EVALUATION OF FUTURE UTILITY SERVICES THROUGH VERTICALLY EXPANDING COMPACT CITY CENTER, CENTRAL BUSINESS DISTRICT GULBERG, LAHORE

Aqsa Mahmood[*1], Muhammad Aizaaz Ul Haq[2], Rana Muhammad Shoaib[3], Aisha Khan[4]

*[*1]BSC CRP, LCWU, MSC CRP UET LAHORE*
[2]NUST, NICE, U&RP DEPT.
[3]MSC URP, NUST ISLAMABAD
[4]UET LAHORE

[*1]aqsamahmood2719@gmail.com, [2]aizaazhaq@ymail.com

Corresponding Author: *
Aqsa Mahmood

DOI: https://doi.org/10.5281/zenodo.16792058

Received	Revised	Accepted	Published
09 May, 2025	22 June, 2025	15 July, 2025	11 August, 2025

ABSTRACT

Lahore's urban expansion, particularly around the Central Business District (CBD) at Quaid-e-Azam, is a significant shift towards vertical growth under the guidance of the Punjab Central Business District Development Authority (CBD Punjab). This strategy aims to optimize land use and accommodate a rising population, but it may inadvertently complicate the city's development further. Rapid growth has led to numerous housing societies, which have further strained Lahore's already overburdened utility services. Untreated wastewater from these expanding neighborhoods flows into the River Ravi, negatively impacting water quality and surrounding aquifers. As Lahore transitions to vertical development with high-rise buildings, the concentrated population densities in these areas increase the demand on utilities such as water, electricity, and sanitation systems.

The existing infrastructure, designed for a lower population density, struggles to keep up with the demands of high-rise living, leading to inefficiencies and system failures. Vertical expansion often requires advanced infrastructure solutions, such as sophisticated sewerage systems and high-capacity power grids, which may fail to effectively support the increased population density. The current growth rate in Lahore District is estimated at 2.7%, but with the shift towards vertical expansion, population density on the same amount of land will increase drastically, creating a greater strain on utility services. A comprehensive new master plan has been developed to address these problems and plan for Lahore's water and sanitation needs over the next 25 years.

while vertical expansion is intended to solve the issues associated with urban sprawl, it may inadvertently aggravate existing utility problems and introduce new challenges. The development of high-rise buildings must be accompanied by a comprehensive upgrade of infrastructure to ensure that it can handle the increased demands of a densely populated urban environment. Addressing Lahore's rapid urban growth and infrastructure needs through a new, comprehensive master plan is essential for fostering sustainable development and improving the quality of life for all residents. This paper evaluates the potential of public utilities services currently present in the new administrated economic center of Lahore city.

Keywords: *Lahore, Urbanization, Water and Sanitation, Master Plan, vertical expansion, Wastewater, Infrastructure, Environmental Challenge*

INTRODUCTION

Problem Statement:

Lahore is the capital of Punjab Province and Pakistan's second largest city. It is located in north-eastern Pakistan, with its core within 25 kilometers of the international border with India. It is centrally positioned in the Upper Indus Plain, on the left bank of the Ravi River. Lahore's current population has surpassed 13 million (13,004,135) according to Census data 2023, and there is a rapid inflow of people from surrounding areas due to improved educational, health, housing, recreation, and job prospects. (Water and Sanitation Agency - WASA, 2019)

Lahore is a rapidly growing economic base. Its education, health, work availability, better infrastructure, increasing business & employment chances and high standards of urban facilities are attracting people from all corners of the country, particularly, from the surrounding regions. (ACE, 2022).

Due to the expansion of Lahore and changing market demands, a new Central Business District is being developed in the Gulberg area to cater to the needs of modern businesses and improved mobility. The old city center is congested and limited in availability, making it difficult to access. The new district aims to provide a more accessible and modern business hub for Lahore. The project is being undertaken by the Lahore Central Business District Authority. (ACE, 2022). According to the designated development authority the project will stretch its benefits by determining Gulberg as an economic corridor for the whole city. But densification can cause many constrains within a city center, as it has been observed in Japanese cities. The constrains can lead towards a shortage in basic utilities, congestion at various linkages caused by the increase in vehicular traffic, depletion of water tables, electricity load and increase in the rental value of land in CBD area. To overcome such planning constrains various responsible professional units have been assigned to analyze the future economic growth pattern of the city so that in the coming years the city should not strive for basic services.

Literature Review:

A city reflects both continuity and change within a society, and urbanization now a global trend poses challenges for accommodating growing populations. Lahore, the heart of Pakistan, expanded beyond its historic walled city, particularly during the British period (1848–1947), when Civil Lines, Cantonment, and Model Town were developed to house the elite, separate from the local population. The Lahore Improvement Trust (LIT), established in 1936, began preparing a master plan, but progress was halted by World War II. After 1947, rapid urban development took place to house incoming migrants, leading to new colonies like Gulberg, Shad Bagh, Chauburji, and Wahdat Colony from 1947 to 1958.

Gulberg, situated within a triangle formed by the railway line, Ferozepur Road, and the Lower Canal, was inspired by the Garden City Movement its name derived from Urdu words meaning "flower-tree." Covering 2,368 acres, it was developed in five phases: Gulberg I (126 acres), II (448 acres), III (1,653 acres), IV (85 acres), and V (56 acres). Planned by S.A. Rahim (1950–1954), Gulberg was designed as a low-density, affluent housing scheme featuring bungalows from 2 to 12 Kanal, with a minimum of 7 Marlas. It included provisions for schools, parks, hospitals, cinemas, and shopping areas. Its layout reflected western suburban ideals of modernity and status, with Main Market and Liberty Market emerging as key commercial hubs in 1954 and 1967, respectively.

Lahore plays a vital role in the Upper Indus Plain. Its strategic position along the River Ravi and near the India-Pakistan border has driven rapid urban growth. With a population exceeding 10 million, Lahore continues to attract people seeking better education, healthcare, housing, and employment opportunities (ACE, 2022). This influx has stressed municipal services, especially water and sanitation systems. Urban sprawl has led to unplanned housing societies lacking basic services and wastewater disposal. Untreated sewage is discharged into the River Ravi, harming water quality and aquatic life. This pollution has also seeped into underground aquifers near the river, further degrading water sources (ACE, 2022).

Lahore's most recent comprehensive master plan was developed in 1975, but rapid urban expansion since then has revealed critical deficiencies in infrastructure especially in water and sanitation. The city frequently experiences monsoon-induced waterlogging, while the absence of effective wastewater management underscores the urgent need for a revised and up-to-date plan. Currently, master planning efforts include the ongoing Master Plan 2050, which was initiated around 2018–19 and has yet to be finalized or fully implemented. This will be Lahore's second major citywide master plan in nearly five decades, following the original 1975 version. The proposed 25-year master plan aims to cover all of Lahore District spanning approximately 1,772 km², which includes both urban (around 350 km²) and rural (approximately 144 km²) zones as well as peripheral areas managed by WASA, TMAs, PHED, and private developers.

Rising population and sprawl have increased residential water demand. Based on a daily per capita need of 50 imperial gallons (227.3 liters), the average water demand is 7.28 million gallons (33,100 m³) per day. This includes 5.02 million gallons (22,850 m³) for the Walton site and 2.25 million gallons (10,250 m³) for the Bab-e-Pakistan site (CBD Punjab, 2024).

Vertical economic centers high-rise developments mixing commercial, residential, and retail uses are becoming common in global cities, optimizing land use but straining infrastructure. In Dubai, the Burj Khalifa consumes 946,000 liters (250,000 gallons) of water daily, requiring high-pressure pumping systems and stressing the city's desalination-based water supply (Al-Dubai et al., 2017).

In New York, One World Trade Center houses over 8,000 occupants and adds heavy loads to the aging sewer system. During storms, combined sewer overflows (CSOs) can release untreated wastewater, worsening pollution (Rosenzweig et al., 2019). Taipei 101 generates around 2,000 tons of waste annually, challenging waste management and risking contamination (Huang & Chen, 2018). These centers also demand vast amounts of electricity. Hong Kong's International Commerce Centre (484m tall) uses about 870 GWh annually (Chan et al., 2016), straining the grid, especially during peak summer demand. Burj Khalifa requires up to 50 MW during peak hours equivalent to a small city's needs further stressing Dubai's fossil fuel-based energy infrastructure (Al-Dubai et al., 2017).

Traffic congestion is another challenge. Kuala Lumpur's Petronas Towers cause daily gridlock due to limited road capacity and high visitor numbers (Ng & Rahman, 2019). Similarly, New York's One World Trade Center intensifies traffic in Lower Manhattan, reducing road efficiency and increasing air and noise pollution (Rosenzweig et al., 2019). In Lahore, Gulberg evolved into a major economic center by the late 20th century. With its modern infrastructure, it attracted retail and corporate activity, particularly along M.M. Alam Road and Liberty Market. High-rise buildings and plazas reinforced its commercial status.

Simultaneously, Lahore Cantt, especially around Fortress Stadium and Y Block DHA, developed into an upscale commercial zone with luxury shopping and dining. This transformation reflected rising consumer power and shifting preferences. More recently, areas like DHA and Bahria Town have become economic hubs due to planned infrastructure and modern amenities. These developments attracted investment and decentralized economic activity from the city center. The Lahore Ring Road has further supported decentralization, enhancing connectivity citywide. Peripheral areas like Johar Town and Wapda Town have grown into commercial centers, offering a mix of educational, healthcare, and retail services. This shift contributes to Lahore's diversified and expanding economy.

METHODOLOGY:

Study Area:

This location in Lahore offers excellent connectivity, being close to Kalma Chowk and just 11 kilometers from both Azadi Chowk and the railway station. The General Post Office is 9.4 kilometers away, while Allama Iqbal International Airport is a convenient 12-kilometer drive. It's also within reach of Gajju Matah (15 km) and Thokar Niaz Baig Flyover (13 km), making it ideal for easy access to various city points. (ACE, 2022)

Proposed site consists of two pieces of land. One is the site of existing Walton Airport being accessed by Main Boulevard Gulberg, while other is the location of Bab-e-Pakistan being accessed by Walton Road. In between these two sites is a local road and a railway track. (ACE, 2022)

The overall area of the project that is estimated for development is approximately 1262445 Sqm (312 acres).

The land-use plan, which is based on the zoning strategy, offers alternative spatial uses connected with each zone and tries to create a comprehensive approach to zoning and the functions associated with it. It also seeks to establish a consistent framework for the overall project while stressing the distinctive characteristics of each proposed zone.

- The zone 1 office/commercial towers combine functions that can be distinguished from other urban uses and capitalize on the projected open spaces to provide maximum view and building coverage.

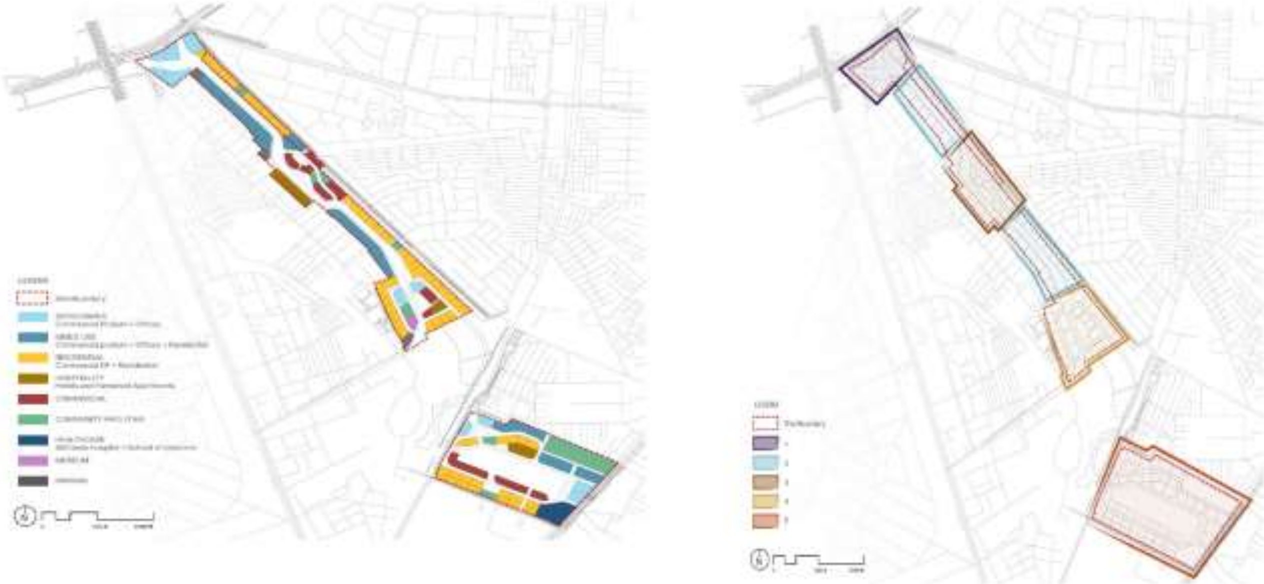
- The synergy between mixed-use and residential towers in zone 2 creates a unique live-work environment that benefits from the projected urban composition.
- The centered commercial node with surrounding green areas in zone 3 aids in the allocation of frontages and accommodates for the building heights associated with each purpose. The projected commercial towers define the low-rise commercial buildings, providing for views of neighboring towers and an increase in floor count.
- Cultural functions in zone 4 are restricted to a minimum floor number to provide better height and view arrangements for the residential uses that surround them.
- The central park imposes the requirement for precise standards determining how functions are arranged in zone 5. Buildings close to the center space are kept at a lower height to provide the necessary perspective for back-row buildings. Furthermore, commercial towers and skyscrapers are placed so that they do not obstruct the view of the preserved green center. (ACE, 2022)

Table 1 (LAND USE DISTRIBUTION OF STUDY AREA, Plot for each Amenity)

S. No	Land use	Number of Plots
1	Residential	20
2	Commercial	8
3	Mix Use	1
4	Community facility	7
5	Hospitality	27
6	parking	3
7	HealthCare	56
8	Skyscraper	11
	Total Plots	**133**

SOURCE: (Urban Planning and Detailed Urban Design for Urban Regeneration of Walton Airport Project) (ACE, 2022)

Figure: 1(LAND USE DISTRIBUTION OF STUDY AREA, Plot for each Amenity)



SOURCE: (Urban Planning and Detailed Urban Design for Urban Regeneration of Walton Airport Project) (ACE, 2022)

Globally, urban growth continues to accelerate due to rising populations, transforming cities from small, isolated hubs into vast, interconnected economic and environmental zones. Lahore, once renowned for its gardens, now faces unchecked urban sprawl evident in the rapid rise of shopping plazas, traffic congestion, and shrinking open spaces. The city has become a center for multinational corporations, banks, telecom companies, and global food chains.
Gulberg, once a prestigious residential area, has undergone intense commercialization, with Main Boulevard now dominated by offices and plazas. The road network has been designed assuming Main Boulevard will handle most traffic entering and exiting the CBD, while also accommodating internal circulation. According to the Master Plan, all proposed highways will directly serve adjacent plots. Both CBD locations will be connected via a planned underpass aligned with a 70-foot-wide collector road. The underpass road has a vertical clearance of 5.1 meters (16.73 feet) to allow full-height vehicle access (ACE, 2022). A detailed breakdown of the road design is provided in the following table.

Table 3 (Cross-sectional elements of roads)

Sr. No.	Type of Road	Right of Way, ft	No. of Lanes	Lane Width, ft	Pavement Width, ft
1	Main Boulevard	150	3 + 3	11 x 3 + 11 x 3	66
2	Collector Roads	70	2 + 2	11 x 2 + 11 x 2	44
3	Local Roads	70	2	11 x 2	22

Source: Urban Planning and Detailed Urban Design for Urban Regeneration of Walton Airport Project (ACE, 2022)

Population Comparison of Lahore:

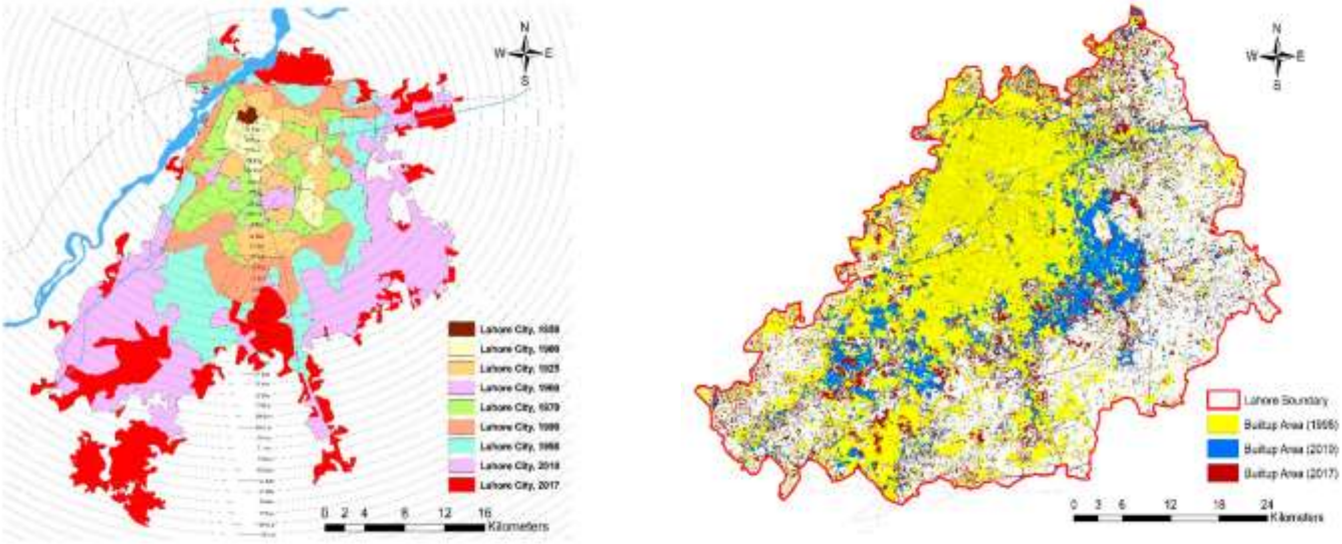
Table 2(Population Comparison between 2017-2023)

Name of Admin Unit	Household	Average household size	Population 2023	Population 2017	Growth rate
LAHORE DISTRICT	2,012,526	6.46	13,004,135	11,119,985	2.65
LAHORE DIVISION	3,498,991	6.51	22,772,710	19,389,856	2.72

Source: Pakistan Statistical bureau, Home | Pakistan Bureau of Statistics (pbs.gov.pk)

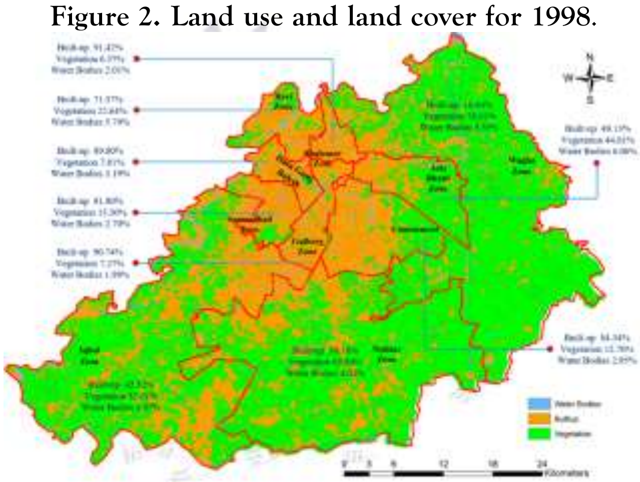
In compliance of latest land use plan, population for the project area is comes out as;
Total Number of Residents = 58,379 Persons
Total Number of Employees = 196,274 persons
Total Number of Visitors = 179,534 persons
Total Population = 434,187 persons

Figure 2 (Population comparison Analysis of Lahore 1928-2017)



Source: (Urban Planning and Detailed Urban Design for Urban Regeneration of Walton Airport Project) (ACE, 2022)

Figure 2. Land use and land cover for 1998.



Source: (PDF) Scaling the Potential of Compact City Development: The Case of Lahore, Pakistan

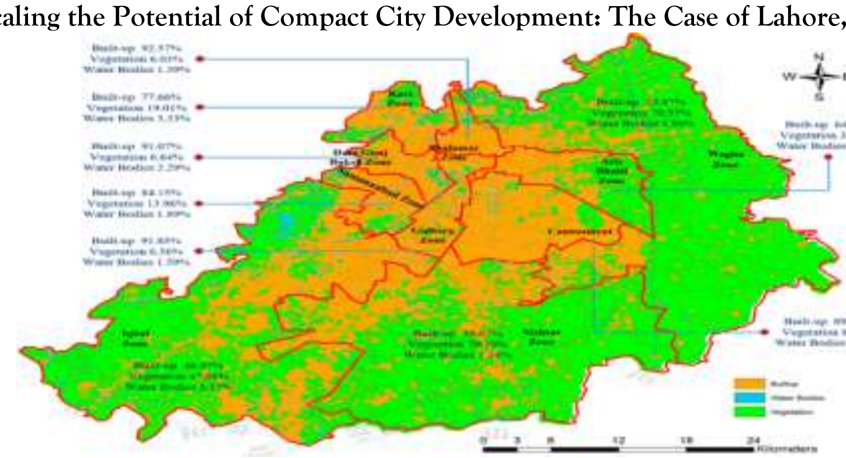
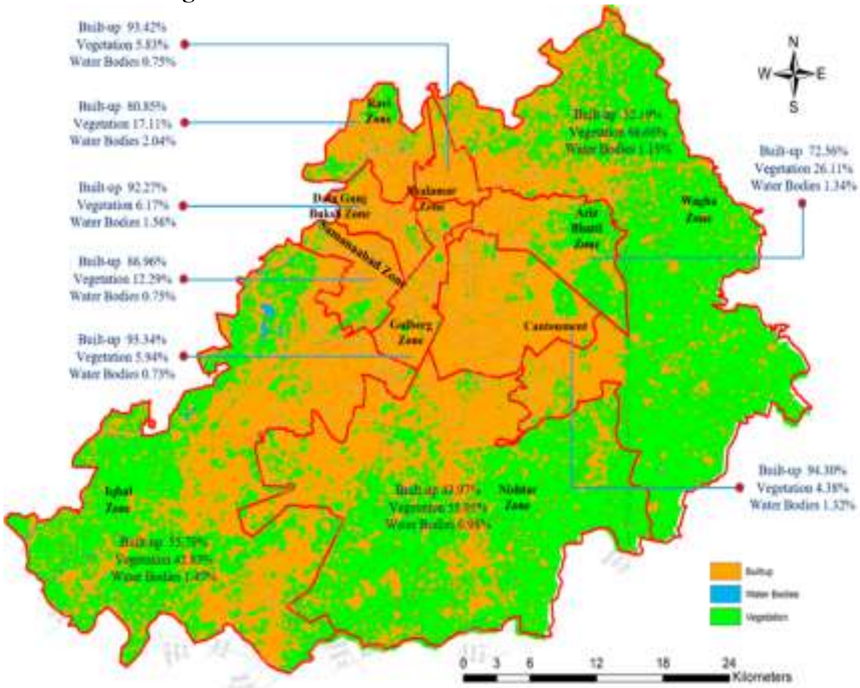


Figure 3. Land use and land cover for 2010.

Source: (PDF) Scaling the Potential of Compact City Development: The Case of Lahore, Pakistan

Figure 4. Land use and land cover for 2017.



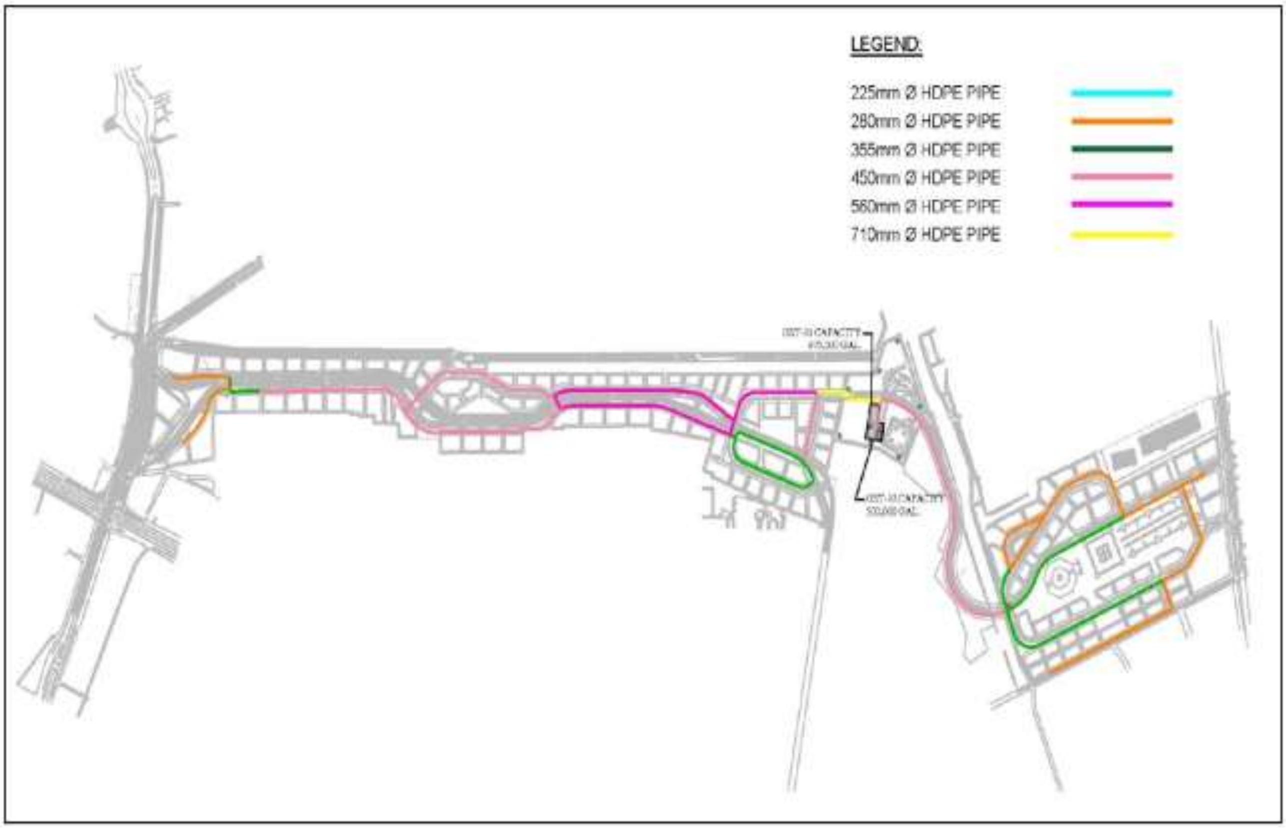
Source: (PDF) Scaling the Potential of Compact City Development: The Case of Lahore, Pakistan

WATER SUPPLY NETWORK DESIGN:

Lahore's expansion and shifting market needs have led to the development of a new Central Business District (CBD) in Gulberg to support modern businesses and improve mobility, as the old city center is congested and hard to access (ACE, 2022). The CBD aims to position Gulberg as a city-wide economic corridor. However, densification may cause issues like utility shortages, traffic congestion, groundwater depletion, high electricity demand, and rising property values. To address this, experts are analyzing future growth to prevent service shortfalls. Lahore's water system, originally reliant on groundwater for a smaller population, now struggles to meet rising demand. In the project area, residential water demand is set at 50 Imperial Gallons (227.3 liters) per person daily, with groundwater as the main source. The water and firefighting system for Walton and Bab-E-Pakistan will use groundwater wells, store water in a central reservoir, and pump it to underground tanks on each plot.

In the project area, residential water demand is set at 50 Imperial Gallons (227.3 liters) per capita per day, with groundwater as the primary source for both potable and firefighting needs. The proposed system for the Walton and Bab-E-Pakistan sites includes groundwater wells located within the utility area, with extracted water stored in a central reservoir and then pumped to underground tanks at each plot. Tubewells are distributed across the utility site and designed to meet maximum daily demand, operating 16–17 hours per day to supply an average potable water demand of 7,276,250 Imperial Gallons per day. Initially, only chlorination will be used for disinfection, with water quality testing to determine if further treatment is required (ACE, 2022). Based on discussions with the client, 30% of total sewage (greywater) will be treated on-site and reused for toilet flushing, reducing groundwater extraction to 70% of the total demand 5,093,375 Imperial Gallons per day (23,100 m³/day), while 2,015,050 gallons (9,160 m³/day) will be supplied through treated greywater. Additionally, 180,380 gallons per day (620 m³/day) will be extracted for irrigation. Tubewells pump water to the central reservoir via rising/transmission mains within the same utility site, with pipe diameters ranging from 355 mm to 710 mm (OD). Lahore's growing population continues to pressure its aging water infrastructure, highlighting the need for sustainable and innovative water management solutions. (Water and Sanitation Agency - WASA, 2019)

Figure 3 (Water Distribution network of Project Area)



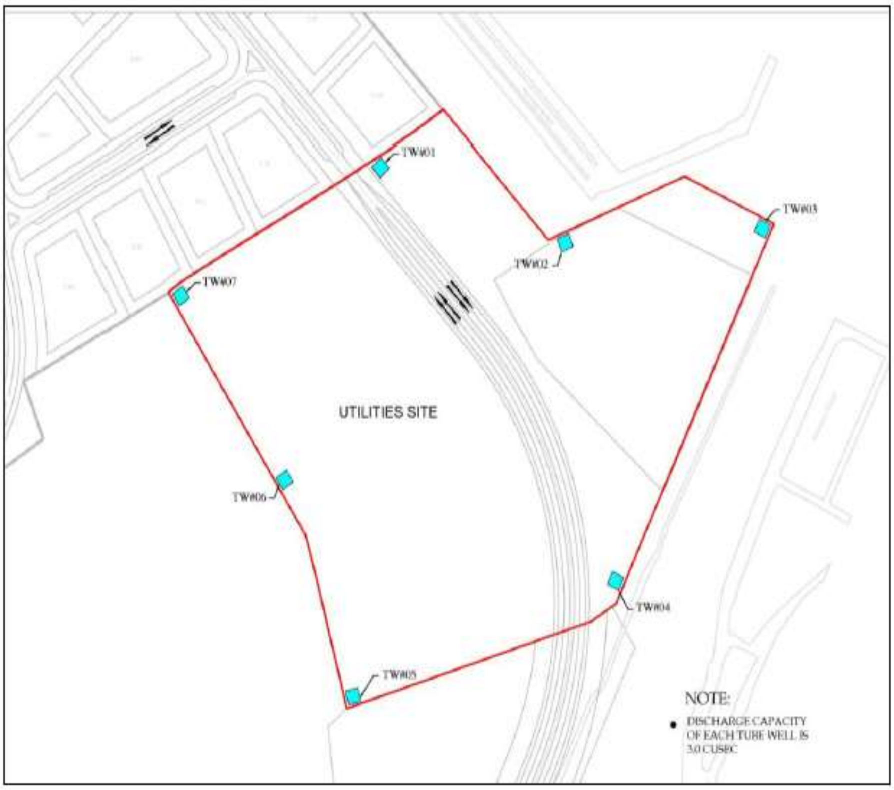
Source: Urban Planning and Detailed Urban Design for Urban Regeneration of Walton Airport Project (ACE, 2022)

Table 3(Pump Head Calculation)

Sr. No.	Description	Calculations
1	Frictional losses	10 feet
2	Level Difference	5 feet
3	Depth of Water Table	140 feet
4	Draw Dawn during Pumping	10 feet
5	Variation in Water Table	10 feet
6	Allowance for fittings etc.	15 feet
7	Delivery Head	10 feet
	Total Head	**200 feet**
The total head requirement for pumping machinery is 200 feet.		

Source: Urban Planning and Detailed Urban Design for Urban Regeneration of Walton Airport Project, (ACE, 2022)

Figure 4 (Location Plan of Tubewells at Bab-e-Pakistan)



Source: Urban Planning and Detailed Urban Design for Urban Regeneration of Walton Airport Project. (ACE, 2022)

SANITATION SYSTEM NETWORK DESIGN:
Lahore's current sewerage system, managed by WASA, covers only about 27% of the district, leaving most areas without proper service. The system includes 15 outfall stations, 85 lift stations, and around 3,725 km of sewer lines. The Gulshan-e-Ravi disposal station, with a peak discharge of 560 cubic feet per second, handles the largest load, discharging into the Cantonment drain and then into the River Ravi. Most disposal stations, except two in the south, are located on the outskirts to facilitate direct discharge into the river (Water and Sanitation Agency - WASA, 2019).

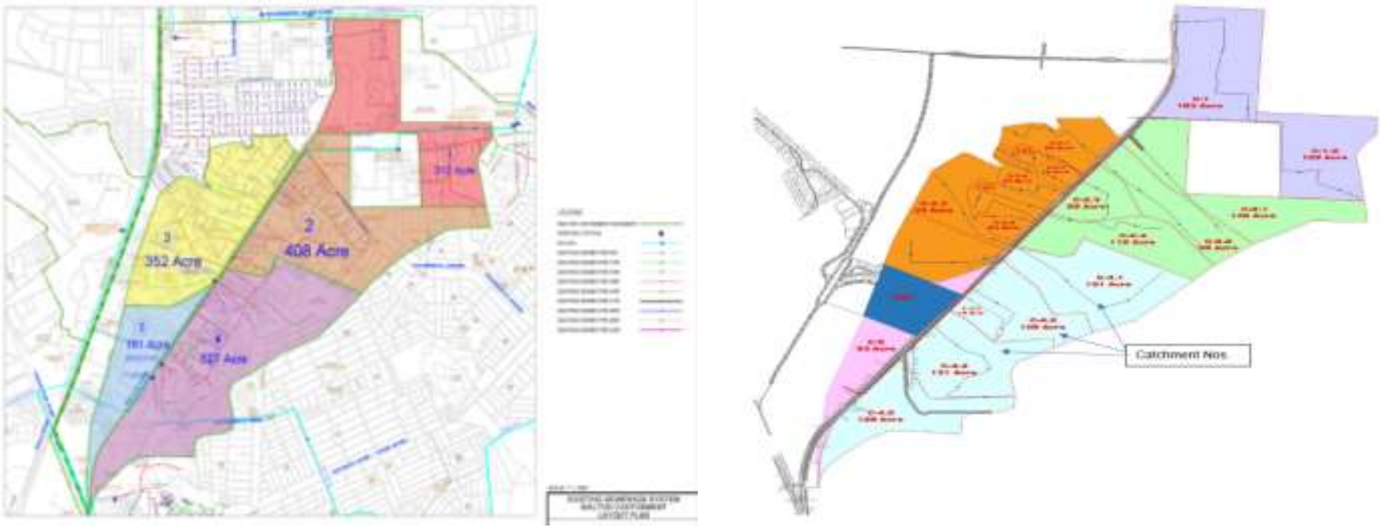
The network comprises old British-era brick sewers and newer reinforced concrete lines installed over the past 25 years. In many areas, sewage is still conveyed through open drains or storm drains due to the lack of trunk sewers. Lift stations help divert flows temporarily. In Shahdara, low-lying areas suffer from sewage ponding, with two disposal stations releasing untreated effluent directly into the River Ravi highlighting the urgent need for improved sewer and stormwater systems.

Despite multiple sewerage master plans in the past decade, only about 23% of the district was addressed, mostly urban areas. The current master plan aims to integrate past efforts and expand coverage district-wide. Rural areas remain underserved, with most villages lacking sewerage infrastructure and discharging wastewater into open fields or natural drains, resulting in environmental degradation.

In the Walton Road study area, two disposal stations No. 27 and Work Shop receive sewage from various catchments via laterals and trunk sewers and discharge into ADA Nullah. Unauthorized connections to ADA Nullah worsen the situation, especially during monsoons, leading to flooding, odor, and infrastructure damage.

To address these issues, the sewerage design is divided into two phases: Phase 1 covers Defense Chowk to Qainchi Stop, and Phase 2 continues from Qainchi Stop to Hudiara Drain, in line with the Lahore Master Plan. Rapid population growth has overwhelmed Lahore's sewerage infrastructure, necessitating comprehensive upgrades to ensure a sustainable, reliable system for the future (Water and Sanitation Agency - WASA, 2019)

Figure 5 : (Existing Sewerage System including catchment areas of Walton Road), (Catchment Areas Distribution)



Source: Rehabilitation of Walton Road, Design Report, (Water and Sanitation Agency - WASA, 2019)

Design Period

The future period for which the provision is made in designing the capacities of the various components of the sewerage system is known as the design period. The design period depends upon the following:

- Ease and difficulty in expansion;
- Amount and availability of investment;
- Anticipated rate of population growth, including shifts in communities and commercial investments;
- Hydraulic constraints of the systems designed; and
- Life of the material and equipment. Design life periods of different components of sewerage system are as follow:
- Allied Civil Works and Sewers: 25 years
- Machinery: 15 years

Machinery needs continuous upkeep and maintenance, if properly maintained, it can last for 20 years. For replacement purposes 15 years' period is recommended (CBD Punjab, 2024).

Table 4(Project Area Catchment Wise Population Distribution)

Catchment No.		Ward No.	Ward Density (Per Acre)	Catchment Area (Acre)	Current Population (Persons)	Growth Rate (%age)	Future Population (Persons)
C-1	C-1.1	W-2	44	183	8040	3.8	20427
	C-1.2			129	5668	3.8	9299
C-2	C-2.1	W-9	72	146	10578	2	17354
	C-2.2			95	6883	2	11292
	C-2.3			55	3985	2	6537
	C-2.4			112	8114	2	13312
C-3	C-3.1	W-1	45	68	3042	2	4991
	C-3.2			15	671	2	1101
	C-3.3			19	850	2	1394
	C-3.4			25	1118	2	1835
	C-3.5		60	31	1860	2	3052

	C-3.6	W-1&10		25	1869	2	3066
	C-3.7	W-10	75	75	5606	2	9197
	C-3.8			88	6578	2	10792
C-4	C-4.1	W-8	72	128	9568	2	15697
	C-4.2			161	11664	2	19137
	C-4.3			89	6448	1.2	8624
	C-4.4	W-9	765	19	14532	1.2	19436
	C-4.5			131	100192	1.2	134007
C-5	C-5.1	W-10	75	104	7764	3.8	19725
	TOTAL			1698	215030		330275

Source: Rehabilitation of Walton Road, Design Report (Water and Sanitation Agency - WASA, 2019)
Phase I of the sewerage project, initially planned by WASA but not implemented, is now being executed by CBD Punjab. This phase includes installing a sewerage system along both sides of Walton Road from Defense Chowk to Qainchi Stop. On the left side, multiple sewer lines (S-2 to S-9) with diameters ranging from 24 inches to 72 inches will carry sewage from left-side catchment areas. Each line will connect to the main trunk sewer (S-1) on the right side of the road, which ranges from a 48-inch diameter pipe to a 10ft x 6ft box conduit (ACE, 2022).

Phase II involves extending a conduit along Ferozepur Road up to Hudiara Drain, ending at a disposal station, aligned with the Lahore Master Plan (ACE, 2022).

Design Calculations for Phase I estimate the total sewage flow from five catchment areas by 2048 to be approximately 27 cusecs. The Central Business District (Walton & Bab-e-Pakistan) alone will contribute an average flow of 8 cusecs. The design also includes adjacent road drainage and stormwater from Ghora Chowk Flyover. Additionally, future flows from Makah Colony and Falcon disposal stations along Academy Road are incorporated as per client instructions. Accounting for peak flow factors, infiltration, 20% non-domestic flow, and a 50% stormwater allowance, the total design discharge at Qainchi Stop is calculated at 172 cusecs (ACE, 2022).

Table 5(Catchment area and Average sewerage flow)

Sr. No	Catchment No.	Area Served (Acre)	Avg. Sewerage Flow (Cusec)
1.	C-1	312	2.3
2.	C-2	408	3.7
3.	C-3	346	2.8
4.	C-4	528	15.5
5.	C-5	104	1.4
6.	C-1 TO 5	Commercial	5.0
	Total	**1,698**	**30**

Source: Rehabilitation of Walton Road, Design Report (Water and Sanitation Agency - WASA, 2019)

Table 6(Average Sewerage Flow)

Sr. No	Description	Avg. Sewerage Flow (Cusec)
1.	Catchment Area Flow	30.0

2.	Makah Colony Disposal	2.5
3.	Falcon Disposal	0.3
4.	Flow from Walton Site	5.5
5.	Flow from Bab-e-Pak	2.5
	Total	**40.8**

Source: Rehabilitation of Walton Road, Design Report (Water and Sanitation Agency - WASA, 2019)

Table 7 Drainage Discharge

Sr. No	Description	Drainage Flow (Cusec)
1.	Ghora Chowk Flyover drainage discharge	15.0
2.	Walton Road drainage discharge	18.6
	Total	**33.6**

Source:(Rehabilitation of Walton Road, Design Report, (Water and Sanitation Agency - WASA, 2019)

Table 8 (Design Sewerage Flow)

Sr. No	Description	Design Flow (Cusec)
1.	Peak Design Flow	86.9
2.	Infiltration & Non-Domestic Flow Allowance	8.0
3.	Strom water Allowance	43.5
4.	Drainage Discharges	33.6
	Total	**172.0**

Source: Rehabilitation of Walton Road, Design Report (Water and Sanitation Agency - WASA, 2019)

Main Sewer Line (S-1)

The main sewer line (S-1) is an RCC sewer line ranging from 48" to 72" in diameter, extending from Defense Mor to the 27 No. disposal station. It will run along the right side of Walton Road, carrying sewage from lateral sewers in the surrounding catchment areas. It will also accommodate all parallel running sewer lines (S-2 to S-5), thereby eliminating the need for the 27 No. disposal station by transporting sewage under gravity (ACE, 2022).

Sewer Lines (S-2 to S-9)

The RCC sewer lines S-2 to S-9 range from 24" to 72" in diameter and will run along the left side of Walton Road from Defense Mor. These lines will connect to S-1 through several crossings, carrying sewage from lateral sewers in their respective catchment areas to the trunk sewer/conduit up to Qainchi Stop (ACE, 2022).

8ft x 6ft Rectangular RCC Conduit

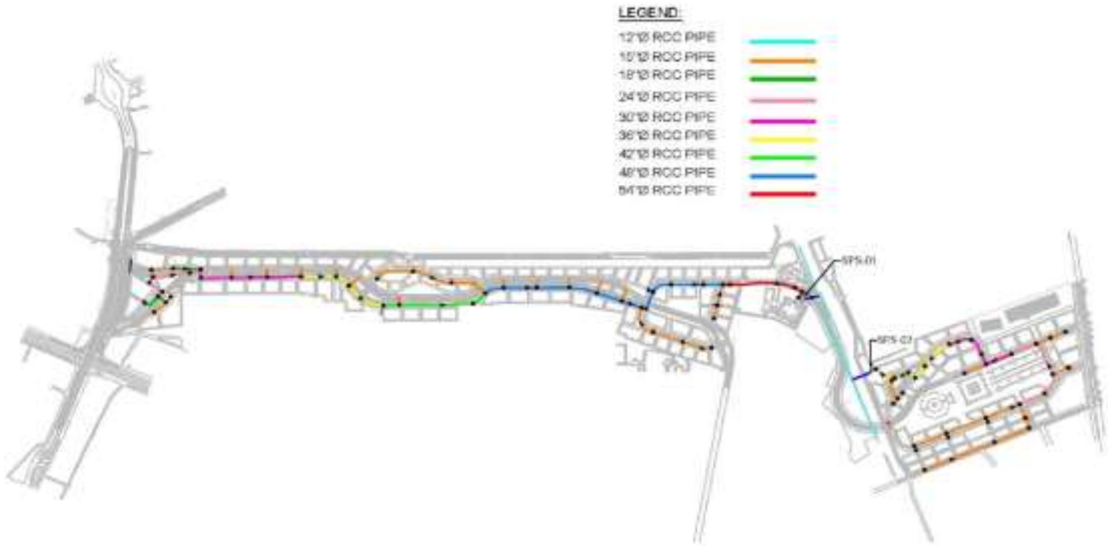
An RCC conduit measuring 8 ft x 6 ft and running for 4,000 ft is proposed. This conduit will handle sewage from relevant catchment areas and the 72" preceding sewer line. The Work Shop and DHA disposal stations will be eliminated by this conduit, which will connect to the 10 ft x 6 ft RCC conduit (ACE, 2022).

10ft x 6ft Rectangular RCC Conduit

A 10 ft x 6 ft RCC conduit with a total length of 4,500 ft is proposed to run from Shaheen Chowk to Qainchi Stop. From there, it will extend along Ferozepur Road (during Phase II) and ultimately dispose of sewage into Hudiara Drain (ACE, 2022).

The vertical expansion of the city center can create significant constraints on future development due to increased pressure on the sewerage infrastructure. The growing population and development will lead to higher sewage flows and stormwater management challenges, necessitating substantial upgrades to the existing system to accommodate this increased load (ACE, 2022).

Figure 7 (Sewerage Network Design of Project Area)



Source: Rehabilitation of Walton Road, Design Report (Water and Sanitation Agency - WASA, 2019)

ELECTRICAL SYSTEM NETWORK DESIGN:
The proposed distribution network for plot owners will primarily consist of underground 11kV cables originating from the new 132/11kV grid stations. These cables will extend to the plot limits, where cable coils will be provided to enable each plot owner to connect their secondary distribution substation. An exception to this approach will apply to smaller plots with demand loads less than 400kW, which will have low voltage connections (CBD Punjab, 2024).

Design Parameters for Electrical Power Estimation
The following design parameters have been adopted for electrical power estimation in apartment buildings, commercial areas, and other project zones:

Diversity and Rating of Distribution Transformers: A development factor of 1.00, a diversity factor of 1.25, and a power factor of 0.85 have been used for electrical power estimation. Transformer ratings of 100 kVA, 200 kVA, 400 kVA, 630 kVA, 750 kVA, 1000 kVA, 1250 kVA, 1500 kVA, 2000 kVA, 2500 kVA, 3000 kVA, 4000 kVA, and 5000 kVA have been proposed for the plot areas. However, the installation of compact substations is not part of the infrastructure scope of work; the ratings are provided for informational purposes only (CBD Punjab, 2024).

Table 10 (Configuration of the Distribution Network)

Category	11kV Network Configuration	Land Use Demand Load	Interface RMU / Switchgear
Category A	Low voltage connection	≤ 0.4 MW	-
Category B	11kV - Open Loop Configuration	> 0.4 MW up to 1.6 MW	One Metered RMU
Category C	11kV - Open Loop Configuration	> 1.6 MW up to 3.2 MW	Two Metered RMUs
Category D	11kV - Open Loop Configuration	> 3.2 MW up to 5 MW	Three Metered RMUs

Category E	11kV - Radial Configuration (Three Feeders)	> 5 MW – 10 MW	Switchgear (3 IN + 2 BC)
Category F	11kV - Radial Configuration (Four Feeders)	> 10 MW – 15 MW	Switchgear (4 IN + 3 BC)

Source: CBD Design Report (CBD Punjab, 2024).

Electrical Power Utilization of Distribution Transformers
The distribution transformers shall be utilized up to 80% of its rated capacity as per WAPDA/NEPRA/LESCO standard rules and regulations (CBD Punjab, 2024).

Maximum Utilization Capacity of MV/LV Power Cables
MV (8.7/15kV) and LV (0.6/1 kV) power cables shall be utilized within 60% to 70% of its normal ampere ratings considering cable laying installation factors as per site requirement.

Rating of MV RMU Switches
The rating of switches shall be 630A as per applicable WAPDA/NEPRA/LESCO standard rules and regulations.

Maximum Short Circuit. Voltage Drops and Energy Losses
The maximum short-circuits level of 25/31.5 kA for Medium Voltage Switchgear installation, permissible limits of 5% for voltage drop and 3% for energy losses has been taken.

Design Concept
The proposed locations for electrical utility corridors within the Right of Way (ROW from plot boundary to plot boundary) are based on two main objectives: ease of access for repairs, typically placing cables under sidewalks or paved surfaces, and minimizing land use while maintaining clearances per local and international standards. Power supply corridors in the project include:

1) **High Voltage Power Transmission (PT) Corridor**: Initially, one 132 kV circuit will supply a new 132/11 kV substation within the utility area for Phase 1 loads. The ultimate supply will come from a 220 kV overhead line from Old Kot Lakhpat 220/132/11 kV substation, pending NTDC confirmation. Coordination of ROW for this line is required between LCBDDA and NTDC (ACE, 2022).
2) **Medium and Low Voltage Power Distribution (PD) Corridors**: Due to limited ROW and high 11 kV cable volume for dense loads, direct burial of 11 kV cables (standard LESCO/WAPDA practice) is not feasible within sidewalks. Instead, they will be placed in a utility tunnel within a 10 ft setback from plot lines (ACE, 2022)
3) **Utility Tunnel Installation:**

- **Cons:**
    - I. Highest initial cost compared to direct buried or duct bank methods due to structural and MEP systems.
    - II. Requires approvals from local authorities, Civil Defense, and utility providers.
- **Pros:**
    - I. Reduces land usage with narrower ROWs.
    - II. Provides easy access for maintenance and upgrades.
    - III. Minimizes disruption to traffic, other utilities, and the environment (noise, air, dust).

4) **LV Cable Corridors**: To be placed under sidewalks per LESCO/WAPDA standards.
5) **Street Lighting (SL) Corridors**: Installed under the Pedestrian Realm or Medians, often aligned with tree corridors (ACE, 2022)

RECOMMENDATINS:

1. Strengthen Implementation of the Existing Master Plan
While Lahore's Master Plan 2050 is in place, its success depends on effective execution. All development authorities LDA, WASA, PHED, and TMAs must coordinate to ensure that zoning laws, infrastructure expansion, and service

delivery align with the vision and timelines of the master plan.

2. Upgrade and Expand Water and Sanitation Services

WASA and relevant agencies should be supported to expand service coverage to informal and peri-urban areas. Investments in wastewater treatment and proper disposal systems are urgently needed to stop untreated sewage from contaminating the River Ravi and underground aquifers. Introducing decentralized sewage systems and water recycling facilities in high-density commercial zones can also help.

3. Regulate Vertical Growth Through Infrastructure-Linked Approvals

The development of vertical economic centers like Gulberg and the CBD boosts the economy but puts pressure on urban systems. A performance-based regulation system is recommended where high-rise permits are approved only if water, electricity, and waste systems can handle the increased demand without compromising nearby residential areas.

4. Promote Equitable Decentralization of Economic Hubs

The shift of commercial growth toward southern Lahore (DHA, Bahria Town, Johar Town) is encouraging. This trend should continue, but with balanced planning and infrastructure to avoid overburdening selective zones. Improved public transport and road linkages must support these emerging hubs.

5. Enhance Energy and Transport Resilience in High-Rise Zones

Vertical centers like Liberty Market, MM Alam Road, and CBD should incorporate energy-efficient technologies, backup power systems, and smart transport planning. Parking structures, electric vehicle (EV) stations, and non-motorized mobility zones should be integrated to manage traffic and reduce emissions.

6. Strengthen Enforcement in Private Housing Societies

Many private housing schemes lack proper waste, drainage, and sanitation systems. Authorities should ensure strict adherence to development regulations, with utility connections contingent on compliance with service infrastructure benchmarks.

7. Encourage Environmental Sustainability in All Urban Development

All new commercial and residential developments should integrate green infrastructure such as rooftop gardens, rainwater harvesting systems, and permeable pavements. Zoning incentives can promote low-carbon construction and improve climate resilience.

8. Improve Public Engagement and Urban Awareness

Citizen awareness is essential for sustainable urban living. The government should promote public education campaigns around water conservation, waste disposal, and responsible energy use, especially in commercial and high-rise areas.

9. Foster Inter-agency Coordination and Data Sharing

To avoid duplication of efforts and to increase efficiency, data-sharing platforms between WASA, LDA, CBD Authority, and others should be developed. Real-time monitoring of water, energy, and waste loads in commercial centers can help guide responsive planning.

10. Encourage and Support the Vision of a Modern Lahore

The government's proactive approach to Lahore's transformation from CBD development to mega infrastructure projects must be applauded. With the right checks, public participation, and smart investment, Lahore is well on its way to becoming a sustainable, economically strong, and globally competitive metropolis.

CONCLUSION:

Lahore's rapid urban expansion and growing trend toward vertical development have brought significant challenges related to water and sanitation, electricity, infrastructure, and environmental sustainability. The construction of high-rise buildings has led to increased pressure on utilities, especially electricity and freshwater supply, adding strain to already burdened systems. In particular, untreated wastewater continues to pollute natural water bodies, reinforcing the urgent need for modern sewerage systems and better environmental management practices.

The development of the Central Business District in the Gulberg area is a step forward in meeting modern commercial and mobility needs. However, it also poses challenges such as utility shortages, traffic congestion, and the depletion of underground water resources. Recognizing these challenges, Lahore's civic authorities are making notable progress through a well-structured and forward-looking master plan. This comprehensive approach focuses not only on sanitation and storm water drainage but also on the expansion and upgrading of road networks, improved water distribution systems, and the enhancement of electrical infrastructure to meet rising demands.

Key initiatives include the phased introduction of advanced sewerage and drainage systems, reliable and uninterrupted power supply across all city zones, rehabilitation of old roads and construction of new corridors to ease traffic congestion, and the development of efficient water distribution networks to ensure access to clean and safe drinking water for all residents.

Departments across Punjab especially those responsible for water, power, transport, urban development, and environment deserve recognition for their relentless efforts. Their commitment to sustainable urban development, inter-departmental coordination, and long-term planning is essential to Lahore's transformation into a resilient, well-managed, and future-ready metropolis. With continued dedication, innovation, and public-private collaboration, Lahore can not only overcome its current urban challenges but also emerge as a model for sustainable city development across the region.

REFERENCES:

CBD Punjab. (2024). Sewerage system development along Walton Road: Phases I and II. Lahore Master Plan.

Asian Consultant. (2024). Design report for Central Business District sewage flow. Lahore Master Plan.

CBD Punjab. (2024). Proposed distribution network and electrical power estimation for plot owners. Lahore Master Plan.

CBD Punjab. (2024). Electrical power utilization and distribution network for plot owners. Lahore Master Plan.

Water and Sanitation Agency - WASA. (2019). Preparation of Master Plan for Water Supply, Sewerage and drainage system of Lahore. Lahore: Ltd., MM Pakistan (Pvt.).

ACE, A. C. (2022). Design Report for CBD Gulberg. Lahore. Retrieved 09 09, 2022

CBD Punjab. (2024). Lahore Urban Development and Infrastructure

Statistical bureau, Home | Pakistan Bureau of Statistics (pbs.gov.pk)

Al-Dubai, S. A., El-Shazly, M., & Hussien, A. A. (2017). Analysis of sustainability and innovation in high-rise buildings. Journal of Building Engineering, 12(1), 123-135.

Zhao, Y., Li, H., & Wang, J. (2018). Energy performance of high-rise buildings: THE CASE of Shanghai Tower. Energy and Buildings, 176(1), 294-305.

Rosenzweig, C., Solecki, W. D., & Slosberg, R. B. (2019). Climate change and urban infrastructure: Toward sustainable energy use. Transportation Research Record, 2400(1), 1-9.

Chan, E. H. W., Qian, Q. K., & Lam, P. T. I. (2016). Urban resilience and utilities: The challenges for Hong Kong. Journal of Facilities Management, 14(2), 149-164.

Ng, M. S., & Rahman, A. R. (2019). Assessment of high-rise buildings in Malaysia. International Journal of Building Pathology and Adaptation, 37(3), 290-307.

Huang, Y., & Chen, C. (2018). Sustainable waste management in high-rise buildings: The Taipei 101 case. Energy Efficiency, 11(4), 989-1002.

Siddiqui, S. (2019). "The Evolution of Lahore: From Walled City to Sprawling Metropolis." The Express Tribune.

Hussain, F. (2021). "Lahore's Shifting Economic Landscape." Dawn News.

Ahmed, Z. (2023). "The Rise of DHA and Bahria Town as Economic Hubs in Lahore." Pakistan Today.

Qureshi, I. (2022). "The Impact of Lahore Ring Road on Urban Development." The News International.

Afzal, M., & Naseem, A. (2018). "Rural-Urban Migration and Its Implications on Socioeconomic Structures:

Evidence from Pakistan." Journal of Social Sciences, 15(2), 234-247.

Farooq, M., & Abbas, F. (2019). "Socioeconomic Impact of Internal Migration in Pakistan: A Case Study of Lahore." Pakistan Journal of Social Issues, 25(1), 58-73.

Gardezi, S. H., & Khan, A. R. (2020). "Patterns and Drivers of Migration to Lahore: A Household Survey Analysis." Urban Studies Research, 2020, 1-12.

Haider, M. Z., & Ullah, N. (2019). "Urbanization, Migration, and Social Adjustment: The Case of Lahore, Pakistan." Asian Journal of Social Science, 47(3), 267-284.

Malik, A., & Ali, T. (2020). "Economic Determinants of Rural to Urban Migration in Lahore." International Journal of Social Economics, 47(8), 987-1002.

Saeed, R., & Ahmad, M. (2018). "The Role of Employment Opportunities in Shaping Migration Patterns: A Study of Lahore City." Lahore Journal of Economics, 23(1), 123-139.

Shah, A., & Qureshi, S. (2021). "Analyzing the Impact of Migration on Urban Development: The Case of Lahore." Pakistan Development Review, 60(4), 421-440.

Zafar, M. I., & Khan, S. (2018). "Socioeconomic Factors Influencing Migration Decisions: A Study of Migrant Workers in Lahore." South Asian Journal of Social Sciences, 11(2), 101-115.

Nadeem, M., Aziz, A., Al-Rashid, M. A., Tesoriere, G., Asim, M., & Campisi, T. (2021). Scaling the potential of compact city development: The case of Lahore, Pakistan. Sustainability, 13(9), 5257. Https://doi.org/10.3390/su13095257