, which can lead to social, economic, and political development. It is recommended to take a comprehensive approach to security by implementing multiple strategies that address different aspects of safety and security.

Safety measure

- will reduce the risk of crime and accidents. Natural surveillance through design is preferred.

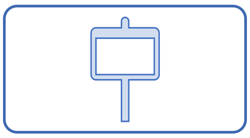
Security Cameras

- Security cameras can deter criminal activity, provide evidence in investigations, and monitor areas for suspicious behavior.



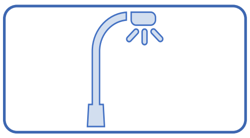
Physical Barriers

- Physical barriers such as walls, fences, gates, and bollards can help to prevent unauthorized access to buildings, public spaces, and transportation infrastructure.



Signage

- design should incorporate signages of different kinds including name of the stop, its route, schedule and timings



Lighting

- Adequate lighting in public spaces and building entrances can improve visibility and deter criminal activity.

Emergency Preparedness

- Buildings and public spaces should have emergency plans in place, including evacuation procedures and emergency response measures.

To enhance the safety and security of the city and reduce the crime rate, establishing new police stations may not be necessary as the existing ones can be improved through capacity building measures. This can be achieved by hiring additional police officials, providing better training, and equipping them with high-quality equipment. The low crime reporting rate in the city indicates that people may face challenges in communicating with the police or that the police may not have enough resources to effectively combat crime. Therefore, taking steps to improve the capacity of the existing police stations can not only enhance their ability to prevent and investigate crime but also increase public trust in the police force, thereby encouraging people to report crimes.

Chapter 18: Quality of Life

In 1948, The WHO defines quality of life (QOL) as an individual purpose-aligned cultural and value system by which a person lives, relative to their aims, hopes, living standards and interests. In Charsadda, the general opinion regarding the quality of life is neutral. While approximately half of the population considers their quality of life to be good, the remaining half either finds it poor or feels indifferent. This perspective is supported by data from a survey consisting of ten questions, with over 50% of the population agreeing with six of the questions. This neutral view can be interpreted in three ways: first, the people of Charsadda might have a neutral attitude and not aspire for betterment; second, they may feel satisfied in most aspects but seek improvement when their dissatisfaction is considered; or third, they might be less aware and perceive the situation as a routine aspect of their lives.

The survey also revealed that the majority of the city's population views their physical health as good. However, this is not the case when it comes to mental health. A significant percentage of the population reported their mental health to be in poor condition, with some experiencing depression, sadness, or melancholy. Additionally, some individuals reported feeling neutral towards their mental health status.

One of the survey questions focused on the safety of the urban environment. The results indicated that a significant portion of respondents considered the overall urban environment to be safe for themselves, their children, and older adults. Some respondents found the urban environment to be unsafe, while others expressed indifference towards the issue. The survey also revealed that the respondents generally considered their children to be safe when traveling to school and found their commutes to public places and commercial areas to be safe. However, a significant number of respondents felt that crime was increasing in their area, with robberies being the most common crime. Public spots and commercial areas were considered the most unsafe places in the city. Despite this, some respondents believed that crime rates could be reduced through effective measures.

Regarding the physical living environment, a significant portion of respondents found their current living conditions to be adequate in terms of accommodation size, ownership status, and space sufficiency for household residents. However, a considerable number of respondents expressed dissatisfaction with utility services, including water availability, sewerage and drainage systems, solid waste management, electricity, and gas facilities.

In terms of the natural living environment, the majority of respondents were displeased with the overall condition of the environment, including green and public spaces. The overall assessment of quality of life through environment was rated as "passable". Similarly, respondents found transportation services, public transport, and walkability to negatively affect their quality of life due to poor service quality.

Public Places & Civic Places

The Sustainable Development Goal 11 “Sustainable Cities and Communities” has endeavoured to provide universal access to safe, inclusive and accessible, green and public spaces, particularly for women and children, older persons and persons with disabilities (Target 11.7). The indicator suggest that each city has a certain average share of the built-up area dedicated to open space for public use for all, by sex, age, and persons with disabilities. According to this indicator, it has already been established in section 1.4.4 that existing public spaces are highly inadequate in terms of space required, however, other aspects of public spaces have been assessed to determine their adequacy with respect to target 11.7 of SDG 11.

The assessment of parks and playgrounds in Charsadda uncovered a concerning lack of inclusivity and accessibility. The existing facilities were found to be in disrepair, with no trees, poorly maintained grass, and a lack of activities for people of all ages, genders, and abilities. There were also no seating areas, jogging tracks, or cafeterias available in any of the parks. Furthermore, the evaluation of food outlets revealed that they were only accessible to adults, particularly men, and not suitable for disabled people or women. Cleanliness was also lacking, with no green elements present as required by the 11.7 target for public places.

Charsadda's only public library, the Charsadda Public Library Prang, is fully functional with a vast collection of reading materials, including 75,000 books, newspapers, and magazines, catering to students and other individuals. The library spans over two acres and offers additional facilities such as a canteen, washrooms, a digital library, and a hall that can accommodate up to 300 individuals for academic gatherings. However, the library's location renders it inaccessible to a significant portion of the population. Therefore, the need for additional libraries throughout the city is necessary to provide adequate access for all residents.

The evaluation of civic places in Charsadda focused on four categories: public toilets, bus stations/stops, parking spaces, and street lighting. Unfortunately, no assessment could be made for public toilets and parking lots due to their absence in the city.

Among the four bus stations/stops, only one - the Charsadda General Bus Stand - was located within the study boundary, while the rest were situated outside. The bus station/stop within the boundary was found to be poorly maintained, with no greenery in its vicinity and a lack of basic amenities such as seating areas, shade, disabled entrances, and trash cans. However, it was determined to be operational despite its poor condition.

18.1. Proposals for Improving Quality of Life

Viewing the data obtained from the results of quality-of-life assessments, certain proposals have been given to cater with the highlighted concerns in the upcoming years till 2042. Following are the brief details of given proposals for uplifting quality of life in the study area.

18.2. Proposals to Improve Health Conditions

For health conditions, proposals have been given to improve the quality of health in the area through certain measures and guidelines including;

- Make Charsadda an active city.
- Develop active environment in Charsadda city.
- Provide opportunities to make people active.

18.3. Proposals To Improve Civic Spaces

For improving the identified civic spaces in the city, certain measures including provision of public toilets improvement of bust stops, etc. have been given accordingly. Following are the brief details of the proposed improvements for civic spaces in the study area.

- Provision of public toilets along with guidelines for
    - Locations of new public toilets
    - Prerequisites in the public toilets.
    - Maintenance works
    - Management
- Provision of bus stops
    - Crime prevention through environmental design.
    - Improving thermal comfort.
    - Improving acoustics.
    - Improving signage.
    - Improving accessibility.

18.4. Proposals to improve public spaces

Similar to civic spaces, proposals have been given to improve public spaces enhancing the accessibility and commute of people living in the surroundings of highlighted public spaces. These proposals have been given in the following two domains which will be further defined in the action plans to be prepared for the city.

- Recommendations for existing and new parks.
- Recommendations for improving sport grounds.

Proposals for Improving Sports Grounds

For improving sports facilities, the proposals have been given in the terms of physical and social interventions. For physical improvements, betterment and provision of maintenance services, lighting, drainage, spectator, and parking facilities are proposed. Similarly, gender inclusiveness and accessibility for each age group are encouraged to support social inclusion in such places. Moreover, provision of multi activities is highlighted to provide more than single option for sports i.e., basketball, football, cricket, etc.

Proposals for Improving Food Outlets.

As an essential aspect of life quality, the proposals have been given to improve the quality of food outlets in terms of both their physical condition and quality of food available on such spots in the city. For physical betterment, provision of street lights, greenery, painting, security equipment's are proposed while for the quality of food, hygiene is supposed to be provisioned for each food outlet in the city. moreover, policy measures imposing several restrictions addressing social and violative measures are given. Details of these interventions will be provided in the action plans for the Charsadda study area.

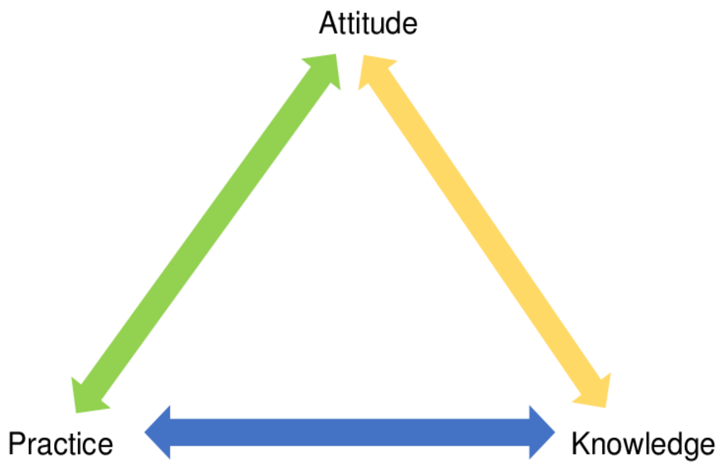
Proposals for Improving Security Situation.

To cater with the possible security risks, proposals are given in light of the existing security situation in the Charsadda study area. The data collected revealed the existing crime rate and threats to the residents of the city and performance/response to the possible threats by security institutions. Also, the existing rescue facilities have been assessed and fire/rescue stations are proposed for the expected future population with respect to the devised standards in national reference manual.

Chapter 19: Citizen's Behavior

Citizen behavior refers to the behaviors, attitudes, and actions displayed by individuals as members of a society or community. It encompasses a broad range of actions, from civic engagement and political participation to social and environmental responsibility. Citizen behavior can be influenced by a variety of factors, including social norms, cultural values, personal beliefs, and institutional structures. It can be observed at various levels of society, from the individual level to the community level and beyond. Examples of positive citizen behavior include volunteering, voting, paying taxes, participating in community events, and practicing sustainable behaviors such as recycling or reducing energy consumption.

For Master Planning of Charsadda city, behavior of citizens with respect to certain highlighted parameters was assessed using a selected model optimizing knowledge, attitude and practice of the city's residents which allowed the consultants to develop a better understanding of people's behavior. The indicators for which the data was collected covered areas of solid waste, public properties, tourism and performance of city managing departments. For each indicator, the knowledge, attitude and practice being carried by the people was assessed and results were determined. Overview of each selected knowledge area is given in the upcoming sections.



19.1. Solid Waste Management

Following the model's hierarchy, the knowledge of the Charsadda's population regarding the type of solid waste, circular economy and TMA's responsibility for collecting solid waste management was assessed through surveys. Continuing the concern of solid waste, the respondents were further judged with respect to their attitudes towards less solid waste generation which showed a positive response from the people showing that most of them believed that less solid waste should be generated. Finally, the current practices being carried in the area w.r.t. solid waste were measured through asking people that what they believe is the reason behind improper solid waste disposal practices. People responded highlighting several factors which they believed hinders the disposal process.

19.2. Vandalizing Damaging Public Spaces

The second concern raised to quantify public behavior was through identifying attitude of people towards public properties. Similar three parameters i.e., knowledge, attitude and practice were used to consider the current status. For knowledge, the respondents were asked that if they know about any such places that exist in the city and knowledge regarding softscape and hardscape elements. A large number of respondents showed positive response about their knowledge regarding public properties in the city while limited people knew about the soft/hardscape elements. Similarly for attitude, the sample population was asked about their sense of responsibility which they feel about safeguarding public properties. Finally, the current practices towards public properties in the city were observed through certain indicators.

19.3. Tourism Promotion

A generalized approach was considered for assessing the knowledge of citizens regarding tourism activities in the city. for knowledge, the people surveyed were asked that if they believe that Charsadda city is an important tourism place. most of the respondents showed a negative response that the don't see the city as tourism oriented. For attitude, the respondents were asked about the tourism promotion in their city. most of the surveyed people agreed for a sustainable tourism development in the city.

19.4. Departments and Institutions

The performance and working of different departments have been evaluated by inquiring about the practices carried out by general public which has shown their inclination towards positive or negative working of the government department.

19.5. Proposals and Recommendations

After analyzing the existing situation, following proposals have been proposed by the consultants to uplift the knowledge, attitude and practice of citizens bringing a positive impact in their behaviors. These include;

Increase awareness: Educate citizens about the impact of their behavior on the city and its residents. Use various channels such as social media, billboards, and community events to promote responsible behavior.

Enforcement of rules and regulations: Enforce existing laws and regulations to deter irresponsible behavior. This may include fines or other penalties for littering, noise pollution, and other offenses.

Community engagement: Engage citizens in community activities, such as clean-up drives, neighborhood watch programs, and tree-planting initiatives. This can help promote a sense of ownership and pride in the city, and encourage responsible behavior.

Provide facilities: Provide citizens with facilities such as trash cans, recycling bins, public restrooms, and public transport systems to encourage responsible behavior.

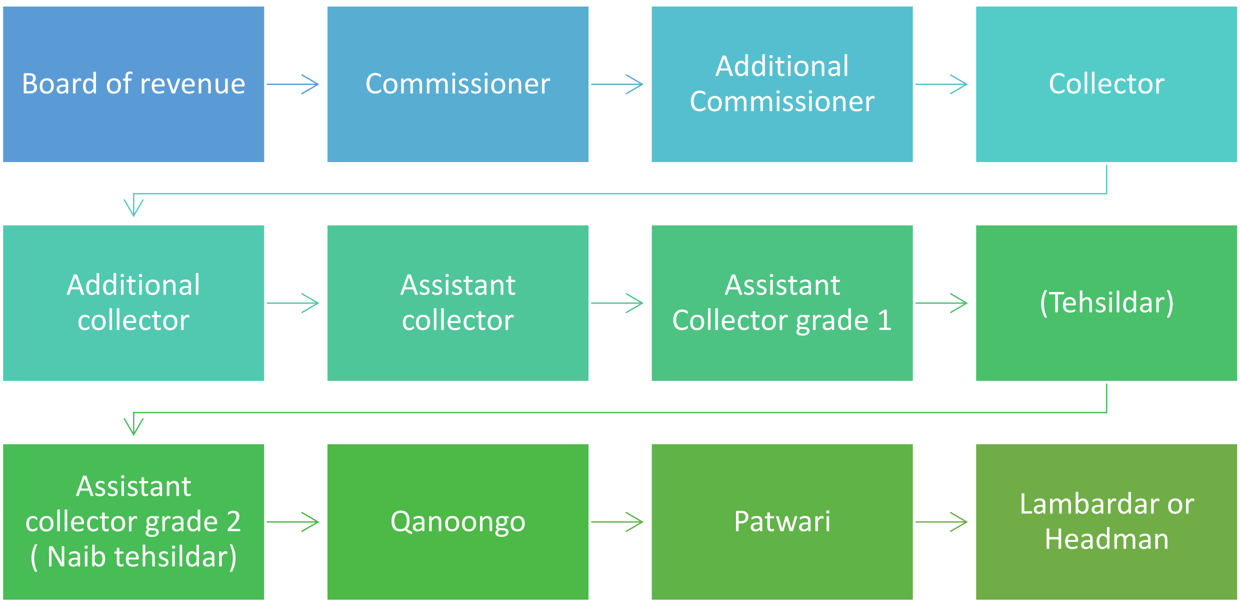
Incentivize good behavior: Reward citizens for responsible behavior, such as recycling, using public transportation, or volunteering for community service.

Promote a culture of civility: Encourage citizens to be respectful and courteous to one another, and promote a culture of empathy and understanding.

Chapter 20: Land Management

In Charsadda, as in many other cities, exploiting land for profit is a common practice. Unfortunately, the city suffers from inadequate urban governance when it comes to managing state-owned, privately-owned, and communal lands. The root causes of this poor land management are related to issues with land titling, insecure land tenure, and improper land record maintenance, which have legal and regulatory dimensions. Additionally, the economic aspects of land use significantly contribute to the inaccessibility of affordable and adequately serviced land for urban dwellers, leading to a shortage of housing options. As a result, the local government is unable to provide affordable housing to low-income people, aggravating the situation and resulting in the development of slums and squatter settlements where occupants have limited or no legal claim to the land they occupy.

In Charsadda, the property includes both tangible and intangible items that can be "owned" by a person. The largest real estate asset in Charsadda is the land. The land record management in Charsadda, similar to the entire KP, is supervised by the provincial director of land record-revenue and estate department, while revenue matters are monitored by the board of revenue. Under the supervision of provincial land record department i.e., Board of Revenue, there are further administrators working at divisional, district, tehsil, and village level. The organizational structure is shown below.



Since 2013, the computerization of land records has been underway, with data being kept at the tehsil level. Charsadda is one of 18 districts in the province undergoing phase 2 of the computerization of land records to improve efficiency, transparency, and access to information on property ownership, including the maintenance of Shajra e Nasab, land registration, and other property-related matters.

In Charsadda, land is divided into three categories: state-owned, privately-owned, and common land. The Charsadda Municipal Corporation manages urban land management at the municipal level. Land revenue systems in Pakistan are divided into divisions, districts, tehsils, patwar circles, and qanugo halqas. There is an institutional system for land management exercises from the Commissioner’s office to the office of Patwaris, but the Department of Local Government's institutional structure is constantly changing in compliance with Local Government Ordinances, with elected officials primarily leading the organizational structures at various levels. Problems in the Existing System

- The policy framework and unfavourable procedures are harming the Charsadda land administration. It is crucial to protect citizens' privacy by reviewing current regulations and making the necessary adjustments with the cooperation of both the general public and experts
- There is no separate project for the land management of urban areas. It is necessary to create comprehensive rules for urban land management since new policy instruments must be developed, tried out, and implemented in place of the current system
- There is no focus on building the capacity of the institutions involved in land administration because the local government in the city is fragile and vulnerable. This is not allowing for alignment, integration, and coordination of various land administration policies being implemented by various authorities
- A proper information system involving base maps, land use maps, and other land management record information, is lacking at the local level within the departments. No standards are currently being followed in the city for the demarcation and updating of land use categories
- There is an urgent need for cooperation between key line departments like the tax department, development authority, patwaris, and local government. Poor controls are in place to keep an eye on illegal developments which is the result of the absence of coordination.

20.2. Recommendations

Following are some recommendations made by the consultant based on existing land management issues in Charsadda;

Local government should initiate a review of existing land regulations with the involvement of both experts and the public. The review should specifically focus on privacy protection concerns and make necessary adjustments to improve the overall land management system.

Create comprehensive rules for managing urban land, which includes developing and implementing new policy instruments to replace the current system. This could be done by establishing a task force made up of representatives from various departments, including urban planning, development authorities, and tax departments, to help develop these policies.

Initiate training programs for technical and non-technical staff and create a coordination mechanism to ensure alignment and integration of various land administration policies being implemented at different lev.

Establish a standardized digital information system that incorporates base maps, land use maps, and other relevant land management record information. This system can be developed in collaboration with local authorities and stakeholders to ensure it meets the specific needs of the city. The system can include protocols for demarcation and updating of land use categories, with clear guidelines and standards for data collection and maintenance.

Strengthening enforcement mechanisms, such as by increasing penalties for illegal land occupations and encroachments, can act as a deterrent and discourage such activities.

To address the lack of cooperation between key line departments like the tax department, development authority, patwaris, and local government, the city should establish a coordination mechanism to ensure proper communication and information sharing between all departments involved in land administration. This would help to keep an eye on illegal developments, and reduce the negative impact of unregulated land use.

Chapter 21: Heritage and Culture

Heritage refers to the legacy, traditions, customs, and artifacts that are passed down from generation to generation within a community or society. It encompasses the tangible and intangible elements of a community's history, including landmarks, historic sites, artifacts, stories, language, and practices. Culture, on the other hand, refers to the shared beliefs, values, practices, and behaviors that define a group or society. It includes the arts, literature, music, food, religion, and social customs of a particular group of people. Culture is often tied to a specific geographical region, ethnicity, or social group and can vary widely between different societies and communities.

For Charsadda city, surveys and assessments were performed for identification and analyzing the current situation of historical and cultural heritage of the city. For historical places, very few buildings, areas and spots were identified defining the historical aspects of the Charsadda city. these included, Ghan Khan Shrine, Sheikh Bakhtiyar Baba, Pushkalavati Museum, Ghani Dheri Museum, and Charsadda Cemetery (Graveyard). all these identified historical places were in poor condition and no specific intervention towards its preservation was seemed to be made.

While assessing the cultural aspects and values, Charsadda city appeared to be having similar nature of belief and norms as that of Khyber Pakhtunkhwa. People are very hospitable, and the men wear Shalwar Kameez with a topic on their head while the women wear trousers and a shirt with a "Chaadar". Hujra is the primary social centre of men while the public and private affairs settled in the "Jirga" system of Pashtun Culture. Traditional dance of the people is "Bhangra" while the classic song is "Tapa".

21.1. Proposals for Heritage and Cultural Preservation

For preserving the heritage and culture of Charsadda city in a best manner of its own, following proposals have been devised to cater with issues and problems currently prevailing in the highlighted areas. These proposals include but not limited to;

Preservation: One of the most important steps to improve heritage is to preserve it. This can be achieved by restoring and maintaining historic buildings, monuments, and sites.

Education: Educating people about the value and significance of heritage can help raise awareness and encourage preservation efforts. This can involve teaching history in schools, promoting cultural events, and providing tours of heritage sites.

Collaboration: Collaboration between heritage organizations, government agencies, and local communities can help to identify and prioritize heritage preservation efforts.

Innovation: Embracing new technologies and creative approaches can help to make heritage more accessible and engaging for visitors. This can include virtual tours, interactive exhibits, and immersive experiences.

Sustainability: Sustainable practices can help to ensure that heritage sites are preserved for future generations. This can involve using environmentally-friendly materials and practices in restoration efforts, as well as promoting responsible tourism.

21.1.1. Proposed Potential Tourism Sites

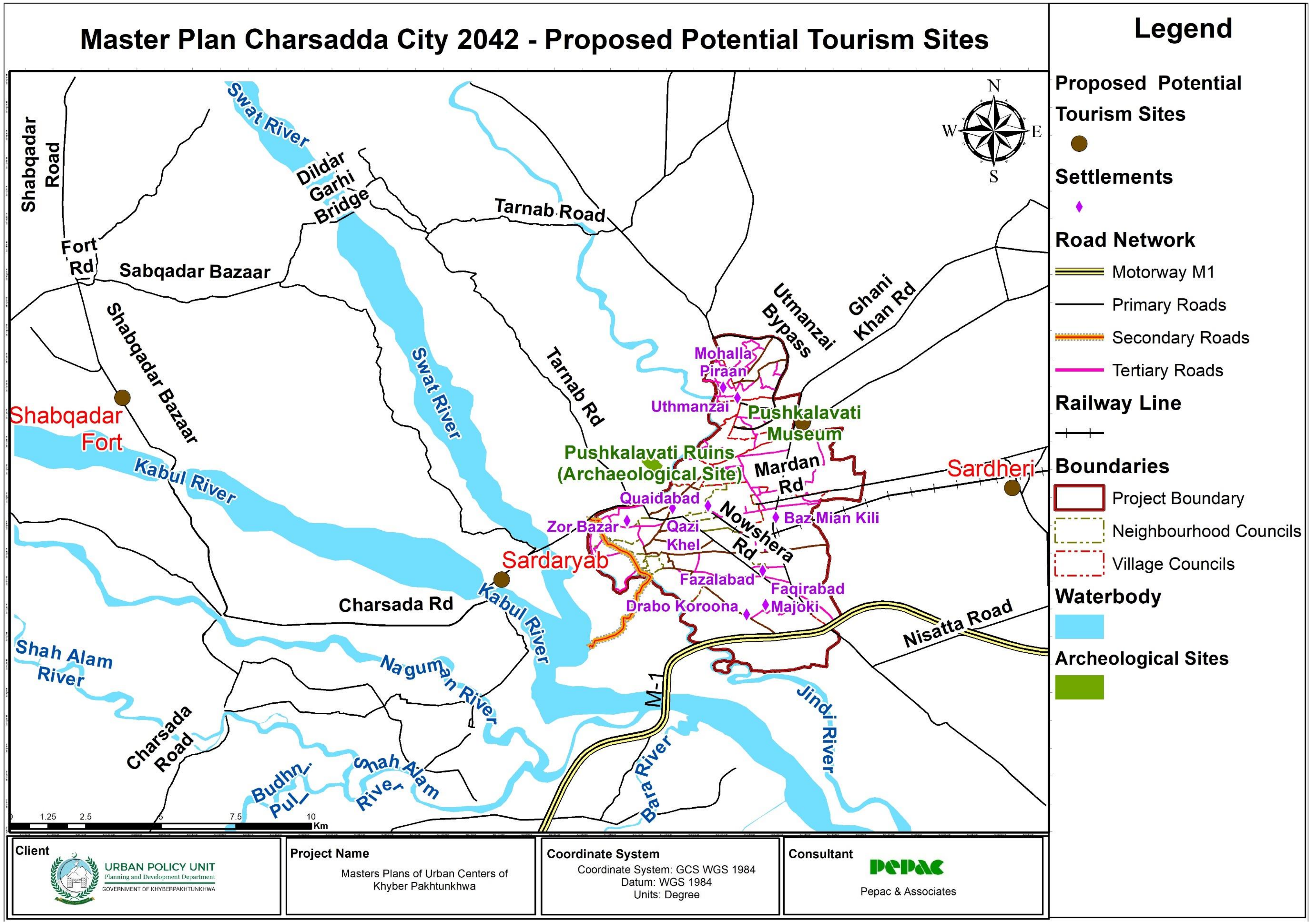
Charsadda boasts several heritage and archaeological sites with significant potential as tourism destinations which possess significant potential as tourism sites due to a variety of compelling factors. Firstly, their historical and archaeological significance attracts tourists interested in exploring and understanding the region's rich past. Sites such as Hissa Dheri and Shar-i-Napursan can offer glimpses into ancient civilizations, providing a unique opportunity for history enthusiasts and researchers to delve into the area's cultural heritage.

Secondly, the natural beauty and picturesque settings of locations like Sardaryab make them attractive destinations for leisure and recreational activities. The scenic views, coupled with the opportunity to enjoy locally cooked fish, can create a serene and pleasurable experience for visitors seeking relaxation and natural landscapes.

Additionally, the presence of unique industries and cultural specialties adds to the tourism potential of these sites. Ser-Dheri's tobacco production and Rajjar's renowned sweets and textile industry can offer visitors a chance to witness and engage with local traditions and economic activities. This cultural immersion can appeal to tourists looking for authentic experiences and the opportunity to explore local customs and craftsmanship.

Moreover, the diverse range of attractions in Charsadda, including military monuments like Shabqadar Fort, can caters to different interests and preferences. History enthusiasts, nature lovers, culinary explorers, and those seeking cultural encounters can all find something of interest in this region, making it a well-rounded and appealing destination for a wide range of tourists.

Map 40: Proposed Tourism Potential Sites - Charsadda Study Area



Source: Devised by Consultants

Chapter 22: Urban Design

Urban design is the process of designing and shaping the physical layout and organization of cities, towns, and other urban areas. It involves the planning and management of the built environment, including the arrangement of buildings, public spaces, transportation systems, and other infrastructure. Some of the key elements of urban design include the layout of streets and public spaces, the design of buildings and public amenities, the integration of transportation systems, and the use of green spaces and public art to enhance the overall quality of life in urban areas.

For assessing the existing urban design aspects of Charsadda city, specific sites were selected for measuring the level of service with respect to urban design interventions. These sites included bazaars, housing schemes, major nodes/chowks, parks/recreational places, etc. The parameters selected for this purpose were divided in two major categories i.e., street scape and building design. For street scape, the indicators selected varied from cleanliness conditions to complex road pavements. Similarly for buildings, the indicators selected for assessments measured façade of building, building condition, paint quality, etc. The results showed fourfold nature for existing conditions of these places and proposals were given accordingly. Following are the names of some of the sites assessed for urban design assessment of Charsadda study area.

- Charsadda Zor Bazar
- Utmanzai Bazar
- Rajjar Bazar
- Tehsil Bazar Charsadda
- Charsadda Park
- Baghicha Family Park
- Abdul Wali Khan Sports Complex

22.1. Urban Design Proposal for Charsadda City

The proposals for improving urban design characteristics of Charsadda city are given in terms of scale, location and response to certain community issues identified through primary studies. By scale, the proposals range from the selected neighborhoods to entire city level while in terms of location, proposals for catering certain recreational sites and open spaces are accommodated. Moreover, proposals for catering specific community needs are provided for the entire city mostly addressing physical constraints. Despite focus on physical improvement, the proposed urban design interventions will bring several social and economic development opportunities ultimately mobilizing the overall urban fabric of the city. following are the domains highlighted which could be followed to achieve a better urban design shape for the existing study area.

22.2. Street Scape Upgradation and Preservation

Viewing the roads and streets in accordance with the needs of 21st century, the urban design interventions for Charsadda city have been made keeping in view the demands of modern world, thus catering both of social and physical activities through road infrastructure. The retrofitting ideas are given considering the existing arterial layout and physical condition along with the deficient infrastructure elements needed to be indulged in the current street structure. Moreover, these interventions are expected to support and uplift the economic activities in the city premises.

- Optimization of Streets as Public Spaces.
- Guidelines for Enhancing Public Space Character in Streets for Charsadda city.
- Enhancing Business Support Character of Streets

22.3. Enhancement in Public Safety and Security Measures

Annually, thousands of people are killed in road accidents due to unjust distribution of rights for using these spaces in daily routines. This is because road engineers give more priority to vehicular traffic and often ignore other users i.e., pedestrians, who travel on streets through just walking. By considering diversified set of street users while designing streets, a more just provision with respect to street can be provided enhancing public safety. Along with the matter of traffic, it is also inevitable to secure street users from criminal activities which do occur on public spaces and specially on streets. While minimal, it has been observed that severe crime activities do take place in Charsadda area which pose threat on the daily life of Master Plan of Charsadda City 2042 street users. Thus, along with the traffic safety, guidelines for controlling street crime are proposed for the study area

22.4. Upgradation of Parks and Recreational Facilities

Parks and recreational facilities are considered as a major source for providing leisure and entertainment to people living in an area. The current recreational spaces and parks identified through primary surveys in Charsadda study area revealed dilapidated condition for most of the spaces located within the city. The observations highlighted issues in these places like improper hardscape and softscape elements, inaccessibility, improper pavements, etc. which affects the utilization of these places and are vulnerable to become negative spaces in the near future. Hence, for improving the current dilapidated parks and recreational facilities, certain guidelines have been proposed to cater the issues being faced with respect to these facilities in the study area.

22.5. Conservation and Upgradation of Buildings

- **Preservation**
  Preservation includes the process of applying measures to sustain the existing form and materials of any property facing dilapidation.
- **Rehabilitation**
  It is defined as the procedure of creating compatibility of use in historic buildings.
- **Restoration**
  It is the process of accurately depicting the features, form and character of a building as it appeared at the time of construction.
- **Reconstruction**
  Reconstruction refers to the new construction of a dilapidating structure which is unable to be restored through other interventions.

22.6. Enhancement of Urban Design Characteristics on Ghani Khan Road Charsadda

Ghani Khan Road, located in Charsadda, is a significant thoroughfare in the Khyber Pakhtunkhwa province of Pakistan. The road is named after Ghani Khan, a renowned Pashto poet, philosopher, and writer and holds cultural and historical significance and serves as a prominent transportation route connecting various parts of Charsadda and nearby areas. Ghani Khan Road runs through the heart of Charsadda, a historic city with a rich heritage dating back to ancient times. Charsadda is known for its archaeological sites, including the ancient Gandhara civilization ruins at nearby Takht-i-Bahi and the ancient city of Pushkalavati. The road provides access to these important landmarks, attracting tourists and history enthusiasts.

The road is lined with a mix of residential and commercial establishments, including shops, markets, and restaurants. This vibrant atmosphere makes it a bustling center of activity, with locals and visitors frequenting the area for shopping, dining, and socializing. The road serves as a focal point for cultural gatherings, festivals, and celebrations, where people come together to showcase their Pashtun heritage through music, dance, and traditional attire. Moreover, Ghani Khan Road plays a vital role in facilitating transportation within and beyond Charsadda. It connects to other major roads, allowing easy access to nearby cities and towns. Commuters use this road to travel to Peshawar, the capital city of Khyber Pakhtunkhwa, as well as to other important destinations in the region.

Viewing the Importance of Ghani Khan Road in overall urban fabric of Charsadda city, the road has been selected for indulging special urban design interventions through upgradation of street scape and building elements along the road.

Figure 32: Ghani Khan Road - Charsadda

Source: Devised by Consultants

Proposed Possible Urban Design Interventions

Improving the urban design of streets and roads involve creating environments that are safe, attractive, functional, and sustainable for all users, including pedestrians, cyclists, and motorists. Following are some elements that are supposed to be included in the street scape of Ghani Khan Road Charsadda to enhance urban design:

Pedestrian-friendly infrastructure: Wider sidewalks, pedestrian crossings, raised crosswalks, and pedestrian-only zones all contribute to making streets safer and more inviting for walkers.

Cycling infrastructure: Dedicated bike lanes, bike-sharing programs, and bike racks encourage cycling and help reduce traffic congestion.

Green spaces and trees: Trees, parks, and green spaces not only improve the aesthetics of streets but also provide shade, reduce air pollution, and promote overall well-being.

Street furniture: The installation of benches, public seating, bus stops, and other amenities provides comfort for pedestrians and encourages social interaction.

Public art and cultural elements: Art installations, sculptures, and cultural markers can add character and identity to the street, making it more enjoyable for residents and visitors.

Effective lighting: Properly placed and well-designed street lighting enhances safety and ensures visibility during nighttime hours.

Safety measures: Implementing traffic calming measures like speed bumps, raised intersections, and traffic circles can reduce accidents and encourage slower driving.

Parking solutions: Efficient parking management, including multi-level parking structures and designated parking zones, can reduce on-street congestion and improve traffic flow.

Rainwater management: Incorporating sustainable drainage systems can help manage rainwater runoff and mitigate flooding issues.

Street-level retail and cafés: Encouraging storefronts and outdoor dining can create a lively atmosphere and encourage economic activity.

Wayfinding signage: Clear and informative signs help pedestrians and cyclists navigate the area effectively.

Transit-oriented design: Integrating public transportation facilities and designing streets to be pedestrian-friendly around transit hubs can promote sustainable urban mobility.

The following Image visualizes some of the defined urban street scape elements which could be included to enhance the urban design characteristic of streets and roads.

22.7. Pedestrian Crossings in Charsadda

The consultant has recommended the provision of different types of pedestrian crossings in Charsadda that will improve the urban design by prioritizing pedestrian safety, promoting active transportation, enhancing walkability, and creating a more visually appealing and user-friendly urban environment. The specific locations and types of pedestrian crossings should be determined based on thorough traffic analysis, pedestrian flow patterns, and consultation with relevant stakeholders to ensure their effective integration into the urban fabric of Charsadda. Details and relevant actions will be done in the Action Plans (Task D). Following are the types of pedestrian crossing recommended in Charsadda.

22.7.1. Zebra Crossings

Zebra crossings is recommended by the consultant in Charsadda, as they are simple and cost-effective. They provide a designated space for pedestrians to cross the road safely. Zebra crossings improves the urban design by enhancing walkability, promoting pedestrian-friendly streetscapes, and ensuring a clear visual indication for drivers to yield to pedestrians.

Figure 33: Example of Zebra Crossing

Source: Accessed from wired.com on 10th July, 2023

22.7.2. Pelican Crossing

A pelican crossing is an advanced type of pedestrian crossing that includes traffic signals. Pedestrians press a button to activate the lights, which control the flow of vehicles. When the pedestrian light turns green, pedestrians can cross while vehicles are stopped. Pelican crossings, equipped with traffic signals, are recommended at high-traffic intersections in Charsadda. They provide controlled crossing opportunities, allowing pedestrians to safely navigate busy roads. By incorporating pelican crossings, Charsadda will enhance pedestrian safety, particularly at locations with heavy vehicular movements.

Figure 34: Example of Pelican Crossing

Source: Accessed from 4wheelz.co.uk on 10th July, 2023

22.7.3. Puffin Crossing

A puffin crossing uses sensors to detect when pedestrians have fully crossed the road, adjusting the signal timings accordingly. Puffin crossings offer an updated and safer version of pelican crossings. With the use of sensors and pedestrian detection technology, they provide more efficient and user-friendly crossing experiences. Implementing puffin crossings in Charsadda will enhance pedestrian safety, reduce waiting times, and improve traffic flow, contributing to a well-designed urban environment.

Figure 35: Example of Puffin Crossing

Source: Accessed from 4wheelz.co.uk on 9th July, 2023

22.7.4. Toucan Crossing

Similar to a pelican crossing, a toucan crossing also includes traffic signals, but it is designed for both pedestrians and cyclists. The name "toucan" is derived from "two can," meaning both pedestrians and cyclists can cross at the same time. It is recommended in Charsadda to consider implementing toucan crossings to accommodate both pedestrians and cyclists. As cycling becomes more popular, providing dedicated crossings for cyclists encourages active transportation and supports sustainable urban design. Toucan crossings promote inclusivity, allowing pedestrians and cyclists to cross together safely.

Figure 36: Example of Toucan Crossing

Source: Accessed from wordpress.com on 10th July, 2023

22.8. Cycling Track along Railway Lines

Charsadda, being a vibrant and growing town, is experiencing increased vehicular traffic and pollution. With the railway line running through the heart of the town, the consultants have proposed a unique idea to utilize the underutilized space alongside the tracks to create a cycling track that caters to the needs of cyclists and contributes to a greener and healthier environment.

22.8.1. Possible Outcomes of the Proposed Cycling Track

The cycling track project in Charsadda along railway line will provide numerous benefits to the community including;

Enhanced Safety: By providing a segregated route for cyclists, we can significantly reduce the risk of accidents and ensure the safety of cyclists, pedestrians, and motorists.

Sustainable Mobility: Encouraging cycling as a mode of transportation will contribute to the reduction of carbon emissions, helping our town move towards a more sustainable future.

Improved Public Health: The cycling track will promote physical activity, leading to improved public health and well-being for residents.

Tourism and Recreation: A cycling track running alongside the picturesque railway route will attract tourists and offer recreational opportunities to both residents and visitors.

Economic Growth: The project will stimulate economic growth by supporting local businesses catering to cycling needs and promoting tourism in the area.

22.9. Urban Design Proposal for Kalay Ingaar Chowk

The consultants have proposed possible interventions with respect to urban design upgradation in selected area of Kalay Ingaar Chowk and possible elements which could be added to enhance the street scape and building elements are shown in the figure below.

Existing

Proposed

22.10.Urban Design Proposal for Utmanzai Committee Ground

Utmanzai Committee Ground is located in the northern side of the Charsadda study area and has been selected to visualize the possible upgradation with respect to the urban design parameters. Following are the visuals for the proposed urban design interventions in Utmanzai Committee Ground Charsadda.

Existing

Proposed