Dera Ghazi Khan
Regional Development Plan
Environment & Social Safeguards Division

The Urban Unit

Environment Sector

DGK Regional Development Plan

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01 Setting the Context

Rapid urbanization, population expansion in urban centers and massive economic activities are among certain challenges that Punjab province is facing. To tackle these issues and improve Punjab's population's livability, development and planning at the regional level have been brought to attention.

> There is a multifaceted way to express the terminology **"Region"** depending upon the scale of analysis. It could be any land that has common natural and artificial features. It could also be any basic administrative unit that either encompasses an area, division, or district for local government. More distinctively, it could be any administrative or politically/economically/spatially defined area that may cover different states/countries or could be at a national/sub-national/local scale and has a role in a certain level of development[1].

Punjab Spatial Strategy 2047 outlines division as a good region for achieving larger development goals in harmony with districts and cities as well as for assessing the comparative advantages at a macro scale. **The strategy identifies division as a 'region' which forms the economic units based on a regional vision and development plans that not only enhance competitiveness and productivity of the region but also enable efficient resource allocation and more economic returns.** In an international context, China has successfully achieved its economic transition from an agrarian economy to an industrialized economy by focusing on regional developments and integrated planning frameworks.

Dera Ghazi Khan Division, located in the extreme south-western area of Punjab, covers approximately 20% of the total area of the province. This division comprises four districts: Dera Ghazi Khan, Rajanpur, Muzaffargarh, and Layyah. The region holds significant potential for economic growth and offers abundant opportunities for investments. However, it is also rich in natural resources that

Figure 1: Divisions of Punjab Province

[1] Schmitt-Egner, P. 2010. The Concept of 'Region': Theoretical and Methodological Notes on its Reconstruction. *Journal of European Integration*. 24(3): 179-200.

are currently threatened by various natural and anthropogenic hazards, including abrupt temperature variations, industrialization, urbanization, deforestation, and the depletion of water resources.

This situation thus, demands a number of interventions with a range of amenity green structures and improved environmental quality in order to develop a proportion between grey and green areas of the region. Therefore, a regional development plan of the environment sector is being prepared for the spatial, economic, and environmentally sustainable development in the region. It also helps in managing the challenges, disparities and competition for development resources between cities in a region as well as keep the goods and resources available to them as per their needs.

02 DG Khan Regional Profile

Geographically, the DG Khan Region lies from 30'03" North latitudes and 70'38" East longitudes covering a total area of about 38,780 km².[2] It is situated in the extreme south-western part of the Punjab province occupying roughly 20% of Province's total area. According to Pakistan Population and Housing Census 2017, the Region has a population of about 11.013 and comprises of four districts and 14 tehsils. Districts in DG Khan region include Dera Ghazi Khan, Rajanpur, Layyah, and Muzaffargarh; among them DG Khan district is the largest district.[3]

Geographically, Dera Ghazi Khan is bordered by Dera Ismail Khan to the north and Rajanpur to the south. To the east, the Indus River flows, with Muzaffargarh and Layyah districts situated across it. On the western side, the Koh-e-Suleman mountain range separates Dera Ghazi Khan from the Loralai and Dera Bugti districts of Balochistan Province.[4] Topographically, the region is characterized by diverse features, including fertile plains and riverine areas in the east, and the rugged Koh-e-Suleman mountain range in the west. The region also encompasses semi-arid and desert zones, creating a varied landscape with elevations ranging from about 100 meters to over 1,500 meters above sea level.

Demographically. DG Khan region exhibits a substantial rural-urban difference in population size. According to the Census 2017, the annual growth rate of DG Khan is estimated to be **2.81%.** This growth rate reflects the change in population size over the years and accounts for factors like birth rates, death rates, and net migration. Moreover, the regional level analysis shows that the ratio of Urban and Rural population is 17.27% and 82.73% respectively for DG Khan Region. The detailed demographic profile of DG Khan Region is given below:

Table 1: Demographic Profile of DG Khan Region[5,6]

DG Khan Region					
Sr. #	**Particulars**	**DG Khan District**	**Layyah District**	**Muzzaffargarh District**	**Rajanpur District**
1.	**Location**	30.2748° N, 70.2408° E	31.0998° N, 71.0022° E	30.1392° N, 71.0973° E	29.1044° N, 70.3301° E
2.	**Area**	11.922 km²	6,289 km²	8,249 km²	12,318 km²
3.	**Population (2017)**	2,872,631	1,823,995	4,328,549	1,996,039
4.	**Population Density/ km²**	240.95	290.03	524.74	162.04
5.	**Urban Proportion**	19.01	17.61	16.13	16.90

[2] https://dgkhandivision.punjab.gov.pk/index.php/geographic_conditions
[3] https://dgkhandivision.punjab.gov.pk/division_profile
[4] Ibid at 2
[5] https://www.pbs.gov.pk/sites/default/files/population/2017/tables/punjab/Table01p.pdf
[6] DISTRICT_WISE_CENSUS_RESULTS_CENSUS_2017.pdf

DG Khan Region					
Sr. #	**Particulars**	**DG Khan District**	**Layyah District**	**Muzzaffargarh District**	**Rajanpur District**
6.	**Average Households**	8.15	6.42	6.48	7.44
7.	**No. of Tehsils**	**04** (Dera Ghazi Khan, Kot Chutta, Taunsa, Koh e Suleman)	**03** (Layyah, Karor Lal Esan and Choubara)	**04** (Muzaffargarh, Alipur, Kot Addu, Jatoi)	**03 Tehsils and 1 Tribal Areas** (Jampur, Rajanpur, Rojhan, De-Excluded Area)

District-wise population projection is provided in the below tables;

Table 2: Projected Population[7]

Districts	Growth Rate (2017-2023)	2023	2028	2033	2038
DG Khan Region	**2.66**	12,892,465	14,700,844	16,762,877	19,114,144
DG Khan District	2.83	3,393,705	3,901,874	4,486,136	5,157,885
Layyah District	2.40	2,102,386	2,367,076	2,665,091	3,000,626
Muzaffargarh District	2.49	5,015,325	5,671,612	6,413,779	7,253,063
Rajanpur District	2.99	2,381,049	2,758,949	3,196,825	3,704,198

With an increase in the population in the next 15 years, the stress on the natural resources and environment of the DG Khan Region could be much higher. Thus, demanding a regional-level development plan where development efforts are focused on the creation of a system of cities that foster intercity networking, create more jobs and increase productivity as well.

2.1. Climate Profile of DG Khan Region

According to Köppen Climate Classification, the climate of DG Khan Region can be classified as a Subtropical desert climate (Classification: BWh).[8] The region generally experiences diversity in climatic patterns, owing to its topographical variations.

Generally, Dera Ghazi Khan has a semi-arid to arid climate with hot summers, mild winters, and low annual rainfall. From April to September, temperatures frequently exceed 40°C (104°F), and during the peak months of June and July, they can rise above 45°C (113°F). This season is typically dry with occasional dust storms. The winter months, from December to February, are mild, with daytime temperatures between 15°C and 25°C (59°F to 77°F), and nighttime temperatures dropping to around 5°C (41°F), resulting in pleasant and dry weather. The monsoon season, occurring from July to September, brings most of the annual rainfall, which is around 200-300 mm (8-12 inches). Despite being relatively low, this rainfall can cause occasional flooding, especially

[7] Based on the Statistical Analysis done by the Urban Unit
[8] https://weatherandclimate.com/pakistan/punjab/dera-ghazi-khan

in the areas near the Indus River. The region experiences low humidity throughout the year, contributing to its arid conditions, and strong winds during the summer months, often leading to dust storms. Moreover, Dera Ghazi Khan enjoys abundant sunshine year-round, with predominantly clear skies. This climate profile significantly impacts agricultural practices and water management strategies, requiring efficient irrigation techniques and the cultivation of drought-resistant crops.

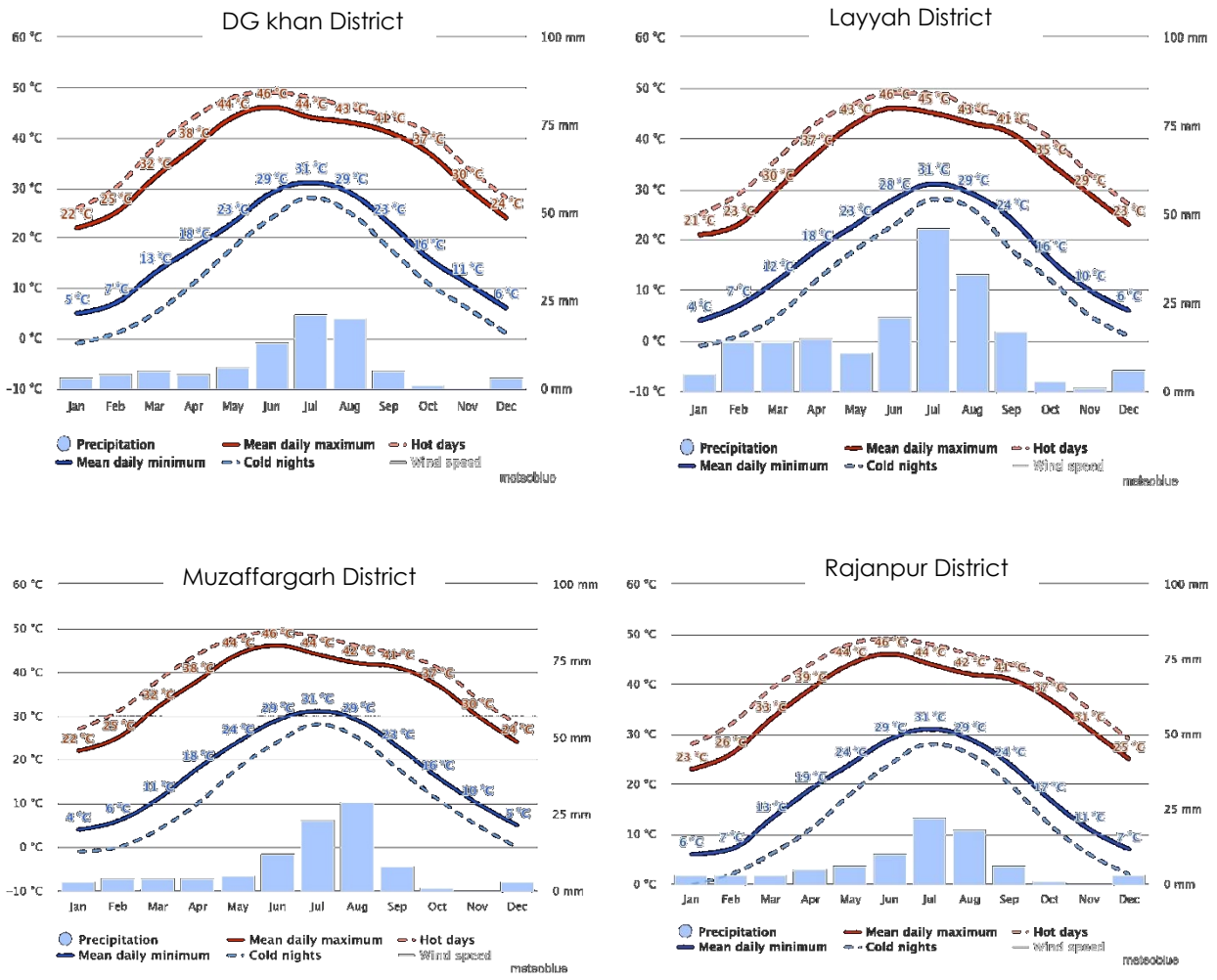


Figure 2: Average Annual Temperature and Precipitation of DG Khan Region

As per the Global Climate Risk Index 2021 ranking by Germanwatch, Pakistan ranked in the top ten countries that suffered the most from climate-related risks. A report by the Asian Development Bank on the Climate Profile of Pakistan provides district-wise ranking on the basis of vulnerability to different climate-related risks and hazards. The ranking of DG khan Region is exhibited below in Table 3.

Table 3: District-Level Climate Risk and Hazard Assessment Classification [9]

[9] https://www.adb.org/sites/default/files/publication/357876/climate-change-profile-pakistan.pdf

Rank	Districts	Flood Risk	Landslide Risk	Earthquake Risk	Cyclone Risk	Drought Risk	Avalanche	GLOF Risk	Cumulative Risk Level
79	DG Khan	5	1	2	2	3	1	1	Medium
81	Rajanpur	5	1	2	2	3	1	1	Medium
83	Layyah	5	1	2	2	3	1	1	Medium
84	Khushab	4	2	3	2	2	1	1	Medium

Scoring Key				
Very High	High	Medium	Low	Very Low
5	4	3	2	1

According to this ranking, DG khan Region is most vulnerable to climate disasters, particularly with respect to flood risk followed by drought and earthquake risks.[10]

Apart from that, Dera Ghazi Khan is located in a seismically active zone due to its proximity to the tectonic plate boundaries and fault lines associated with the Koh-e-Suleman mountain range. This region is prone to earthquakes, with seismic activity primarily resulting from the tectonic movements along the Indian and Eurasian plates.[11]

2.2. Environmental Quality Assessment:

Dera Ghazi Khan Division is the southernmost region of the Punjab Province. It is present at an elevation of 415 ft., along the west bank of River Indus[12]. It borders both the Sindh and Baluchistan province, serving as a significant inter-provincial trade route and road pass. Owing to a distinct regional inequality, various governments have assigned higher development priorities for the region. Thus, the urban areas of the district have seen a population boom along with economic developments[13]. This has led to a myriad of environmental challenges, including inadequate air & water quality, insufficient access to services including clean water, waste management, recreational spaces, etc.), congestion, and health issues. Moreover, the green cover of the region is also deteriorating.

[10] Chaudhry, Q. 2017. Climate Change Profile of Pakistan. Asian Development Bank, Philippines. doi.org/10.22617/TCS178761

[11] https://cms.ndma.gov.pk/storage/app/public/publications/December2020/MzOtLevMsttKF7aqqb6X.pdf

[12] Ghias, S., Satti, K.H., Khan, M., Dilband, M., Naseem, A., Jabbar, A., Kali, S., Ur-Rehman, T., Nawab, J., Aqeel, M., Khan, M.A., Zafar, M.I., Health Risk Assessment of Radioactive Footprints of the Urban Soils in the Residents of Dera Ghazi Khan, Pakistan, Chemosphere.

[13] Khurshid, M., & Shirazi, S. A. (2021). Applications of Geospatial Techniques to Identify Landscape Changes and Urban Expansion of Dera Ghazi Khan City, South Punjab-Pakistan. International Journal of Economic and Environmental Geology, 12(3), 40-43.

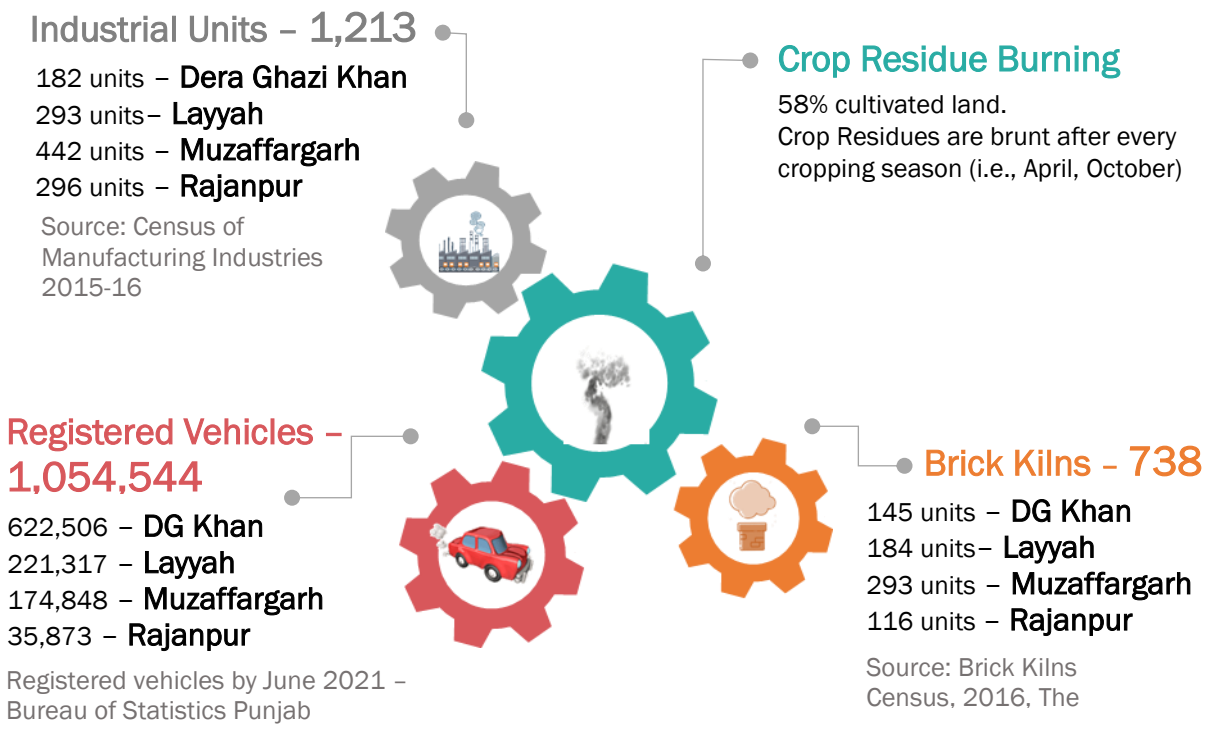


Figure 3: Key factors affecting Environmental Quality of DG Khan Region

2.2.1. Air Quality Assessment

The air quality of the Dera Ghazi Khan Region is largely influenced by industrial emissions, poor traffic management and inadequate transport infrastructure, polluting industries, insufficient availability of clean fuels, outdated technologies, absence of air quality monitoring equipment, open burning of wastes and crop residues, non-availability of resources for enforcement of regulations in emissions control, and ineffective implementation of legislations.

Dera Ghazi Khan region has an agrarian economy. The region is present at a junction of Sindh, Baluchistan, KPK, and Punjab provinces. There are a total of 1,213 industrial units, present in the form of scattered clusters across the region. DG Khan District hosts 182 industrial units, 442 units in District Muzaffargarh, 293 units in District Layyah, and 296 units in District Rajanpur.[14] Various thermal power stations, sugar mills, and oil refineries are located in the region. Muzaffargarh district is the main industrial hub. It consists of 4 sugar mills, 6 thermal power generation units, and an oil refinery PARCO. The power generation units in Muzaffargarh are oil and coal-fired units. Residents have reported black smoke and its health impacts from the power generation units in Muzaffargarh[15]. Other major industries include a cement manufacturing unit in DG Khan, nuclear power plant in Taunsa Sharif, sugar mills in Layyah and Rajanpur, and stone crushing units in the entire division[16]. The total number and categories of registered industries, in DG Khan Region, recorded by the Census of Manufacturing Industries 2015-16, are given in Figure 4.

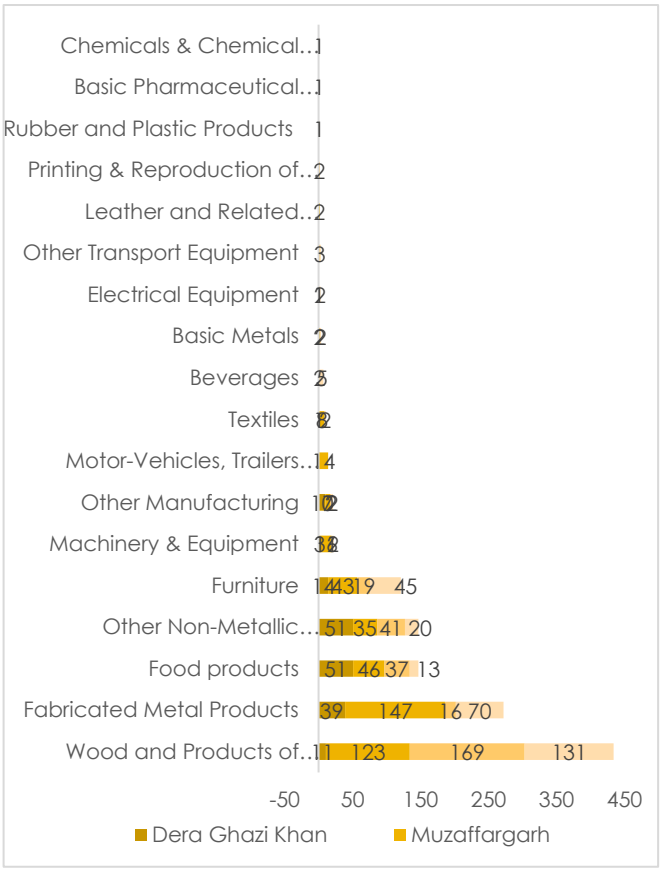


Figure 4: Industries in DG Khan Region
(Source: Census of Manufacturing Industries 2015-16)

The Sakhi sarwar gravel complex consisting of 7- stone crushing units are located in the southern Punjab region. These crushing units meet the demand of mega projects in nearby areas by supplying 7,500 cft/d of crushed aggregates. Open pot excavation of rocks and their transportation activities are carried out through the region, influencing the air quality. Dust emissions from such activities are a key concern[17]. Moreover, fossil fuel burning in thermal power stations, brick kilns, sugar mills, and oil refineries located in the region are a source of many toxic air pollutants[18].

[14] Census of Manufacturing Industries 2015-16, the urban unit.
[15] Urban Unit Field Survey in the District
[16] Dera Ghazi Khan Division. Government of the Punjab. Division Profile. https://dgkhandivision.punjab.gov.pk/division_at_glance
[17] Gondal, M. M. I., Ahsan, N. A. V. E. E. D., & Javid, A. Z. (2008). Evaluation of Shaki Sarwar and Rajan Pur aggregates for construction in southern Punjab province, Pakistan. Geol. Bull. Punjab Univ, 43, 101-107.
[18] Tariq, S., Ali, M., Mahmood, K., Batool, S. A., & Rana, A. D. (2014). A study of tropospheric NO2 variability over Pakistan using OMI data. Atmospheric Pollution Research, 5(4), 709-720.

According to the Punjab Brick Kilns Census 2016, there are a total of 738 brick kilns in Dera Ghazi Khan Division. The fuel source used in brick kilns is coal. The burning of poor-quality coal emits oxides of carbon (CO, CO_2) and sulfur (SO_2), particulate matter (PM_{10}, $PM_{2.5}$), Polycyclic aromatic hydrocarbons (PAHs), and Volatile organic compounds (VOCs)[19]. In addition, solid waste burning, power sector, crop residue burning, and other industrial processes also emit pollutants in the air[20].

The transport sector is reportedly the major contributor to atmospheric emissions in Punjab. It emits CO, CO_2, NO_2, N_2O, SO_2, and PM. About 1.05 million vehicles have been registered in DG Khan Region[21]. Majority of the vehicles in the district include two-wheelers, three-wheelers, and tractors. These contribute to toxic air pollutants, and consequently health issues among the residents. Since, DG Khan is a junction of all four provinces, many large vehicles pass through the region and deteriorate the air quality[22]. Inefficient vehicular engines, use of poor-quality fuel, broken road infrastructure in some places, and construction & other activities leading to traffic congestion are also responsible for traffic-related emissions.

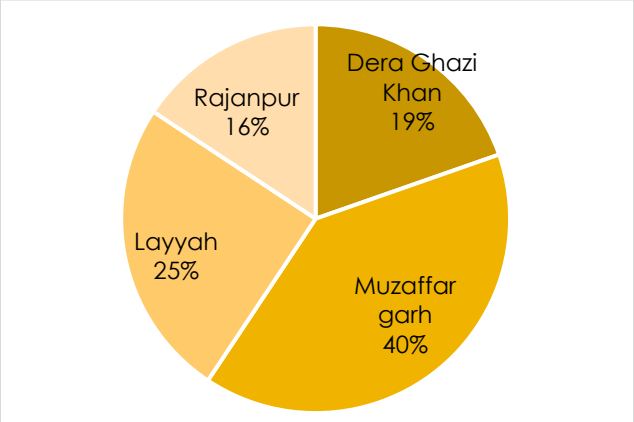


Figure 5: Number of Brick kilns in DG Khan Region
(Source: Punjab Brick Kilns Census 2016)

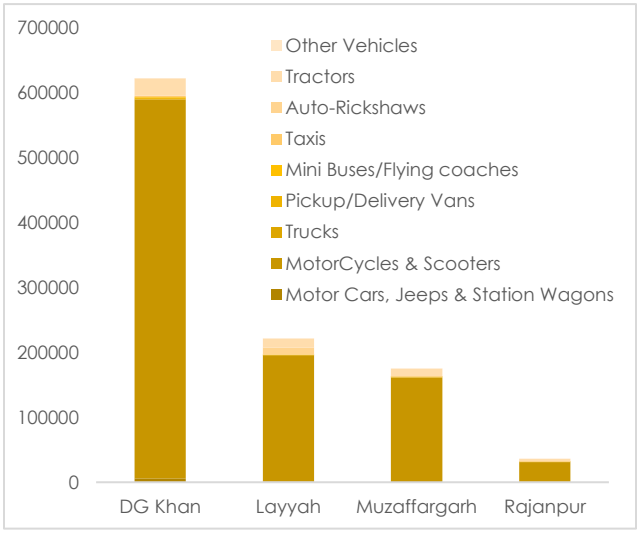


Figure 6: Registered Vehicles in DG Khan Region
(Source: Punjab Development Statistics 2022)

[19] Pervaiz, S., Khan, F., Javid, K., Altaf, A., Aslam, F., Tahir, M., … & Hayat, S. (2022). Development of air quality and brick kilns during the onset of COVID-19: An Analysis. Biological and Clinical Sciences Research Journal, 2022(1).
[20] Tabinda, A. B., Ali, H., Yasar, A., Rasheed, R., Mahmood, A., & Iqbal, A. (2020). Comparative assessment of ambient air quality of major cities of Pakistan. Mapan, 35, 25-32.
[21] Bureau of Statistics. Population Development Statistics Report, 2022. Government of Punjab.
[22] Ajmal, M., Tarar, M. A., Arshad, M. I., Gulshan, A. B., Iqbal, M. A., & Tanvir, F. (2016). Air Pollution and Its Effect on Human Health: A Case Study in Dera Ghazi Khan Urban Areas, Pakistan. Journal of Environment and Earth Science, 6(9), 87-93.

According to the Air Quality Life Index (AQLI), high particulate matter ($PM_{2.5}$) in the air is shortening the average Pakistani's life expectancy by 3.9 years annually, relative to what it would have been if the World Health Organization (WHO) guideline was met. The average annual concentration of $PM_{2.5}$ in Punjab was recorded to be 52 µg/m³ in 2021, which is higher than the PEQs Limits of 15 µg/m³ and WHO limits of 5 µg/m³ for $PM_{2.5}$ concentrations in ambient air. The Life Expectancy Gain (Years) by meeting WHO Guidelines for the residents of Dera Ghazi Khan Region is 4-5 Years (Figure 7).[23]

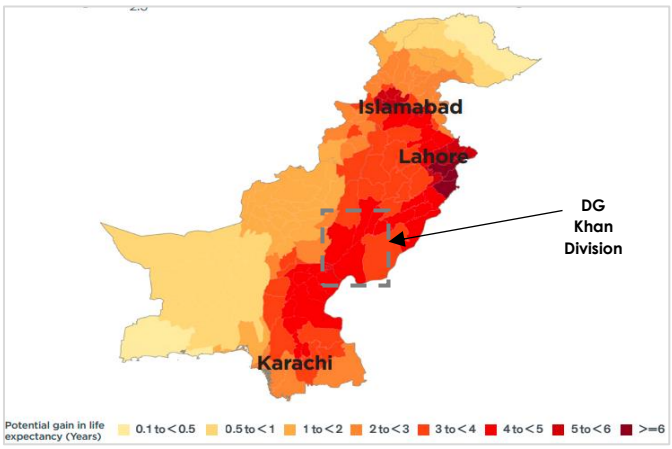
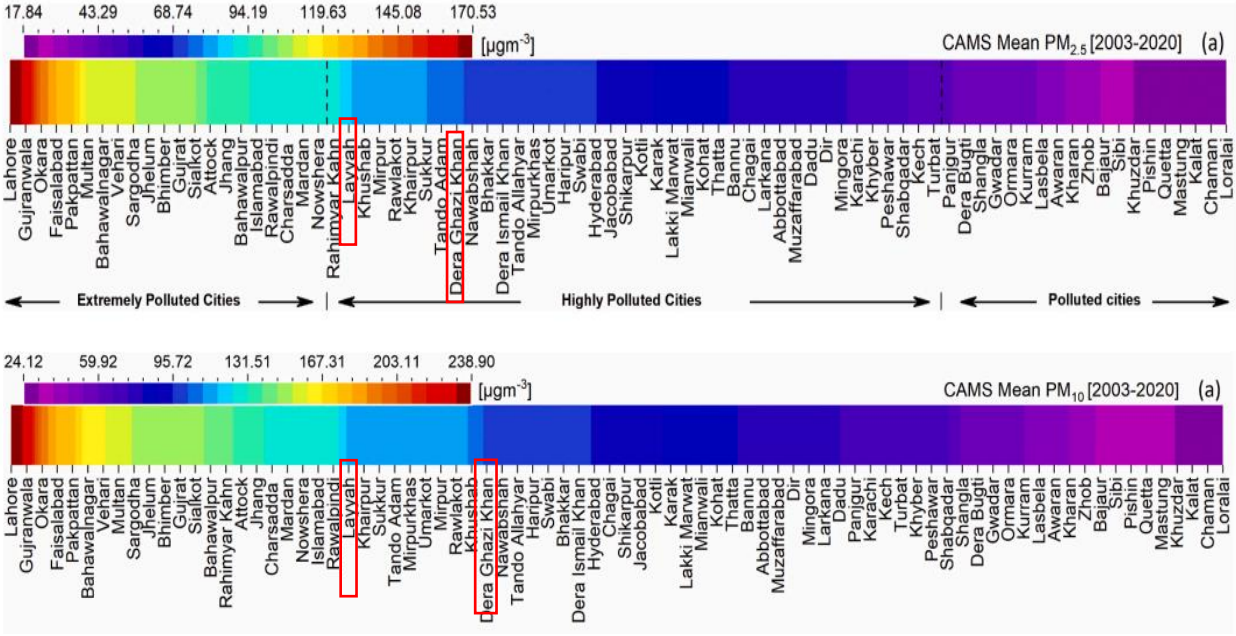


Figure 7: Life Expectancy Gains if WHO Guidelines for Ambient Air Quality are met.
(Source: AQLI Pakistan Factsheet 2023)

Air Quality data for 80 Cities in Pakistan was accessed from CAMS (Copernicus Atmospheric Monitoring System), AERONET (Aerosol Robotic Network, and Merra-2 (Modern-Era Retrospective Analysis for Research and Applications, Version 2) Satellites, in a research study[24]. The results reported that $PM_{2.5}$, PM_{10}, NO_2, and SO_2 concentrations in Layyah were in the range of 90 µg/m³, 130 µg/m³, 2.5×10^{15} molecules cm^{-2}, and 9.5×10^{15} molecules cm^{-2}, respectively. The concentrations of $PM_{2.5}$, PM_{10}, NO_2, and SO_2 concentrations in DG Khan were in the range of 80 µg/m³, 100 µg/m³, 2×10^{15} molecules cm^{-2}, and 9×10^{15} molecules cm^{-2}, respectively. Muzaffargarh and Rajanpur were not parts of this assessment study. The results are presented below;



[23] Pakistan Fact Sheet, August 2023. Air Quality Life Index. University of Chicago.
[24] Bilal, M., Mhawish, A., Nichol, J. E., Qiu, Z., Nazeer, M., Ali, M. A., ... & Ke, S. (2021). Air pollution scenario over Pakistan: Characterization and ranking of extremely polluted cities using long-term concentrations of aerosols and trace gases. Remote Sensing of Environment, 264, 112617.

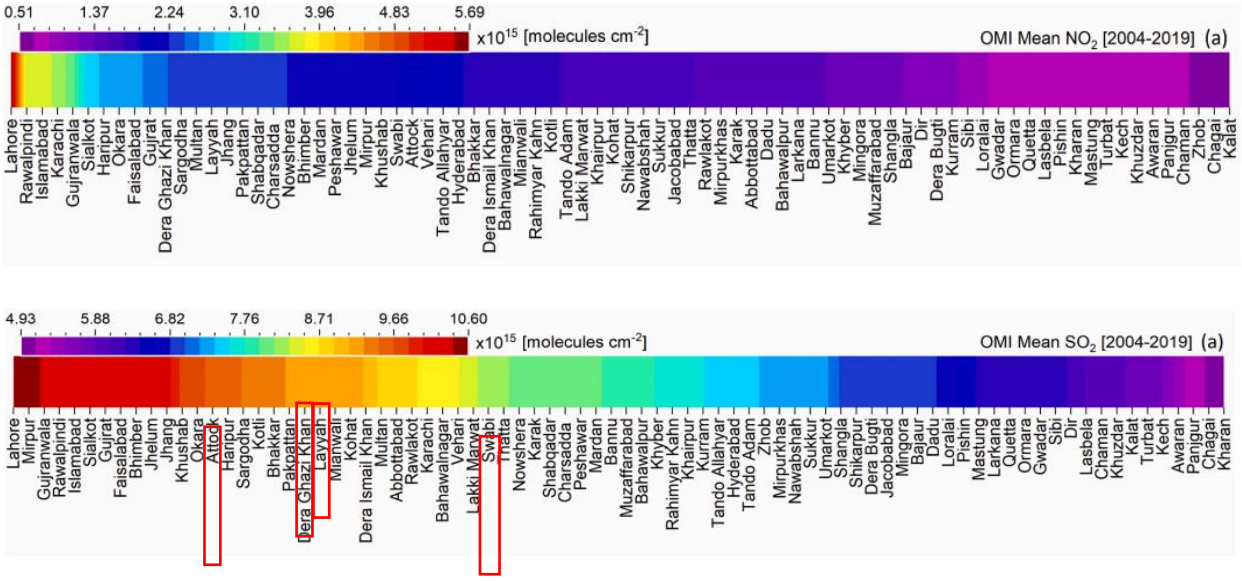


Figure 8: Ranking of Cities in terms of Mean $PM_{2.5}$, PM_{10}, NO_2, and SO_2 concentrations in Pakistan
(Source: Bilal et. al, 2021)

The environment team also monitored particulate matter (PM2.5 and PM10) in the field with the help of portable air quality monitoring instruments in the Dera Ghazi Khan Region. The monitoring results showed that the concentrations of $PM_{2.5}$ were recorded above the Punjab Environmental Quality Standards i.e., 35 µg/m3 specifically in various areas. The cities of DG Khan, Muzaffargarh, and Kot Addu are the most polluted areas. The sources of high $PM_{2.5}$ concentrations include vehicular emissions, crop residue burning, brick kilns, fossil fuel burning in industrial units, and biomass burning. The results are depicted in Figure 9.

In addition, the monitoring done in the field showed that the concentrations of PM_{10} are recorded higher than the permissible limit of PEQS i.e., 150µg/m^3 mainly in some areas of the region. The most polluted cities in terms of PM_{10} are Karor, DG Khan, Ali Pur and Jatoi urban centers. The concentration was lowest in Layyah. The sources of PM10 in the region include roadside dust, biomass burning, brick kilns, and crop residue burning. It is significant to note that the concentrations of particulate matter are also influenced by meteorological conditions, i.e., wind speed, wind direction, temperature, humidity, and precipitation) and seasonal conditions. The results are depicted in below Figure 10.

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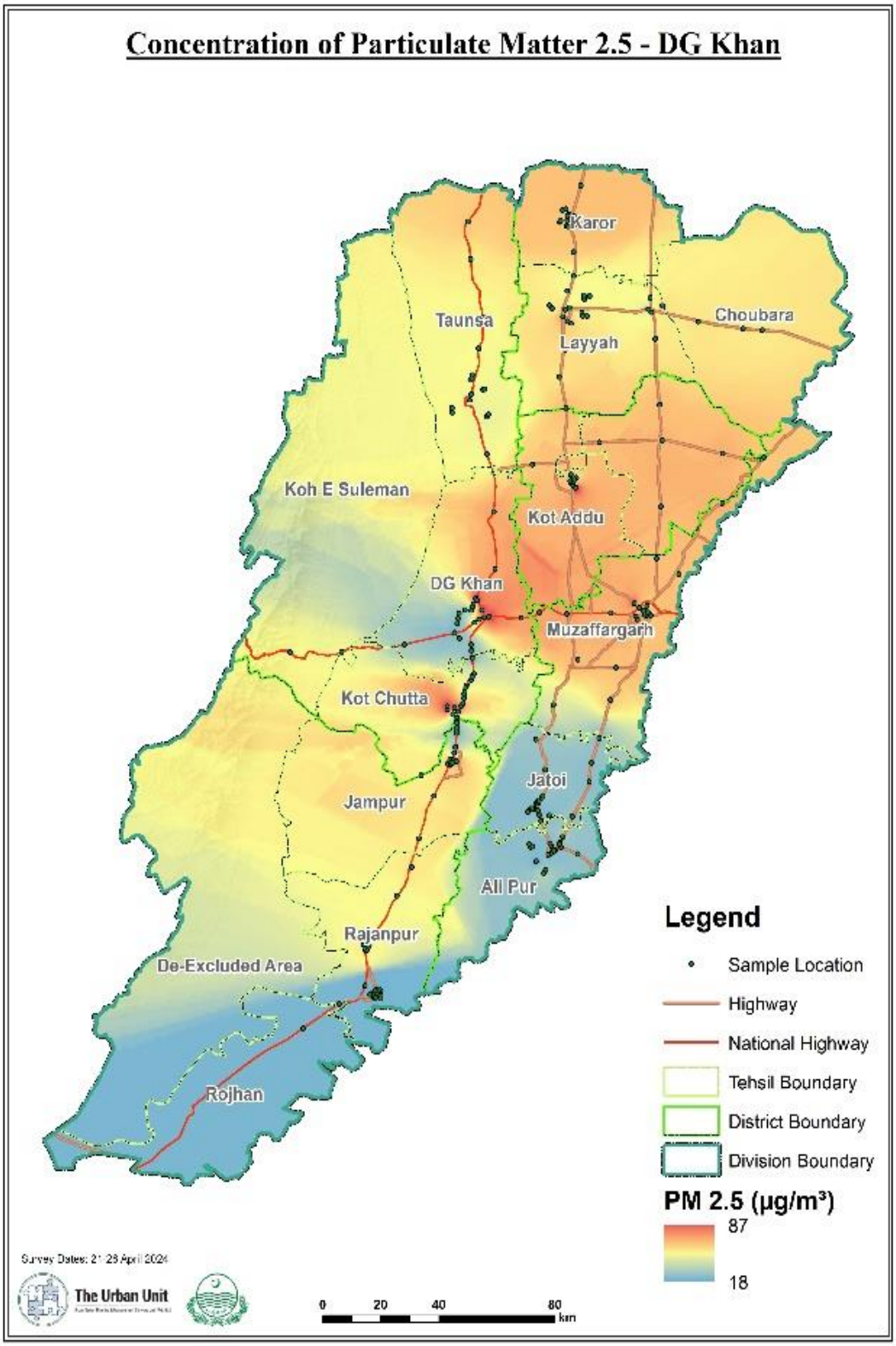


Figure 9: $PM_{2.5}$ Concentrations of DG Khan Region
(Source: Field Survey, UU Team, 2024)

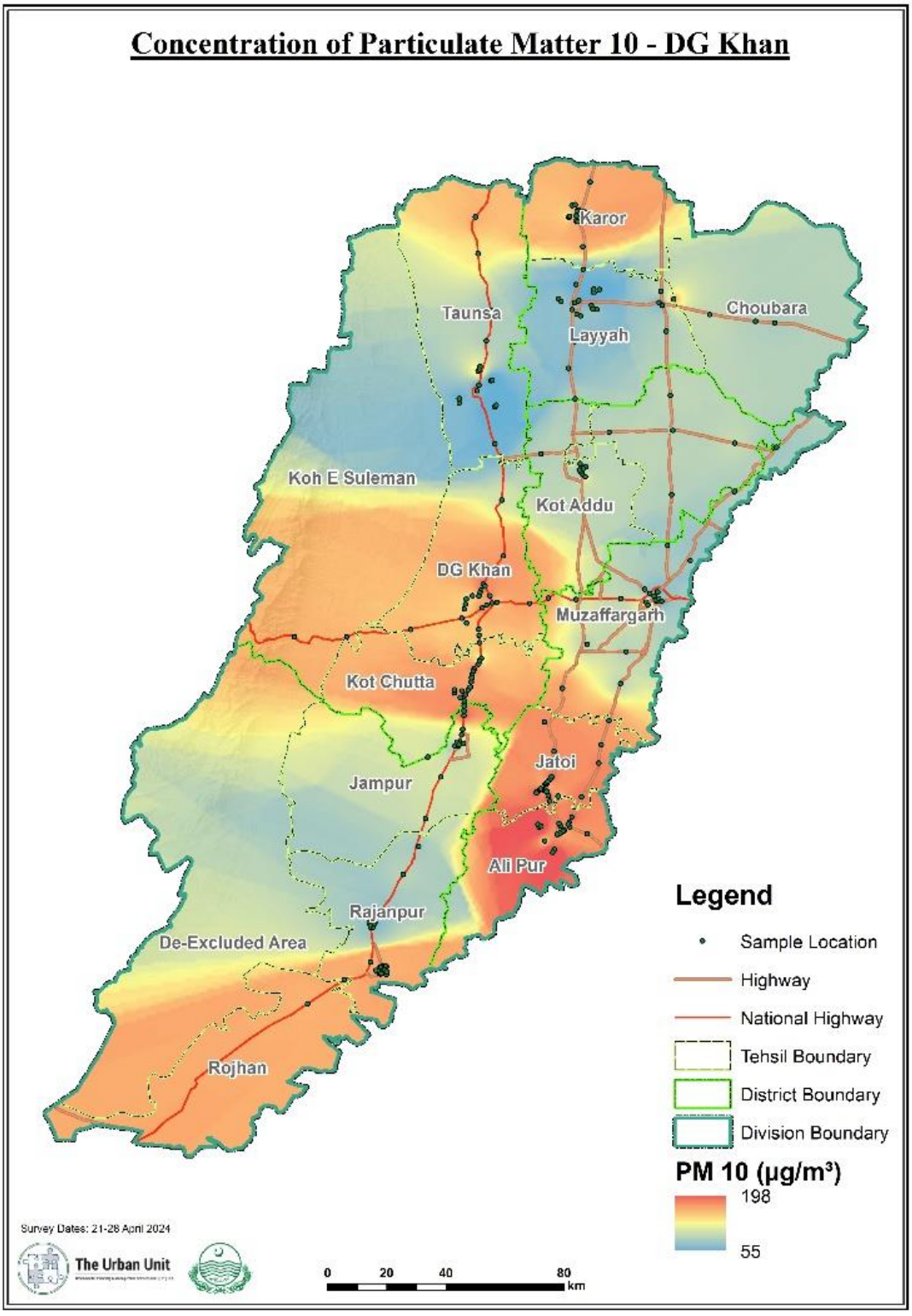


Figure 10: PM_{10} Concentrations of DG Khan Region
(Source: Field Survey, UU Team, 2024)

To complement air quality monitoring in the field, the research team at the Urban Unit uses remote sensing and satellite data to evaluate the pollution concentrations of Aerosol Index, Sulfur Dioxide and Nitrogen Dioxide in the region. The results of these spatial analyses are represented below.

- Aerosol Index (AI): Aerosol Index is higher in Layyah and Rajanpur districts. Major sources include; Emissions from brick kilns, sugar mills, stone crushing units, biomass burning, and vehicular emissions.
- Carbon Monoxide (CO): Carbon Monoxide (CO) concentration is high in the entire division. Major sources include crushing units, fossil fuel burning, vehicular emissions, and biomass burning.
- Nitrogen Dioxide (NO_2): The concentration of NO_2 is highest in the urban areas of DG khan, Kot Addu, and Layyah districts. Emissions sources include vehicular emissions and combustion activities.
- Sulfur Dioxide (SO_2): Sulfur Dioxide pollution is distributed throughout the entire division. Major sources for this high concentration are Biomass burning, Industrial emission, Traffic congestion.

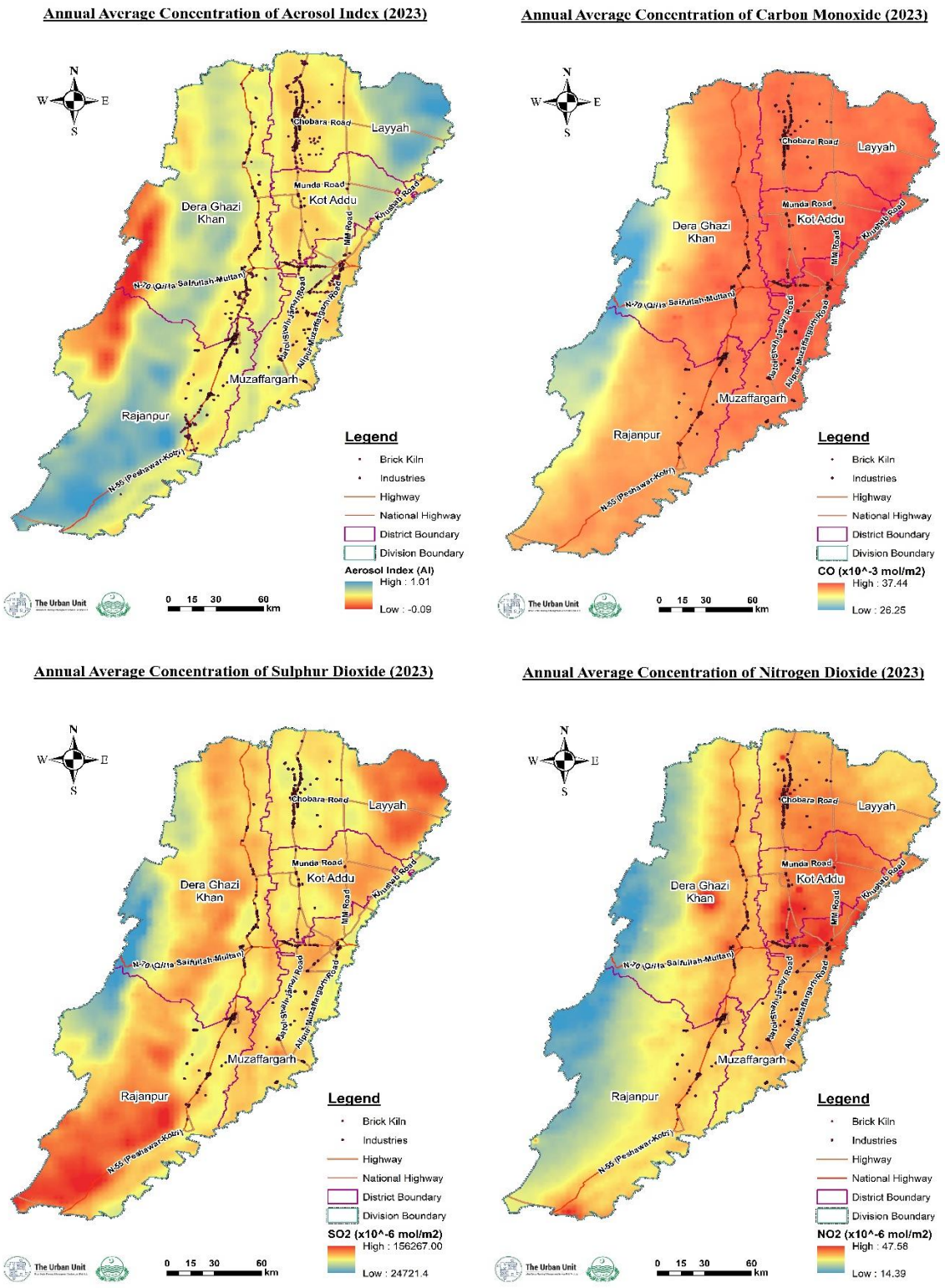


Figure 11: Concentration of AI, CO, NO_2 and SO_2 in DG Khan Region (2023)
(Source: Sentinel-5P data)

2.2.2. Water Quality Assessment

A 2022 study investigated the quality of drinking water and its potential health effects in the Dera Ghazi Khan (D.G. Khan) district, focusing on three tehsils: D.G. Khan, Kot Chutta, and Taunsa. A total of 50 water samples were collected and analyzed for various quality parameters. The water quality chemical properties of different samples are given below;

Table 4: Chemical properties of the water samples in DG Khan (2022)[25]

Parameters	WHO limits	Mean	Maximum	Mean	S. D
pH	6.5-8.5	7.28	8.75	6.52	0.462
EC (dS m-1)	1	2.21	9.78	0.31	2.131
TDS (mg L-1)	500	476	985	105	223.4
Cl- (mg L-1)	250	67.53	156.33	15.16	40.74
HCO3 (mg L-1)	500	186.15	459.33	22.36	82.45
Ca2+ (mg L-1)	200	25.02	70	10.22	14.21
Mg2+ (mg L-1)	150	28.02	70	10.22	14.21
SO42- (mg L-1)	250	111	324	2	31.65

The pH levels across the samples were generally within the acceptable WHO range of 6.5-8.5, with an overall mean of 7.35 ± 0.27 in Kot Chutta, 6.92 ± 0.20 in Taunsa, and 7.28 ± 0.46 in D.G. Khan. However, one sample (L11) exceeded the limit with a pH of 8.75.

Electrical Conductivity (EC) and Total Dissolved Solids (TDS) indicated elevated levels of dissolved salts in the groundwater. Mean EC values were 1.24 ± 0.64 dS m^{-1} in Kot Chutta, 1.79 ± 0.64 dS m^{-1} in Taunsa, and 2.21 ± 2.13 dS m^{-1} in D.G. Khan, with some samples exceeding the WHO limit of 1 dS m^{-1}. Mean TDS values were within acceptable limits, with 371.1 ± 128.30 mg L^{-1} in Kot Chutta, 611.47 ± 184.40 mg L^{-1} in Taunsa, and 476.88 ± 223.92 mg L^{-1} in D.G. Khan.[26]

Regarding specific ions, concentrations of bicarbonate, chloride, calcium, and magnesium were within WHO limits. However, sulfate levels were a concern, with some samples exceeding the WHO limit of 250 mg L^{-1}, suggesting potential health risks associated with sulfate intake in certain locations. This underscores the need for ongoing monitoring and mitigation efforts to ensure safe drinking water in the region.

A previous study found that most groundwater samples from random sites in Dera Ghazi Khan (City) were unfit for drinking, cooking, washing, bathing, and agricultural use. The study identified high values of electrical conductivity (EC), total dissolved solids (TDS), sulfates, chlorides, sodium, magnesium, bicarbonates, and total hardness (TH), along with bacterial contamination in many

[25] Saeed, M. A., Murtaza, G., Ali, S., Aziz, H., Albeshr, M. F., Mahboob, S., ... & Sajjad ur Rehman, M. (2022). Assessment of drinking water quality and associated socio-economic impacts in arid mountainous regions. *Sustainability*, *14*(19), 12567.
[26] Saeed, M. A., Murtaza, G., Ali, S., Aziz, H., Albeshr, M. F., Mahboob, S., ... & Sajjad ur Rehman, M. (2022). Assessment of drinking water quality and associated socio-economic impacts in arid mountainous regions. *Sustainability*, *14*(19), 12567.

samples, which did not comply with WHO guidelines. However, parameters such as fluoride, potassium, carbonate, alkalinity, and arsenic were within safe limits in many samples.

The study examined the groundwater quality in D.G. Khan, revealing consistently high EC levels, likely due to the region's proximity to mountainous areas, whereas samples closer to the Indus River showed lower EC. Most samples had pH values within the acceptable range of 7.00-8.20, but turbidity exceeded recommended limits in three samples. Additionally, all TDS values were well above the WHO guideline of 1000 mg/L, highlighting significant concerns regarding water quality in the area.

Table 5: Physiochemical Water Quality Parameters [27]

Sample	Location	Temp (°C)	E.C (µS cm)	PH	Turbidity (NTU)	TDS (mg L)
S-1	Block 8	300	7510	8.11	0	6965
S-2	Block 10	28	7400	8.04	0.7	6816
S-3	Block 13	29	6140	8.17	0	5677
S-4	Block 16	30	6630	7.3	0	6580
S-5	Block 28	27	7900	0	6.889	6965
S-6	Block 32	31	6870	7.54	1.3	6626
S-7	Block 42	30	7620	7.8	0	7410
S-8	Block 43	28	5690	7.6	9.4	4,976
S-9	Block 47	29	6140	7.2	0.2	5491
S-10	Block 48	26	7490	7.5	0	6956
S-11	Block D	27	8350	7.9	0	7829
S-12	Block F	29	5480	7.3	0.2	5164
S-13	Block H	30	6490	7.9	0	6700
S-14	Block V	30	7920	7.3	0	8401
S-15	Block X	29	5920	8.1	0.22	5955
S-16	Block Y	31	4870	7.8	0	4844
S-17	Block Z	30	2260	7.5	0	1100
S-18	Abbas Abad	28	6780	7.34	0.34	6244
S-19	Allah Abad	30	8120	7.65	0	8213
S-20	Chourhatta	31	2390	7.52	0	2681
S-21	Gharib Abad	30	3560	7.93	0	3522
S-22	Khiaban-E-Serwar	27	2150	7.45	1.56	1681
S-23	Mastoi Abad	28	1430	7.44	1.45	1484
S-24	Muslim Town	30	2600	7.46	0.2	2585
S-25	New Model Town	31	2200	7.37	0	2387
S-26	Pul Daat	30	2150	7.72	7.04	2.193
S-27	Rajput Colony	30	2340	7.47	5.9	2.69
S-28	Shakir Town	29	2300	7.44	0	2.62
S-29	Not Available	30	2820	7.34	0.81	3.08

[27] Ibid

Sample	Location	Temp (°C)	E.C (µS cm)	PH	Turbidity (NTU)	TDS (mg L)
S-30	Shakoor Abad	27	1990	7.45	0	2.092
S-31	Sikhani Colony	30	2550	7.37	0	2.59
S-32	Umer Town	31	1480	7.34	2.63	1.915

Table 6: Bacteriological Contamination of DG Khan[28]

Sample	Location	Source	Level of bacterial contamination (%)	Result/remarks
S-1	Block 8	Hand pump	High contamination	Unfit for drinking
S-2	Block 10	Hand pump	No contamination	Fit for drinking
S-3	Block 13	Hand pump	High contamination	Unfit for drinking
S-4	Block 16	Hand pump	No contamination	Fit for drinking
S-5	Block 28	Hand pump	No contamination	Fit for drinking
S-6	Block 32	Hand pump	Moderate contamination	Unfit for drinking
S-7	Block 42	Hand pump	No contamination	Fit for drinking
S-8	Block 43	Hand pump	No contamination	Fit for drinking
S-9	Block 47	Hand pump	Moderate contamination	Unfit for drinking
S-10	Block 48	Hand pump	No contamination	Fit for drinking
S-11	Block D	Hand pump	No contamination	Fit for drinking
S-12	Block F	Hand pump	Slight contamination	Unfit for drinking
S-13	Block H	Hand pump	No contamination	Fit for drinking
S-14	Block V	Hand pump	No contamination	Fit for drinking
S-15	Block X	Hand pump	No contamination	Fit for drinking
S-16	Block Y	Hand pump	Slight contamination	Unfit for drinking
S-17	Block Z	Hand pump	No contamination	Fit for drinking
S-18	Abbas Abad	Hand pump	Slight contamination	Unfit for drinking
S-19	Allah Abad	Hand pump	No contamination	Fit for drinking
S-20	Chourhatta	Hand pump	Slight contamination	Unfit for drinking
S-21	Gharib Abad	Hand pump	No contamination	Fit for drinking
S-22	Khiaban-E-Serwar	Hand pump	No contamination	Fit for drinking
S-23	Mastoi Abad	Hand pump	No contamination	Fit for drinking
S-24	Muslim Town	Hand pump	No contamination	Fit for drinking
S-25	New Model Town	Hand pump	High contamination	Unfit for drinking
S-26	Not Available	Not Available	Not Available	Not Available

[28] ibid

S-27	Pul Daat	Hand pump	No contamination	Fit for drinking
S-28	Shakir Town	Hand pump	No contamination	Fit for drinking
S-29	Not Available	Hand pump	No contamination	Fit for drinking
S-30	Shakoor Abad	Hand pump	No contamination	Fit for drinking
S-31	Sikhani Colony	Hand pump	No contamination	Fit for drinking
S-32	Umer Town	Hand pump	No contamination	Fit for drinking

The above table of the study provides an analysis of 32 groundwater samples in various locations revealed potential bacterial contamination in 10 of them (S-1, S-3, S-6, S-9, S-12, S-16, S-18, S-20, S-25, S-27). These samples were categorized based on contamination levels but without specific percentages. Interestingly, only samples S-12 and S-16 were labeled as "slightly contaminated," suggesting there might be a specific threshold used to differentiate between various contamination levels.

Water Quality Assessment at the Regional Level

The Urban Unit team prepared following maps based on UNICEF (2015) data have depicted that the TDS concentration in groundwater in the Dera Ghazi Khan District, Rajanpur, and parts of Muzaffargarh (Chowk Sarwar Shaheed) and Layyah (Chowk Azam, Chaubara) exceed the permissible limits set by PEQS and WHO (>1000 ppm). The proximity to the Fort Munro mountains in the west likely contributes to these high TDS values. This can be attributed to the geographical location's influence on mineral weathering, leading to increased ion concentrations in the water, including nitrates and sulfates. Notably, the total dissolved solids (TDS) concentrations surpassed the World Health Organization's (WHO) limits.

The Arsenic Map of the Dera Ghazi Khan Region indicates elevated arsenic concentrations in the Muzaffargarh District, Karor Lal Eesan in Layyah, and Kot Chutta in Dera Ghazi Khan District, along with surrounding areas as compared to permissible limit of WHO i.e., 10 ppb. This contamination is attributed to agricultural practices using arsenic-based pesticides and industrial activities. Additionally, the geological location of D.G. Khan exposes groundwater to rocks containing naturally occurring arsenic. As water interacts with these rocks, arsenic is dissolved and mobilized, leading to its presence in groundwater.

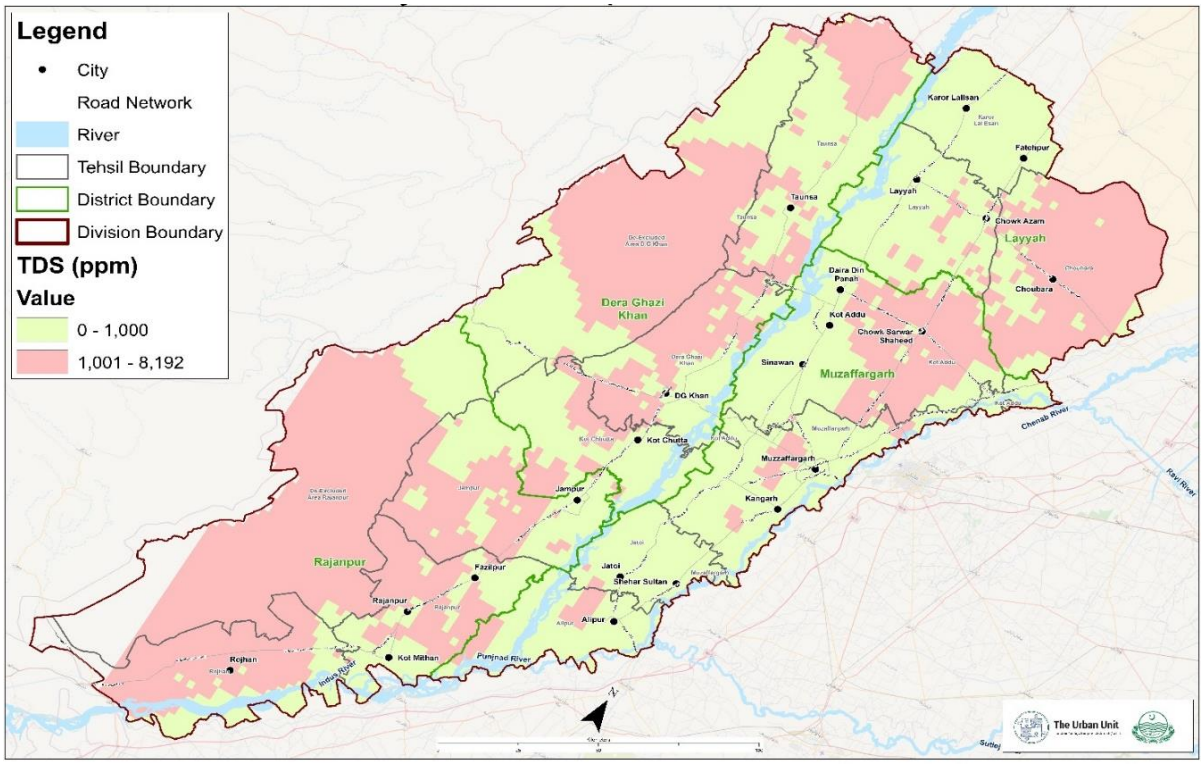


Figure 12: TDS concentration in Groundwater of DG Khan Region
(Source: UNICEF, 2015)

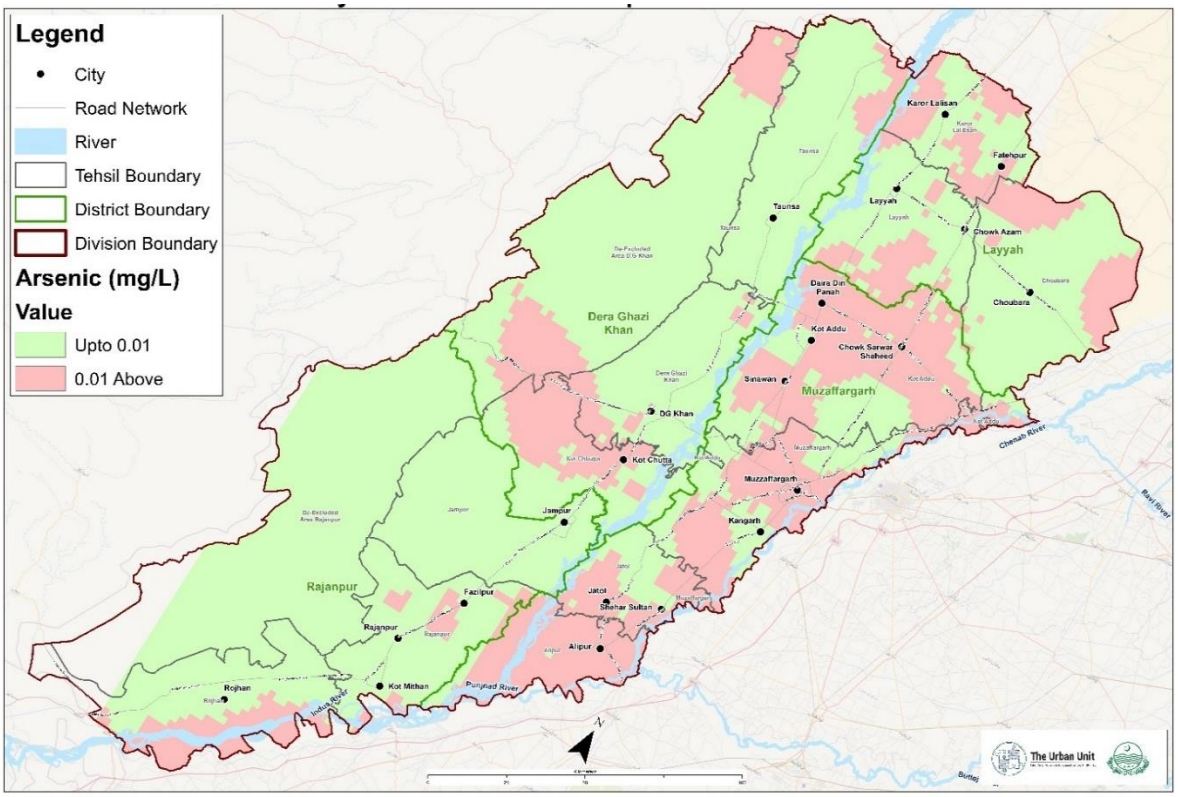


Figure 13: Arsenic concentration in Groundwater of DG Khan Region
(Source: UNICEF, 2015)

2.3. Green Spaces Assessment

2.3.1. Assessment of Urban Recreational Parks

Urban Recreational parks are a significant component of sustainable development planning and offer a wide range of benefits in terms of revitalization of the natural environment. Briefly, urban recreational parks have the following advantages;

- Recreational Opportunity for all Age-Groups
- Health & Safety Benefits
- Protection of Local Biodiversity and Natural habitat
- Improved provision of ecosystem services such as carbon sequestration, decontamination of water, climate regulation, etc.
- Centers for different community facilities, including zoos, historical sites, educational centers, community well-being and cultural centers, etc.
- Promote economic stability through tourism, creation of jobs, increased real-estate worth, etc.

Urban Recreational parks in DG Khan were surveyed to assess their sufficiency and accessibility, existing conditions as well as areas for improvement through a survey-based tool. The employed assessment criteria include park ownership, status of maintenance, category of park, and availability of various facilities. A total of **62 Parks** were surveyed in DG Khan Division. The location map is given in Figure 14.

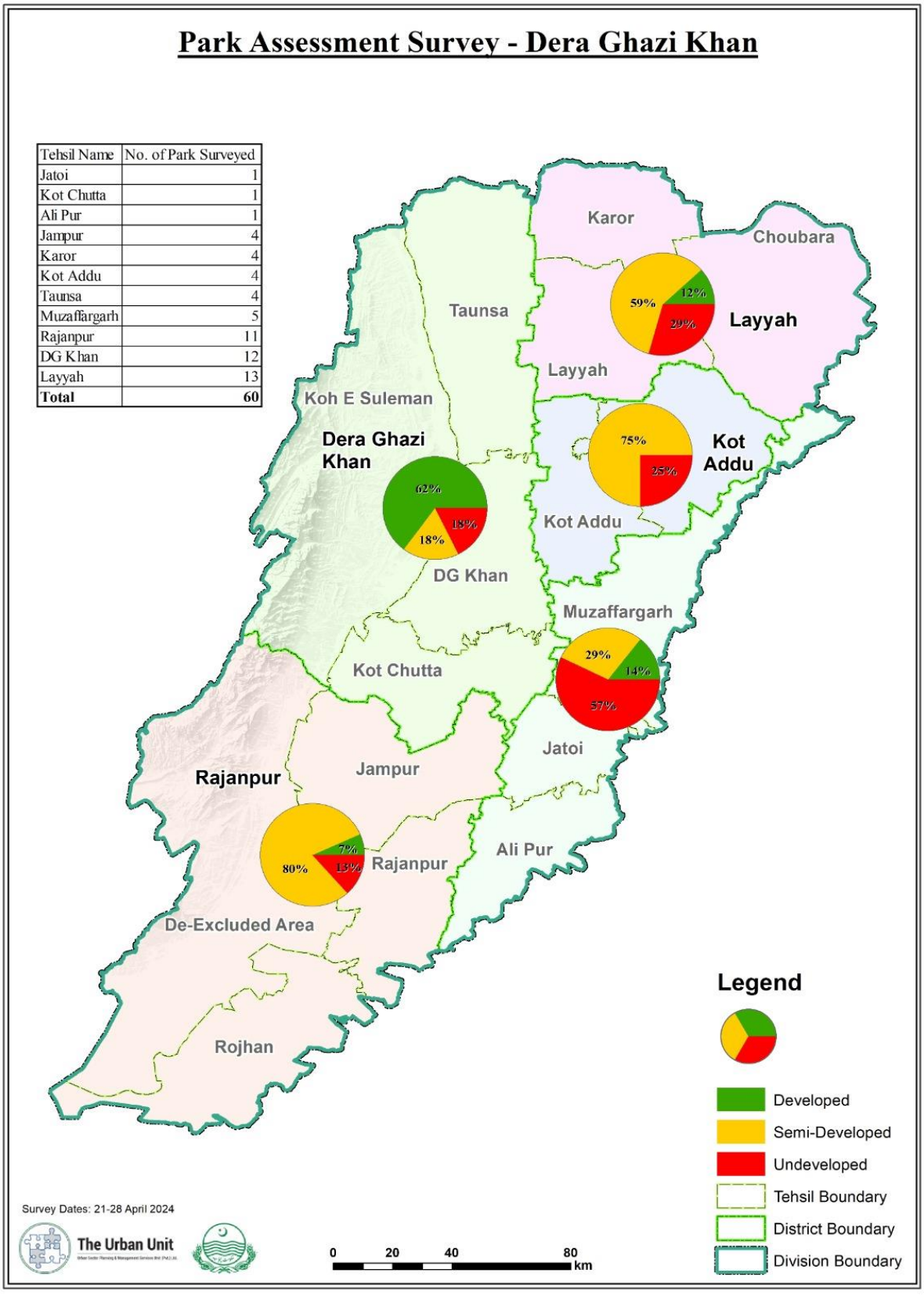


Figure 14: Location map of Parks Assessment Survey

The majority of the parks in the main cities of DG Khan were maintained by the PHA, whereas relevant district and tehsil governments were responsible for development and maintenance of parks in all other districts and tehsils. However, these parks are not sufficient for these emerging urban centres. Therefore, vacant sites, small open waste dump sites, and less developed parks were surveyed in all cities of the region to increase the green cover in the city. The findings of the survey are given in Figure 15.

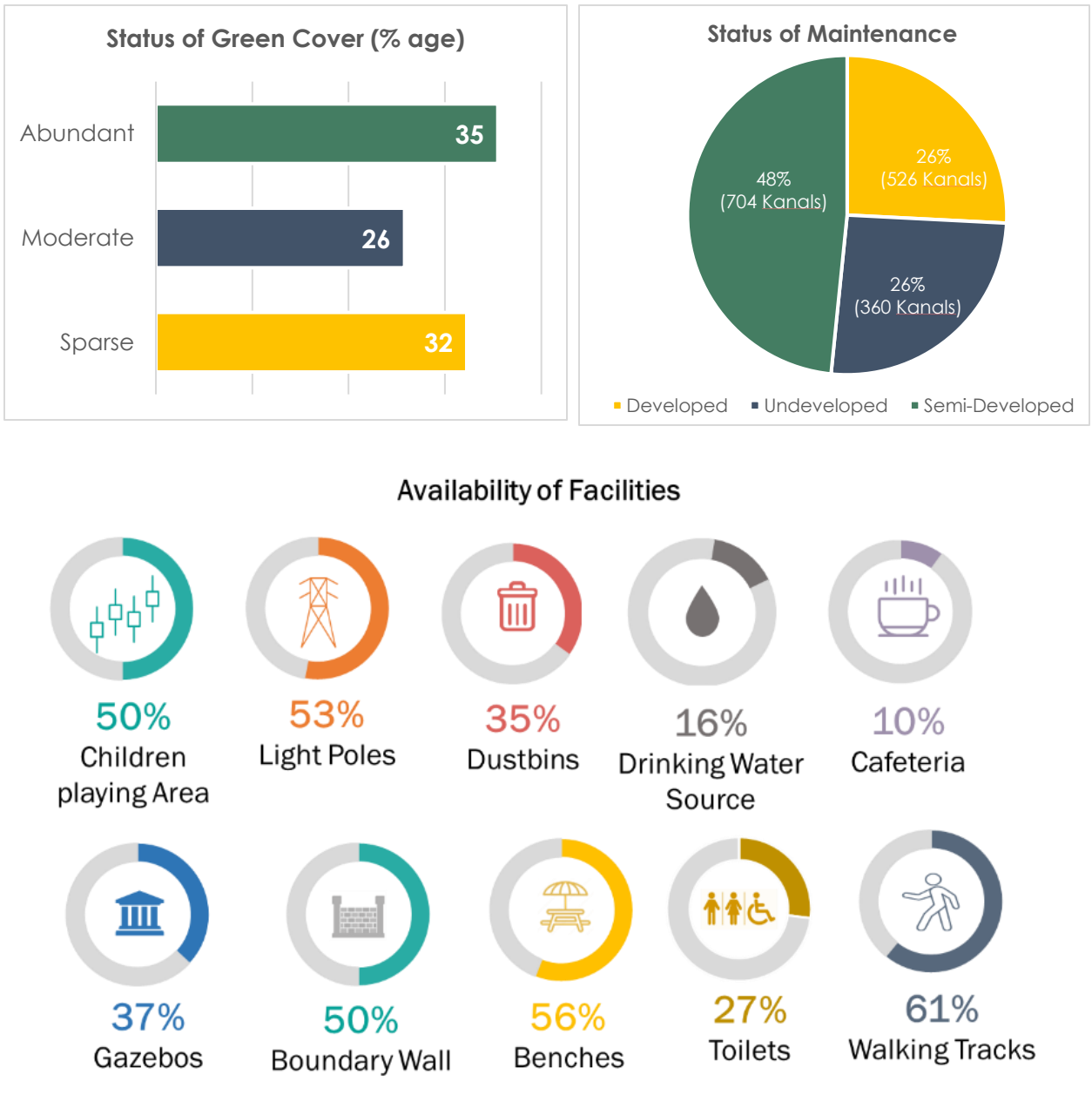


Figure 15: Results of Parks Assessment Survey

2.3.2. Local Community Perception Survey – Green Spaces DG Khan

To complement the Environment & Social Safeguard's Team survey, a perception survey with the local community of Dera Ghazi Khan Region was also conducted to assess the local community perception regarding green spaces of Dera Ghazi Khan Region.

The planning team thus visited each tehsil of four districts of Dera Ghazi Khan (DG Khan, Muzaffargarh, Layyah, and Rajanpur Districts) in April 2024. A Survey form (Attached as Annexure – A) was formulated to record people's perceptions and attitudes regarding urban green spaces as well as their willingness to pay for these services in their areas. The empirical analysis of the survey helped to conclude the perception and expectations of the local community regarding urban green spaces in the DG Khan Region.

The public effectively participated in the survey. The sample size was assigned based on the population of districts of DG Khan Region; overall ***12%*** were ***females*** and ***88%*** were ***male*** participants in the perception survey. The data from the perception survey was analyzed and the results were considered in the prioritization of need-based development projects.

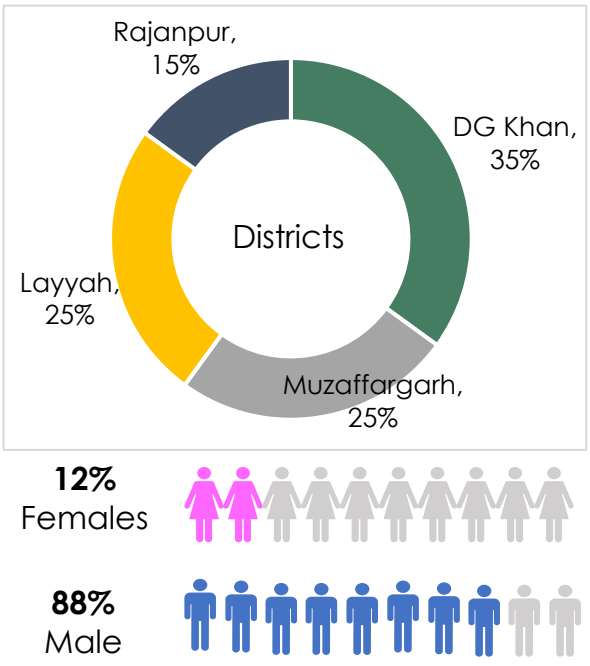


Figure 16: Demographics of Public Perception

Availability of Parks and Green Spaces in the Urban Areas

In DG Khan Region, the availability of Parks is generally limited and is usually present at a distance apart from residential areas. However, most of the parks are usually crowded all day particularly in the evening. It is also worth mentioning here that the number of ladies' parks is also significantly low in DG Khan Region to accommodate a huge number of female populations. Furthermore, the facilities present in the existing parks are also limited thus requiring urgent attention and proper management. The most pressing concerns were the lack of drinking water, cafes, washrooms, insufficient lighting, and broken light poles, long distances, inadequate or missing play areas, damaged benches, and other infrastructure.

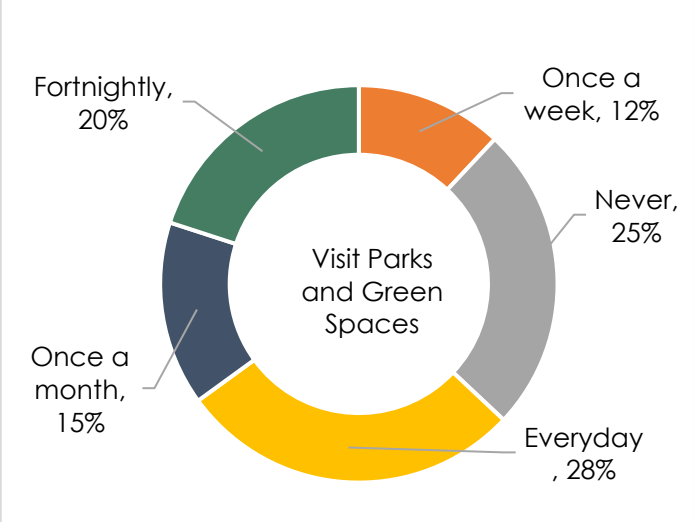


Figure 17: Local Community Visited Parks & Green Spaces

Community Participation and their Willingness to Pay

It is pleasing to comprehend that community of DG Khan Region know the fact that their active participation is much important to improve the existing condition of green spaces and parks. 81% of the total respondents expressed their opinion that their active participation in maintaining health of green spaces is essential. Moreover, they also suggested that greening of vacant spaces and plantations along the roadsides can enhance the vegetation cover in their cities. It is reported in the study of Riaz *et al*., that the local communities that are involved in the activities to manage the green spaces and plantations are more sustainable communities.[29] Similarly, another study also revealed that public participation is required to improve green spaces.[30]

Another crucial component of the survey is the determination of a hypothetical value to find the respondents' willingness to pay for existing and future environmental resources, such as parks and green spaces. After inquiring and analyzing the survey results, it is affirmed that more than 58% of respondents are willing to pay 50-100 Rs for increasing and improving the green spaces in their area and 20 % of low-income groups are willing to pay Rs. 50/-.

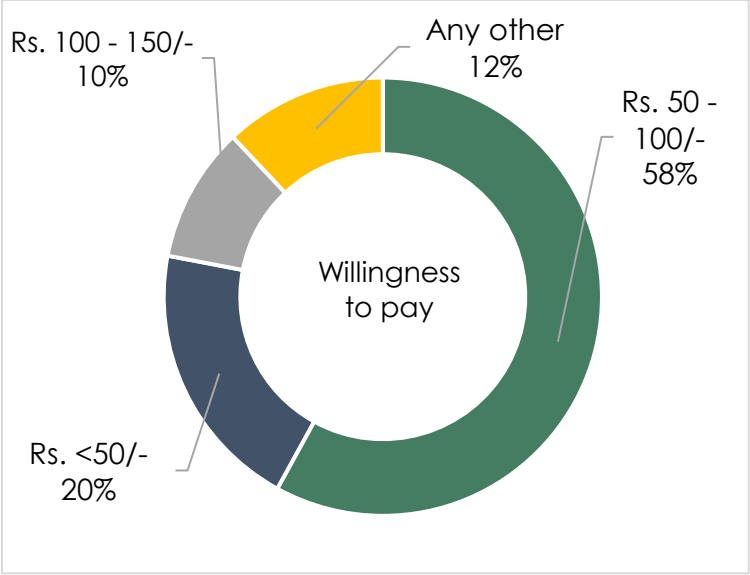


Figure 18: Community's Willingness to Pay for improvement of Parks and Green Spaces

This survey underscores that those who express a willingness to contribute financially are prepared to allocate a modest portion of their income to support the critical need for expanding and maintaining green spaces, especially given the rapid urbanization occurring in the DG Khan Region.

[29] Riaz, A., Younis, A., & Naveed, S. (2010, August). Impact analysis of urban and rural landscapes as perceived by respective communities: a case study of Multan city, Pakistan. 954 (pp. 99-107).

[30] Fors, H., Molin, J. F., Murphy, M. A., & van den Bosch, C. K. (2015). User participation in urban green spaces–For the people or the parks? Urban Forestry & Urban Greening, 14(3), 722-734.

2.4. Key Environmental Challenges – DG Khan Region

Key Environmental Challenges and Issues that DG Khan Region is experiencing are:

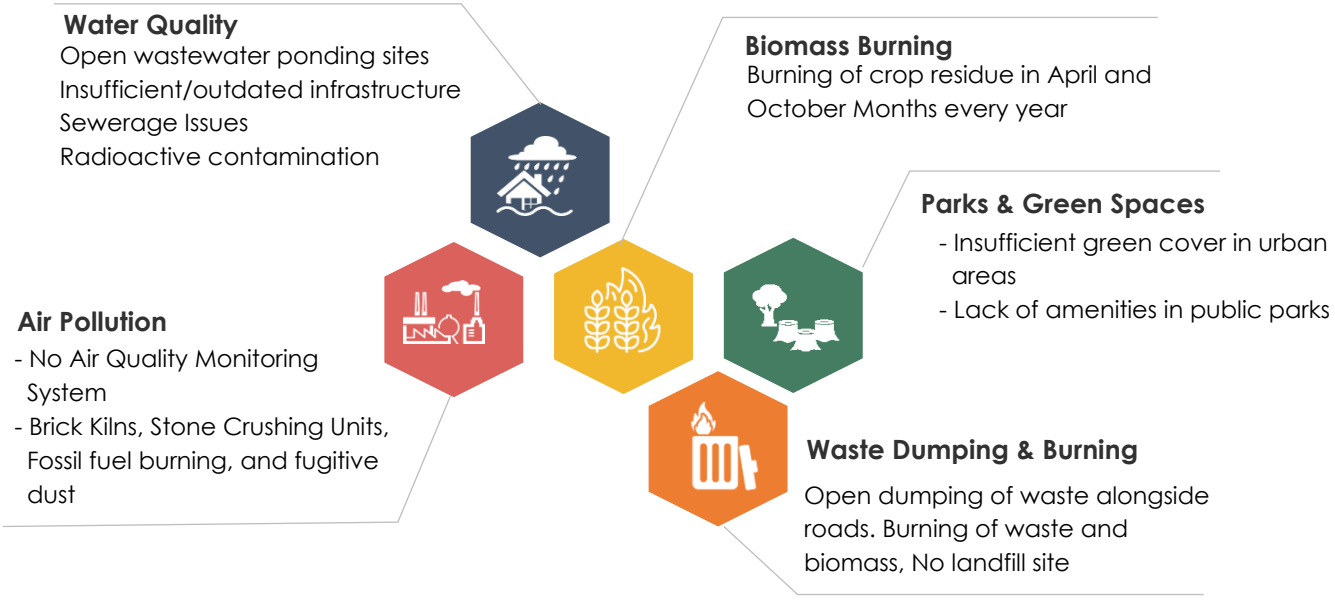


Figure 19: Key Challenges & Issues of DG Khan Region

To compliment Environment & Social Safeguard's Team findings, the local community of DG Khan Region is also consulted. Around 100 respondents (88 males; 12 females) from DG Khan Region were consulted. It is observed that almost 20% of total respondents have reported that air pollution and smog is the major issue in their respective areas. 22% of the respondents claimed that Waste Burning & dumping is the chief environmental challenge they are facing every day. 18% of the total respondents expressed their displeasure towards the water quality of their areas. 12% of the total respondents expressed their concerns on Noise pollution while 28% reported that the lack of tree shades & green spaces is the highest environmental issue in their respective areas of the DG Khan Region due to overpopulation and urbanization.

2.5. Biodiversity Conservation Area

Dera Ghazi Khan Region is rich in forest and wildlife areas across all four districts: Dera Ghazi Khan, Rajanpur, Muzaffargarh, and Layyah. These areas fall under various categories of forest and protected areas acts of Punjab. Forests in this region are defined by the presence of trees and the absence of other primary land use activities. The term "forest" broadly encompasses areas designated for the conservation, protection, and production of natural resources. Forest cover in national parks within Dera Ghazi Khan Region plays a crucial role in conserving habitats, natural reserves, and other protected areas.

The Urban Unit team visited **21** environmentally sensitive and high conservation value areas during the field visit of DG Khan Region. These includes:

DG Khan	Layyah	Muzaffargarh	Rajanpur
▸ DG Khan Zoological Garden ▸ Rind wala Forest ▸ Kalu wala Forest ▸ Thatta Jhoke Forest ▸ Triman Forest ▸ Fish Seed Nursery Drahma	▸ Machu Wildlife Sanctuary ▸ Inayat Willife Sanctuary ▸ Rajan Shah Wildlife Sanctuary ▸ Kharewala Wildlife Sanctuary ▸ Fateh Pur Forest Park ▸ Forest Park Chowk Azam	▸ Rakh Khanpur Plantation Wildlife Sanctuary ▸ Taunsa Barrage Wildlife Sanctuary ▸ Panjnad Head wildlife Sanctuary ▸ Thal Wildlife Public wildlife Reserve	▸ Daman Wildlife Sanctuary ▸ Kot Sabzal Wildlife Reserve ▸ Rakh Bangala Forest ▸ Rakh Hassan Jamra Forest ▸ Fish Seed Hectuary Rajanpur

Detailed assessments of these visits were conducted which provides a basis to understand the key challenges of biodiversity and its habitat in the region. Details of forest lands in each district, key field observations and threats of these sites are presented in the subsequent sections.

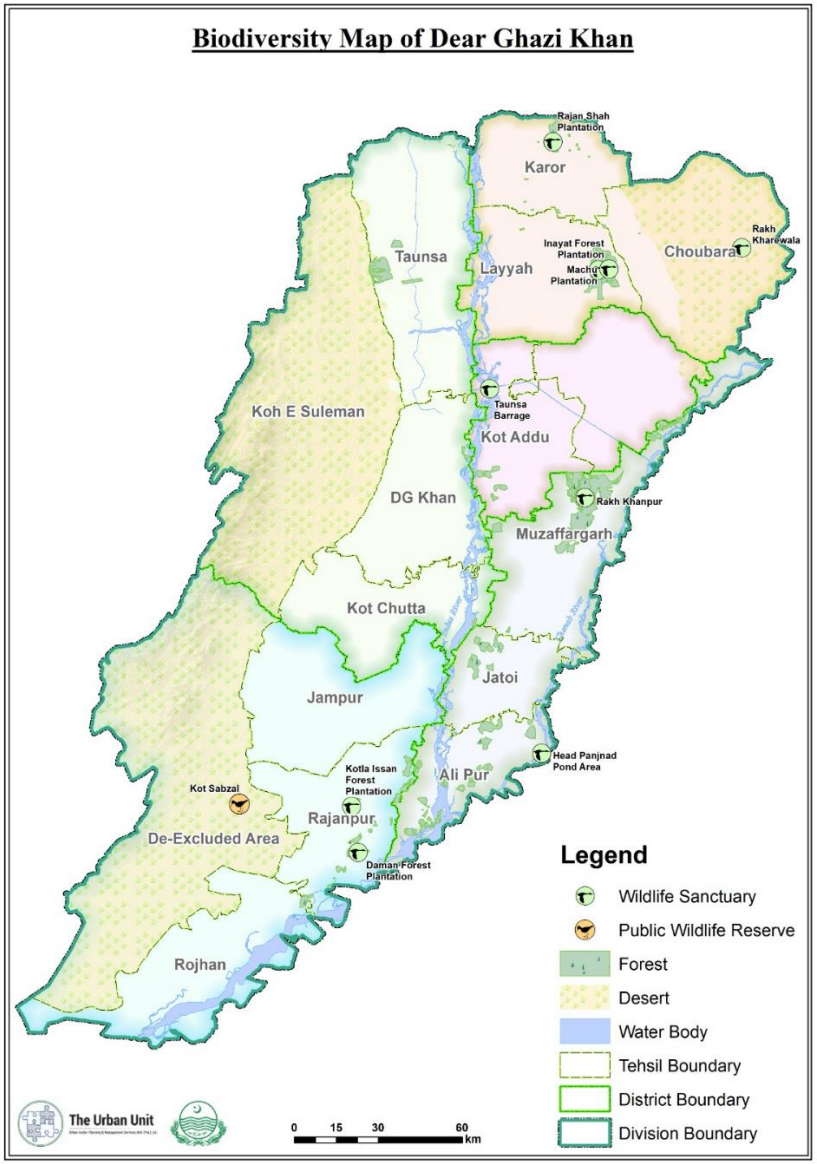


Figure 20: Map showing Visited Forest & Protected Areas of DG Khan Region

2.5.1. Dera Ghazi Khan Conservation Areas

Dera Ghazi Khan district features a diverse topography, situated between the Indus River to the east and the Koh-e-Suleman range to the west. Although the district's biodiversity has not been thoroughly documented, its topography and forest habitats support a variety of flora and fauna adapted to the region's semi-arid and arid climate. In DG Khan, the irrigated, riverine, and rangeland forests, protected under reserved forest enactment, serve as key habitats for biodiversity. These forests are home to a variety of fauna, including black partridge, grey partridge, wild hare, wild boar, and various reptilian species. Dominant tree species in the district's planted forest lands include Phulai, Kikar, Eucalyptus, and Prosopis. The key biodiversity areas of the district are as follows:

- DG Khan Zoological Garden
- Rind wala Forest
- Kalu wala Forest
- Thatta Jhoke Forest
- Triman Forest
- Fish Seed Nursery Drahma

Figure 21: (a) DG Khan Zoological Garden, (b) Rakh Rindwala Forest, (c) Rakh Kaluwala Forest

Key Observation & Threats

- Wood theft and fuel wood collection is commonly practiced by the local.
- DG Khan Zoological Garden is experiencing damage of cages and poor shelter due to shortage of funds.
- The wildlife resident in forest of district facing poaching and hunting threats as the areas are not notified under wildlife protected areas enactment.
- Invasive alien flora e.g. *Prosopis juliflora* is the common weed throughout the forest range of region.

2.5.2. Layyah Conservation Areas

Layyah District features a semi-arid and arid topography with rectangular sandy dunes situated between the Chenab River doab and the Indus River. The riverine areas of the district support sub-tropical thorn vegetation, including kikar, phulai, karir, and jhand, while the desert areas are home

to xerophytic and halophytic plant species. The Thal Desert in Choubara of Layyah District consists of rangeland forest types and patches of barren land with low sand dunes. This diverse habitat supports key wildlife species such as jackals, porcupines, grey and black partridges, chakur, wild hare, and wild boar. In District Layyah, the following are key biodiversity areas designated for the conservation and protection of the region's biodiversity:

- Machu Wildlife Sanctuary
- Inayat Willife Sanctuary
- Rajan Shah Wildlife Sanctuary
- Kharewala Wildlife Sanctuary
- Fateh Pur Forest Park
- Forest Park Chowk Azam

Figure 22: (a) Forest Park Fatehpur, (b) Rajanshah Forest Wildlife Sanctuary, (c) Inayat Plantation

Observation and Threats

- Most of the forested compartment of Inayat & Machu plantation has *Eucalyptus camaldulensis* as dominant species which is exotic species and has diverse effect on native biodiversity.
- In Layyah, two forest parks i.e. Fateh pur and Chowk Azam, located in city centers are well managed and promoting the ecotourism and socializing the forestry.
- In Layyah, four notified wildlife sanctuaries are the hotspot to wildlife of the region, however shortage of field staff leading to illegal practiced by the local within protected areas.
- Illegal hunting of Grey and Black Partridges, tree cutting and forest fire are the key issues within the district.
- Habitat fragmentation in the Machu and Inayat plantations is reducing the extent of localization for wildlife.

2.5.3. Muzaffargarh Conservation Areas

Muzaffargarh district, characterized by an arid to semi-arid climate, experiences hot summers with dust storms and receives minimal rainfall. The district's topography features alluvial flat plains, with areas near the Chenab River prone to flooding during the monsoon season. This diverse landscape supports a rich variety of flora and fauna. The district's forests include irrigated, riverine, and rangeland types. Irrigated forests are found near the banks of the Indus and Chenab rivers, with some plantations watered by canals. Key tree species include shisham, frash, kikar, eucalyptus, and musqat. The region is notable for its aquatic native and migratory birds. Key

wildlife species in Muzaffargarh include the Indus dolphin, hog deer, wolf, jackals, partridges, and wild hare. Important biodiversity areas for conservation and protection of these species include:

- Rakh Khanpur Plantation Wildlife Sanctuary
- Taunsa Barrage Wildlife Sanctuary
- Panjnad Head wildlife Sanctuary
- Thal Wildlife Public Wildlife Reserve

Figure 23: (a) Rang Lake Rakh Khanpur; (b) Rakh Khanpur Forest; (c) Lashariwala Forest

Key Observation and Threats

- Lashariwala Forest is the only key habitat of hogdeer in District, that experiencing illegal hunting, sectoral-communal conflict and land encroachment leading to lower the population size of wildlife.
- Illegal hunting of Grey and Black Partridges, tree cutting and forest fire are the key incidence in district.
- Invasive alien plant species e.g. *Parthenium hysterophorus and Prosopis juliflora* is the threat to native flora of the region

2.5.4. Rajanpur Conservation Areas

Rajanpur District features diverse habitats, with the aquatic Indus River to the east and the mountainous Suleiman Range to the west. The district's topography ranges from alluvial flat plains to the rugged terrain of the Suleiman Range. These varied habitats support sub-tropical thorn forests, scrub forests, and rangeland forests, fostering a wide array of floral and faunal biodiversity. Dominant tree species in these forests include kikar, jand, karir, frash, phulai, and shisham. Common wildlife species in Rajanpur District include wild hare, wild boar, jungle cat, black partridge, chakur, grey partridge, and houbara bustard. The Koh-e-Suleiman Mountain range is a hotspot for urial, though communal-sectoral conflicts lead to poor management in these areas. The key biodiversity areas for the conservation and protection of wildlife species are as follows:

- Daman Wildlife Sanctuary
- Kot Sabzal Wildlife Reserve
- Rakh Bangala Forest
- Rakh Hassan Jamra Forest

Figure 24: (a) Rakh Bangala Forest; (b) Rakh Hassan Jamra Forest

Key Observation and Threats

- Rakh bangala forest is one of significantly important forest land where the native species (*Dalbergia sissoo*) is dominant.
- Rakh bangala and rakh rindwala has potential to protect and conserve native biodiversity within region.
- Rakh Daman and Kot Sabzal wildlife protected areas experiencing illegal hunting and poaching of key game birds.
- The activities of forest fire and fuel wood collection is imposing threats to natural habitat.

2.6. Conservation Areas Diversity Analysis

The conservation areas analysis is the key to understand the habitat potential and their significance level to others habitat within the division. In DG Khan division different habitat and forest types are situated with the varied diversity and land areas.

2.6.1. Forest Areas Statement

The forest within the district is the to evaluate the conservation potential and ability to mitigate and absorb the carbon emission of any region. In Muzaffargarh district only 7.2% of total forest land is planted where as in Layyah 40.9% is planted followed by Rajanpur and DG Khan with 28.1% and 21.6% respectively.

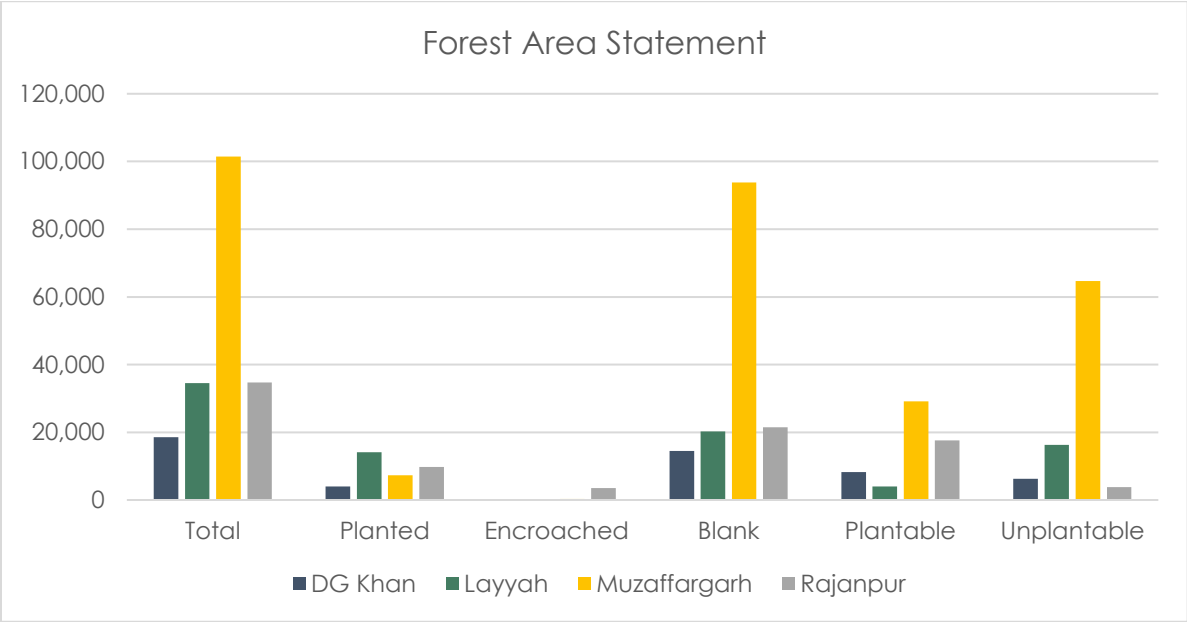


Figure 25: Forest Area Statement of DG Khan Region

2.6.2. Species Diversity Index

The Species diversity of visited areas of DG Khan division has been computed through the Shannon Diversity index to evaluate the species richness within each particular forest type on scale of 1 and above. Shannon diversity Index greater than 1 indicate that the area has diverse range of species whereas index value below 1 indicate the poor species richness. In Muzaffargarh, Lashariwala forest has the diversified plant species richness with stable plant communities.

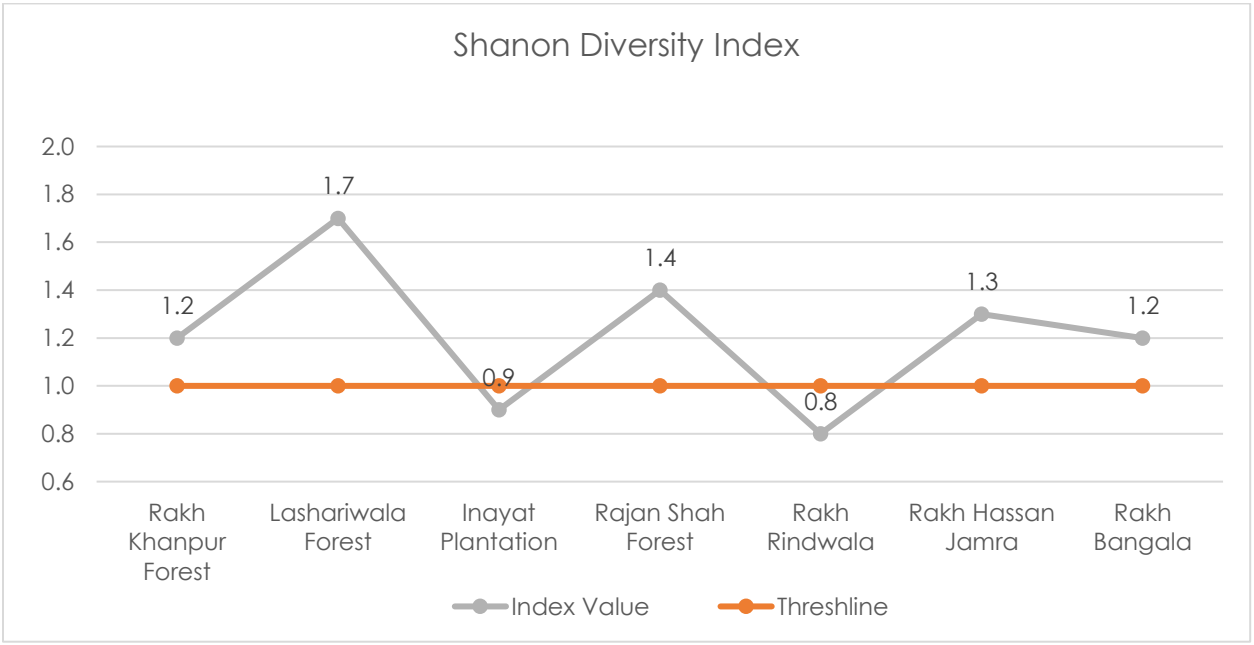


Figure 26: Shannon Diversity Index Analysis

2.6.3. Major Threats to Conservation Sites in DG Khan Region

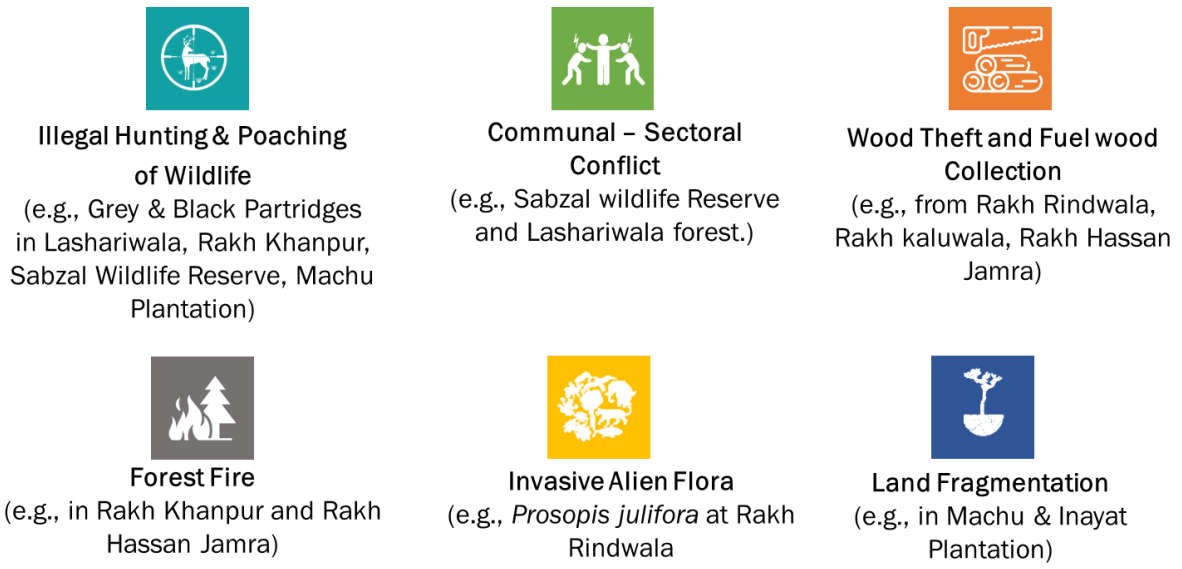


Figure 27: Major Threats to Conservation sites of DG Khan Region

03 Legal Landscape

The constitution of Pakistan has substantially altered the allocation of legislative powers between the National and Provincial Assemblies, resulting in more Provincial autonomy. Powers have been assigned to provincial Environmental Protection Agencies/Departments (EPAs/EPDs) Some of the key national/provincial regulations that are considered related to the Regional Development Plan of DG Khan is enlisted below:

National Framework	Provincial Framework
▪ Pakistan Climate Change Act, 2017	▪ Punjab Environment Protection Act, 2017
▪ Forest Act, 1927	▪ Policy on Controlling Smog, 2017
▪ Pakistan Environmental Protection Act, 1997	▪ Punjab Environmental Protection (Delegation of Powers for Environmental Approvals) Rules, 2017
▪ National Climate Change Policy, 2012	▪ Punjab Hospital Waste Management Rules, 2014
▪ Framework for Implementation of Climate Change Policy, 2013	▪ Punjab Environmental Protection Motor Vehicle Rules, 2013
▪ National Sustainable Development Strategy, 2012	▪ Punjab Environmental Protection Administrative Penalty Rules, 2013
▪ National Disaster Risk Reduction Policy, 2013	▪ Regulation of Disclosure of Environmental Information and Citizen Engagement, 2020
▪ National Forest Policy, 2015	▪ Environmental Sampling Rules, 2001
▪ National Rangeland Policy, 2010	▪ Pollution Charge Rules, 2001
▪ Review of IEE / EIA Regulations, 2000	▪ Environmental Tribunal Rules, 2012
▪ National Conservation Strategy, 1992	▪ Punjab Forest Policy, 2019
▪ Biodiversity Action Plan for Pakistan, 2000	▪ Punjab Environmental Quality Standards (municipal and liquid effluents, drinking water, motor vehicles, ambient air, noise, treatment of liquid and disposal of biomedical waste and Industrial gaseous emission), 2016
▪ Guidelines for sensitive and critical areas, 1997	

04 Vision, Goals & Objectives

4.1. Vision

A vibrant and internationally competitive region with sustainable development in a conducive environment whilst protecting and improving biodiversity where ecological resources are proficiently managed and conserved, cleaner environment, climate resilience and recreational facilities may be important indicators of the region's macro-level socio-economics.

4.2. Goals

To protect, conserve and retain the ecological values as well as sustainable development of the region for current and future generations, predominantly as a derivation of glory, inspiration, education, recreation and enhance the local community's livelihood.

4.3. Objectives

This plan helps to prioritize development projects at the regional level based on current conditions and future growth needs. Specific objectives of the plan are as follows:

- To identify potential projects & programs that can contribute to sustainable growth, environment protection, conservation, employment opportunities and exploit competitive benefits of the region.
- Improve the overall state of environment in the DG Khan Region.
- Project Prioritization and capacity needs to improve livability and competitiveness.
- Such a plan will fulfill a longstanding demand of local officials to have a document that can provide them with a strategic vision for the development of the region and have a voice in the overall planning process in the province.

05 Methodology

The DG Khan Regional Development Plan for the Environment sector was developed to prioritize the most resilient and sustainable solutions for the mitigation of the baseline environmental issues. The plan focuses on adopting a combined approach of data collection from field visits and literature while involving all regional and provincial stakeholders (government organizations and local community) and using modern remote sensing technology for impact assessment on the ground scale. It provides a framework of interventions for environmental improvement, divided into short, medium, and long-term plans spanning from three to ten years. The methodology adopted for the purpose of this plan is given below:

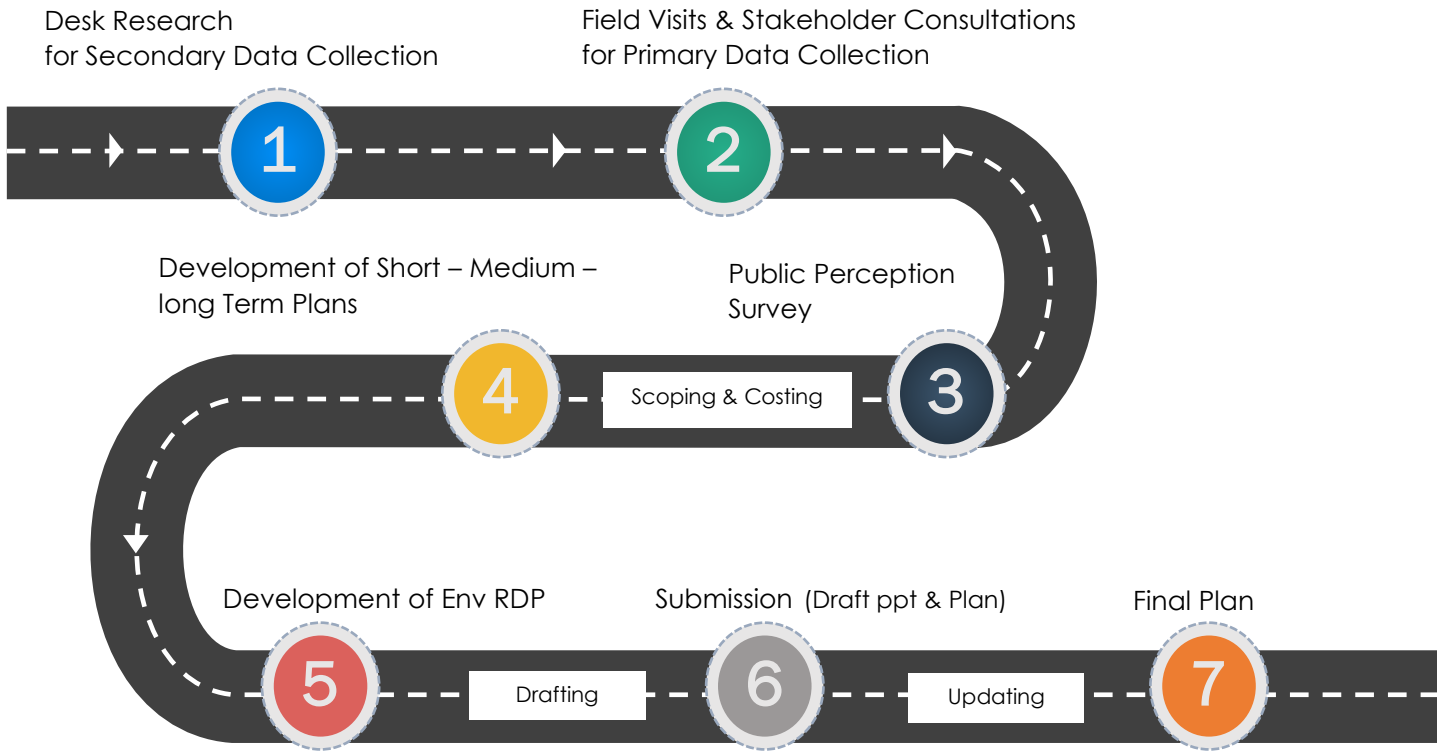


Figure 28: Methodology Map for DG Khan – RDP

5.1. Desk Research for Secondary Data Collection

A comprehensive desk research was conducted in order to understand the state of environment of the DG Khan Region during the past decade. Existing legal landscape, administrative and institution set-up, relevant reports and journals as well as similar projects and programs executed in the previous years for the improvement of environmental conditions and green spaces were also assessed.

5.2. Primary Data Collection

5.2.1. Field Visits

For on-ground information, the team of experts consisting of environmental scientists, environmental engineers, biodiversity professionals, and archaeological experts from the Environment and Social Safeguards Division visited the DG Khan Region. Field Visits were conducted in three phases;

Inception Visit:

The inception visit of DG Khan Region was conducted on March 19th, 2024 by the senior officials of the Environment Team. During this visit, meeting with key stakeholders which include; Commissioner of DG Khan Region, as well as Deputy Commissioners of DG Khan, Muzaffargarh, Layyah, and Rajanpur Districts were conducted to gather essential insights and input.

Rapid Assessment Visit:

Following the inception visit, a team of experts from the Environment & Social Safeguards Team conducted Rapid Assessment Survey of DG Khan region between April 21st, 2024 – April 28th, 2024. During this course, a series of meeting with various stakeholders as well as Rapid assessment surveys of the major urban centers of DG Khan including DG Khan, Muzaffargarh, Layyah and Rajanpur, Districts were conducted.

The institutional hierarchies, inter-linkage of departments, key concerns of the stakeholders, and technical and capacity-building issues were identified during this survey. In addition, air quality and noise quality were monitored, key sources of air and water pollution were identified, and existing biological, cultural and archaeological conditions were also assessed in major urban centers of DG Khan Region. Apart from that, key areas of interventions for environmental improvement were also identified and documented.

Public Perception Survey/ Community Consultation:

Subsequently, the Environment & Social Safeguards Team also held a detailed Public Perception visit between April 21st, 2024 – April 28th, 2024. This survey mainly focused on assessing the concerns of local inhabitants regarding public and green spaces as well as existing environmental conditions. The community recorded their perception about current changes in the environmental quality over the years, sources of air and water pollution and causes of the negative environmental impacts due to development and construction activities in the region. All of these issues have been considered during the development of this regional plan in order to ensure the benefit of the community.

Stakeholder Consultation:

A total of 16 Consultation Meetings with key government officials in the DG Khan Region were conducted by the Environment & Social Safeguards team. During these meetings, the key concerns of relevant departments and suggestions for environmental improvements were

documented. In addition, institutional capacities were also examined. All key stakeholders provided complete support in the development of a practical and attainable regional development plan.

Figure 29: Stakeholder's Consultations – DG Khan Region

Figure 30: Field Visits & Public Perception Survey – DG Khan Region

5.2.2. Air Quality Assessment

Data of four air quality parameters (AI, NO_2, SO_2 and CO) were downloaded from ***Copernicus website*** for year 2022, to analyze their spatial pattern over DH Khan Region.

5.3. Development of Short-Medium-Long term plan

Based on the exercise discussed above, schemes / projects were identified and prioritized for each district. This ten-year plan provides short term (up to 3 years), Medium Term (3 to 6 years) and long term (up to 10 years) projects focusing on improved service delivery, better environmental quality, enhanced climate resilience along with increased economic growth of the region.

5.4. Development of RDP Dera Ghazi Khan

Finally, a sectoral plan for Environment component was developed for DG Khan Region with a comprehensive investment Plan for the period of 10 years (2024-2034). Each project contains its title, cost, category (short/medium/long term) and mode of investment (Government / Donor / PPP).

5.5. Feedback visit

Consultation is an essential step to engage the multi-stakeholders and get their feedback and ownership in finalizing the project digest for the DG Khan Region. Therefore, a feedback visit will be conducted for final consent from the relevant department before submitting it to the Planning and Development Board, Government of Punjab.

06 Regional Development Plan

6.1. Framework

Punjab is the most vibrant as well as the populous province of Pakistan. However, from past few decades the province has been facing challenges not only from the economic front but also from the ecological side. The Government of Punjab is well cognizant to the myriad problems that the province is facing. Therefore, in order to tackle these challenges Government of Punjab has taken series of initiatives and drafted various regulation/policies/strategies that address such issues (viz., rapid urbanization, unreliable service provision, low municipal service recovery, high environmental pollution and so forth) and create a regionally equitable economy across the province. As in the province, the public spending is distributed on the basis of administrative jurisdiction i.e., division (region), districts and tehsils, it is desired to consider spatial and socio-economic dimensions for improved service delivery and environmentally sustainable development at a macro scale

Keeping in view of all the facts; such as present challenges, risks, gaps, needs and priorities for future economic development, a Framework for Environment Sector of Regional Development Plan of DG Khan Region is designed. Each component of this framework is passed through a lens of existing infrastructure, governance and population factor. Comparative advantage is gained by using credible mapping resource and Geographic Information Systems (GIS) for spatial representation of relevant data along with current state of environmental conditions. Consultation is another keystone of the RDP drafting process which is done through meetings, data collection forms, field visits, planning exercises and feedback sessions. Finally, the framework is drafted which enlisting the priority projects at district level which are consolidated as one broader plan/project digest of DG Khan Region.

6.2. Project Digest/ Investment Plan

Based on the framework of regional development plan, desk review/secondary information, on-ground survey, perception and expectation survey, consultations with local community and meetings with local authorities, a Project digest is developed for DG Khan Region, which can also call as Investment Plan. These projects are divided based on their urgency / priority for a ten-year span and divided in to short, medium and long term.

The total cost of the environmental sector project digest for DG khan Region is **Rs. 2207.5 million**.

6.3. Proposed Projects

The proposed projects for the improvement of environmental values and biodiversity conservation of DG Khan Region are as follows:

A. Short – Term Plan (Up To 03 Years) Estimated

Sr. No.	Projects	Estimated Cost (Millions Rs.)
Short – Term Projects		
1.	Afforestation/ Reforestation	
	DG Khan (300 Acres)	90.8
	Muzaffargarh (300 Acres)	90.8
2.	Forest Sapling Reserve	
	▪ Muzaffargarh (4 acres)	14.0
	▪ Rajanpur (5 acres)	17.5
3.	Nature Park and Biodiversity Reserve	
	Rakh Bangala Rajanpur	172
4.	Botanical Garden	
	Botanical Garden Layyah	110.5
5.	Agro – Canopy Forest	
	▪ DG Khan (25 Av. KMs)	6.2
6.	Dry Afforestation	
	▪ Muzaffargarh (150 acres)	6.8
7.	Floating Wetland Remediation of Urban Canals	
	▪ Kot Sultan Canal, Kot Addu (5 km)	5.67
8.	Rejuvenation of Wastewater Ponding Sites at Kot Addu city (4 Acres)	37
9.	Eco-Rejuvenation of Damas Lake, Fort Munro	15
10.	Linear Plantation and Green Corridors in Cities of DG Khan	
	Jatoi Permit Road Green Belt, Muzaffargarh (3 Km)	4.37
	Jatoi Shehr Sultan Road Linear Plantation, Muzaffargarh (1.98 Km)	3.73
	Karor Bhakkar Road Linear Plantation, Muzaffargarh (1.46 Km)	2.85
	Alipur Khairpur Road Linear Plantation, Muzaffargarh (2 Km)	3.96

	Alipur Jatoi Road Linear Plantation, Muzaffargarh (1.1 Km)	2.15
	Alipur-Muzaffargarh Road Linear Plantation, Muzaffargarh (2 Km)	3.96
11.	Development and Restoration of Parks	
	▪ Restoration & Improvement of 13 Parks	337.13
12.	Linear Plantation along sideways Railway Lines and Canal banks	
	Taliri Canal, Muzaffargarh (5.6 Km)	5.88
	Layyah Minor Canal, Layyah (6.5 Km)	12.57
	Layyah Railway Track, Layyah (8.0 Km)	11.57
	Kot Addu Railway track, Kot Addu (7.8 Km)	12.38
13.	Urban Park Complex - Environmental Recovery of Stretch Along Railway Line Muzaffargarh	41
14.	Purification of Manka Canal by Integrated Interceptors and Floating Wetlands	50
15.	Installation of Air Quality Monitoring Equipment in DG Khan district	
	▪ (1 BAM & 25 Low cost equip)	24.6
	▪ Display of big screen	16
	Total	**1098.5**

B. Medium – Term Plan (Up To 05 Years) Estimated

Sr. No.	Projects	Estimated Cost (Millions Rs.)
Medium – Term Projects		
1.	Afforestation/ Reforestation	
	Layyah (200 Acres)	60.5
2.	Forest Sapling Reserve	
	▪ Layyah (2 Acres)	7.0
3.	Agro – Canopy Forest	
	▪ Muzaffargarh (50 Av. Kms)	12.4
4.	Dry Afforestation	
	▪ Rajanpur (100 acres)	4.5
5.	Floating Wetland Remediation of Urban Canals	
	▪ Qutab Canal, Rajanpur - Length (4 km)	4.80
6.	Linear Plantation and Green Corridors in Cities of DG Khan	

	Main Indus Highway side plantation, Muzaffargarh (5 Km)	9.91
	Manka Road Linear Plantation, DG Khan (2.72 Km)	5.39
	New College Road Linear Plantation, Taunsa Sharif, DG Khan (0.3 Km)	0.59
	Sakhi Sarwar Road Linear Plantation, DG Khan (2.54 Km)	5.03
	Railway Road Linear Plantation, DG Khan (1.94 Km)	3.84
	Jampur Road Linear Plantation, DG Khan (1.54 Km)	3.05
7.	Development and Restoration of Parks	
	▪ Development of 15 Parks	252.5
8.	Linear Plantation along sideways Railway Lines and Canal banks	
	Nai Abadi Bypass Road Plantation, Kot Mithan, Rajanpur (2 Km)	3.05
	Railway Road Green Belt, Kot Mithan Rajanpur (1.2 Km)	2.38
	Stadium Road Green Belt, Kot Mithan Rajanpur (1.44 Km)	2.85
9.	Riverine Recreational Complex at Ghazi Ghat Lake DG Khan	180
10.	Installation of Air Quality Monitoring Equipment in Layyah district	
	▪ (1 BAM & 25 Low cost equip)	24.6
	▪ Display of big screen	16
	Total	**598.5**

C. Long – Term Plan (Up To 10 Years) Estimated

Sr. No.	Projects	Estimated Cost (Millions Rs.)
Long – Term Projects		
1.	Afforestation/ Reforestation	
	Rajanpur (150 Acres)	45.4
2.	Agro – Canopy Forest	
	▪ Rajanpur (25 Av. Kms)	6.2
3.	Dry Afforestation	
	▪ Layyah (100 acres)	4.5
4.	Floating Wetland Remediation of Urban Canals	

	▪ Ganaish Wah Canal Length (4 km)	4.80
5.	Linear Plantation and Green Corridors in Cities of DG Khan	
	Rajanpur Main Road Linear Plantation, Rajanpur (3.1 Km)	6.14
	Bypass Road Jampur Plantation, Rajanpur (1 Km)	1.98
	Chaubara Road Plantation, Chowk Azam, Layyah (2.5 Km)	4.95
6.	Development and Restoration of Parks	
	▪ Development of 15 Parks	252.5
7.	Linear Plantation along sideways Railway Lines and Canal banks	
	Kot Chutta Railway, DG Khan (2.5 Km):	6.79
	Rojhan Railway Line, Rojhan (1.9 km)	6.20
	Jampur Canal, Rajanpur (3.5 Km)	3.62
8.	Construction of Stormwater Retention Pond with Constructed Wetland in Iqbal Park DG	36.145
9.	Conversion of Traditional Fish Hatchery to Sustainable Biofloc System (Zero Liquid Discharge Technology) - DG Khan	90.607
10.	Installation of Air Quality Monitoring Equipment in Layyah district	
	▪ (1 BAM & 25 Low cost equip)	24.6
	▪ Display of big screen	16
	Total	**510.5**

D. Proposed Interventions Map

- Eco-Rejuvenation of Damas Lake
- Development & Rehabilitation of Parks
- Botanical Garden
- Urban Garden Complex
- Nature Park & Biodiversity Reserve
- Forest Sapling Reserves
- Agro Canopy Forest
- Dry Afforestation
- Linear Plantation
- Stormwater Retention Pond and Treating Wetland
- Upgradation of Traditional Fish Hatchery
- Reforestation/Afforestation
- Nature-Based Solution for Rejuvenation of Wastewater Ponding Sites
- Installation of Air Quality Monitoring Equipment
- Floating Wetlands Remediation of Urban Canals

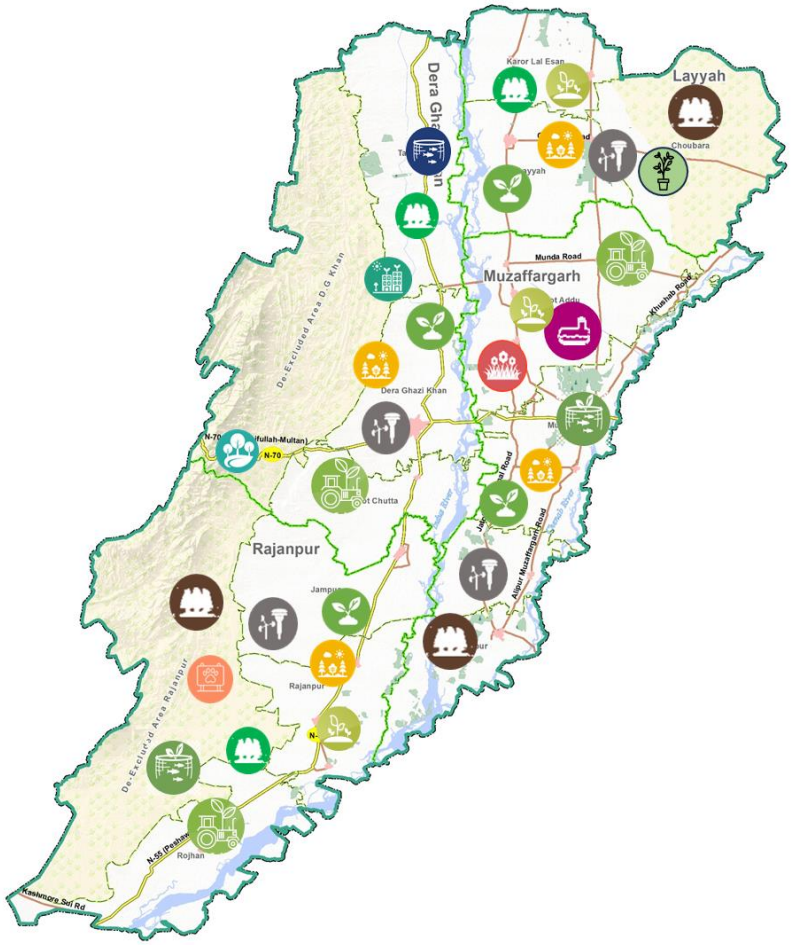


Figure 31: Proposed Interventions in DG Khan Region

6.3.1. PROJECT 1: Floating Wetland Remediation of Urban Canals

Floating wetlands remediation involves the plantation of hydrophytes in the form of a floating raft. In hydroponic systems, plants grow above the waterline, while their roots extend into the water column through a growth medium. This allows the plants to absorb nutrients directly from the water. Additionally, the biofilm that forms on the roots, rhizomes, and floating mats of hydrophytes through the attached growth process plays a crucial role in removing pollutants from the water. Following are the benefits associated with this treatment system:

- Pollutant Absorption Capacity
- Low Carbon Footprint
- Carbon Sequestration
- Urban flood Management
- Low O&M Cost
- Biodiversity Enhancement.

Proposed Sites

Sr.	Drains/ Ponds	Coordinates	Length
1.	Ganaish Wah Canal	30.06913312; 71.20056784	4 km
2.	Kot Sultan Canal, Kot Addu	30.45986068; 70.96596763	5 km
3.	Qutab Canal, Rajanpur	29.10318321; 70.33453786	4 Km

Ganaishwah Canal Muzaffargarh

Kot Sultan Canal Kot Addu

Qutb Canal Rajanpur

Scope

- Floating bed wetlands
- Plantation for floating wetlands treatment
- Active Edges of green cover for biodiversity enhancement

Estimated Cost

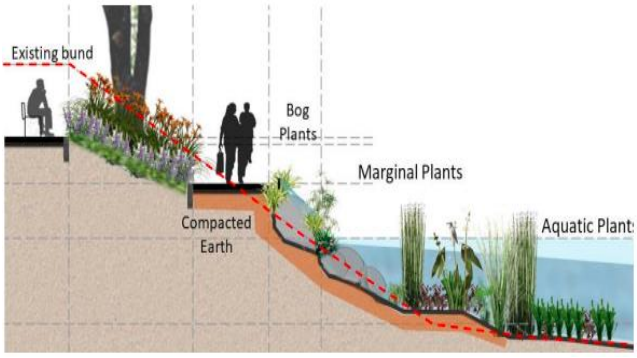
Sr. No	Description	Amount in PKR	Amount in Millions
Kot Sultan Canal, Kot Addu (30.45986068, 70.96596763) Length (5 km)			
1	Construction of Green Area and Plantation	4,796,530	4.80
2	Outdoor Furniture Benches	504,120	0.50
	Sub- Total Amount	**5,300,650**	**5.30**
	Add 2% Contingency Charges	106,013.00	0.11
	Add 5% PST	265,032.50	0.27
	Total Amount R. s	**5,671,695.54**	**5.67**

Sr. No	Description	Amount in PKR	Amount in Millions
Qutab Canal, Rajanpur (29.10318321,70.33453786) Length (4 km)			
1	Construction of Green Area and Plantation	3,986,008	3.99
2	Outdoor Furniture Benches	504,120	0.50
	Sub- Total Amount	**4,490,128**	**4.49**
	Add 2% Contingency Charges	89,802.57	0.09
	Add 5% PST	224,506.42	0.22
	Total Amount R. s	**4,804,437.30**	**4.80**

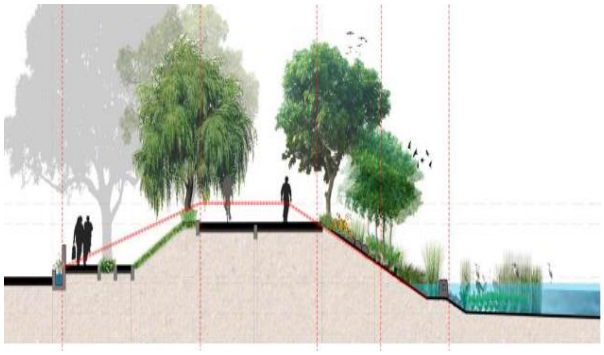
Sr. No	Description	Amount in PKR	Amount in Millions
Ganaish Wah Canal (30.06913312, 71.20056784) Length (4 km)			
1	Construction of Green Area and Plantation	3,986,008	3.99
2	Outdoor Furniture Benches	504,120	0.50
	Sub- Total Amount	**4,490,128**	**4.49**
	Add 2% Contingency Charges	89,802.57	0.09
	Add 5% PST	224,506.42	0.22
	Total Amount R. s	**4,804,437.30**	**4.80**

Conceptual Design

Floating Wetlands



Active Edges: Plantation along the edges of ponds for slope stabilization and biodiversity enhancement



Plantation of native species in stratified layers and of varying characteristics

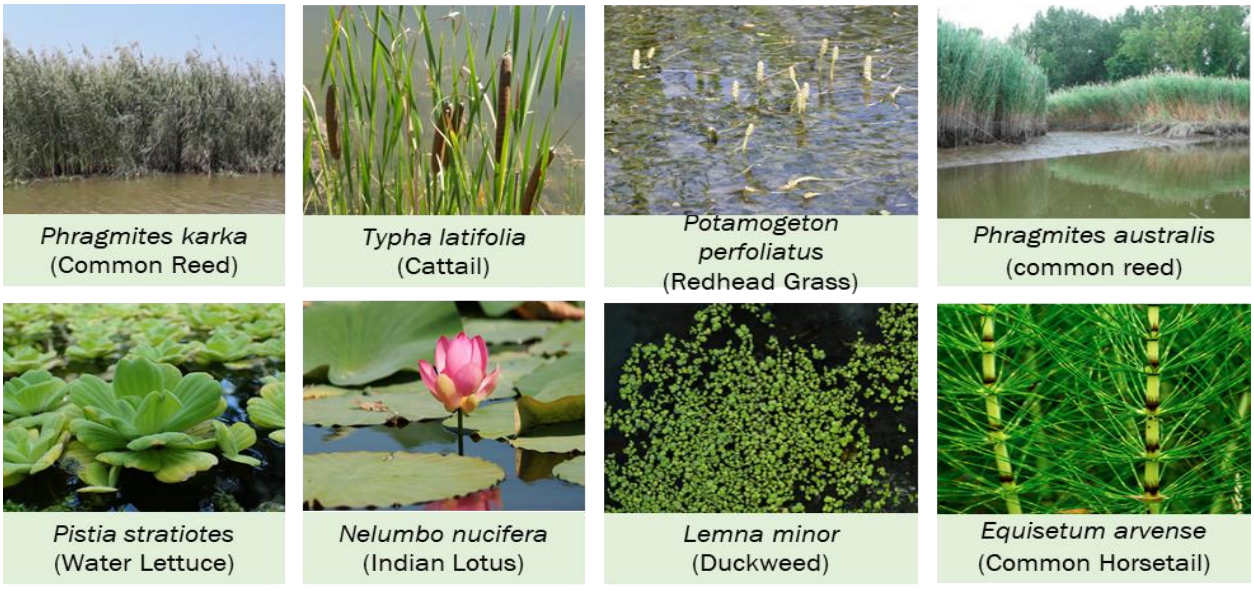


Figure 32: Conceptual Design and Plants used for Floating Wetland Remediation of Urban Canals

6.3.2. PROJECT 2: Rejuvenation of Wastewater Ponding Sites

Constructed wetlands are intricate ecosystems that utilize a combination of physical, chemical, and biological processes to remove and transform pollutants from wastewater. As the water flows through the system, these mechanisms work together, sometimes simultaneously and sometimes in sequence, to purify the water and break down contaminants. This multi-faceted approach enables constructed wetlands to effectively manage complex wastewater treatment challenges. Constructed wetlands are a form of nature-based solutions which can be utilized to rejuvenate wastewater ponding sites in urban areas. The associated benefits of this project include;

- Pollutant Absorption Capacity
- Low Carbon Footprint
- Carbon Sequestration
- Urban flood Management
- Low O&M Cost
- Biodiversity Enhancement

Proposed Sites:

- Kot Addu city: 30.47233669 70.96154693 (4 Acres)

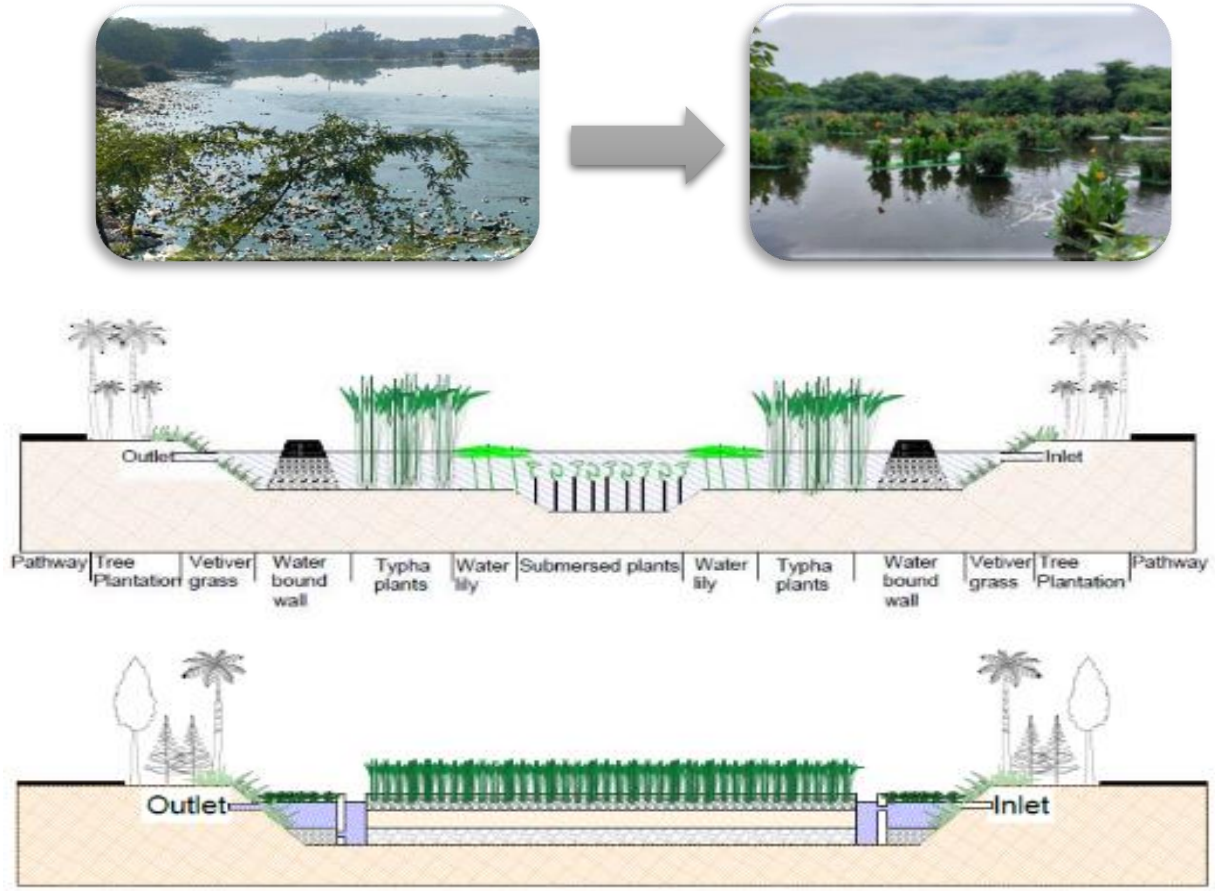
Scope:

- Plantation for Constructed wetlands
- Active Edges of green cover for biodiversity enhancement

Estimated Cost:

Sr. No	Description	Amount in PKR	Amount in Millions
1	Rejuvenation of wastewater ponds	32,937,679	33
2	Plantation for Constructed wetlands	1,362,609	1.4
	Sub- Total Amount	**34,300,288**	**34**
	Add 2% Contingency Charges	686,006	1
	Add 5% PST	1,715,014	2
	G-Total Amount R. s	**36,701,309**	**37**

Conceptual Design:



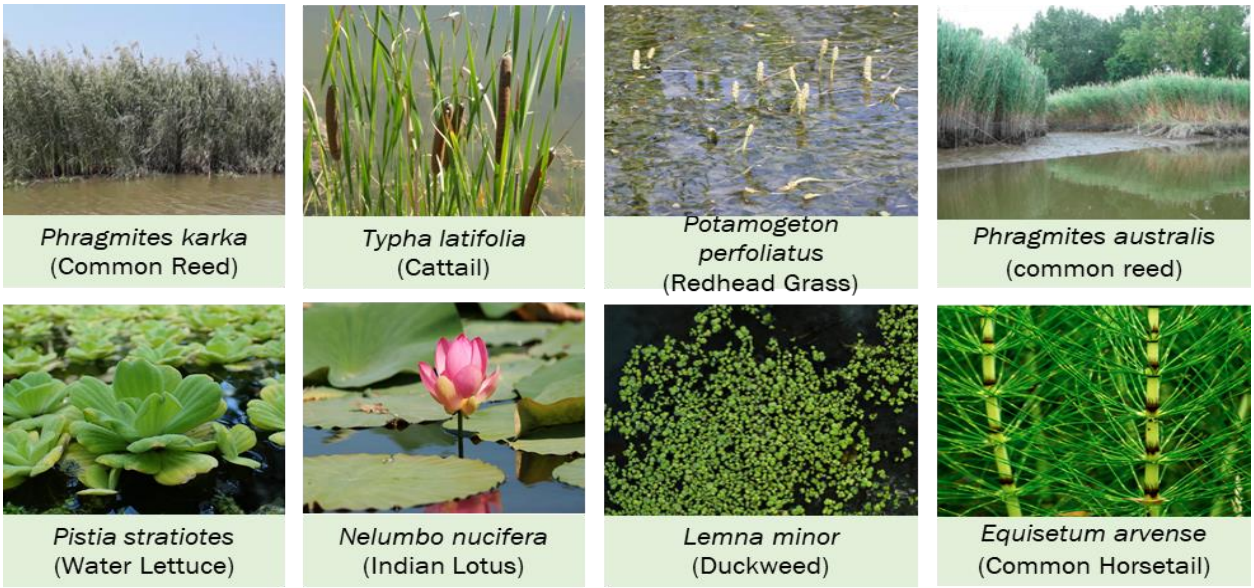


Figure 33: Conceptual Design and Plants used for Rejuvenation of Wastewater Ponding Sites

6.3.3. PROJECT 3: Development & Restoration of Urban Parks

Urban parks are designated open areas, typically characterized by a prevalence of vegetation and water features, and are typically set aside for public use. These parks play a significant role in urban amenity green spaces and serve as crucial yardsticks for assessing the sustainability of cities.

The presence of green spaces within urban areas is instrumental in promoting sustainable urban planning. Conversely, haphazard urban expansion with limited green or open public spaces not only undermines the sustainability of an area but also has adverse effects on human health and well-being.

Prioritizing the establishment of urban green spaces is a major focus in creating cities that are pleasant to live in. The total count of green spaces within a city serves as a pivotal indicator of a city's sustainable urban ecosystem and the overall quality of urban life.

Scope of the Project

The scope of the project aims to provide the following facilities in the parks:

- Children's Play Area
- Gazebo
- Walking Track & Pathways
- Drinking Water faucets
- Fountains
- Rest areas/washrooms
- Parking area
- Cafeteria
- Benches
- Toilets

Proposed Site for Development of New Parks:

- 03 Parks – DG Khan District
- 07 Parks – Muzaffargarh District
- 04 Parks – Layyah District
- 02 Parks – Rajanpur District

Proposed Site for Restoration & Improvement of Parks:

- 03 Parks – DG Khan District
- 05 Parks – Muzaffargarh District
- 10 Parks – Layyah District
- 12 Parks – Rajanpur District

Estimated Cost:

Conceptual Design for Parks

Sr #	Restoration & Improvement of Parks	Cost (M)
1	City Park Taunsa (30.71500168; 70.6510375) 12 Kanals	9
2	Housing Colony Park Taunsa (30.7115152 70.65660223) 7 Kanals	5.25
3	Aqil Pura Park Rajanpur (29.10547934; 70.33875585) 15 Kanals	11.25
4	Fatima Jinnah Ladies Park Rajanpur (29.10735919; 70.32384043) 13 Kanals	9.75
5	Khalil Children Park Rajanpur (29.09957896; 70.32481309) 1 Kanal	0.75
6	Sir Syed Park Rajanpur (29.10315216; 70.33445543) 8.5 Kanals	6.36
7	Johar Park Rajanpur (29.10504864; 70.33443546) 3 Kanals	2.25
8	Kashmir Park Rajanpur (29.10842382; 70.33413478) 3 Kanals	2.25
9	Qaim Dresham Park Rajanpur (29.10638118; 70.33434967) 3 Kanals	2.25
10	Children Park Jampur (29.64062851; 70.60212613) 22 Kanals	16.5
11	Sports Park Jampur (29.65147485; 70.60774595) 12 Kanals	9
12	MC Park Jampur (29.6401327; 70.5939595) 31 Kanals	23.25
13	Jinnah Park Layyah (30.96341238; 70.94380682) 14 Kanals	10.5
14	Siddique Children Park Layyah (30.97121288; 70.96135745) 72 Kanals	54
15	Manzoor Park Layyah (30.96639323; 70.96332136) 6 Kanals	4.5
16	Pir Khurshid Ladies Park Layyah (30.96291785; 70.95935701) 14 Kanals	10.5
17	Children Park Layyah Road MC Chowk Azam (30.961479; 71.21158) 10 Kanals	7.5
18	Tooba Park Kot Addu (30.48234696; 70.96217317) 3 Kanals	2.25
19	MC Park Kot Addu (30.4834895; 70.96109356) 20 Kanals	15
20	Mumtaz Park Kot Addu (30.46611268; 70.96200059) 30 Kanals	22.5
21	Nawab Muzaffar Khan Park Muzaffar garh (30.06481994; 71.21155151) 184 Kanals	138
22	Municipal Ladies Park Mohallah Gujran wala Layyah (30.96254; 70.937712) 6 Kanals	4.5
23	Kashmir Park near Veera Stadium Layyah (30.962482; 70.938635) 1 Kanal	0.75
24	Fazal Hussain Jakhar Park Layyah (30.962938; 70.95334) 23 Kanals	17.25
25	Alipur Ladies Park (29.386064; 70.913291) 4 Kanals	3
26	Muhammadia Park Karor Lal Esan (31.225017; 70.950363) 16 Kanals	12
27	Jahangir Park Karor Lal Esan (31.22902; 70.950396) 8 Kanals	6

28	Jinnah Family Park DG Khan (30.03141651; 70.63076923) 104 Kanals	78
29	Jammal Park Mithan Kot (28.965404; 70.362892) 20 Kanals	15
30	Kammal Fareed Park Mithan Kot (28.961146; 70.366932) 8 Kanals	6
	Total Amount Millions	**505.11**

Sr #	Restoration & Improvement of Parks	Cost (M)
1	Aslam Park Rajanpur (29.10283835 70.32047861) 10 Kanals	9.2
2	Kalsoom Nawaz Park Jampur (29.63943089 70.60136945) 14 Kanals	13.1
3	Bakhtawar Bhutto Park Layyah (30.98412794 70.93711366) 5 Kanals	4.7
4	Park Near JanazGah MC Chowk Azam (30.958829 71.211713) 20 Kanals	18.8
5	Old Cattle Mandi Park Kot Addu (30.46129149 70.97069047) 14 Kanals	13.1
6	City Park Muzaffargarh (30.08521969 71.18553242) 30 Kanals	28.1
7	Park at tibba karim abad Muzaffargarh (30.09109178 71.1720919) 12 Kanals	11.3
8	Park Near PHED Office Muzaffargarh (30.08577221 71.18244208) 13 Kanals	12.2
9	Children Park Housing Colony no. 1 Z Block (30.97589568 70.95876292) 2 Kanals	1.9
10	Children Park Housing Colony X Block (31.70511821 74.02270657) 5 Kanals	4.7
11	General Park Jatoi (29.512228 70.850131) 33 Kanals	30.8
12	Family Park Karor Lal Esan (31.22366 70.954437) 16 Kanals	15.0
13	Children Park Karor Lal Esan (31.222897 70.95594) 18 Kanals	16.9
14	General Bus Stand Park DG Khan (30.049224 70.651353) 64 Kanals	60.0
15	Allama Iqbal Park DG Khan (30.0658 70.628556) 96 Kanals	90.0
16	Community Park Kot Chutta (29.88675 70.652493) 8 Kanals	7.5
	Total Amount Millions	**337.13**

Figure 34: Conceptual design of Ladies Park

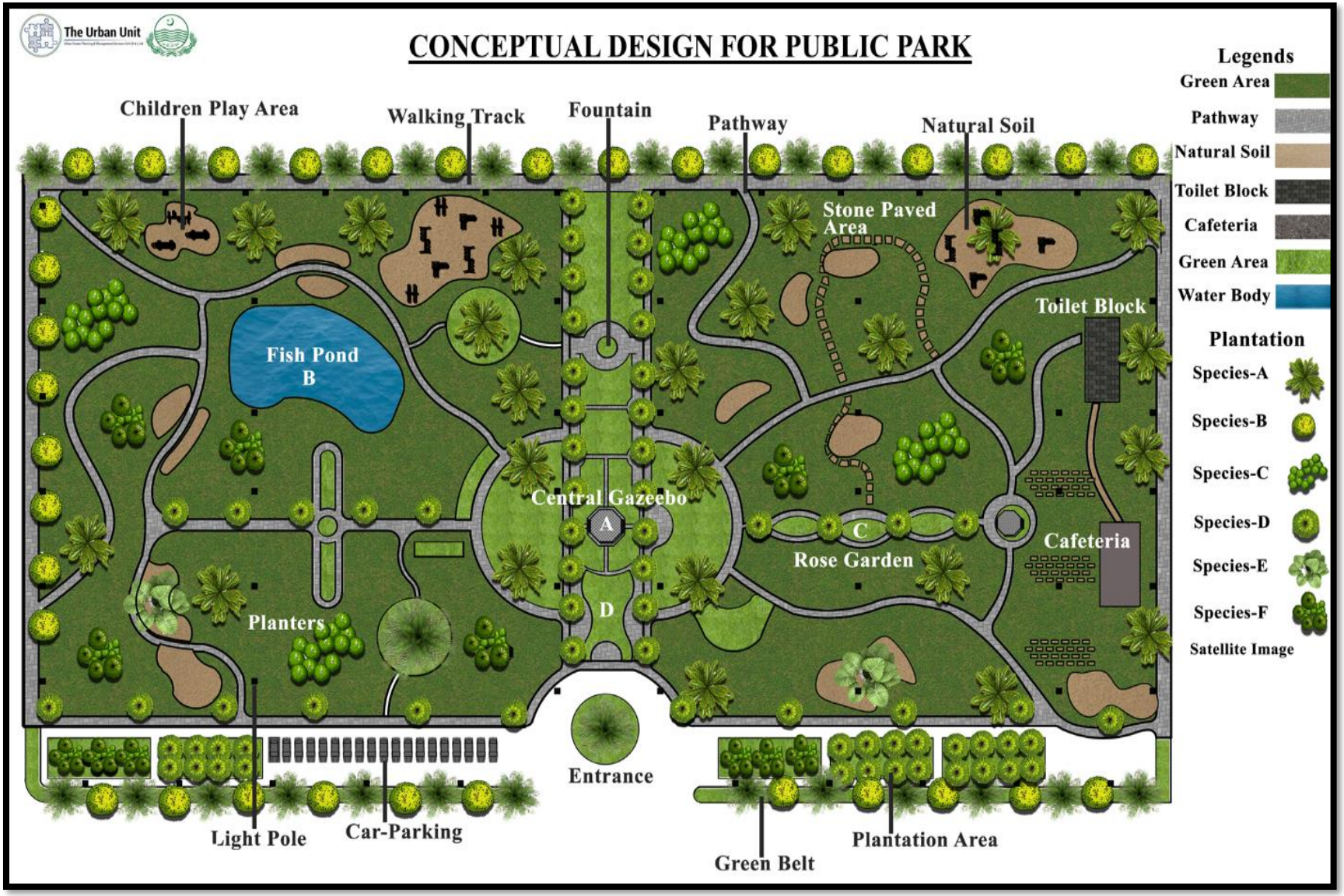


Figure 35: Conceptual Design for Public Park

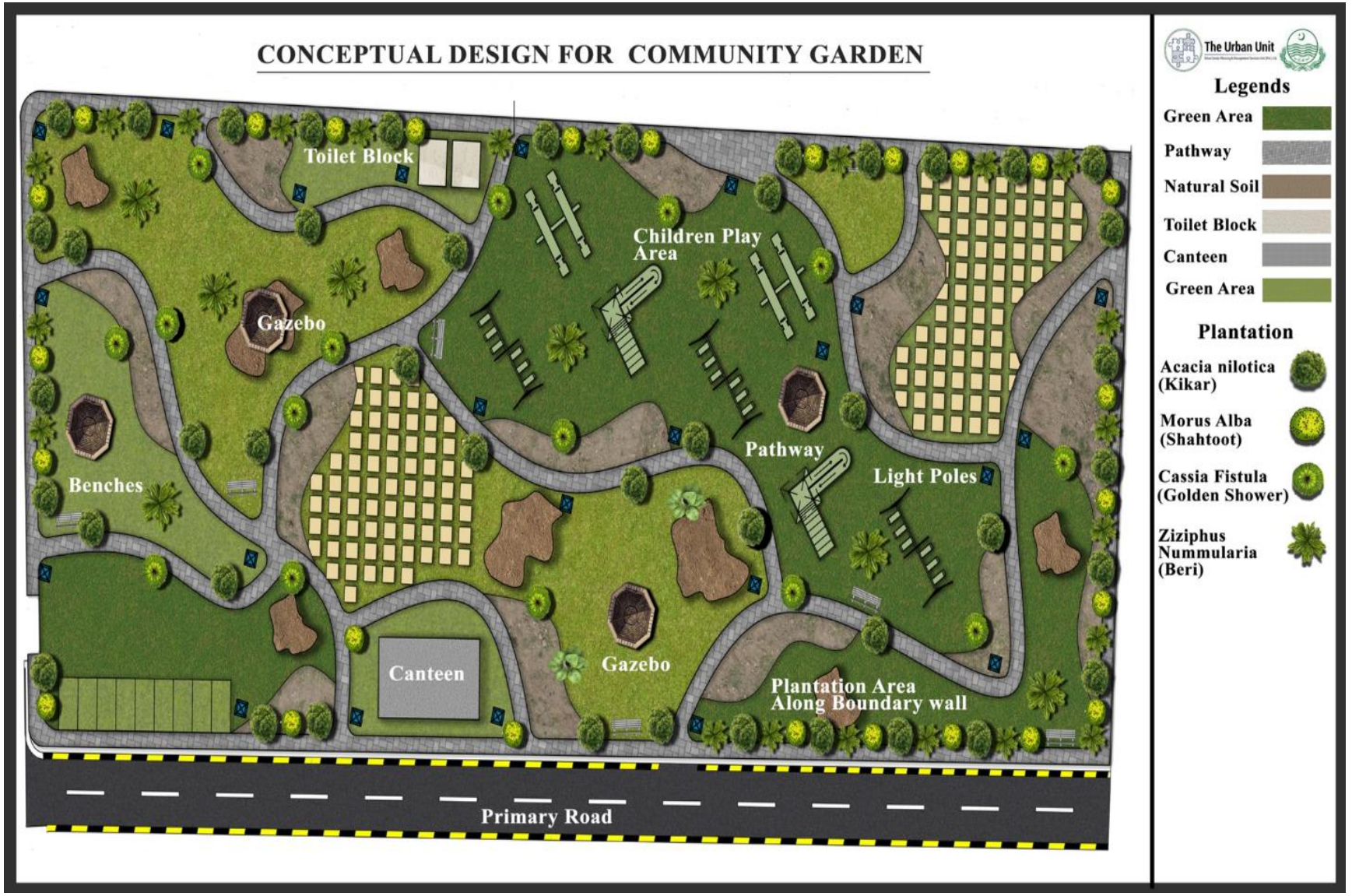


Figure 36: Conceptual Design for Community Garden

6.3.4. PROJECT 4: Eco-Rejuvenation of Damas Lake, Fort Munro

Damas Lake is present in Fort Monroe hill station, at a distance of 85 km from Dera Ghazi Khan city. The site is an important tourist destination. The temperature at the hill station is lower than the rest of the region, owing to its green terrain and elevated height. Historically, Damas Lake served as a source of water for the residents of Fort Monroe. The water level in the lake depends on seasonal rainfall. At present, the water in the lake has become polluted because of unchecked tourist activities and sewage discharge into the lake from surrounding residential areas. With the development of the fort monro region, the site is expected to attract more visitors in the future. It is important to rehabilitate this lake to sustain its ecosystem services;

Proposed Sites:

- Area: 4.76 Acres
- Coordinates: 29.9287987 ° N 69.993893° E
- **Gravel Bed Location:** 29.9294183° N 69.9941708 ° E

Figure 37: Lake View

Scope:

- SWAB Treatment System for Bioremediation of Lake
  Dimensions of Gravel Bed
  – Length: 25 m, Width: 10.11m, Depth: 2.0 to 2.6m;
  – No. of chambers: 5;
  – Filler stone aggregate of nominal size of 200 to 300mm over a depth of 77cm, 100mm over a depth of 38cm, 80mm over a depth of 115cm;
  – Five manholes for sewage collection;
  – 150mm sewage collection pipe;
- Bird Watching Tower
- Gazebo
- Walking Trail
- Light Poles
- Plantation

Estimated Cost:

Sr. No	Description	Amount in PKR	Amount in Millions
1	SWAB Treatment System for Bioremediation of Lake	4,482,227	4.5
2	Bird Watching Tower	1,618,914	1.6
3	Gazebo	450,000	0.5
4	Walking Trail	3,023,632	3.0
5	Light Poles	2,867,647	2.9
6	Plantation	1,362,609	1.4
	Sub- Total Amount	**13,805,029**	**14**
	Add 2% Contingency Charges	276,101	0
	Add 5% PST	690,251	1
	G-Total Amount R. s	**14,771,381**	**15**

Conceptual Design:

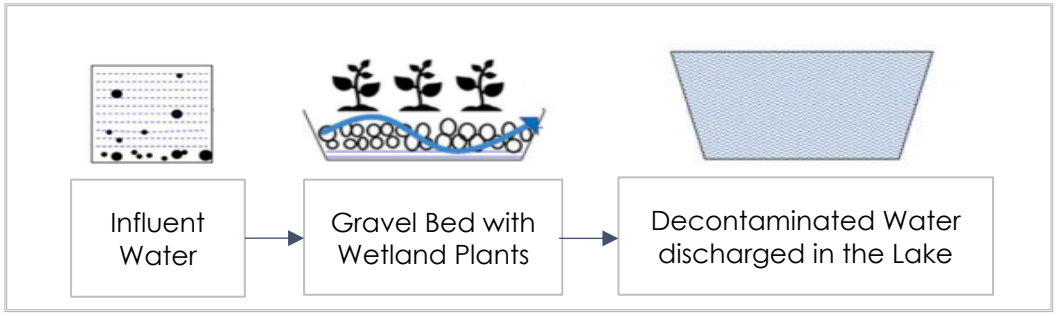


Figure 38: Schematic Diagram of SWAB Treatment

Figure 39: Conceptual Illustration

6.3.5. PROJECT 5: Linear Plantation and Green Corridors in Cities of DG Khan

The networks of linear corridor which are connecting pathway among green belts, green spaces and linear plantation along roads, canals and tracks are designed to improve the environmental qualities of the district. Green corridors are especially beneficial for regional biodiversity as they create cool air pathways that cool cities and improve air quality. Additionally, green corridors help to improve the aesthetic view of highways and offer locals recreational opportunities. In order to improve the environmental values of division, the networks of linear green corridors are need of districts to frequently developed along green belts and increase the green infrastructure.

Proposed sites

- Jatoi Permit Road Green Belt, Muzaffargarh (3 Km)
- Jatoi Shehr Sultan Road Linear Plantation, Muzaffargarh (1.98 Km)
- Karor Bhakkar Road Linear Plantation, Muzaffargarh (1.46 Km)
- Alipur Khairpur Road Linear Plantation, Muzaffargarh (2 Km)
- Alipur Jatoi Road Linear Plantation, Muzaffargarh (1.1 Km)
- Alipur-Muzaffargarh Road Linear Plantation, Muzaffargarh (2 Km)
- Main Indus Highway side plantation, Muzaffargarh (5 Km)
- Manka Road Linear Plantation, DG Khan (2.72 Km)
- New College Road Linear Plantation, Taunsa Sharif, DG Khan (0.3 Km)
- Sakhi Sarwar Road Linear Plantation, DG Khan (2.54 Km)
- Railway Road Linear Plantation, DG Khan (1.94 Km)
- Jampur Road Linear Plantation, DG Khan (1.54 Km)
- Nai Abadi Bypass Road Plantation, Kot Mithan, Rajanpur (2 Km)
- Railway Road Green Belt, Kot Mithan Rajanpur (1.2 Km)
- Stadium Road Green Belt, Kot Mithan Rajanpur (1.44 Km)
- Rajanpur Main Road Linear Plantation, Rajanpur (3.1 Km)
- Bypass Road Jampur Plantation, Rajanpur (1 Km)
- Chaubara Road Plantation, Chowk Azam, Layyah (2.5 Km)

Total: 60 Av Kms

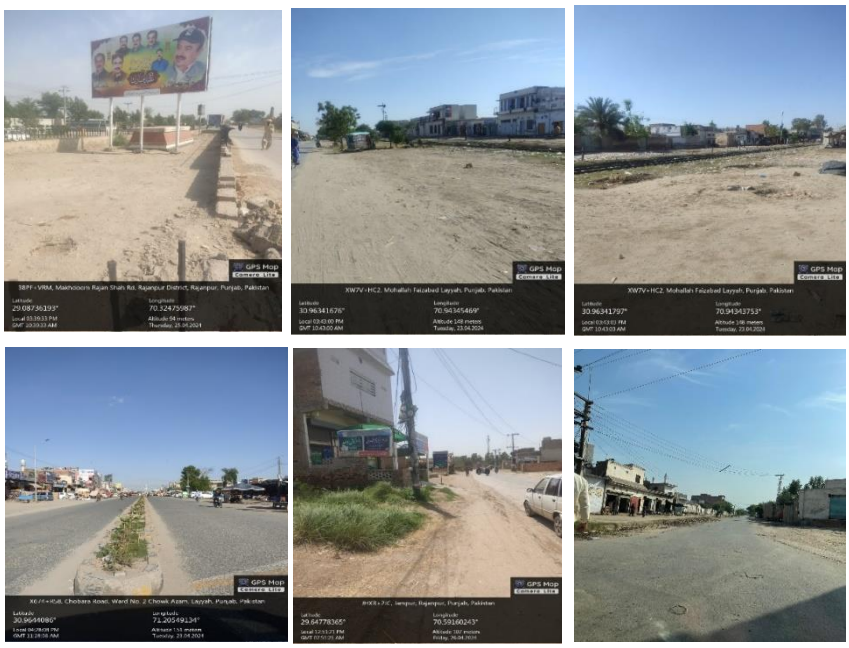


Figure 40: Proposed Project sites for Linera Plantation

Benefits:

- Micro Climatic Modification
- Economic Diversification
- Eco-Friendly environment
- Preventing Soil Erosion
- Carbon Sequestration
- Improved Ecosystem services
- Human-Biodiversity Interactions
- Recreational Point

Conceptual Design:

- The green corridor should be a connected network of green cover and green spaces to achieve the basic aim of the project.
- The plantation along the water channel should be planned and based on stratification to enhance the beauty of the region.
- Number of rows based on the availability of spaces along the planting area.
- The placement of vegetation around developments and the maintenance of larger, interconnected green spaces throughout regions should be done to promote air quality improvement.

Estimated Cost:

Sr. No	Description	Cost	Add 2% Contingencies	Add 2% Consultancy	Add 5% PST	Cost	Millions
	Development of Green belts along the main roads of the city						
1	**Jatoi Permit Road Green Belt, Muzaffargarh (3 Km)**						
	Planters along Road	1,157,655	23,153	23,153	57,883	1,261,844	1.26
	Green Belt	2,852,576	57,052	57,052	142,629	3,109,308	3.11
	Total Amount	**4,010,232**	**80,205**	**80,205**	**200,512**	**4,371,153**	**4.37**
2	**Jatoi Shehr Sultan Road Linear Plantation, Muzaffargarh (1.98 Km)**						
	Planters along Road	681,213	13,624	13,624	34,061	742,522	0.74
	Green Belt	2,741,505	54,830	54,830	137,075	2,988,240	2.99
	Total Amount	**3,422,718**	**68,454**	**68,454**	**171,136**	**3,730,762**	**3.73**
3	**Karor Bhakkar Road Linear Plantation, Muzaffargarh (1.46 Km**						
	Planters along Road	596,863	11,937	11,937	29,843	650,580	0.65
	Green Belt	2,021,517	40,430	40,430	101,076	2,203,453	2.20
	Total Amount	**2,618,379**	**52,368**	**52,368**	**130,919**	**2,854,033**	**2.85**
4	**Alipur Khairpur Road Linear Plantation, Muzaffargarh (2 Km)**						
	Planters along Road	865,867	17,317	17,317	43,293	943,795	0.94
	Green Belt	2,769,289	55,386	55,386	138,464	3,018,525	3.02
	Total Amount	**3,635,156**	**72,703**	**72,703**	**181,758**	**3,962,320**	**3.96**
5	**Alipur Jatoi Road Linear Plantation, Muzaffargarh (1.1 Km)**						
	Planters along Road	446,123	8,922	8,922	22,306	486,274	0.49
	Green Belt	1,523,084	30,462	30,462	76,154	1,660,162	1.66
	Total Amount	**1,969,207**	**39,384**	**39,384**	**98,460**	**2,146,436**	**2.15**
6	**Alipur-Muzaffargarh Road Linear Plantation, Muzaffargarh (2 Km)**						
	Planters along Road	865,867	17,317	17,317	43,293	943,795	0.94
	Green Belt	2,769,289	55,386	55,386	138,464	3,018,525	3.02
	Total Amount	**3,635,156**	**72,703**	**72,703**	**181,758**	**3,962,320**	**3.96**
7	**Main Indus Highway side plantation, Muzaffargarh (5 Km)**						
	Planters along Road	2,164,668	43,293	43,293	108,233	2,359,488	2.36
	Green Belt	6,923,222	138,464	138,464	346,161	7,546,312	7.55

	Total Amount	**9,087,890**	**181,758**	**181,758**	**454,394**	**9,905,800**	**9.91**
8	**Manka Road Linear Plantation, DG Khan (2.72 Km)**						
	Planters along Road	1,177,497	23,550	23,550	58,875	1,283,471	1.28
	Green Belt	3,766,154	75,323	75,323	188,308	4,105,107	4.11
	Total Amount	**4,943,650**	**98,873**	**98,873**	**247,183**	**5,388,579**	**5.39**
9	**New College Road Linear Plantation, Taunsa Sharif, DG Khan (0.3 Km)**						
	Planters along Road	129,868	2,597	2,597	6,493	141,556	0.14
	Green Belt	415,319	8,306	8,306	20,766	452,698	0.45
	Total Amount	**545,187**	**10,904**	**10,904**	**27,259**	**594,254**	**0.59**
10	**Sakhi Sarwar Road Linear Plantation, DG Khan (2.54 Km)**						
	Planters along Road	1,099,522	21,990	21,990	54,976	1,198,479	1.20
	Green Belt	3,517,061	70,341	70,341	175,853	3,833,596	3.83
	Total Amount	**4,616,583**	**92,332**	**92,332**	**230,829**	**5,032,075**	**5.03**
11	**Railway Road Linear Plantation, DG Khan (1.94 Km)**						
	Planters along Road	839,746	16,795	16,795	41,987	915,323	0.92
	Green Belt	2,686,175	53,724	53,724	134,309	2,927,931	2.93
	Total Amount	**3,525,921**	**70,518**	**70,518**	**176,296**	**3,843,254**	**3.84**
12	**Jampur Road Linear Plantation, DG Khan (1.54 Km)**						
	Planters along Road	666,588	13,332	13,332	33,329	726,581	0.73
	Green Belt	2,132,169	42,643	42,643	106,608	2,324,065	2.32
	Total Amount	**2,798,758**	**55,975**	**55,975**	**139,938**	**3,050,646**	**3.05**
13	**Nai Abadi Bypass Road Plantation, Kot Mithan, Rajanpur (2 Km)**						
	Planters along Road	865,867	17,317	17,317	43,293	943,795	0.94
	Green Belt	2,769,289	55,386	55,386	138,464	3,018,525	3.02
	Total Amount	**2,798,758**	**55,975**	**55,975**	**139,938**	**3,050,646**	**3.05**
14	**Railway Road Green Belt, Kot Mithan Rajanpur (1.2 Km)**						
	Planters along Road	519,512	10,390	10,390	25,976	566,268	0.57

	Green Belt	1,661,524	33,230	33,230	83,076	1,811,061	1.81
	Total Amount	**2,181,036**	**43,621**	**43,621**	**109,052**	**2,377,329**	**2.38**
15	**Stadium Road Green Belt, Kot Mithan Rajanpur (1.44 Km)**						
	Planters along Road	623,299	12,466	12,466	31,165	679,396	0.68
	Green Belt	1,993,730	39,875	39,875	99,686	2,173,165	2.17
	Total Amount	**2,617,029**	**52,341**	**52,341**	**130,851**	**2,852,561**	**2.85**
16	**Rajanpur Main Road Linear Plantation, Rajanpur (3.1 Km)**						
	Planters along Road	1,342,090	26,842	26,842	67,105	1,462,878	1.46
	Green Belt	4,292,373	85,847	85,847	214,619	4,678,686	4.68
	Total Amount	**5,634,463**	**112,689**	**112,689**	**281,723**	**6,141,565**	**6.14**
17	**Bypass Road Jampur Plantation, Rajanpur (1 Km)**						
	Planters along Road	432,934	8,659	8,659	21,647	471,898	0.47
	Green Belt	1,384,644	27,693	27,693	69,232	1,509,262	1.51
	Total Amount	**1,817,578**	**36,352**	**36,352**	**90,879**	**1,981,160**	**1.98**
18	**Chaubara Road Plantation, Chowk Azam, Layyah (2.5 Km)**						
	Planters along Road	1,082,354	21,647	21,647	54,118	1,179,766	1.18
	Green Belt	3,461,734	69,235	69,235	173,087	3,773,290	3.77
	Total Amount	**4,544,088**	**90,882**	**90,882**	**227,204**	**4,953,056**	**4.95**

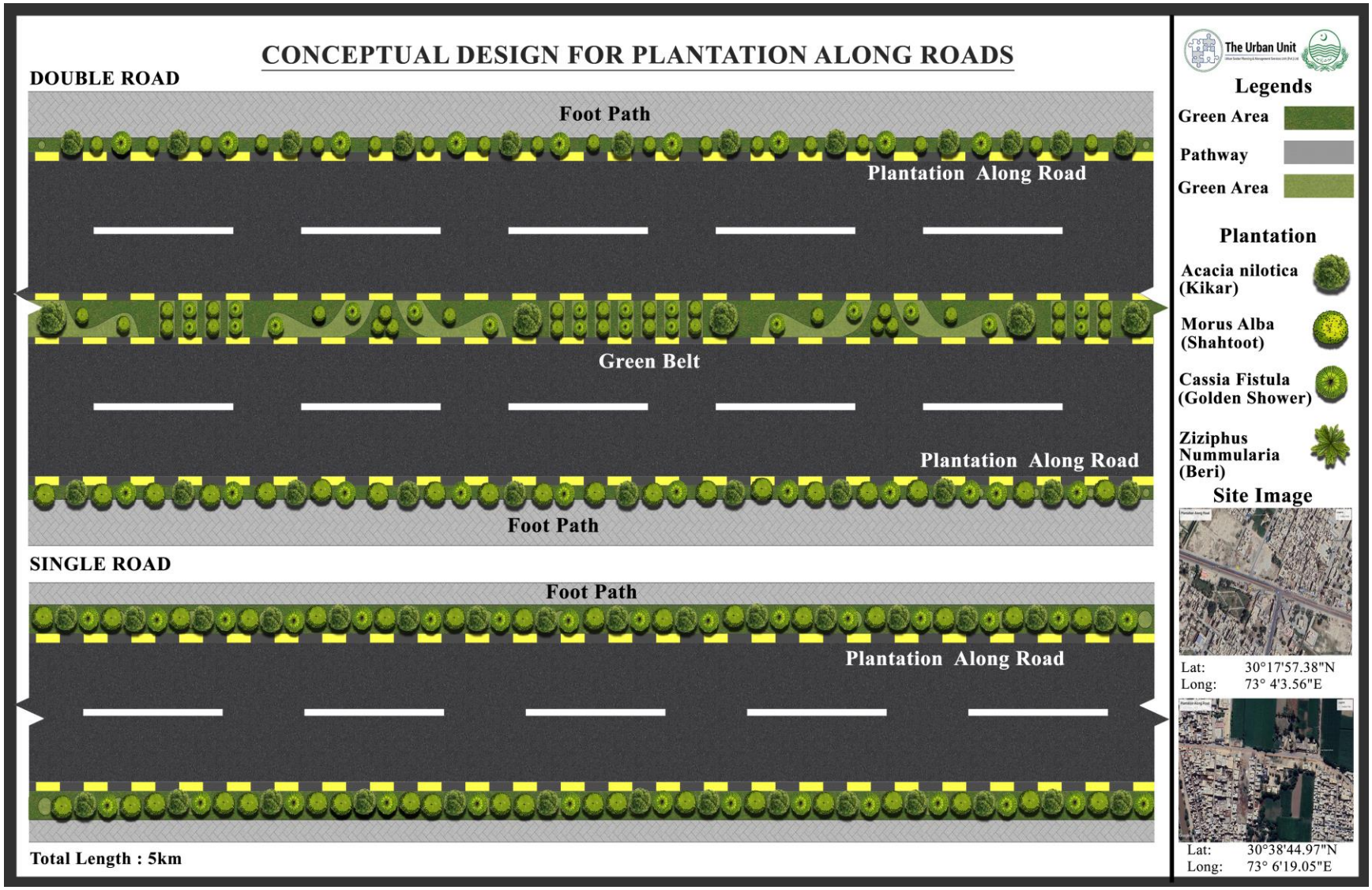


Figure 41: Conceptual Design of Roadside Linear Plantation

6.3.6. PROJECT 6: Linear Plantation along sideways Railway Lines and Canal banks

Sideways plantations focus on developing green spaces along linear features such as trails, roadsides, or riverbanks. These sideways linear plantations are designed to provide recreational opportunities, promote biodiversity, improve air quality, and enhance the visual appeal of urban or natural environments. They typically feature walking and biking trails, native plantings, water elements, seating areas, and sustainable landscaping practices. Pathway lineage parks offer benefits such as outdoor recreation, active transportation options, mental well-being improvement, wildlife habitats, urban cooling, noise reduction, and community engagement. They contribute to creating healthier, more resilient, and liveable communities.

Project Sites

Total Area: (72 Av. Km)

- Taliri Canal, Muzaffargarh (5.6 Km)
- Layyah Minor Canal, Layyah (6.5 Km)
- Layyah Railway Track, Layyah (8.0 Km)
- Kot Addu Railway track, Kot Addu (7.8 Km)
- Kot Chutta Railway, DG Khan (2.5 Km)
- Rojhan Railway Line, Rojhan (1.9 km)
- Jampur Canal, Rajanpur (3.5 Km)

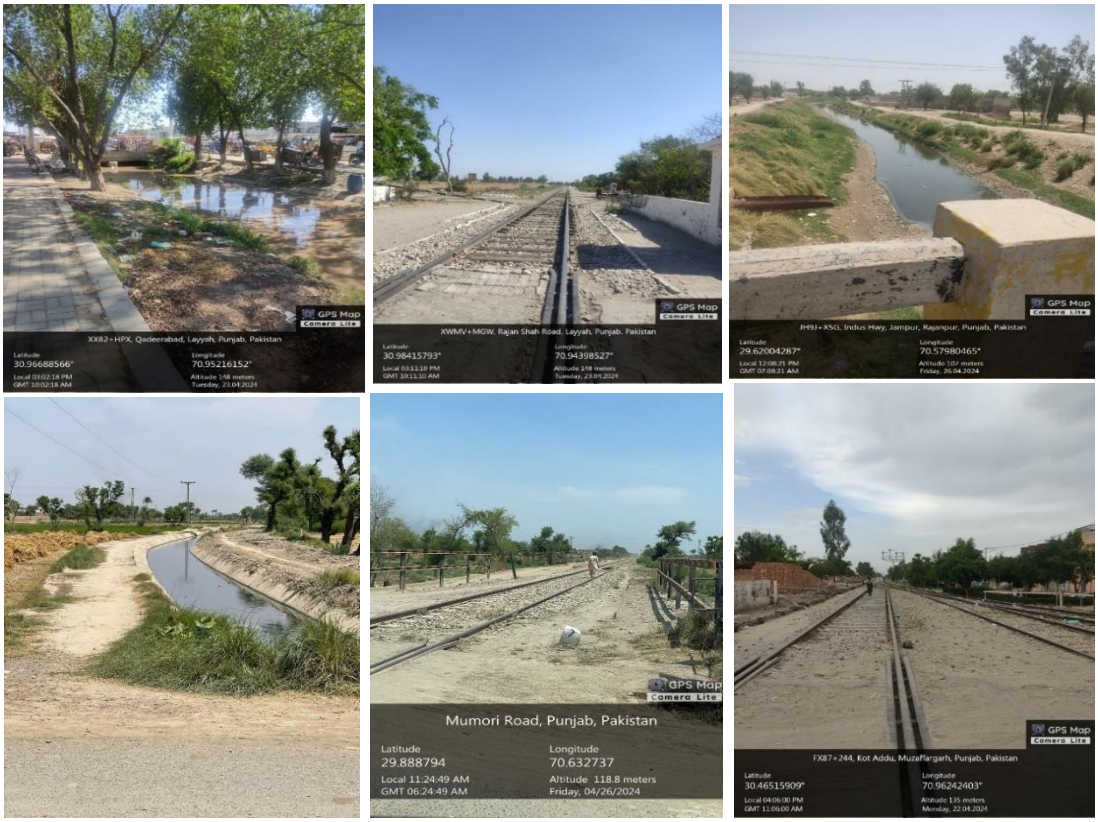


Figure 42: Proposed Area Project

Conceptual Design

- The Green Way linear corridors should form a cohesive network of green cover and spaces, aligning with the project's core objectives.
- These pathways are planned to serve multiple functions, such as pedestrian and cyclist routes, recreational spaces, wildlife corridors, and cultural or historical trails.
- The number of rows of vegetation should be determined based on available space along the pathway.

Estimated Cost

SUMMARY OF ROUGH COST ESTIMATE TALIRI CANAL MUZAFFARGARH BEAUTIFICATION			
Sr. No	**Description**	**Amount in PKR**	**Amount in Millions**
1	Construction of Green Area and Plantation	5,078,002	5.08
2	Outdoor Furniture Benches	420,100	0.42
	Sub- Total Amount	**5,498,102**	**5.50**
	Add 2% Contingency Charges	109,962.04	0.11
	Add 5% PST	274,905.10	0.27
	Total Amount R. s	**5,882,969.10**	**5.88**

SUMMARY OF ROUGH COST ESTIMATE LAYYAH RAILWAY TRACK BEAUTIFICATION			
Sr. No	**Description**	**Amount in PKR**	**Amount in Millions**
1	Construction of Green Area and Plantation	7,254,523	7.25
2	Construction of Stones	3,655,118	3.66
3	Outdoor Furniture Benches	840,200	0.84
	Sub- Total Amount	**11,749,841**	**11.75**
	Add 2% Contingency Charges	234,996.81	0.23
	Add 5% PST	587,492.04	0.59
	Total Amount R. s	**12,572,329.58**	**12.57**

SUMMARY OF ROUGH COST ESTIMATE LAYYAH RAILWAY TRACK BEAUTIFICATION			
Sr. No	**Description**	**Amount in PKR**	**Amount in Millions**
1	Construction of Green Area and Plantation	7,073,031	7.07
2	Construction of Stones	3,655,118	3.66
3	Outdoor Furniture Benches	840,200	0.84
	Sub- Total Amount	**11,568,349**	**11.57**

	Add 2% Contingency Charges	231,366.98	0.23
	Add 5% PST	578,417.46	0.58
	Total Amount R. s	**12,378,133.69**	**12.38**

SUMMARY OF ROUGH COST ESTIMATE LAYYAH MINOR CANAL BEAUTIFICATION			
Sr. No	**Description**	**Amount in PKR**	**Amount in Millions**
1	Construction of Green Area and Plantation	2,267,015	2.27
2	Construction of Stone	3,655,118	3.66
3	Outdoor Furniture Benches	420,100	0.42
	Sub- Total Amount	**6,342,233**	**6.34**
	Add 2% Contingency Charges	126,844.66	0.13
	Add 5% PST	317,111.66	0.32
	Total Amount R. s	**6,786,189.57**	**6.79**

SUMMARY OF ROUGH COST ESTIMATE LAYYAH MINOR CANAL BEAUTIFICATION			
Sr. No	**Description**	**Amount in PKR**	**Amount in Millions**
1	Construction of Green Area and Plantation	1,722,810	1.72
2	Constriction of Stone	3,655,118	3.66
3	Outdoor Furniture Benches	420,100	0.42
	Sub- Total Amount	**5,798,029**	**5.80**
	Add 2% Contingency Charges	115,960.57	0.12
	Add 5% PST	289,901.43	0.29
	Total Amount R. s	**6,203,890.66**	**6.20**

SUMMARY OF ROUGH COST ESTIMATE LAYYAH MINOR CANAL BEAUTIFICATION			
Sr. No	**Description**	**Amount in PKR**	**Amount in Millions**
1	Construction of Green Area and Plantation	3,173,854	3.17
2	Outdoor Furniture Benches	210,050	0.21
	Sub- Total Amount	**3,383,904**	**3.38**
	Add 2% Contingency Charges	67,678.07	0.07
	Add 5% PST	169,195.18	0.17
	Total Amount R. s	**3,620,776.85**	**3.62**

Figure 43: Conceptual Design for Linear Plantation

6.3.7. PROJECT 7: Nature Park & Biodiversity Reserve

Nature Park & Biodiversity Reserve will serve as diversified habitat for the native biodiversity and magnificent to climate and ecosystem value of the region. Biodiversity Reserve will helps to improve the quality of the water and air and reduced the consequences of climate change. The nature park ecology will help to conserve the habitat for native species, supports wildlife, and keeps the area cool. In addition to environmental values it enhances the recreational opportunities, improve mental and physical health of locals. The nature park also increases the faunal and floral diversity of the area and also increase the research opportunities for biological and environmental researcher.

Proposed Site:

- Rakh Bangala Forest

Figure 44: Existing Condition of Rakh Bangala Forest

Estimated Cost

Sr. No	Description	Millions
1	Construction of Walking Trail	20.85
2	Construction of Brid Cages	0.36
3	Construction of Butter Fly House	15.44
4	Construction of Information Center/ Cafeteria	28.59
5	Construction of Toilet Block (Women and Men)	1.56
6	Construction of Parking Area	24.72
7	Construction of Admin Office	18.59
8	Construction of Rose Garden	7.83
9	Construction of Natural Soil	30.42
10	Provision & Fixing of Wire fencing Wall	7.32
11	Fixing of Information Signage Boards	0.84
12	Construction of Green House	1.22
13	Plantation (Arboretum, Fruticetum, Orchidarium & Scatter Plantation)	2.70
	Sub- Total Amount	**160.43**
	Add Contingencies Cost (2.5%)	**4.01**

	Add PST (5%)	**8.02**
	Grand Total Amount	**172**

Conceptual Design

- The nature park & biodiversity reserve with the key softscape components including arboretum, Grassy lawns, green house, Rose Garden, scattered plantation and butterfly house.
- The Plantation in reserve includes understory indigenous, ornamental, and fruiting plants to attract and conserve the avifaunal diversity of the region.
- The hardscaping component of reserves includes forest trail, admin and monitoring office, parking area, toilet block, jogging track and cycling track to enhance recreational and public use opportunities.
- The art scaping of reserve includes the signage board, sitting, gazebo, entrance and others to maintain the attraction for visitors.

Figure 45: Conceptual design of Nature Park and Biodiversity Reserve

6.3.8. PROJECT 8: Reforestation/ Afforestation

Forest plantations in any area have a primary objective to increase the forest cover by planting trees on barren lands, degraded areas and other suitable sites of forest land. Forest plantations help to improve native tree species richness that is suitable to the local climate, soil conditions, and ecological requirements.

Planting diverse tree species and creating forest corridors can help maintain connectivity between habitats and support the survival of various plant and animal species. Forest plantation is an important step towards environmental stability, which contributes to carbon sequestration and helps to mitigate climate change. Forest plantations will also be focused on mitigating key issues like deforestation by replanting trees in areas that were once covered by forests but have now been degraded due to human activities or natural causes.

Estimated Cost:

Sr. #	Site	Description	Unit	Qty	Rate (Rs)	Amount (Rs. Million)
1	DG Khan Forest Division – 300 Acres	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	165,000	550.0	**90.8**
2	MuzaffarGarh Forest Division – 300 Acres	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	165,000	550.0	**90.8**
3	Layyah Forest Division – 200 Acres	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	110,000	550.0	**60.5**
4	Rajanpur Forest Division – 150 Acres	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	82,500	550.0	**45.4**
					Total Amount	**287.5**

Conceptual Design:

- The plantation design should be based on mix cropping or polyculture design to attract and conserve the wild diversity of the region.
- The species selection based on indigenous plant species which are native to the division includes:

- *Acacia modesta* (Phulai)
- *Acacia nilotica* (Kikar)
- *Ziziphus nummularia* (Beri)
- *Dodonia viscosa (Snatha)*
- *Tamarix aphylla* (Frash)
- *Morus alba* (Toot)
- *Dalbergia sissoo* (Shisham)

- The plantation spacing based on 10 x 8 Line and tree for the well-maintained growth of plant.

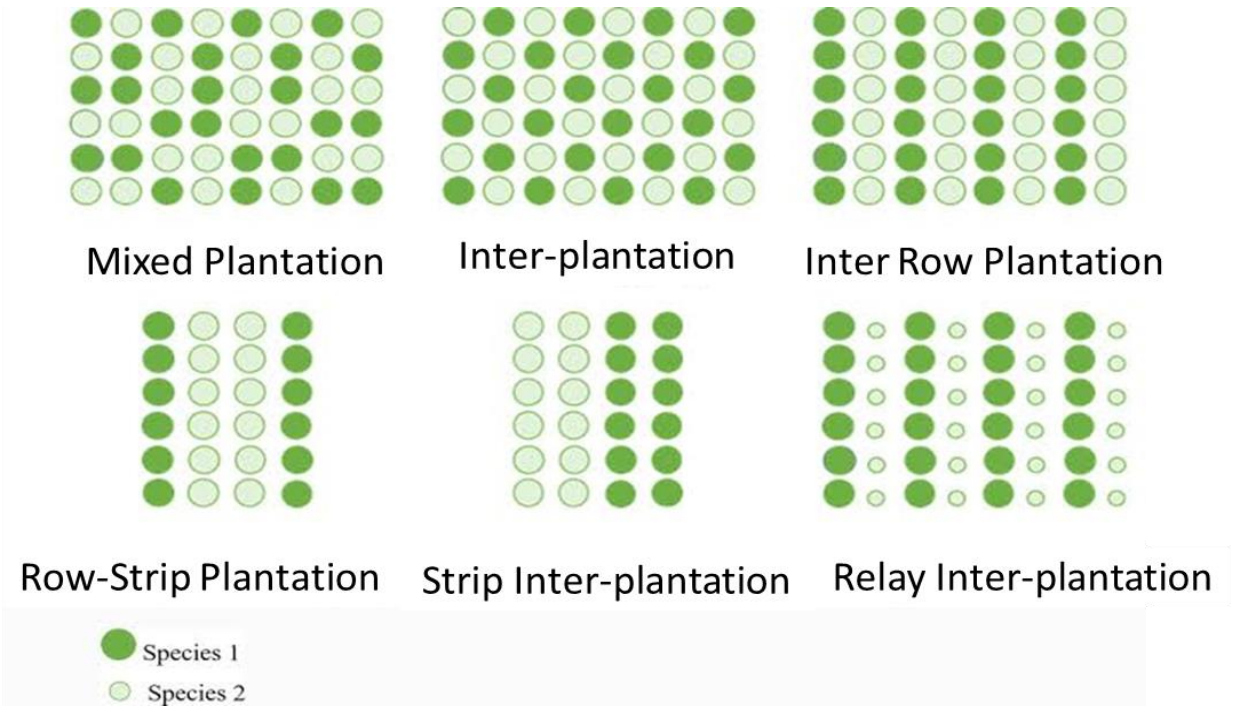


Figure 46: Conceptual Design for Reforestation

6.3.9. PROJECT 9: Botanical Garden

Botanical gardens are the exclusive contributions towards socialize forestry, conserve diversified plant collection, mitigate climate change, and improve public engagement. The diverse collection of plant species growing in natural conditions, maintained in green house, and other resources, helps to promote research collaboration and enhanced opportunities volunteers and sustainable tourism. Botanical garden in Layyah will be the first ever most place in the region, that is dedicated to conduct high-quality research on medicinal flora, plant disease, ornamental plant stock raising, habitat conservation and nature attraction.

Estimated Cost:

Sr. No	Description	Millions (PKR)
1	Construction of Main Gates and Boundary Wall	0.8
2	Construction of Horticulture Works	20.4
3	Construction of Green House	10.9
4	Construction of Information Center	13.9
5	Construction of Garden Center	9.9
6	Construction of Bins, Wood Bench-01, Water Cooler	8.9
7	Construction of Toilets	2.4
8	Construction of Monitoring Room	0.5
9	Construction of Hard Land Scaping (Inner & Out Side Tuff Pavers with Parking Area, Jogging Track Area,	7.4
10	P/L of Wildlife habitat, Sensory Lawn, Cacti Lawn ornamental Plantations	17.0
11	Construction of Cafeteria	5.2
12	Construction of Light Poles	6.0
	Total	**103.2**
	Add Contingencies Cost (2%)	**2.1**
	Add PST (5%)	**5.2**
	Grand Total Amount	**110.5**

Conceptual Design:

- The botanical garden with core zone having key components including Seed Bank Composition center, Ornamental species lawn Aquarium for aquatic species, Indigenous species block, Cacti plants block, Medicinal plants block, Exhibition Lawn, Green House and others.
- Public use zone with key components including information center, toilet block, administration block, monitoring and surveillance center.

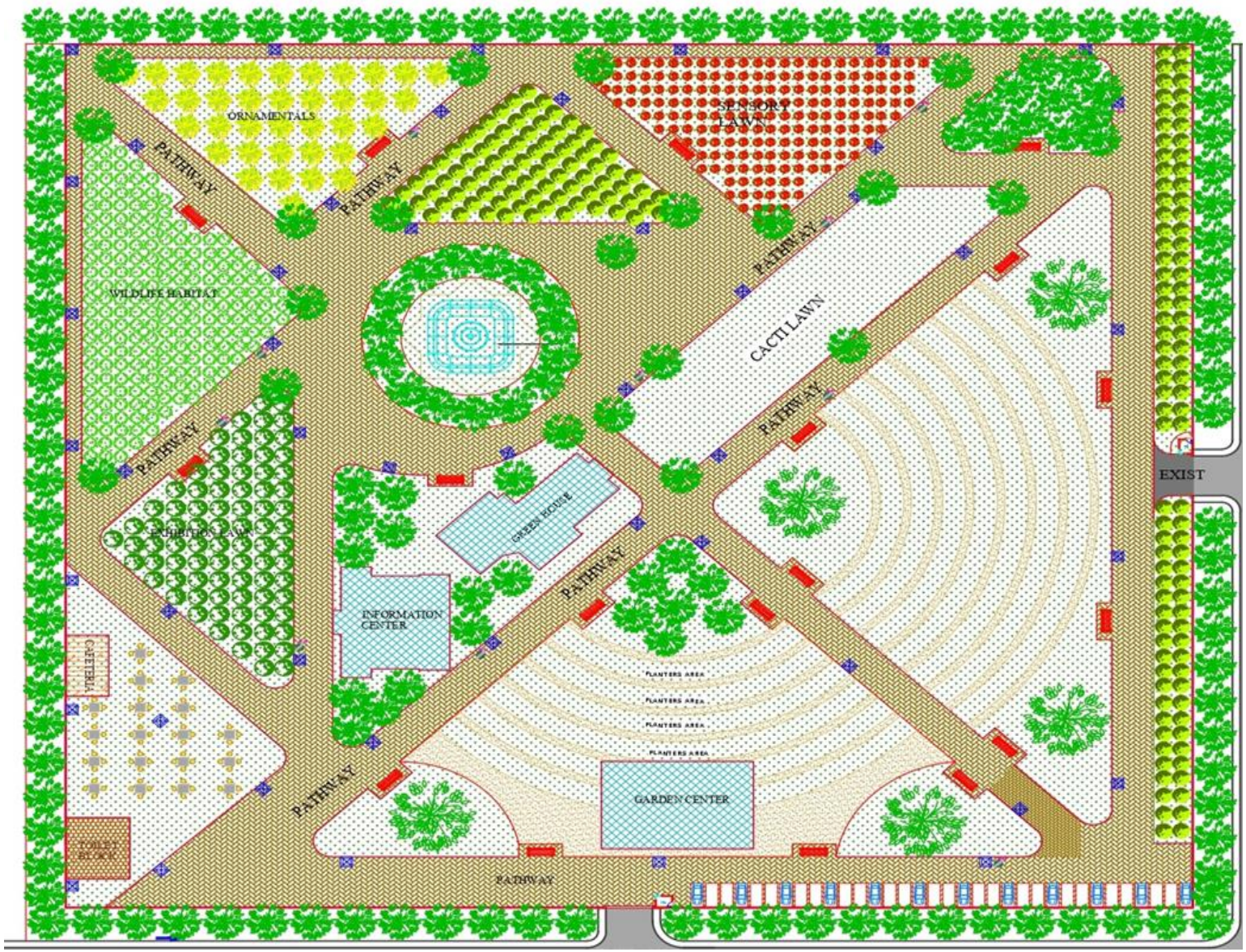


Figure 47: Conceptual Design for Botanical Garden

6.3.10. PROJECT 10: Agro Canopy Forest

The socialization of forestry through the integration of trees on farm land or farming on forested areas is the main objective of agro-canopy forest. The agro-canopy is the most practiced and effective approach in developing countries where the forest cover is comparatively less than required. The integration of tree on farm land, offer diverse range of advantages, including better soil fertility, increased water retention, decreased soil erosion, and increased revenue diversification for farmers. By directly benefiting local people and encouraging their involvement in conservation efforts, social forestry initiatives seek to engage them in the planting of trees and management of forests. Agro-canopy forest along crops periphery protect crops against wind flow ten times more than tree height through breaking wind pressure and lowering the risks of crop loss.

Estimated Cost:

Sr. #	Proposed Location	Description	Unit	Qty	Rate (Rs)	Amount (Million)
1	Agricultural & Forest Land around the Urban Settlement in DG Khan Forest Division – 25 Av. Km	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	11,250	550.0	**6.2**
2	Agricultural & Forest Land around the Urban Settlement in Muzaffargarh Forest Division – 50 Av. Km	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	22,500	550.0	**12.4**
3	Agricultural & Forest Land around the Urban Settlement in Rajanpur Forest Division – 25 Av. Km	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering completes in all respect.	No's of Plants	11,250	550.0	**6.2**
					Total Amount	**24.4**

Conceptual Design

- The plantation design is to plant trees along periphery of farm land.
- The proposed species should be indigenous and environment friendly.
- Some of planting should have fruiting tree species to attract the avifaunal diversity of the region.

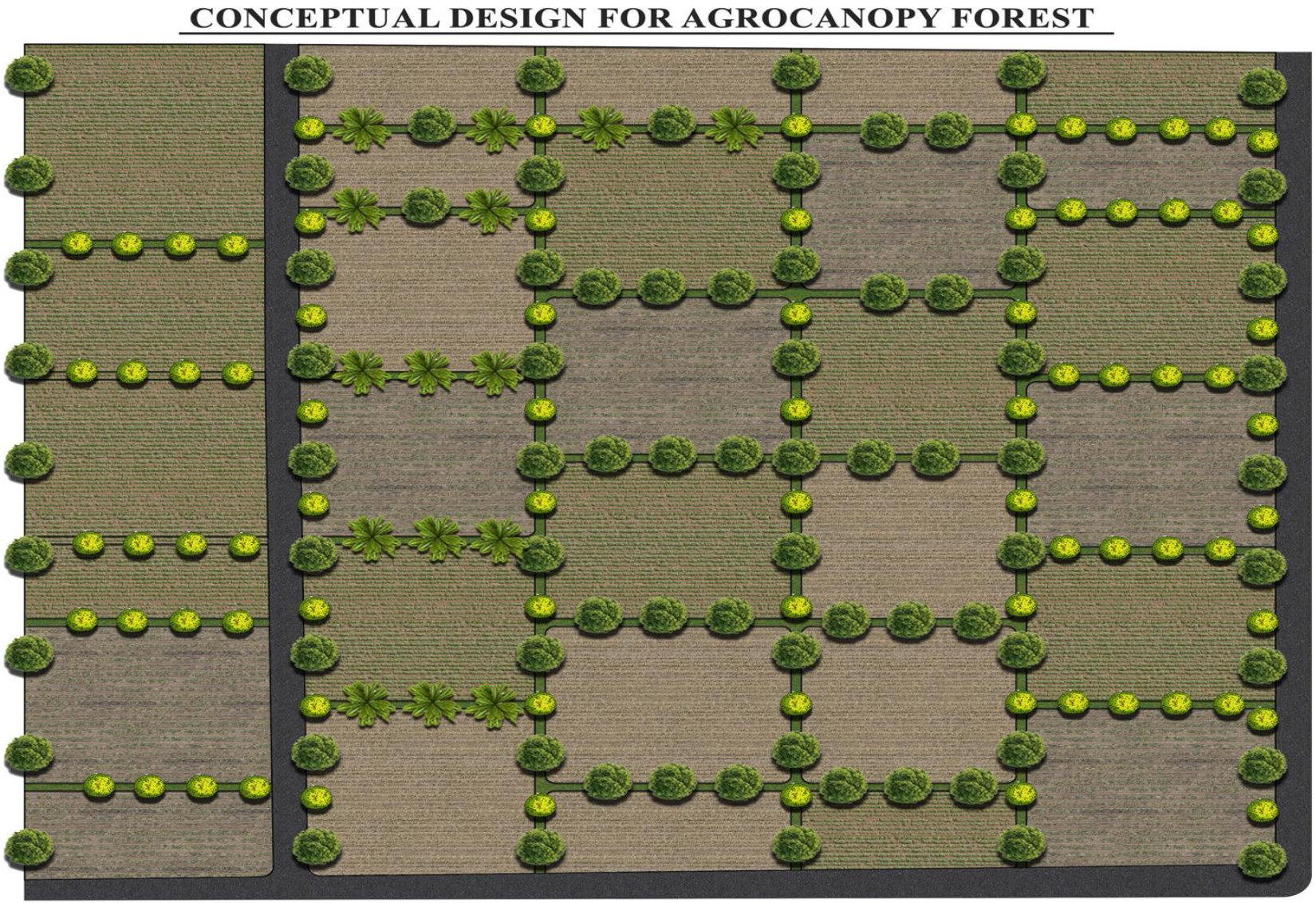


Figure 48: Conceptual Design for Agro Canopy Forest

6.3.11. PROJECT 11: Forest Sapling Reserve

In order to reforestation, forest regeneration and afforestation in any areas to increase tree cover, seedlings and saplings availability are the basic need. Therefore, Forest sapling reserve are essential to raise and germinate native species in their native soil and habitat. As a result, seedlings and saplings are protected from pre- and post-threats from replanting and sapling translocation. Additionally, these areas serve as a hub for the development, study, propagation, and care of a variety of tree species. The forest sprouting reserve will serve the following objective:

- Improve sapling growth of slow growing Plant Species.
- Produced diseased Free sapling.
- Raised Stock for Reforestation and afforestation.
- Increase vigour and viability by lower competition.
- Improves environment stability

Cost Estimate

Sr. #	Proposed Location	Description	Unit	Qty	Rate (Rs)	Amount (Million)	Amount with 5% PST / 2%Conti
1	Muzaffargarh (30.072, 71.132) – 4 Acres	Earth Work for digging of trenches making of pits and ridges, kacha bands etc. Included cost of collection/ purchase of seeds, cuttings etc. Sowing/ dibbling of seed or cutting. Also cost of dreshi & watering complete in all aspects.	sft	174,240.0	75.00	**13.06**	**14.0**
2	Layyah (31.156, 71.2094 – 2 Acres	Earth Work for digging of trenches making of pits and ridges, kacha bands etc. Included cost of collection/ purchase of seeds, cuttings etc. Sowing/ dibbling of seed or cutting. Also cost of dreshi & watering complete in all aspects.	sft	87,120.0	75.00	**6.5**	**7.0**

	Rajanpur (29.705, 70.418) – 5 Acres	Earth Work for digging of trenches making of pits and ridges, kacha bands etc. Included cost of collection/ purchase of seeds, cuttings etc. Sowing/ dibbling of seed or cutting. Also cost of dreshi & watering complete in all aspects.	sft	217,800.0	75.00	**16.3**	**17.5**
						Total Amount	**38.5**

Conceptual Design

- The bed and pocket sowing techniques can be used for effective growth of mixed indigenous species.
- The ornamental plant species can be raised through cutting of plants to improve the health of plants and enhanced the aesthetic quality of flowering plants.
- The gradual thinning and removal of weed species for better growth of native seedling species.

Figure 49: a) Bed Sowing b) Pocket Sowing

Figure 50: Conceptual Design for forest Sprouting Reserve

6.3.12. PROJECT 12: Dry Afforestation

Dry afforestation is referring to establishing and maintaining plantation in arid and semi-arid areas, where the availability of water is serious problems and plantation raised through seed dispersal on rain water. Dry afforestation helps to enhance the carbon sequestration, mitigate the climate change impact, conserve native biodiversity, reduced desertification, and restore degraded forest lands. The implementation of effective water management techniques and the selection of drought-resistant tree species, it can establish resilient and sustainable forest ecosystems in regions with infrequent rainfall.

Cost Estimate

Sr. #	Proposed Location	Description	Unit	Qty	Rate (Rs)	Amount (Million)
1	Layyah Forest Division – 100 Acres	Providing and spreading of seeds including the cost of pitting, digging, complete in all respect.	Acres	100	45000.0	**4.5**
2	Muzaffargarh Forest Division – 150 Acres	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	Acres	150	45000.0	**6.8**
3	Rajanpur Forest Division – 100 Acres	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	Acres	100	45000.0	**4.5**
					Total Amount	**15.8**

Conceptual Design

- The development of U and V shape water carriages to collect the rain water.
- The dispersal of mixed indigenous seed species resilient to water scarcity and harsh environment.
- The dispersal of native wild grasses seed through seed ball and direct dispersal to promote the germination right after the rainfall.

Figure 51: Dry Afforestation and Seed Dispersal

6.3.13. PROJECT 13: Urban Park Complex - Environmental Recovery of Stretch Along Railway Line Muzaffargarh

Urban parks are seamlessly integrated into cityscapes. These advantages include improved health, stronger community connections, and enhanced resilience to climate impacts. It delivers environmental benefits such as improved air quality, mitigation of the urban heat island effect, and effective management of wastewater and stormwater. It fosters the community engagement and social cohesion by establishing communal green spaces that cultivate a sense of belonging and pride among residents. The 1.8 km stretch along the railway line in New Basti Talkot, Muzaffargarh, requires rehabilitation urgently due to its current state as bare land, which is contributing significantly to fugitive dust emissions and the formation of wastewater ponds.

Proposed Site:

- New Basti Talkot
- Coordinates: Lat: 30.8553 Lon: 71. 1867

Figure 52: Proposed Project Site

Scope of work

- Development of Walkways and Children Park
- Rejuvenation of wastewater ponds
- Provision of grassy lawns
- Tree plantation
- Gazebos and Benches

Benefits:

- Improved Environmental Conditions
- Provision of Recreational Facilities
- Land Reclamation

Estimated Cost

Sr. No	Description	Amount in PKR	Amount in Millions
1	Development of Walkways and Children Park	3,991,783	4
2	Rejuvenation of wastewater ponds	32,073,916	32
3	Provision of grassy lawns & Tree plantation	1,362,609	1
4	Provision of Gazebos and Benches	1,090,000	1
	Sub- Total Amount	**38,518,309**	**39**
	Add 2% Contingency Charges	770,366	1
	Add 5% PST	1,925,915	2
	G-Total Amount R. s	**41,214,590**	**41**

Conceptual Design

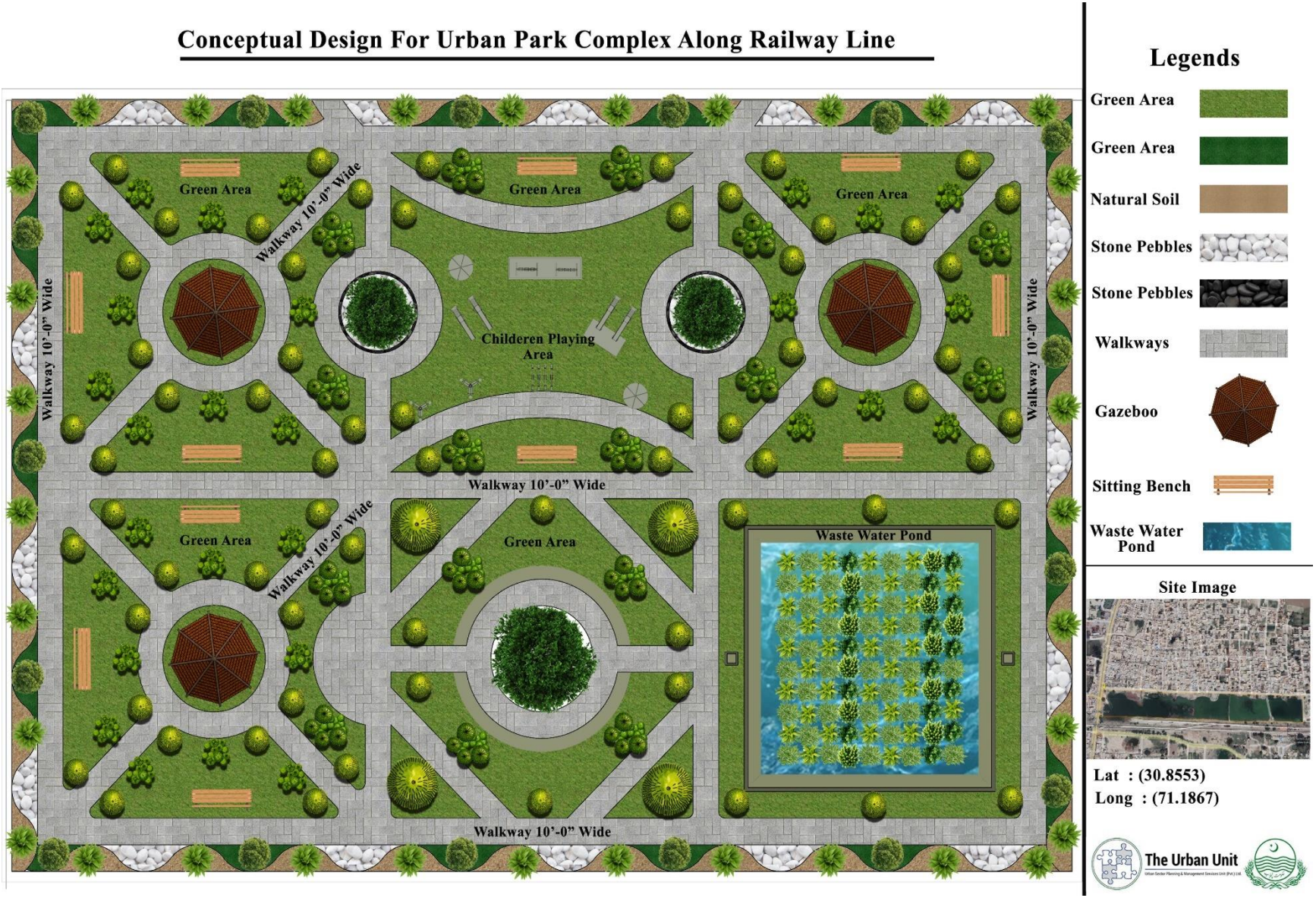


Figure 53: Conceptual Design for Urban Park Complex along Railway Line

6.3.14. PROJECT 14: Installation of Air Quality Monitoring Equipment

Nowadays, mega cities across the globe are facing major problem of deteriorating air quality which is impacting the ecosystem, human health, and economy. Megacities of DG Khan Region, like other mega cities, are also grappling with deteriorating air quality. Factors such as unplanned urbanization, industrial growth, and traffic congestion contribute substantially to air. Effective air quality monitoring is crucial for informed decision-making and addressing these pressing issues.

Air quality monitoring is an important factor in enabling effective monitoring decision-making on-air quality issues. One of the biggest challenges in air quality management is proper access to air quality data. The Pakistani government has started to respond to this air pollution challenge. The proposed project is to establish an air quality monitoring system in major hotspots of Pollutant concentration in the DG Khan Region.

Scope of Project:

The project aims to record air pollutant concentrations ($PM_{2.5}$, PM_{10}) in each district of the DG Khan Region (i.e., DG Khan, Muzaffargarh, Layyah and Rajanpur Districts).

Activities:

Installation of air quality monitoring equipment (US-EPA Approved BAM 1025) and low-cost sensors in hotspot areas of DG Khan Region.

Proposed Areas:

- DG Khan
- Muzaffargarh
- Layyah
- Rajanpur

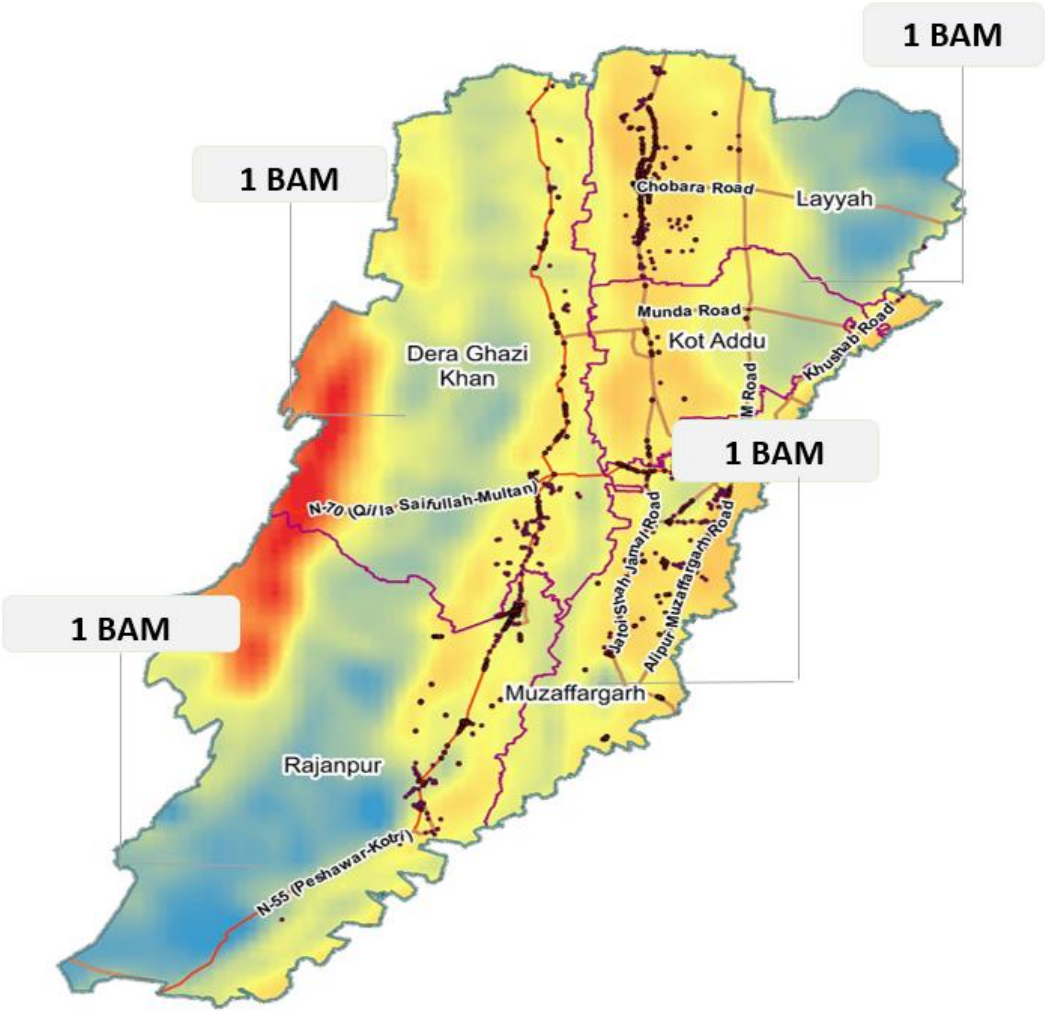


Figure 54: Proposed Areas for Installation of Air Quality Equipment in DG Khan Region

Figure 55: Air Quality Equipment's

6.3.15. PROJECT 15: Construction of Stormwater Retention Pond with Constructed Wetland in Iqbal Park DG

Constructed wetlands and stormwater retention ponds are crucial components of sustainable stormwater management systems, designed to improve water quality, reduce urban flooding, and support ecological functions. Constructed wetlands remove pollutants from runoff via vegetation uptake, retention, and settling. Stormwater ponds temporarily store runoff, fostering wetland plant growth. These systems should complement other practices like rain gardens and permeable pavements to maximize effectiveness.

Advantages/Benefits:

- Relatively low maintenance costs.
- High pollutant removal efficiencies for soluble pollutants and particulates.
- Removes nitrogen, phosphorus, oil and grease
- Enhances the aesthetics of a site and provides recreational benefits.
- Provides wildlife habitat.

Existing Condition

Currently, DG Khan lacks a proper sewage treatment plant, resulting in wastewater being dumped into water bodies or collected in open ponds. During a field visit, the team found a vast open pond on the outskirts of the city, named Iqbal Park Ground, covering an area of 8 acres. This open space receives and retains stormwater and sewage from adjacent urban areas. The pond contains high levels of pathogens, bacteria, and excessive nutrient loads, which lead to algae blooms, uncontrolled mosquito breeding, and runoff from adjoining roads. This situation poses significant health risks and leads to groundwater contamination problem.

Figure 56: Existing Condition of Urban flooding and sewage pond in Iqbal Park DG Khan

Location of Proposed Project

- Coordinates: 30.064950 N, 70.628076 E
- Area 8 Acre

Figure 57: Proposed Constructed Stormwater Wetland in DG Khan

Elevation Profile

- Area of Pond=8 Acre
- Elevation = 408 ft
- Avg. Slope = 1.7 %

Figure 58: Elevation Profile of Proposed Stormwater Pond

Key Design Considerations:

1. Pretreatment Component: Pretreatment features remove coarse sediment particles by settling.
2. Inlet Control Component: it convey and control the flow of stormwater from the contributing catchment area to retention pond.
3. Retention Pond: it temporarily hold stormwater runoff until it can either evaporate, or used by plants.
4. Vegetative wetlands: Plants provides wildlife habitat, and helps to stabilize soil. The surface area of stormwater wetlands should make up at least 1 percent of the area draining to the practice..
Proposed Species for Wetland:

- *Acacia modesta* (Phulai)
- *Acacia nilotica* (Keekar)
- *Ziziphus nummularia* (Beri)

6. **Outlet Control Component: it** Controls the rate of discharge and limiting water surface elevations during various storm events.

Estimated Cost:

Proposed Schemes	Scope	Cost Million
Constructed Stormwater Wetland Construction of Stormwater Retention Pond with constructed Wetland in Iqbal Park DG khan, Total Area 8 Acre	• Stormwater Retention Pond with Constructed wetlands including inlet & outlet structure, earthworks and vegetation.	36.145

Conceptual Design

Figure 59: Conceptual Design for Stormwater Retention Pond and treatment wetland

6.3.16. PROJECT 16: Conversion of Traditional Fish Hatchery to Sustainable Biofloc System (Zero Liquid Discharge Technology) - DG Khan

Sustainable Bio-floc Technology (SBFT), considered a novel "blue revolution," continuously recycles and reuses nutrients in the culture medium, benefiting from minimal or zero water discharge. SBFT is an environmentally friendly aquaculture technique based on in-situ microorganism production.

Traditional fish hatcheries often face environmental challenges, including water quality degradation and secondary pollution. Converting these systems to Sustainable Biofloc Technology (SBFT) offers an innovative solution, ensuring nutrient recycling, minimize water usage and discharge, reduce pollutants and enhanced environmental control. This proposal has benefits of converting a traditional fish hatchery in DG Khan to a sustainable biofloc system.

Comparison of Traditional Hatchery & Bio-floc Technology

Sr.	Parameters	Traditional Fish Aquaculture	Sustainable Bio-floc Aquaculture System
1.	Land Requirement	High	Moderate
2.	Capital Construction Cost	Medium	High
3.	Cost of Aquaculture Feed	High	Low
4.	Power Consumption	High	Moderate
5.	Quantities of Sludge Produced	High	Low
6.	Ease of Operation and Maintenance	No	Yes
7.	Water usage	High	Low
8.	Control over water quality	Limited	High

Existing Traditional Fish Hatchery

- Coordinates: 30.066585 N, 70.742156 E
- Area: 5.8 Acre

Figure 60: Existing Traditional Fish Hatchery System in DG Khan

Proposed Sustainable Bio-floc System

Based on the above comparisons, a sustainable bio-floc fish aquaculture system utilizing Zero Liquid Discharge technology has been proposed to upgrade the existing fish hatchery in DG Khan. This modification aims to improve fish production while minimizing environmental pollution. The proposed sustainable bio-floc aquaculture system will approximately occupy an area of 5.8 acres.

Location of Proposed Project

Figure 61: Geographical Location of Proposed Fish Aquaculture System

Design Consideration

The construction phase will involve building of fish ponds or tanks with proper lining and water retention features, installing water circulation pumps, aeration devices, and filtration systems to maintain water quality and bio-floc stability. Bio-floc management practices will be implemented to promote nutrient recycling and microbial growth.

Components of Proposed Biofloc Fish Aquaculture System

The capacity of the system is decided, based on the biomass and feed rate. The basic components are;

- Filtration screens
- Breeding ponds
- Fish culture Pond
- UV light for the disinfection of the water
- Bio filter basin combined with Aeration and Membrane bio filtration

- Gravel filter to trap the sludge particles.
- Water recycling Pond to recycle the overload water
- Sludge basin to gather sludge waste.
- IOT Monitoring System

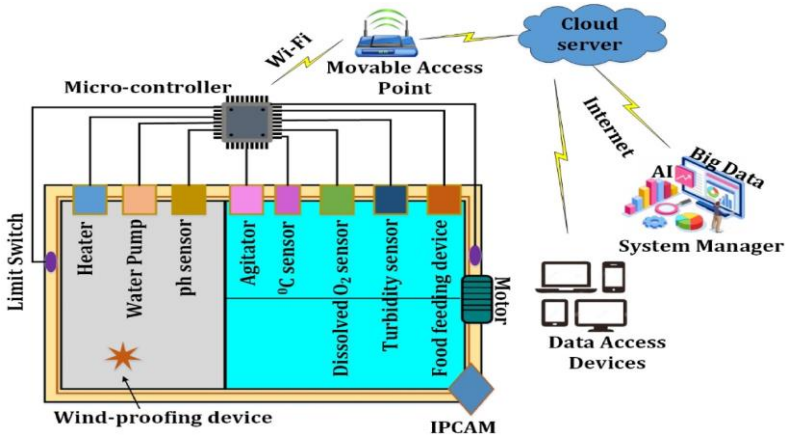


Figure 62: IOT Monitoring System of Biofloc fish Aquaculture System

Technical Specifications of Biofloc Fish Aquaculture System – DG Khan

Sr.	Component	Details
1	Area Available for Fish Aquaculture system	5.8 Acre
2	Number of Fish Tanks	7
3	Area of one tank	50 m^2
4	Tank size	8-meter diameter and 3.5-meter height (3 m water depth)
5	Water holding capacity of each tank	150 m^3 (150,000 Liter)
6	Volume of 7 tanks	1055 m^3
7	Tanks Material	Concrete & HDPE liner
8	Stocking density	80 Nos./m3 (12,000 Nos. per tank - depending on species)
9	Survival (%)	Approx. 80% (9,600 Nos. per tank)
10	% of feed	2-3% per Average Body weight
11	Duration of culture	6 months
12	Fish Production in one year	134,400 per year
13	Total Fish Production of 07 tanks	0.14 = Million/year

Rough Cost Estimation of Biofloc Fish Aquaculture System – DG Khan

Sr. No	Description	Amount (Millions)
Capital Investment		

1	Construction of Office Building (Area 1250 Sqft)	5.218
4	Seven (07) Circular Tank (8 m diameter, 3.5 m height, 3 m depth)	14.70
5	4 Rectangular Tanks	8.74
6	Two Feed Storage Room (Area 500 Sq.ft)	2.087
7	Chowkidar Hut (Area 300 Sq.ft)	1.252
10	Compound wall around Residence	7.89
11	Construction of Boundary Wall (1600 Rft)	3.00
12	Upgradation of existing Over Head Reservoir 5000 G	2.10
13	Capacity enhancement of Turbine 0.5 cusec to 1 cusec	3.40
14	provision of motor 40 hp	1.00
15	Construction of Thermo Control Laboratory (120 m2)	14.50
16	Provision of RCC drainage channel	5.00
17	Construction of Gate	1.00
18	Four (04) Blower (1 HP), Air pump and accessories	1.00
19	Transformer 300 KVA (as Alternative)	12.00
20	IOT monitoring system with unit control	7.00
	Sub- Total Amount	**84.297**
	Add Contingencies Cost (2.5%)	**2.10**
	Add PST (5%)	**4.21**
	Grand Total Amount with Contingencies and PST	**90.607**

Conceptual Design:

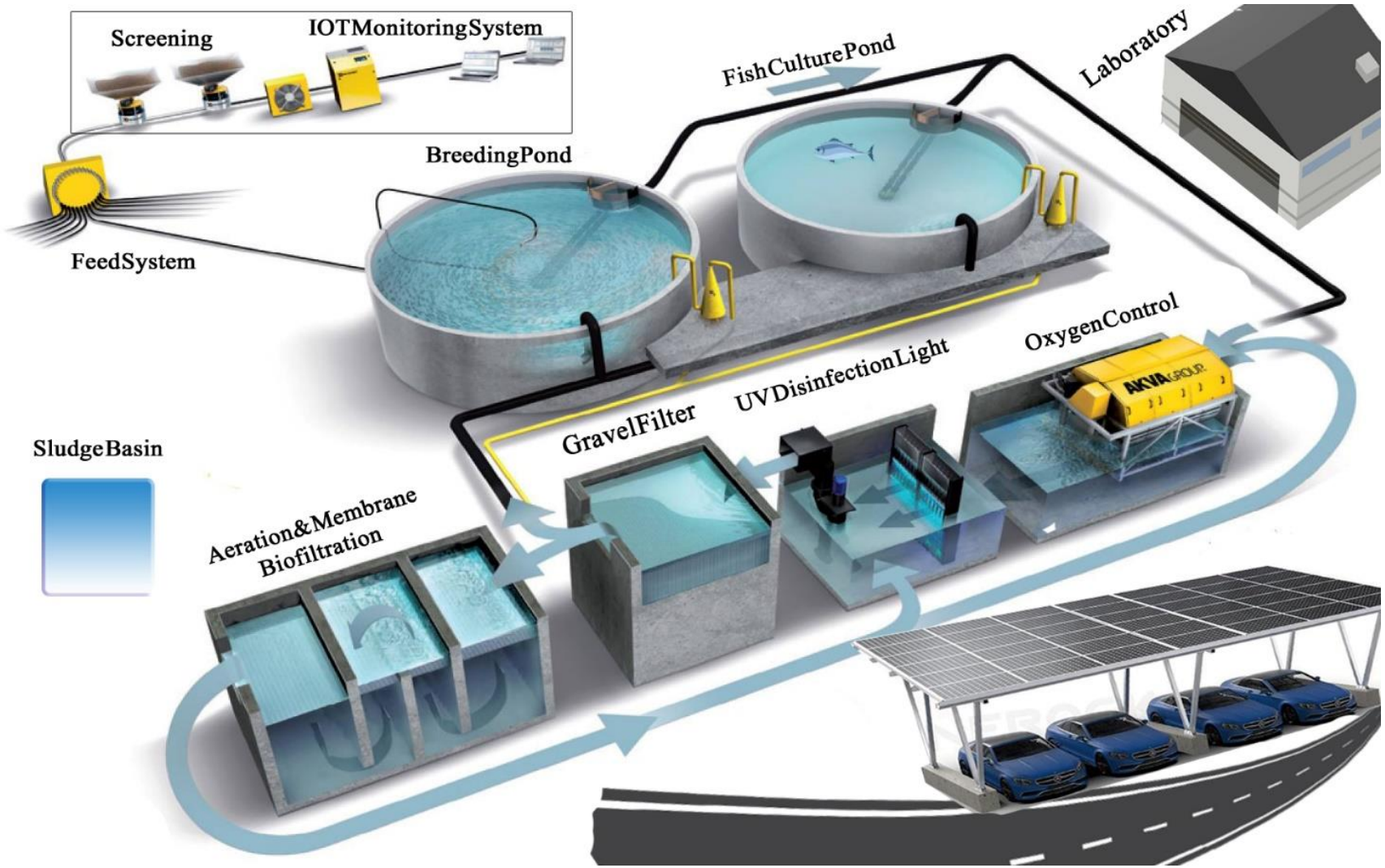


Figure 63: Conceptual Design of Sustainable Biofloc System

6.3.17. PROJECT 17: Riverine Recreational Complex at Ghazi Ghat Lake DG Khan

The proposed Riverine Recreational Complex at Ghazi Ghat Seasonal Lake in DG Khan aims to create a sustainable environment for residents and visitors. This complex will increase the natural beauty and ecological significance of the seasonal lake to promote tourism, environmental awareness, and community engagement.

Location of Proposed Project

- Coordinates: 30.065581 N, 70.804345 E
- Area: 70 Acre

Figure 64: Location for proposed Recreational complex

Key Facilities

The following Recreational facilities will be provided:

- Landscaped garden and green spaces
- Riverfront walkway and cycling trail
- Picnic spot and children play area
- Boat launching area
- Fishing spot
- Rain Garden
- Sports & recreational area
- Food and beverage outlets (e.g. cafes)
- Administration office
- Parking, Lighting and illumination
- Gazebos and Seating arrangements
- Cultural heritage site

Benefits of Riverine Recreational Complex DG – Khan

- Ecosystem Protection
- Water Quality Management
- Flood Mitigation
- Sustainable Landscaping
- Climate improvement

Estimated Cost

Proposed Schemes	Scope	Cost Million
Riverine Recreational Complex Construction of Riverine Recreational Complex on Ghazi	▸ Landscaped garden and green spaces ▸ Riverfront walkway and cycling trail	180

Ghat Seasonal Lake at Indus River, DG Khan (30.065581°, 70.804345°) Total Area 70 acre	▸ Picnic spot and children play area ▸ Boat launching and docking area ▸ Fishing spot ▸ Administration office ▸ Parking ▸ Lighting and illumination ▸ Gazebos and Seating arrangements	

Figure 65: Conceptual Design of Riverine Recreational Complex

6.3.18. PROJECT 18: Purification of Manka Canal by Integrated Interceptors and Floating Wetlands

The Manka Canal in DG Khan is a crucial waterway that faces significant pollution challenges. To address these issues and improve the canal's water quality, an integrated approach using interceptors along with vegetative floating and constructed wetlands are proposed.

Location of Proposed Project

Installation of Integrated Trash racks and interceptors with vegetative floating and constructed wetland from RD 40+000 to 50+000 (Chowk Chuhatta to Rizwan Mehboob Chowk)

Implementation Strategies:

1. Integrated Interceptors & Trash Racks: installation of Integrated Interceptors and Trash racks are a cost effective and efficient prescreening system that are installed at canal inlets and strategic locations along the canal to capture floating debris and gross pollutants.

2. Wetlands: Create constructed wetlands along the canal banks and deploy floating treatment wetlands that float on the canal surface providing root zones for nutrient uptake, enhancing water quality.

3. Microbial Consortia: Introducing beneficial bacteria and microbes into the canal to break down organic pollutants and contaminants naturally

Proposed Projects Cost Estimation:

Proposed Schemes	Scope	Cost Million
Purification of Manka Canal by Integrated Interceptors and Vegetative Wetlands Installation of Integrated Interceptors and Trash racks along with with vegetative constructed and floating wetland.	▸ 05 slots Trash Racks with frame ▸ Screen Interceptors ▸ Constructed and Floating wetlands	50.00

Construction of Floating Wetlands

A floating wetland is an engineered system that uses aquatic plants and natural processes to clean canal water through physical, chemical, and biological processes. Plants slow water flow, aiding sedimentation, and release antibiotics to kill pathogens. They also use photosynthesis, respiration, and other processes for water purification, absorbing contaminants through their roots in a method called phytoremediation.

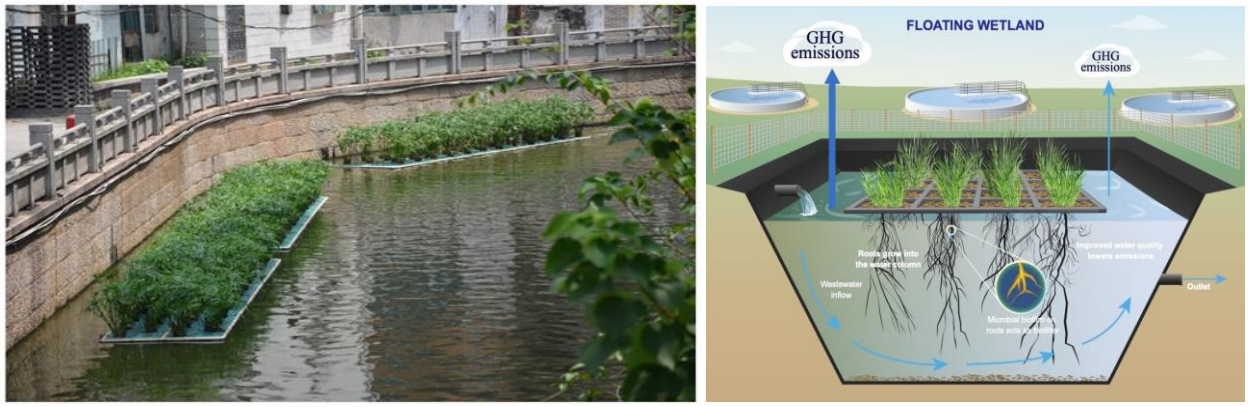


Figure 66: Conceptual Design Integrated Interceptors Trash Racks

Conceptual Design

Figure 67: Conceptual Design of Constructed, Floating Wetlands

Annexures

Annexure – A: Public Perception of Existing Environmental Issues, Green Spaces and Water Supply & Sanitation

DEMOGRAPHIC PROFILE

1.Gender: Male ☐ Female ☐ others_____

2. City/Tehsil Name

Area Name

Location Latitudes _____ Longitudes _____

3.Occupation:

Student ☐ Self Employed ☐

Gov. employee ☐ Private job holder ☐

Retired ☐ Unemployed ☐ Others _____

4. What age bracket do you belong to?

Less than 18yrs ☐ 18yrs - 25yrs ☐

25yrs - 40yrs ☐ 40yrs -60 yrs ☐ > 60yrs ☐

5. What is the latest level of education you have had?

Illiterate ☐ Primary ☐ Secondary Level ☐ High School Level ☐
University Level ☐ Religious Education ☐ Other ☐

6. In which Income Level would you categorize yourself?

☐ Low-Income Group 0-40,000/-

☐ Middle Income Group 40,000-80,000/-

☐ High-Income Group 80,000-120,000

☐ Business Class >1.5 lac

A. **ISSUES IN THE AREA**

What kind of Issues you are facing in your area?

- Poor Water Quality
- Limited Water Supply
- Sewerage Ponding
- Lack of Green spaces

- Air Pollution
- Broken / Unpaved Roads
- Solid Waste Management
- Any Other

GREEN SPACES AND PARKS

1. Any Park in the Area? Within 1-2km vicinity

☐ Yes ☐ No

Name of Park (If Yes) _____

☐ Public Park

☐ Private Park

☐ Community Park

2. Visit the Parks and Green space?

☐ Everyday
☐ Once a week
☐ Fortnightly
☐ Once a month
☐ Never

3. Distance to nearest Park

☐ ≥ 5 minutes of walk
☐ ≥ 15 minutes of walk
☐ ≥ 30 minutes of walk
☐ More than 30 minutes of walk

4. Please rate the existing condition of Park/ green spaces in your area.

☐ Excellent
☐ Good
☐ Satisfactory
☐ Unsatisfactory

WILLINGNESS TO PAY FOR GREEN SPACES

1. How important is your participation to increase/improve the green space?

☐ Not Important
☐ Important
☐ Highly important

2. How the green spaces/ parks can be increased and improved in your Area?

☐ Development of parks
☐ Greening of rooftops/ buildings
☐ Owned by Public Sector

- ☐ Handover to the Private sector
- ☐ Planting trees at the sides of roads
- ☐ Greening of vacant areas
- ☐ Providing basic infrastructure facilities
- ☐ All of the above

4. How much you are willing to pay per visit for the greenspaces/ parks of the city if implemented by the Government?

- ☐ Rs <50/-
- ☐ Rs 50/- to 100/-
- ☐ Rs 100/- to 150/-
- ☐ Any other

WATER SUPPLY:

How often do you get drinking water?

- ☐ More than once a day
- ☐ Once a day
- ☐ Less than once a day

What is your Drinking Water Source?

- ☐ Piped Water
- ☐ Handpumps
- ☐ Public Tap Water
- ☐ Bottled Water
- ☐ Filtration Plant
- ☐ Other Source_____

"Is the timing of the water supply convenient?"

- ☐ Yes
- ☐ No
- ☐ Not Available

In the past year, have there been instances when the quality of water has been poor?

- ☐ Yes
- ☐ No

IF YES then Ask

If the water is of poor quality, what do you do in these Instances?

- ☐ Go to a well
- ☐ Ask a neighbor
- ☐ Buy Bottle from a shop
- ☐ Other (Please specify_____)

Can you describe the present Taste of Tap Water?

- ☐ Brackish/Bitter (undrinkable)
- ☐ Sweet (drinkable)
- ☐ Saline (undrinkable)
- ☐ Don't know / Haven't noticed

Is Tap water smell acceptable?

- ☐ Yes
- ☐ No
- ☐ Somewhat

Is there any history of your family member getting sick from using tap water?

- ☐ Yes
- ☐ No
- ☐ Somewhat

What is your satisfaction level with existing Water Supply services?

- ☐ Highly Satisfied
- ☐ Satisfied
- ☐ Not Satisfied

SANITATION:

What is a system of sewerage in your area at the user's end i.e. outside the house (tertiary level)?

- ☐ Unlined or Katcha Drains
- ☐ Lined or Pacca Drains
- ☐ Sewers
- ☐ Sump pit
- ☐ Disposal in adjacent areas
- ☐ Others: _____

Have you observed any sewage ponding in the area?

- ☐ Yes
- ☐ No
- ☐ Sometimes

Have you observed any water ponding after a rainfall?

- ☐ Yes
- ☐ No
- ☐ Sometimes

If yes then for How many days it stays on the roads/ areas?

- ☐ <1 day
- ☐ >2 days

- ☐ >3-4 days
- ☐ >one week

Ultimate Disposal of Sewage?

- ☐ Nallah
- ☐ Piped Sewers
- ☐ Open Drains
- ☐ Canal
- ☐ Others

What is your satisfaction level with existing Sewerage services?

- ☐ Highly Satisfied
- ☐ Satisfied
- ☐ Not Satisfied

WILLINGNESS TO PAY FOR WATER SUPPLY & SANITATION:

How important is your participation to improve the Sanitation and Sewerage Services?

- ☐ Not Important
- ☐ Important
- ☐ Highly important

How much Water Supply & Sewerage bill have you received per month?

- ☐ < 100
- ☐ 200-500
- ☐ 500-1000
- ☐ More than 1000
- ☐ No bill

How much you are willing to pay for the improved services of Water Supply & Sewerage services in your area?

- ☐ 100
- ☐ 200-500
- ☐ 500-1000
- ☐ More than 1000

In your opinion, which needs the most attention in your Area to improve the environment? (Select Three)

- ☐ Air Quality Improvement
- ☐ Traffic Management/ Control
- ☐ Development of Recreational Areas/ Stadiums/ Playing Areas
- ☐ Water Supply and Sanitation Services
- ☐ Greening of Area/ Plantation
- ☐ Solid Waste Management

- ☐ Upgradation of Existing Parks
- ☐ Provision/ Upgradation of Sewerage Infrastructure

Any Other please specify_____

The Urban Unit

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