



**INTEGRATED SOLID WASTE
MANAGEMENT PLAN FOR RAWALPINDI
REGION**



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THE URBAN UNIT
Lahore**

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LIST OF ACRONYMS

RWMC	Rawalpindi Waste Management Company
HR	Human Resource
LF	Landfill
MC	Municipal Corporation
MSW	Municipal Solid Waste
MS	Mechanical Sweepers
MD	Mini dumpers
SWM	Solid Waste Management
SW	Solid waste
TS	Transfer Station
TPD	Ton per Day
WMC	Waste Management Company
KPI	Key Performance Indicators
TOR	Terms of Reference
RFP	Request for Proposal
EOI	Expression of Interest
CBC	Container Base Collection
DTD	Door to Door
TCs	Tehsil Council
CO	Chief Officer
MRF	Material Recovery Facility
HTV	Heavy transport vehicle
LTV	Light transport vehicle

DISCLAIMER

Solid Waste Management Sector of Urban Sector Planning and Management Sector Unit (Pvt.) Ltd. has devised this report for Rawalpindi division to clearly illustrates the current situational analysis of solid waste management practices in the region/ area that helps to design the basis for new solid waste management system for Rawalpindi Division by focusing on area dynamics, i.e., urban and rural areas. The Urban Unit has prepared this report from the perspective of “Regional Solid Waste Management Plan” in Rawalpindi Division. Maximum care and caution have been observed while developing this document.

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EXECUTIVE SUMMARY

Waste production is an inevitable outcome of human activities and requires an effective management system to prevent devastating impacts on the environment and public health. Solid Waste Management is a significant environmental and health hazard in urban areas of Pakistan. As cities' economies continue to grow rapidly, business activity and consumption patterns are contributing to a surge in solid waste quantities. In Pakistan, waste collection is sporadic, and disposal practices are inadequate. The issues¹ related to solid waste and its management in Punjab stem from the absence of a comprehensive waste management system and strategy that encompasses all aspects of governance, institutions, finance, and technology. The problems are wide-ranging and include:

- Inadequate legal and regulatory frameworks for solid waste management
- A lack of awareness among municipal residents regarding proper solid waste handling and treatment due to a shortage of experience with environmental policy and management
- Insufficient comprehensive SWM administration and institutional arrangements
- Financial and technological difficulties to build and operate waste treatment facility and equipment,
- Manpower shortage (SWM experts and municipal collectors/scavengers),
- Absence of private sector and community participations,
- Lack of reliable operational data, etc.

These issues have led to poor waste management practices, resulting in environmental degradation, public health risks, and reduced quality of life for residents. Basic urban services, including municipal refuse disposal, have been significantly overlooked in many towns and cities across Pakistan. Rawalpindi is no exception to this, with a considerable portion of its population lacking access to essential urban facilities. This neglect of basic urban services has led to the accumulation of garbage and waste in the city, resulting in environmental degradation, health hazards, and an overall decline in the quality of life for the city's residents. The need for a comprehensive waste management system in Rawalpindi is therefore urgent. The proposed plan increases the waste collection efficiency through upgradation of solid waste management resources for urban and rural areas along with intermittent waste treatment facility which enhances the quality of segregated material to obtain higher calorific values as well as increases the life of landfill site by decreasing the waste quantity reaching the landfill site. This end to end system design will help the Waste Management Company and Municipalities to make them partially self-sustainable financially.

¹ KOICA-World Bank Joint Study on Solid Waste Management in Punjab, Pakistan (2007)

Currently, the Rawalpindi Waste Management Company (RWMC) and respective municipalities are responsible for the waste management within urban areas and MCs of Rawalpindi division. The RWMC are managing the waste in an efficient way within their jurisdiction but lack human and financial resources. Furthermore, other districts of Rawalpindi division Attock, Jhelum and Chakwal don't have collection efficiencies greater than 60% and their MCs lack proper staff and machinery for solid waste management. The system has thoroughly been assessed and it was found that in order to have a successful waste management system, waste management company and municipalities should be strengthened institutionally. Additional HR and machinery are proposed for upgradation of existing SWM system in the overall Division along with business plan.

1. Introduction

There is an urgent need to strengthen Pakistan's local solid waste system. Unreliable data on the waste sector and related planning issues may lead towards low collection efficiency of the municipalities and waste management companies, resulting in environmental degradation. Therefore, efforts to provide accurate data to plan and design the waste management system in local conditions in consultation with various stakeholders. The other aspects that require urgent attention include upgrading the organizational setup with new technological interventions that can improve the waste collection and disposal system in the Rawalpindi region of Pakistan². Being the fifth-largest country in the world with a population of about 208 million, Pakistan produces 32.6 million metric tons of MSW annually. However, the progress of the SWM sector in the country is hindered by various constraints, including the need for more reliable data, the inability to design new initiatives in the industry, and the inability to implement sectoral policies. To address these challenges, an Integrated Waste Management (IWM) approach is needed, focusing on waste reduction through source segregation and recycling and recovery of recyclables to develop an efficient waste management model for low-income cities globally³.

Rawalpindi is the 4th largest city of Pakistan. It is in Punjab province and located in Pothohar region of Pakistan. Rawalpindi is in the northernmost part of the Punjab province, 275 km (171 mi) to the north-west of Lahore. Rawalpindi is also known as Pindi. Pindi is also known as twin cities along with capital Islamabad. In the 1950s, the city's economy received a boost during the building of Islamabad (1959–1969) during which time Rawalpindi served as the national capital and its population increased from 180,000 at the time of independence. It is the administrative seat of the Rawalpindi district. The total area of the city is approximately 108.8 square kilometres (42.0 sq. mi). Currently the Waste Generation rate is 0.61 kg⁴ per capita per day in Rawalpindi.

² Iqbal A, Abdullah Y, Nizami AS, Sultan IA, Sharif F. Assessment of Solid Waste Management System in Pakistan and Sustainable Model from Environmental and Economic Perspective. *Sustainability*. 2022; 14(19):12680. <https://doi.org/10.3390/su141912680>

³ Rolewicz-Kalińska, A., Lelicińska-Serafin, K., & Manczarski, P. (2020). The circular economy and organic fraction of municipal solid waste recycling strategies. *Energies*, 13(17), 4366.

⁴ Iqbal A, Abdullah Y, Nizami AS, Sultan IA, Sharif F. Assessment of Solid Waste Management System in Pakistan and Sustainable Model from Environmental and Economic Perspective. *Sustainability*. 2022; 14(19):12680. <https://doi.org/10.3390/su141912680>

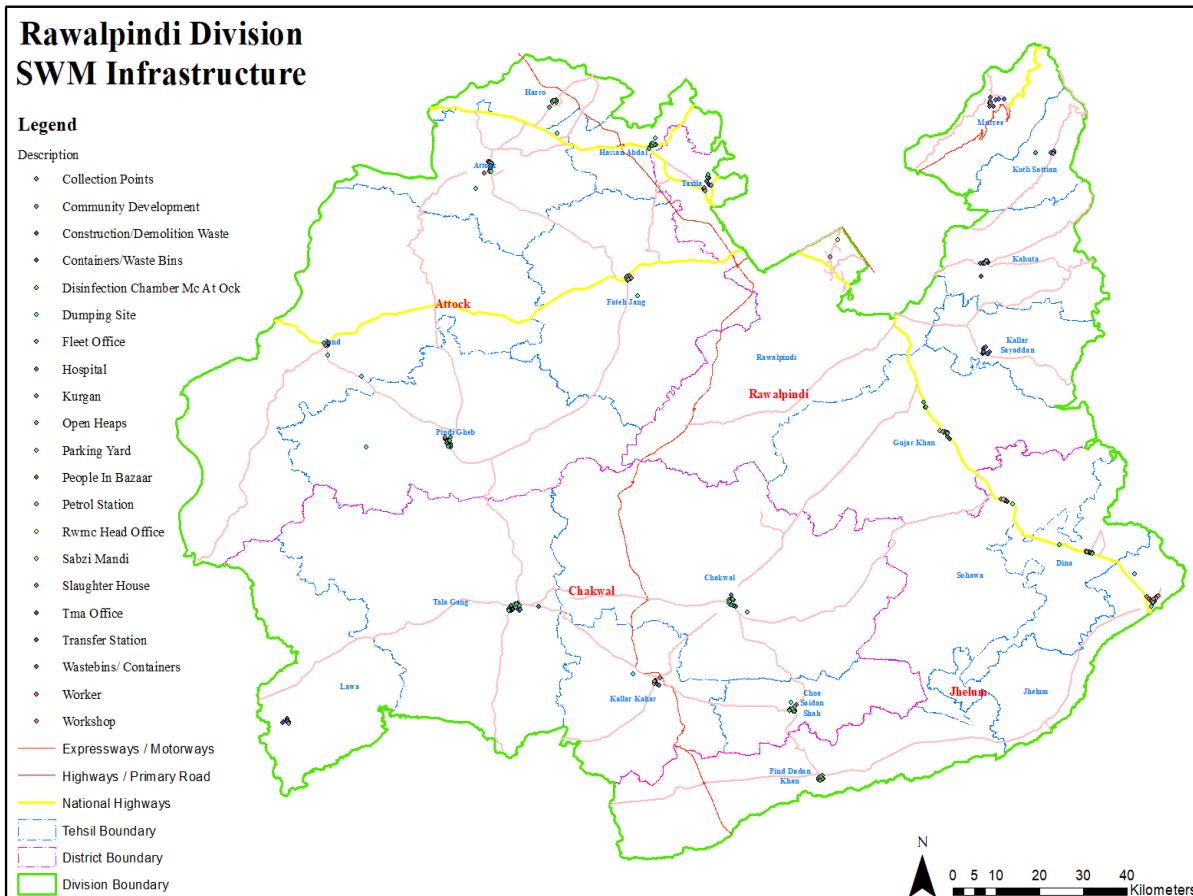


Figure 1.1: Rawalpindi Division SWM Infrastructure

OBJECTIVE

The primary objective of this project is to develop a comprehensive solid waste management plan based on field studies conducted by the SWM team of the Urban Unit in Rawalpindi Division. The study aims to identify the shortcomings of the existing waste management system in each district of Rawalpindi Division and provide a way forward for the development and implementation of an environmentally friendly and sustainable SWM model. The field studies will provide valuable insights into the current waste management practices in Rawalpindi Division, including waste collection, transportation, and disposal. The resulting comprehensive SWM plan will consider the specific needs and challenges of each district and provide practical solutions for addressing them. The development and implementation of a sustainable SWM model will be a crucial step towards improving the environment and public health in Rawalpindi Division. By promoting responsible waste disposal practices and investing in efficient waste management systems, the project aims to enhance the quality of life for residents and promote sustainable development in the region.

APPROACH

The development of a suitable and pragmatic SWM plan for the urban and rural areas of Rawalpindi Division will be based on the following principles:

1. Designing an integrated solid waste management system for both urban and rural areas of Rawalpindi Division.

2. Selecting an appropriate design through analysis of different waste management systems for waste collection and haulage, including Material Resource Recovery Facility (MRF).
3. Designing and implementing SWM systems in each district/tehsil of urban and rural areas of the Rawalpindi Division, including Rawalpindi (RWMC) and MCs of Attock , Chakwal and Jhelum.
4. Designing a sustainable primary and secondary waste collection and transportation system.
5. Recommending remediation approaches for existing unsustainable waste disposal methods.
6. Developing a capital and operational financial plan (including POL & Human Resources) and discussing revenue generation methods.

By following these principles, the SWM plan will be designed to address the specific needs and challenges of each district in Rawalpindi Division. It will provide practical and sustainable solutions for waste management, including waste collection, transportation, and disposal, and promote environmentally friendly practices that enhance the quality of life for residents while also promoting sustainable development in the region.

METHODOLOGY

The SWM team conducted Three-week field visits from August 8, 2023 to August 12th, 2023 and from August 24th to August 28th, 2023 and October 27th 2023 to October 29th 2023 to collect primary data on Rawalpindi Division's solid waste management. Meetings were held with concerned representatives from RWMC and MCs of Rawalpindi Division to introduce them to the master planning project and to address their issues and incorporate them into the planning stage to strengthen their existing solid waste management system. The team visited and evaluated important SWM sites, such as transfer stations, temporary collection points, existing dumping sites, workshops, and parking lots. Primary data was collected on current human resources, equipment, expenditure, population, daily waste generation, and existing SWM machinery. Secondary data was collected from previous SWM studies, including SWM regional plans and available data from respective MC offices and official websites. The team gathered both types of data, which were used to identify gaps in the existing SWM systems of respective cities. The team also took coordinates of existing SWM infrastructure/sites for the mapping of existing SWM infrastructure in each city. The primary and secondary data collected were used to calculate the additional resources required in each district for efficient and sustainable waste management operations. Based, on collected data SWM plan is devised separately for urban and rural areas of Rawalpindi division and resources are allocated accordingly.

The rural model is comparatively simple and economical while the model proposed in urban areas are more advanced where modes of primary and secondary collection is done using modern techniques. Door to door collection is suggested at primary level using mini tippers and hand carts. Secondary collection is done using compactors of different capacities. In rural area storage of waste is suggested in drums and trolleys; secondary collection is done using

loader rikshaws. Whereas in urban areas storage is suggested in best suitable waste containers of different capacities designed for this purpose and transfer stations are also suggested before final disposal to the landfill/ dumping site. Open plots clearance is provided using loader and trolleys where waste is indiscriminately dumped by the residents of the area. Proposed waste management model will also prevent choking of drains due to waste in monsoon season and reduction of vector borne diseases. Moreover, a material recovery facility is also proposed in Rawalpindi city for treatment of solid waste before final disposal. Propose model in urban and rural areas of Rawalpindi division are depicted in figures below:

The tehsils of each districts in Rawalpindi division are as under:



Figure 1.2: Proposed SWM model for Urban Areas

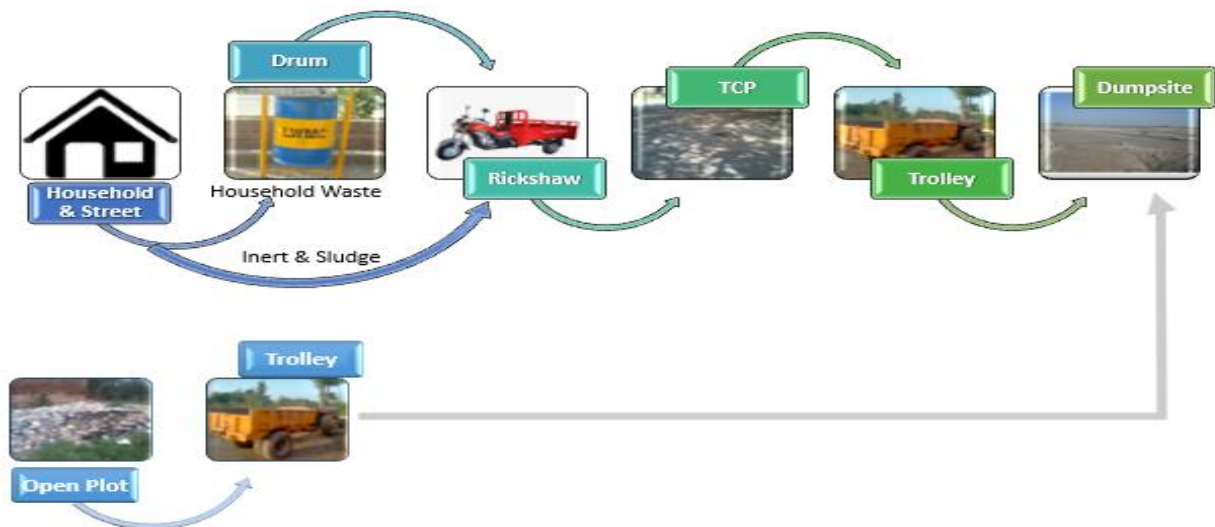


Figure 1.3: Proposed Model for Rural Areas

Table 1:1: Districts and Tehsils of Rawalpindi Division

Districts & Tehsils of Rawalpindi Division			
Jhelum District	District Chakwal	Attock District	Rawalpindi
Jhelum	Chakwal	Attock	Gujar Khan
Dina	Lawa	Fateh Jang	Kahuta
Sohawa	Kalar Kahar	Hazro	Kalar Syedan
Pind Dadan Khan	Talagang	Hassan Abdal	Taxila
	Choa Saiden Shah	Jand	Rawalpindi
		Pindi Gheb	Kotli Sattian
			Murree

Existing Organizational Structure

Municipal Corporations (MCs) and Town/Tehsil Councils (TCs) are responsible to manage MSW at District and tehsil level. Each MC is headed by Chief Officer (CO) and Town Council is headed by Municipal Officer (MO). The following chart shows the existing solid waste management structure followed in RWMC & other District Level of Rawalpindi Division.

ORGANIZATIONAL STRUCTURE OF RAWALPINDI WASTE MANAGEMENT COMPANY (CURRENT)

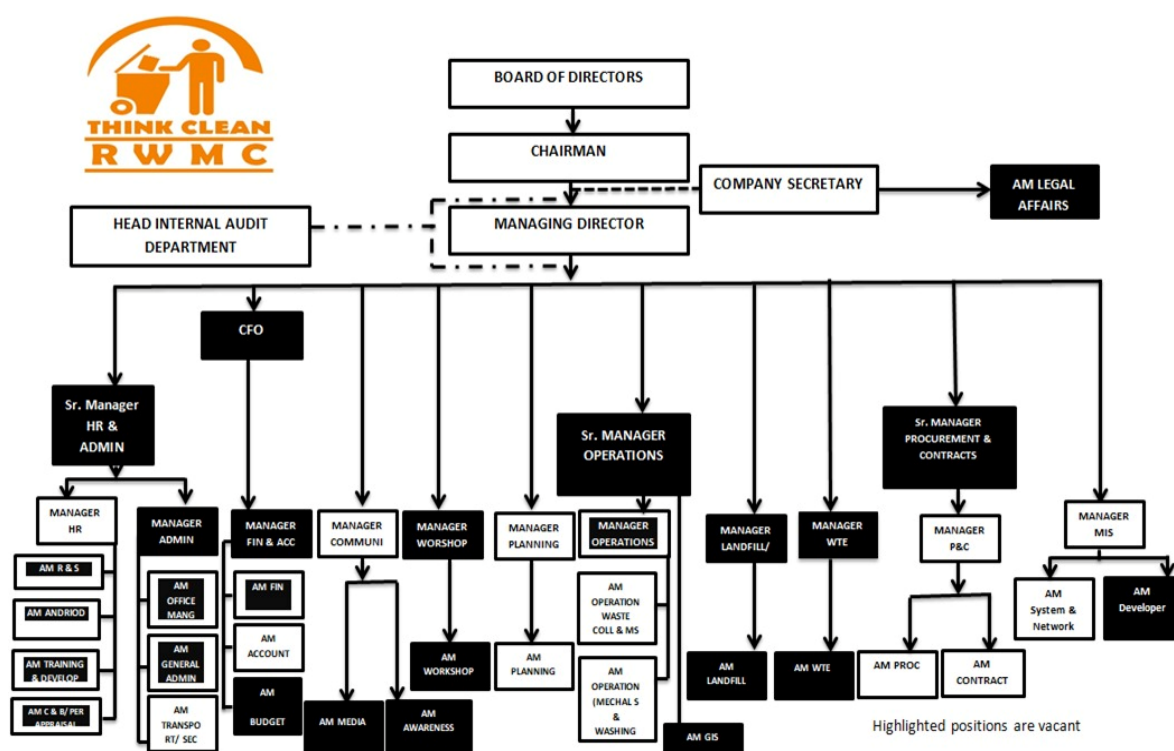


Figure 1.4: Existing organogram of RWMC

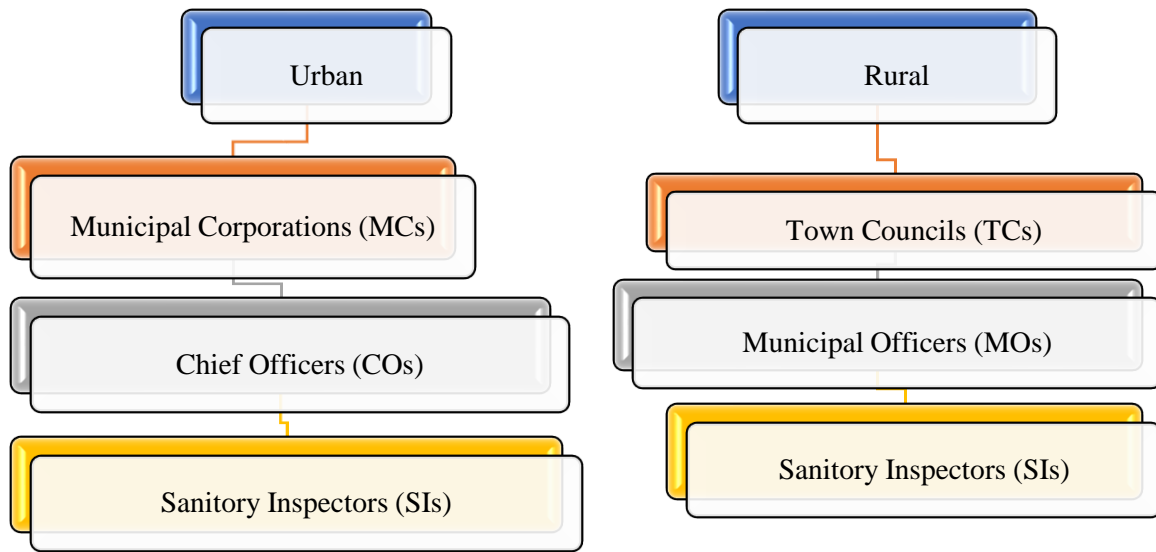


Figure 1.5: Existing Structure in Urban and Rural areas

2. Rawalpindi Division Profile

Rawalpindi, city, Punjab province, Northern Pakistan. It was the capital of Pakistan from 1959 to 1969. The city lies on the Potwar Plateau 9 miles (14 km) southwest of Islamabad, the national capital. Rawalpindi is the third largest city of Pakistan [9]. The transfer of capital city from Karachi to Islamabad in 1959 had milled the number of masses to the city for employment and business activities. The city covers approximately 153 square kilometers (59 sq m). It is located in the northern region of Punjab province, 274 km (170miles) to the North West part of Lahore district. According to estimation, the current total population of Rawalpindi city is 3,039,550.⁵ Average solid waste generation is 1.87 kg/households/day and per capita waste generation rate is 0.32kg the daily.⁶ The division consist of four districts Chakwal, Jhelum, Rawalpindi and Attock. It is one of the oldest cities in the world, the city is adorned with numerous historical sites and religious shrines. The inner city is characterized by congested narrow streets and a densely populated mix of houses, shops, and businesses. On the other hand, the outer regions have undergone significant development, with available land for further expansion.

The solid waste management in Rawalpindi Districts except Kotli sattian is handled by the Rawalpindi Waste Management Company, while in other districts, the responsibility for waste collection, transportation, and disposal lies with the respective Municipal Committees (MCs). The graph below illustrates the waste generation and population of each district within the Rawalpindi division. It is evident that the highest amount of waste is generated in Rawalpindi city, whereas the lowest amount can be observed in Jhelum district. This indicates a significant disparity in waste production across the districts.

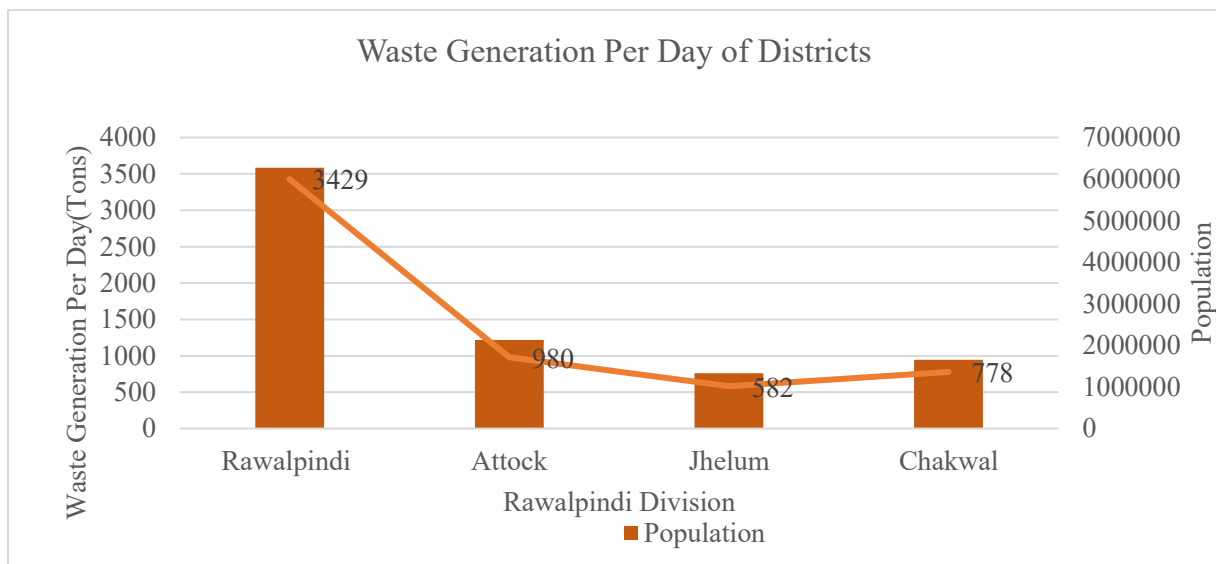


Figure 2.1: Population Vs Waste Generation in Rawalpindi Division

⁵ Ejaz, N., Akhtar, N., Hashmi, H., & Naeem, U. A. (2010). Environmental impacts of improper solid waste management in developing countries: A case study of Rawalpindi city. *The sustainable world*, 142, 379-387.

⁶ Dino, A., Mustafa, U., & Shahzad, K. MUNICIPAL SOLID WASTE MANAGEMENT-ANALYSIS OF WASTE GENERATION: A CASE STUDY OF RAWALPINDI CITY, PAKISTAN.

CURRENT RESOURCES OF RAWALPINDI DIVISION

The primary constraint faced by the Rawalpindi division in terms of solid waste management is the scarcity of resources, including financial resources, human resources, and machinery. The division relies on sanitary workers, who are often utilized as drivers, and the existing machinery is inadequate to effectively collect waste from all districts. Furthermore, the tehsils within the division lack proper infrastructure for solid waste collection, transportation, and disposal. Despite the immense potential for converting this waste into a viable source of income, the division is unable to address the solid waste management issue due to the lack of resources and political will. The figure below explains the holistic view of current waste collection and haulage arrangements in Rawalpindi.

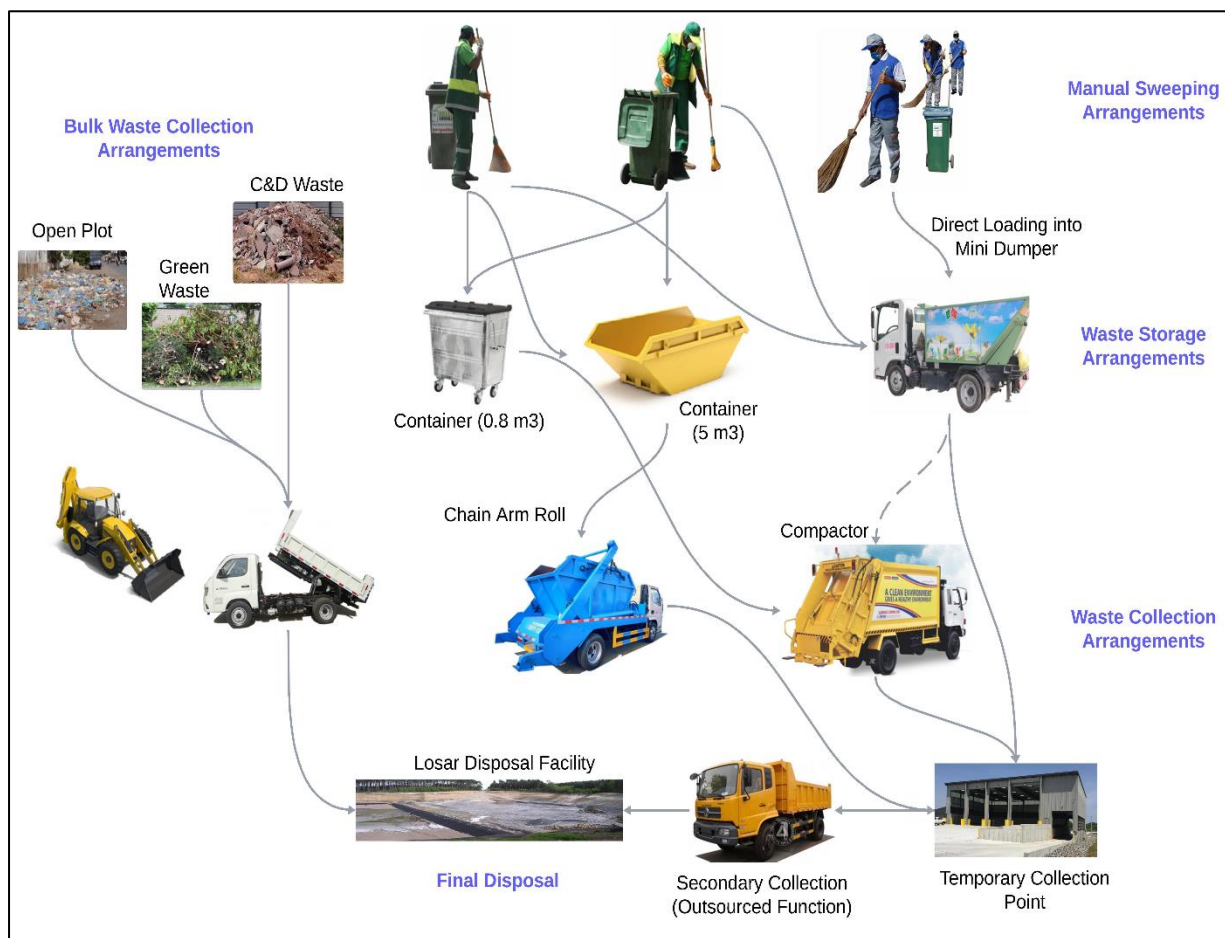


Figure 2.2: Current Waste Collection in Rawalpindi by RWMC

The table below provides an overview of the current infrastructure in the Rawalpindi division:

Table 2:1: Existing Resources in Districts of Rawalpindi

DISTRICT	TEHSIL	Tractor trolley	Compactor	Mechanical sweeper	Handcarts	Arm Roll	Rickshaw	Mini Tipper	Dumper	Shovel
JEHLUM	JEHLUM	7	4	1	95		0	6	0	0
	DINA	3	0		20		0	0	0	0
	SOHAWA	2	0		12		0	0	0	1
	PIND DADAN KHAN	1	0				3	1	1	0
CHAKWAL	CHAKWAL	5	0		25		4	0	0	0
	KALAR KAHAR	1	0		2		2	0	0	0
	TALAGANG	5	0				6	0	0	0
	CHOA SAIDEN SHAH	3	0		10		2	0	0	0
	LAWA	1	0		10		2	2	0	0
ATTOCK	ATTOCK	2	1		15		0	0	0	2
	HAZRO	3	0		62		0	0	0	1
	PINDI GHEB	4	0		7		2	0	0	0
	HASSAN ABDAL	2	0			2	1	0	2	1
	FATEH JANG	3	0		20		0	0	0	0
	JAND	3	1	1	20		0	0	0	0
RAWALPINDI	RAWAL PINDI	2	46		350	7	0	0	0	0
	TAXILA	1	1		25	2	0	7	2	0
	MURREE	0	2		45	0	0	0	0	0
	KOTLI SATTIYAN	2	0		15	0	2	0	0	0
	KALAR SYEDAN	1	1		15	1	0	1		1
	KAHUTA	1	1		12	1	0	0	0	0
	GUJAR KHAN	1	1		83	2	0	0	0	0

3. RAWALPINDI DISTRICT⁷:

Rawalpindi District, located in the Punjab province of Pakistan, holds significant historical, cultural, and strategic importance within the region. With a rich heritage dating back centuries, the district encompasses a diverse landscape, incorporating urban centres, rural areas, and historical landmarks. As one of the most populous districts in the province, Rawalpindi is known for its vibrant communities, bustling markets, and a blend of traditional and modern lifestyles.

Rawalpindi District is situated in the northeaster part of the Punjab province in Pakistan. Geographically, it is positioned between 33.6054° N latitude and 73.0433° E longitude. The district is bordered by various neighbouring districts, including Attock to the north, Jhelum to the northeast, Chakwal to the west, and Islamabad Capital Territory to the southeast. Additionally, it is located adjacent to the nation's capital, Islamabad, and serves as a significant gateway to the northern areas of Pakistan, making it an important transit and logistics hub for regional trade and transportation. The district's strategic location near major highways and transportation networks further enhances its significance as a key commercial and economic centre in the region.

In addition to its commercial significance, Rawalpindi District is renowned for its cultural heritage and historical landmarks. The city is home to numerous architectural marvels, such as the Rawalpindi Museum, Raja Bazaar, and the Shah Faisal Mosque, attracting tourists and history enthusiasts from across the globe. The district's diverse cultural fabric is reflected in its festivals, traditional crafts, and culinary delights, offering a unique and enriching experience for visitors and residents alike.⁸

Towns of Rawalpindi are stated as

- Adiala
- Chak Beli Khan
- Chaklala, Rawalpindi
- Chakri, Rawalpindi
- Dhalla
- Nara, Rawalpindi

The road network in Rawalpindi includes key arteries such as the Grand Trunk Road (GT Road), which connects the city to other major urban centres, including Lahore to the southeast and Peshawar to the northwest. Additionally, the Islamabad Expressway provides a crucial link between Rawalpindi and Islamabad, ensuring smooth connectivity between the two cities. The Rawalpindi Ring Road, an ongoing infrastructure project, aims to further enhance the city's connectivity and reduce traffic congestion, thereby boosting regional trade and commerce.

⁷ https://rawalpindi.punjab.gov.pk/district_profile

⁸ https://en.wikipedia.org/wiki/Category:Towns_in_Rawalpindi_District

Geographic and Demographic Situation

Rawalpindi District, located in the north-eastern part of the Punjab province in Pakistan, consists of 7 tehsils and 84 union councils, covering a total area of 5,286 square kilometers. The district is home to 6 municipal committees and is known for its diverse occupations, with a significant portion of the population employed in civil services, armed forces, and various government positions. The literacy rate in the district stands at 70.5%, reflecting a commitment to education and knowledge acquisition among its residents. With its strategic geographic location, vibrant road networks, and cultural significance, Rawalpindi District continues to play a pivotal role in the economic, social, and administrative landscape of Pakistan.

It includes the tehsils;

- Rawal pindi
- Taxila
- Murree
- Kotli sattian
- Kalar syedan
- Kahuta
- Gujar khan

Population⁹:

In 2017 population of Rawalpindi district was 5,402,380. 2,736,180 were male and 2,665,089 were female. 2,396,672 (44.36%) lived in rural areas and 3,005,708 (55.64%) lived in urban areas. In the divided district, Rawalpindi district had 816,577 households and a population of 5,050,068. Rawalpindi now has a sex ratio of 975 females per 1000 males and a literacy rate of 82.18% - 87.66% for males and 76.61% for females. 2,826,264 (55.96%) lived in urban areas. 1,162,962 (23.03%) were under 10 years of age.

Health and Education Facilities

The district had a total of 4,279 teachers at the primary level, 3,129 at the middle school level, 6,516 at the secondary level, and 1,155 at the higher secondary level. Out of the total number of teachers, 9,788 were female, and 5,291 were male. However, despite the notable educational infrastructure, the data highlighted concerning learning outcomes. Approximately 24% of Class 2 students were unable to read a story in Urdu, 26% struggled to read a sentence in English, and 46% of Class 5 students faced challenges with basic two-digit division. Additionally, the district experienced an 8% dropout rate at the primary school level.¹⁰

⁹ "District Wise Results / Tables (Census - 2017)". www.pbscensus.gov.pk. Pakistan Bureau of Statistics.

¹⁰ "Rawalpindi, Punjab". Alif Ailaan. Retrieved 3 March 2016

DETAILS OF HEALTH FACILITIES ARE AS FOLLOWS:

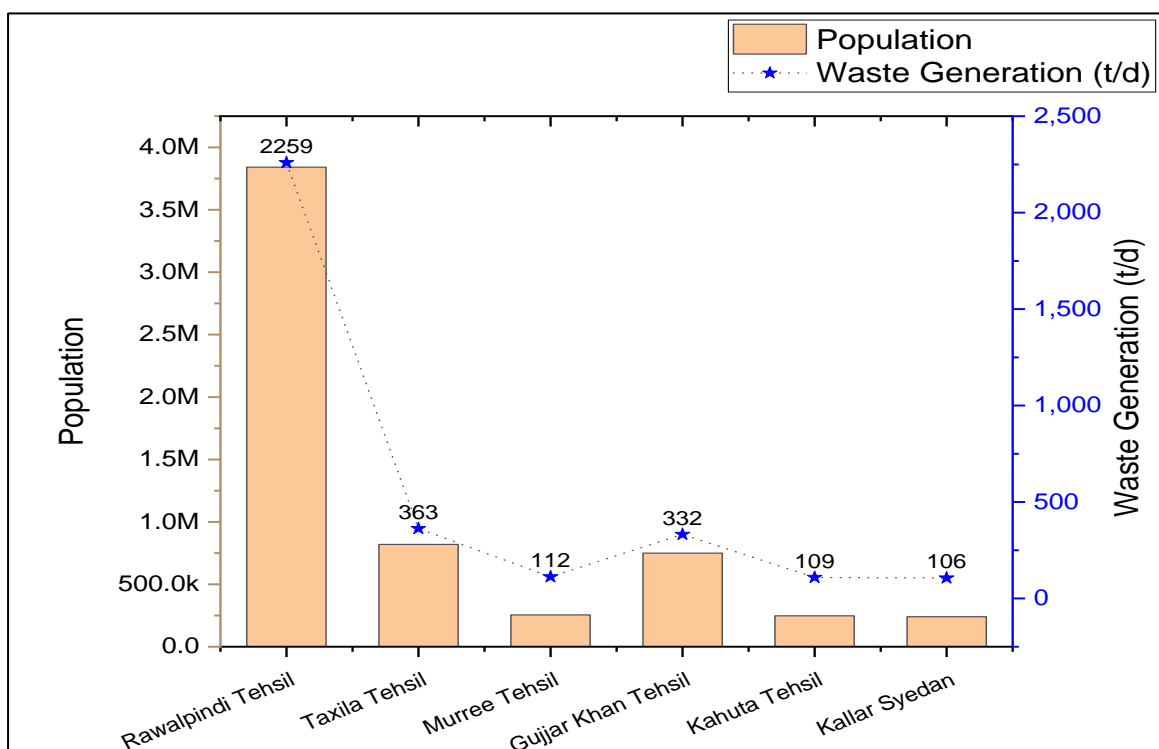
Table 3.1: health facilities in Rawalpindi

Type of Health Facility	Number of Facilities
DHQ (District Headquarters Hospital)	1
THQs (Tehsil Headquarters Hospitals)	6
RHCs (Rural Health Centers)	8
Dispensaries	6
Mother & Child Health (MCH) Centers	6
BHU (Basic Health Units)	98
GRD (General Referral Dispensaries)	6

WASTE GENERATION:

Waste generation of Rawalpindi district has been calculated from the above-mentioned population. By conducting field visits and analysing the quantity of waste generated on a real-time basis, the waste generation rate (WGR) of 0.55 kg/cap-day is taken for urban areas of Rawalpindi. By using this WGR, the calculated waste generation is 3285 tons/day of 2023 for six tehsils of Rawalpindi District in which MSW generation is taken as 70% and bulk waste is taken as about 30% of total solid waste generation. Details of tehsils are as follows; Rawalpindi, Gujar Khan, Kalar Syedan, Kahuta, Kotli Sattian, Murree and Taxila. The amount of waste generated in each tehsil is proportional to its population as depicted in figure below.

Figure 3.1: Population vs Waste Generation in tehsils of Rawalpindi



In Rawalpindi District Rawalpindi Tehsil is the highest waste producing tehsil/city among all the tehsil with the largest population cap in the district as well.

CURRENT SWM INFRASTRUCTURE IN RAWALPINDI DISTRICT:

The Rawalpindi district comprises Seven tehsils: Rawalpindi City, Gujar khan, Kalar Sayedan, Kahuta, Kotli Sattian, Murree and Taxila. The solid waste management operations in Rawalpindi City and all tehsils of Rawalpindi district except Kotli Sattian (SWM services handled by MC) are overseen by the Rawalpindi Waste Management Company. They are responsible for managing waste in the urban areas and cover Union Councils 73 Urban UCs off all tehsils of Rawalpindi except Kotli Sattian (RWMC is providing SWM services in only urban areas of all MCs) within Rawalpindi City and all tehsils of Rawalpindi district. In the remaining tehsil Kotli Sattian the responsibility for solid waste management falls under the preview of the respective MC's.

Except Kotli Sattian one dumpsite named as Losar near Chak Beli road is utilized for the dumping of Waste from all over the Rawalpindi district. Below Given Map is showing the Transfer station in different tehsils of Rawalpindi from where waste is shifted to LOSAR Dumpsite after temporary collections.

In all the tehsil as shown in the map excluding Kotli Sattian RWMC has an office in the TMA offices of every tehsil from where all the operations are made in the tehsil for collection and transfer of waste to Transfer station and then to Losar Dumpsite.

In the below map the distance of all the tehsils from Losar is calculated and shown as follows;

Following table will show you the existing situation of Solid Waste Management infrastructure on Tehsil level which includes the following details

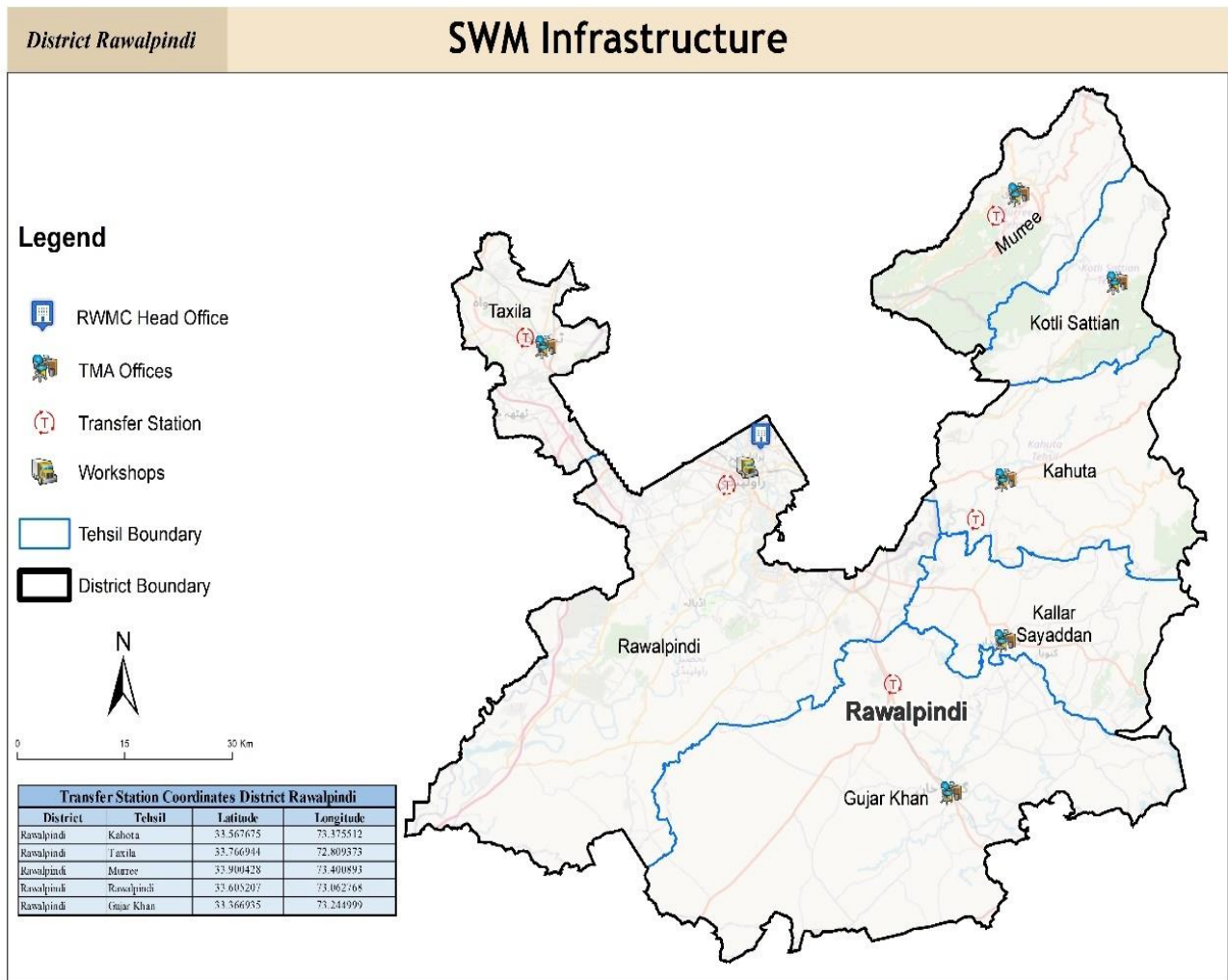


Figure 3.2: SWM Infrastructure of Rawalpindi District

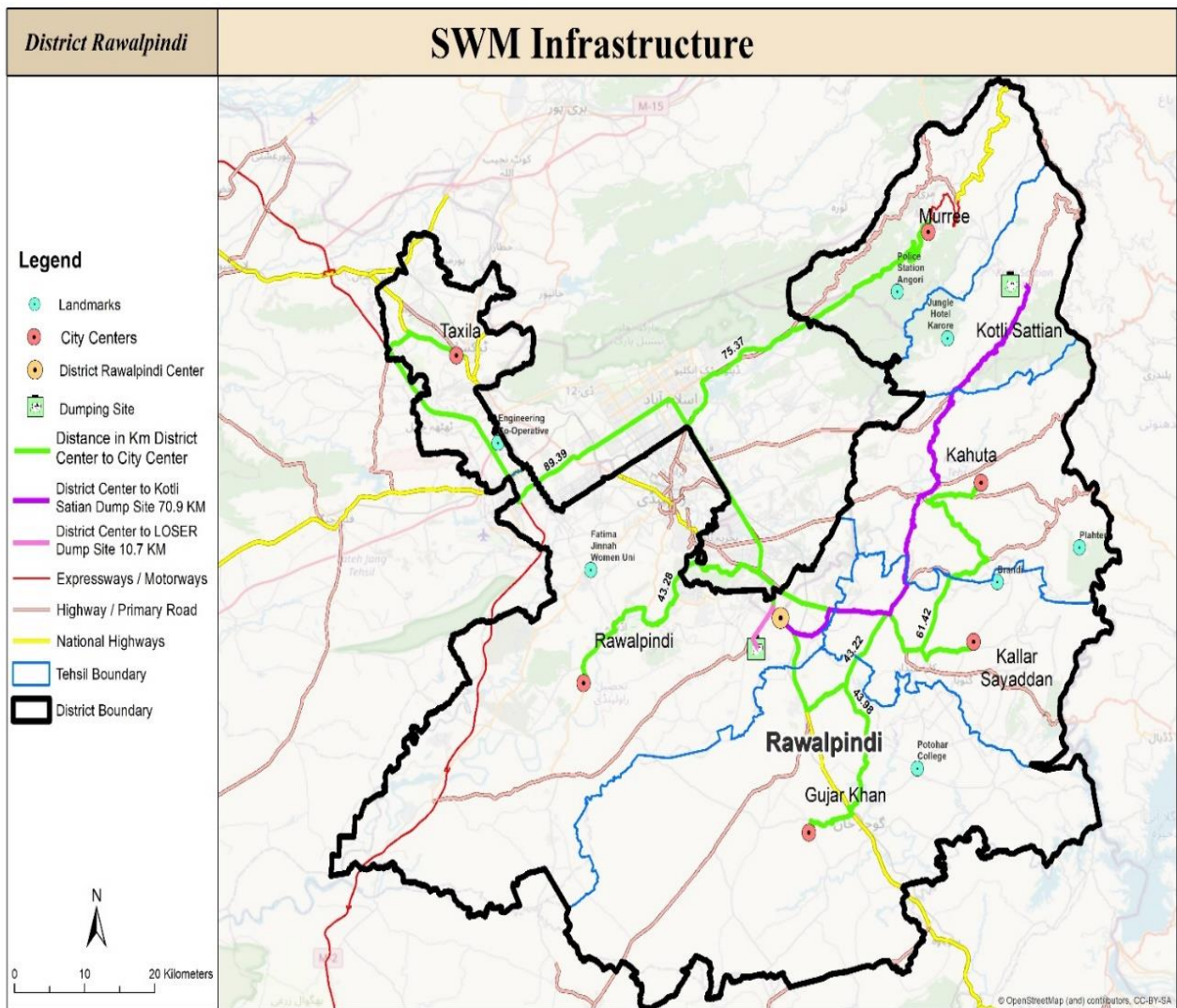


Figure 3.3: SWM infrastructure in Rawalpindi district

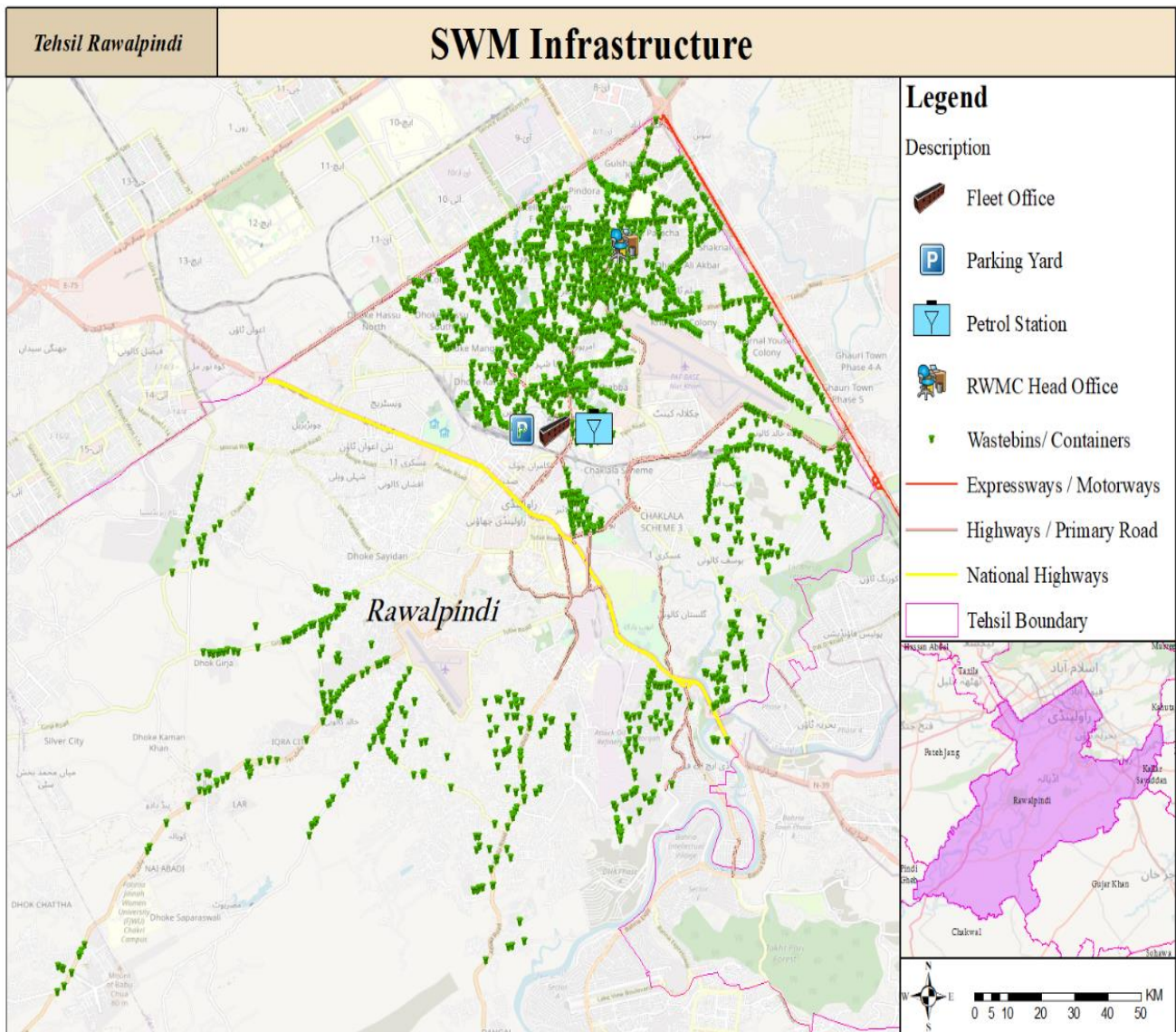
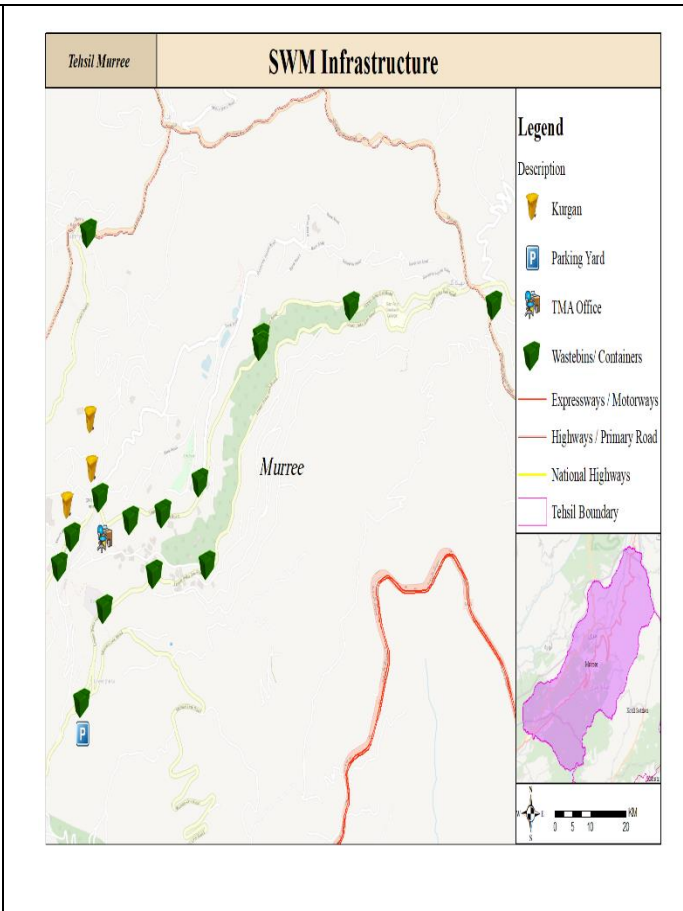
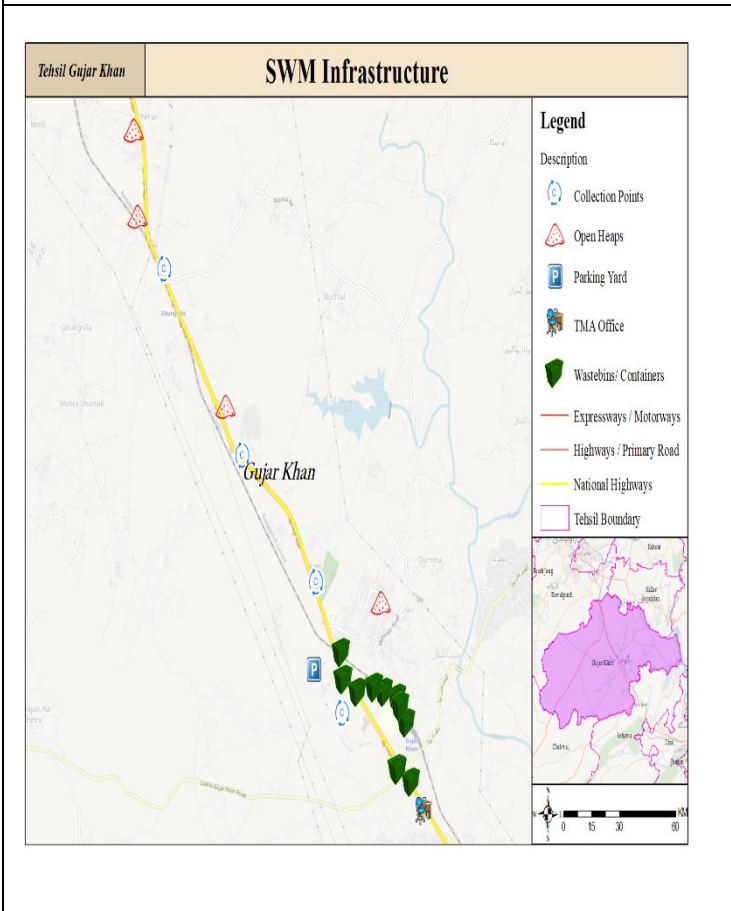
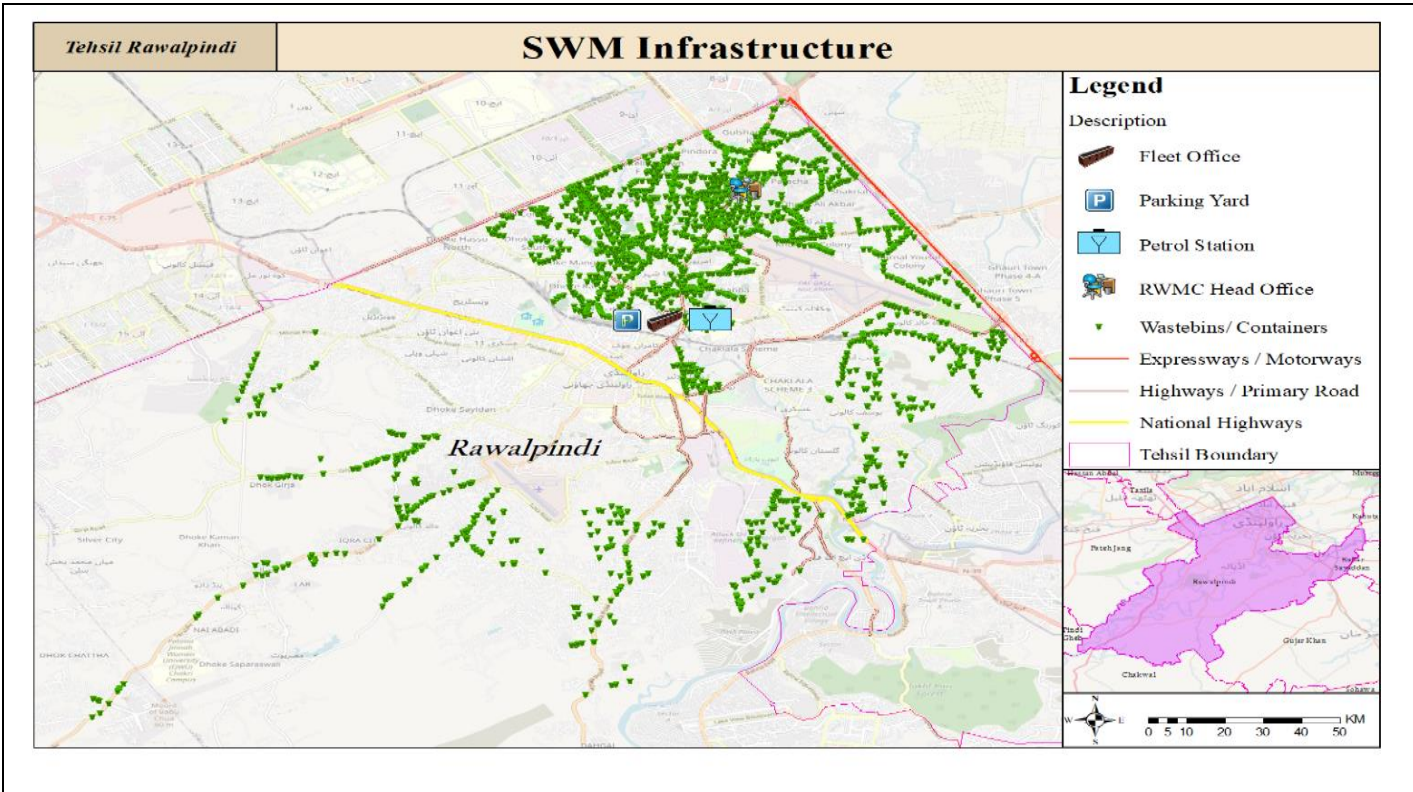


Figure 3.4: SWM infrastructure of Rawalpindi Tehsil



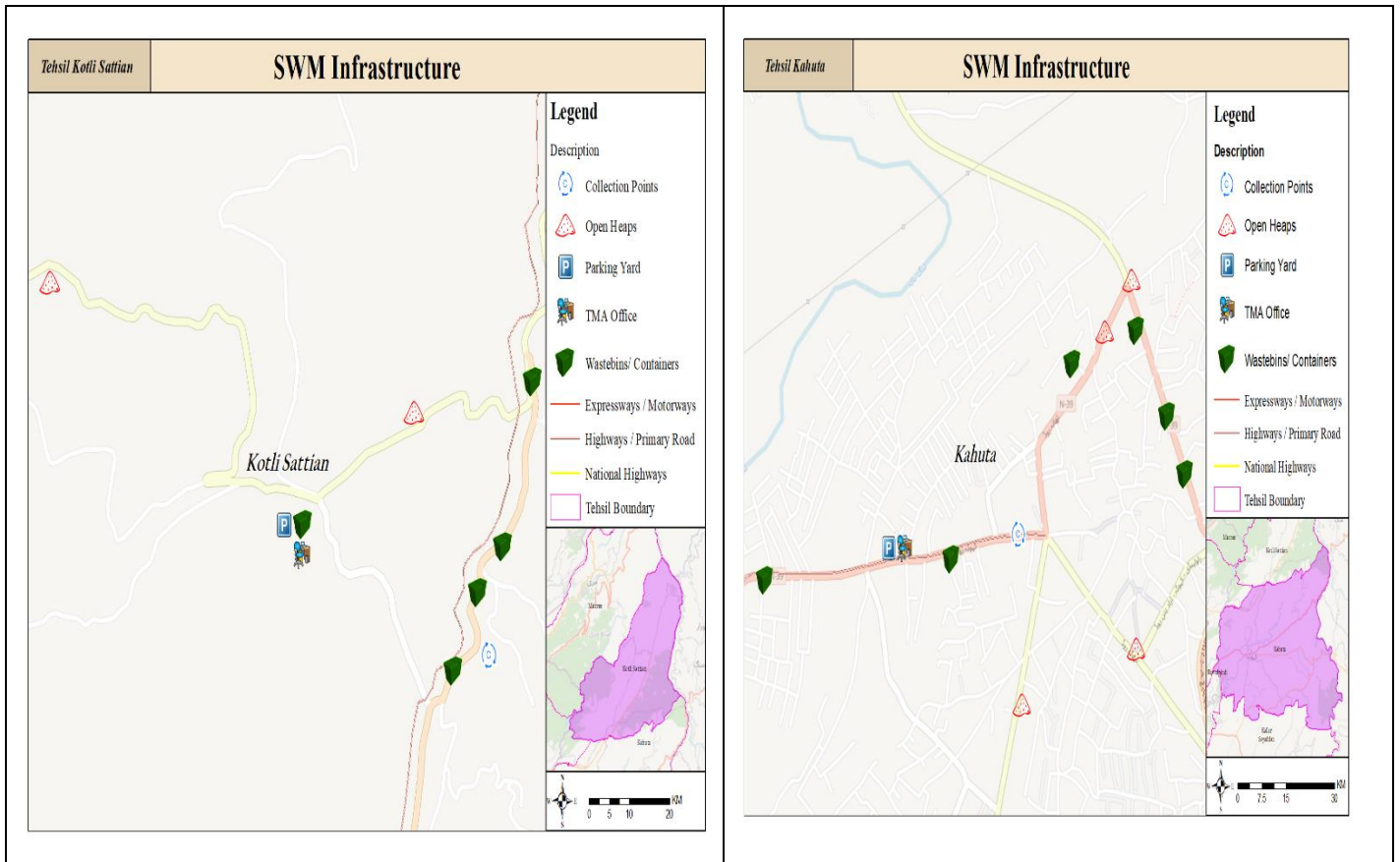


Figure 3.5: SWM Infrastructure of Tehsils of Rawalpindi

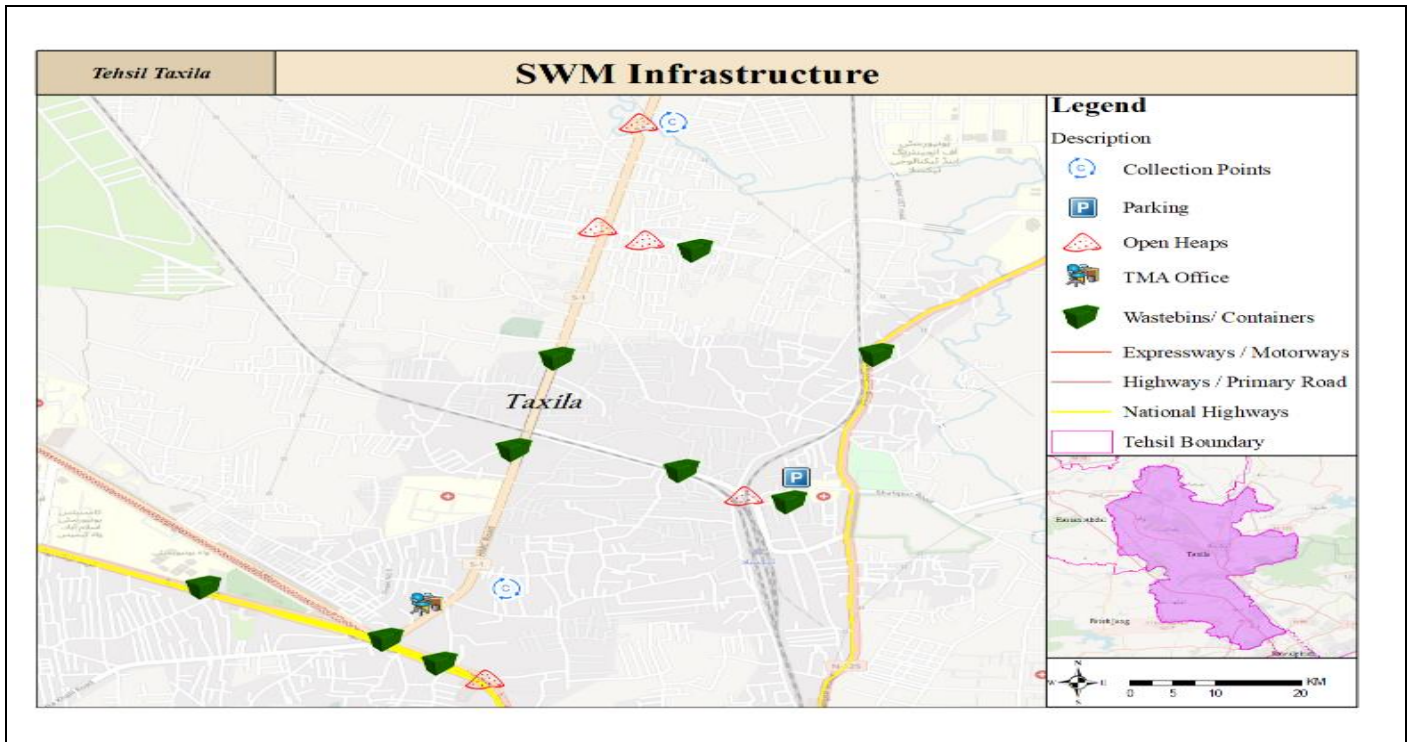


Figure 3.6: SWM Infrastructure of Taxila Tehsil

Required resources

In urban areas of Rawalpindi resources allocation categorized depending upon mode of waste collection as Container Based Collection (CBC), Door to Door waste collection (DTD), commercial areas waste collection, public institutes and buildings waste collection, bulk waste collection, TCPs/ transfer stations, mechanical sweeping & washing. Based on waste load, and area requirements, the number of compactors, arm rolls, mini dumpers, dumpers, loaders, collection containers (having capacities of $0.8\text{m}^3/ 5\text{m}^3$), mechanical sweeper, and required human resources are proposed.

The proposed SWM model is based on current land-use plan of the Rawalpindi District. Total tonnage (waste generation) of the area is calculated/ assigned against the various waste streams, i.e., residential, commercial, institutional and public buildings etc. based on current land-use plan as depicted in Figure.

The pictorial of urban proposed waste collection streams for Rawalpindi is depicted in Figure.

In rural area of Rawalpindi, mechanical resources including tractor loader, tractor trolleys, drum bins, handcart and required human resources are calculated based on waste load and area requirement. The mechanical and HR resources required in urban and rural area of Rawalpindi details are given in the table below.

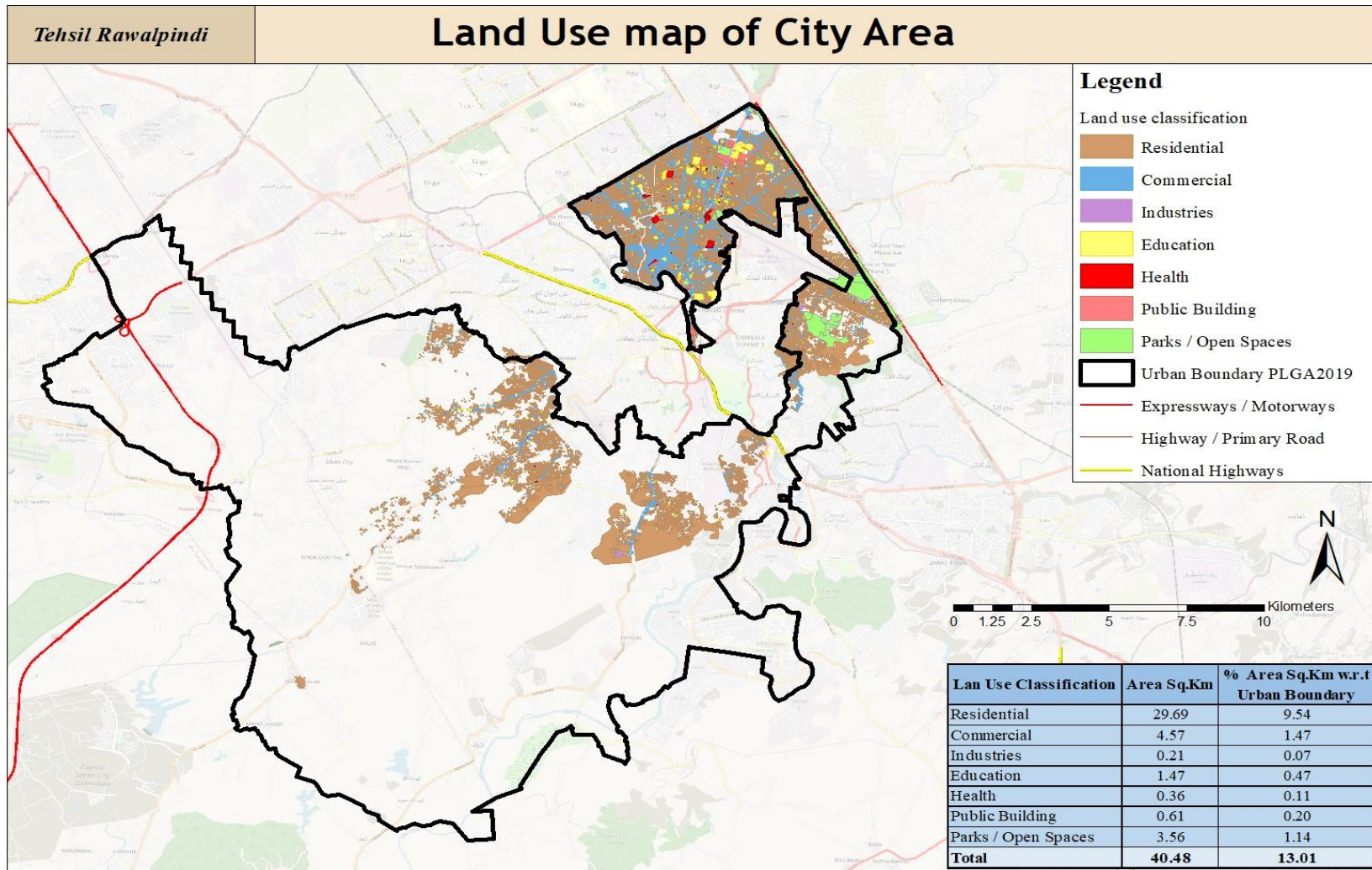


Figure 3.7: Current Land-use Plan of the Rawalpindi District to calculate the Resources for various waste streams

Tonnage Distribution and Scheme of Waste Handling

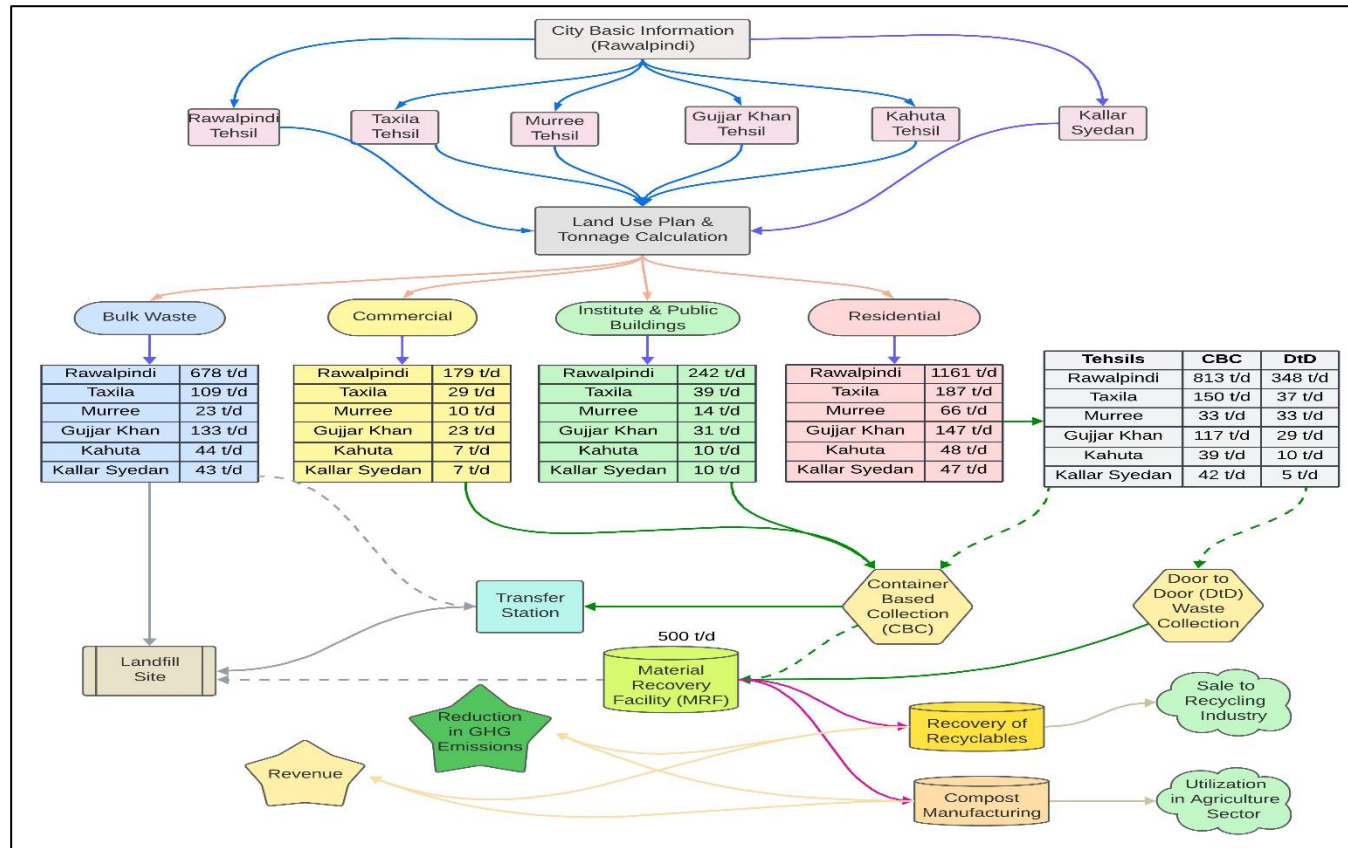


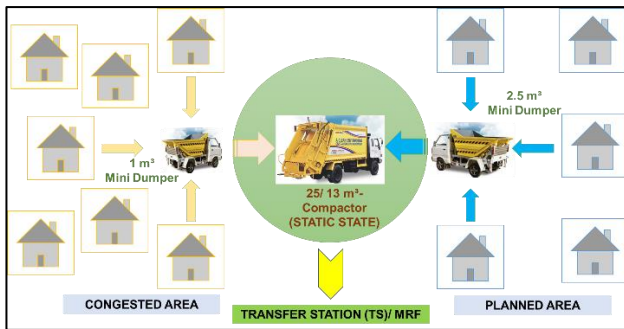
Figure 3.8: proposed waste collection streams for Rawalpindi based on current land-use plan

Table 3:2: Summary of Proposed Resources in Rawalpindi District

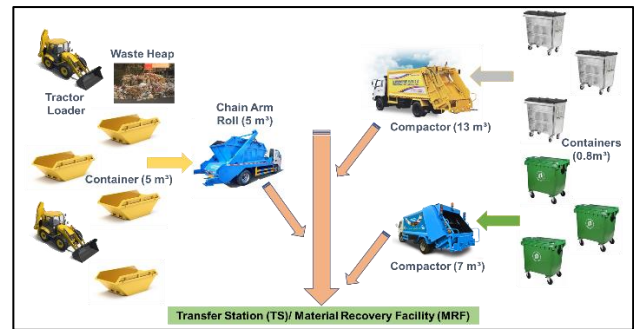
Waste Streams	Resources	Rawalpindi Tehsil	Taxila Tehsil	Murree Tehsil	Gujjar Khan Tehsil	Kahuta Tehsil	Kallar Syedan	Total Fleet
Container Based Collection (CBC)	Compactor 7cum	0	0	0	0	0	0	0
	Compactor 13cum	20	0	1	0	0	0	21
	Chain Arm Roll 5cum	39	12	1	9	3	3	67
	T Loader (4*4)	8	2	0	0	1	1	12
	Container 0.8cum	1445	0	73	0	0	0	1519
	Container 5cum	195	60	7	47	16	17	341
	Handcarts	1423	303	94	278	92	89	2278
	Drivers	67	14	2	9	4	4	100
	Helpers	79	12	3	9	3	3	109
	Workers	4268	910	283	833	275	267	6835
Door to Door (DtD) Collection	Compactor 25cum	13	0	0	0	0	0	13
	Compactor 13cum	9	5	4	4	1	1	23
	Compactor 7cum	0	0	0	0	0	0	0
	Mini Dumper 1cum	56	10	13	6	3	1	89
	Mini Dumper 2.5cum	56	3	0	4	1	0	64
	Drivers	134	18	17	14	5	2	189
	Helpers	44	9	8	7	3	1	72
Commercial Areas Waste Collection	Chain Arm Roll 5cum	7	0	0	0	0	0	7
	Compactor 25cum	0	0	0	0	0	0	0
	Compactor 13cum	0	0	0	0	0	0	0
	Compactor 7cum	8	3	1	2	1	1	16
	Container 0.8cum	398	128	45	101	33	32	737
	Container 5cum	36	0	0	0	0	0	36
	Drivers	15	3	1	2	1	1	23
	Helpers	30	6	2	4	2	2	46
	Compactor 13cum	0	0	0	0	0	0	0

Institutes, Public Buildings and Parks Waste Collection	Compactor 25cum	8	1	0	1	0	0	10
	Compactor 7cum	0	0	1	0	1	1	3
	Container 0.8cum	538	104	43	136	45	44	910
	Container 5cum	48	6	2	0	0	0	56
	Drivers	8	1	1	1	1	1	13
	Helpers	16	2	2	2	2	2	26
Bulk Waste Collection (Debris, Sludge & Tree Branches etc.)	Dumper 5cum	23	6	2	4	2	2	39
	Dumper 10cum	17	0	0	1	0	0	18
	T Loader (4*4)	13	3	1	4	1	1	24
	Excavator (Small)	3	1	0	1	0	0	6
	Trolleys	0	4	0	6	2	2	14
	Fron End Loader	3	1	0	1	0	0	6
	Drivers	59	15	3	17	6	6	107
	Helpers	40	6	2	6	2	2	57
Transfer Station/ Temporary Collection Points (TCPs)	Dumper 25cum (MSW)	22	4	1	3	1	1	32
	Dumper 25cum (Bulk)	8	1	0	2	1	0	12
	Excavator (Large)	12	2	0	2	1	0	17
	Front End Loader	4	1	0	1	0	0	6
	Drivers	46	8	1	8	3	1	67
	Helpers	60	10	2	10	4	2	88
Mechanical Sweeping & Washing	Mech Sweeper 4m3	6	1	2	0	0	0	9
	Mech Sweeper 6m3	4	1	0	0	0	0	5
	Mech Washer 4500l	5	1	2	0	0	0	8
	Mech Washer 8000l	3	1	0	0	0	0	4
	Mech Sweeper with Washer 4m3	0	0	0	0	0	0	0
	Drivers	18	4	4	0	0	0	26
	Helpers	26	6	6	0	0	0	38
Total Drivers		347	63	29	51	21	15	525

Total Helpers		294	52	25	38	15	12	436
Total Workers		4268	910	283	833	275	267	6,835
Grand Total		4,909	1,024	337	921	311	293	7,796



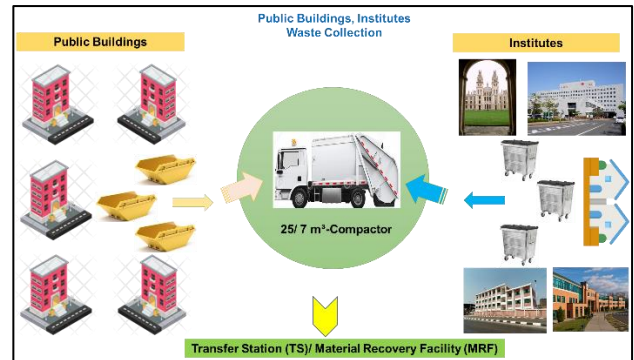
Door to Door (DtD) waste collection



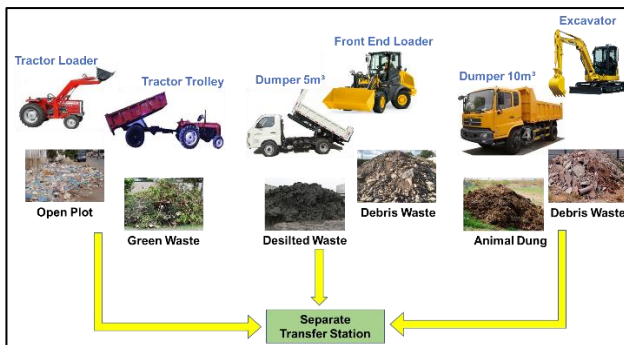
Container Based Collection (CBC)



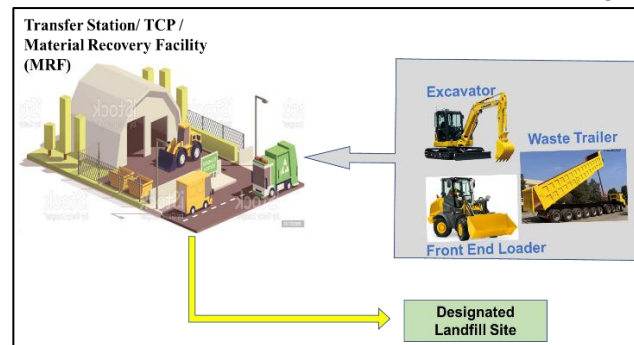
Commercial Waste Collection



Waste Collection from Institutes & Public Buildings



Bulk Waste Collection



Haulage of waste at Transfer Station/ TCP/ MRF and Further at LFS

Figure 3.9: Proposed Models for Waste Collection streams

Financial Costing:

The total cost for primary and secondary waste collection for the whole district has been calculated using above mentioned resources. The following parameters were considered in costing

- Cost of mechanical resources (handcarts, loader rickshaws, containers, compactors, arm roll vehicles, container carrier, Containers), front end loaders.
- Capital cost including R/M cost, registration cost and depreciation cost
- Operational and maintenance Cost.
- Cost of HR for primary, secondary

The detail of each cost has been shown in tables below:

Table 3:3: Operational Cost for Rawalpindi district

Particulars	Rawalpindi Tehsil		Taxila Tehsil		Murree Tehsil		Gujjar Khan Tehsil		Kahuta Tehsil		Kallar Syedan	
	Per Month Cost	Per Annum Cost	Per Month Cost	Per Annum Cost	Per Month Cost	Per Annum Cost	Per Month Cost	Per Annum Cost	Per Month Cost	Per Annum Cost	Per Month Cost	Per Annum Cost
Machinery Operational Cost	179,702,273	2,156,427,270	30,219,555	362,634,658	11,704,174	140,450,084	28,282,842	339,394,107	10,009,506	120,114,069	6,006,623	72,079,473
Equipment & Container Cost	26,122,816	313,473,796	1,129,662	13,555,942	1,539,968	18,479,620	3,409,981	40,919,775	626,630	7,519,563	1,134,391	13,612,691
HR Manual work inc. Janitorial	178,109,992	2,137,319,907	37,142,307	445,707,687	12,227,898	146,734,772	33,376,815	400,521,784	11,286,706	135,440,469	10,634,895	127,618,745
Total Operational Cost	383,935,081	4,607,220,973	68,491,524	821,898,286	25,472,040	305,664,476	65,069,639	780,835,666	21,922,842	263,074,100	17,775,909	213,310,910
Monitoring Cost 4%	15,357,403	184,288,839	2,739,661	32,875,931	1,018,882	12,226,579	2,602,786	31,233,427	876,914	10,522,964	711,036	8,532,436
Total Annual Cost	399,292,484	4,791,509,812	71,231,185	854,774,218	26,490,921	317,891,055	67,672,424	812,069,093	22,799,755	273,597,064	18,486,945	221,843,346
Annual Tonnage	67,785	813,422	10,907	130,889	3,387	40,648	9,980	119,759	3,295	39,543	3,195	38,337
Cost per ton	5,891	5,891	6,531	6,531	7,821	7,821	6,781	6,781	6,919	6,919	5,787	5,787
Population	3,841,272	3,841,272	818,987	818,987	254,339	254,339	749,346	749,346	247,428	247,428	239,881	239,881
House Hold	608,759	588,250	133,169	125,419	41,155	38,949	121,253	114,754	40,037	37,891	38,816	36,735
Cost per Person	104	1,247	87	1,044	104	1,250	90	1,084	92	1,106	77	925
Cost per Household	656	8,145	535	6,815	644	8,162	558	7,077	569	7,221	476	6,039

Table 3:4: Human Resource cost for Rawalpindi district

Tehsil	Workers	Per month Cost including janitorial	Per Annum Cost	Drivers LTV	Per month Cost	Per Annum Cost	Driver HTV	Per month Cost	Per Annum Cost	Helpers	Per month Cost	Per Annum Cost
Rawalpindi Tehsil	4,268	153,224,080	1,838,688,956.96	112.00	4,244,800	50,937,600	235	10,084,718	121,016,610	294	10,556,395	126,676,740
Taxila Tehsil	910	32,668,492	392,021,901.52	13.00	492,700	5,912,400	50	2,128,376	25,540,515	52	1,852,739	22,232,870
Murree Tehsil	283	10,145,314	121,743,772.17	13.00	492,700	5,912,400	16	686,400	8,236,800	25	903,483	10,841,800
Gujjar Khan Tehsil	833	29,890,596	358,687,148.71	10.00	379,000	4,548,000	41	1,750,499	21,005,985	38	1,356,721	16,280,650
Kahuta Tehsil	275	9,869,639	118,435,669.09	4.00	151,600	1,819,200	17	715,000	8,580,000	15	550,467	6,605,600
Kallar Syedan	267	9,568,568	114,822,820.31	1.00	37,900	454,800	14	596,131	7,153,575	12	432,296	5,187,550
Total	6835	245,366,689	2,944,400,269	153	5,798,700	69,584,400	372	15,961,124	191,533,485	436	15,652,101	187,825,210

Table 3:5: Machinery Cost Required

Sr. No.	Vehicle Type	Total Quantity Required	Life (in Year)	Cost /Unit	Registration	Gross Cost/Unit	Gross Cost	R&M Cost /year	Insurance / Year	Operating Expense /year	Depreciation / Year (10% Residual Value)	Total Cost / Annual
1	Compactor 7cum	25	7	14,900,000	298,000.00	15,198,000	379,950,000	37,995,000.00	9,498,750	47,493,750	48,850,714	96,344,464
2	Compactor 13cum	44	7	25,800,000	516,000.00	26,316,000	1,156,588,200	115,658,820	28,914,705	144,573,525	148,704,197	293,277,722
3	Chain Arm Roll 5cum	74	7	1,550,000	31,000.00	1,581,000	116,994,000	11,699,400	2,924,850	14,624,250	15,042,086	29,666,336
4	T Loader (4*4)	36	7	5,300,000	106,000.00	5,406,000	193,479,739	19,347,974	4,836,993	24,184,967	24,875,966	49,060,934
5	COMP 25cum	23	7	30,000,000	600,000.00	30,600,000	705,330,000	70,533,000	17,633,250	88,166,250	90,685,286	178,851,536
6	Mini Dumper 1cum	89	7	2,650,000	53,000.00	2,703,000	240,567,000	24,056,700	6,014,175	30,070,875	30,930,043	61,000,918
7	Mini Dumper 2.5cum	64	7	5,000,000	100,000.00	5,100,000	326,400,000	32,640,000	8,160,000	40,800,000	41,965,714	82,765,714
8	Dumper 5cum	39	7	12,500,000	250,000.00	12,750,000	496,400,000	49,640,000	12,410,000	62,050,000	63,822,857	125,872,857
9	Dumper 10cum	18	7	23,400,000	468,000.00	23,868,000	431,016,300	43,101,630	10,775,408	53,877,038	55,416,381	109,293,419
10	Trolleys	14	7	4,606,549	92,130.98	4,698,680	67,556,577	6,755,658	1,688,914	8,444,572	8,685,846	17,130,418
11	Fronnd End Loader	11	7	15,800,000	316,000.00	16,116,000	184,356,594	18,435,659	4,608,915	23,044,574	23,702,991	46,747,565
12	Dumper 25cum (MSW)	44	7	37,000,000	740,000.00	37,740,000	1,660,560,000	166,056,000	41,514,000	207,570,000	213,500,571	421,070,571
13	Excavator (Large)	23	7	54,900,000	1,098,000.00	55,998,000	1,285,011,513	128,501,151	32,125,288	160,626,439	165,215,766	325,842,205
14	Mech Washer 4500 L	8	7	23,000,000	460,000.00	23,460,000	187,680,000	18,768,000	4,692,000	23,460,000	24,130,286	47,590,286
15	Mech Washer 8000 L	4	7	27,400,000	548,000.00	27,948,000	111,792,000	11,179,200	2,794,800	13,974,000	14,373,257	28,347,257
16	Mech Sweeper 4m3	9	7	18,000,000	360,000.00	18,360,000	165,240,000	16,524,000	4,131,000	20,655,000	21,245,143	41,900,143
17	Mech Sweeper 6m3	5	7	28,900,000	578,000.00	29,478,000	147,390,000	14,739,000	3,684,750	18,423,750	18,950,143	37,373,893
Total Cost (PKR)		531					7,856,311,922	785,631,192	196,407,798	982,038,990	1,010,097,247	1,992,136,237

Table 3:6: Operational Cost requirement

Vehicle	Number of Machine	Depreciation	Fuel /year	R&M & Insurance	Total Cost	Cost per unit / Annum
Compactor 7cum	25	48,850,714	51,688,000	47,493,750	148,032,464	5,921,299
Compactor 13cum	44	148,704,197	105,251,935	144,573,525	398,529,657	9,067,797
Chain Arm Roll 5cum	74	15,042,086	114,747,360	14,624,250	144,413,696	1,951,536
T Loader (4*4)	36	24,875,966	79,281,598	24,184,967	128,342,532	3,586,007
Compactor 25cum	23	90,685,286	102,120,720	88,166,250	280,972,256	12,189,686
Mini Dumper 1cum	89	30,930,043	52,574,080	30,070,875	113,574,998	1,276,124
Mini Dumper 2.5cum	64	41,965,714	51,038,208	40,800,000	133,803,922	2,090,686
Dumper 5cum	39	63,822,857	77,620,608	62,050,000	203,493,465	5,226,716
Dumper 10cum	18	55,416,381	48,003,384	53,877,038	157,296,803	8,710,483
Trolleys	14	8,685,846	31,849,653	8,444,572	48,980,071	3,406,651
Fronnd End Loader	11	23,702,991	48,653,668	23,044,574	95,401,233	8,339,741
Dumper 25cum (MSW)	44	213,500,571	219,304,800	207,570,000	640,375,371	14,553,986
Excavator (Large)	23	165,215,766	121,999,679	160,626,439	447,841,884	19,515,973
Mech Washer 4500 L	8	24,130,286	35,443,200	23,460,000	83,033,486	10,379,186
Mech Washer 8000 L	4	14,373,257	17,721,600	13,974,000	46,068,857	11,517,214
Mech Sweeper 4m3	9	21,245,143	15,949,440	20,655,000	57,849,583	6,427,731
Mech Sweeper 6m3	5	18,950,143	22,152,000	18,423,750	59,525,893	11,905,179
Total Cost (PKR)				982,038,990	3,187,536,171	136,065,994

4. DISTRICT CHAKWAL

DESCRIPTION

Chakwal, a city with a history dating back to the early 1900s, holds significance as a region shaped during the era of the British Empire. The foundations of Chakwal can be traced to its role as a strategic railway junction. The city was a pivotal point on the railway line connecting Wazirabad to Khanewal, offering a crucial link to Karachi through Lahore. The well-organized layout of straight roads suggests careful planning by the British administrators.

Initially, Chakwal was more akin to a village until 1919, when it attained the status of an area committee. Over time, its administrative stature evolved, reaching the level of a Municipal Committee in 1933 and eventually being designated as a district in 1985. The district of Chakwal comprises four tehsils, each contributing to the diverse tapestry of the region:

1. **Chakwal:** The central tehsil and likely the hub of administrative and commercial activities.
2. **Kalar Kahar:** Another tehsil contributing to the district's economic and social landscape.
3. **Talagang:** A tehsil with its unique characteristics and possibly distinct historical significance.
4. **Lawa :** A newly added Tehsil in Chakwal District.
5. **Choa Saidan Shah:** The fourth tehsil, adding to the cultural and geographical richness of Chakwal.

GEOGRAPHICAL INFORMATION:

The district of Chakwal spans an expansive area of 6,524 square kilometers, constituting approximately 3.1% of Punjab's total area and about 0.6% of Pakistan's overall landmass. Situated in the heart of the country, Chakwal shares its borders with several neighboring districts, creating a distinctive geographic profile. It is bordered by district Khushab to the north, district Jhelum to the east, district Attock to the southeast, district Mianwali to the west, and the federal territory of Islamabad to the southwest.

Chakwal experiences a predominantly hot and dry climate, characteristic of the region. The summer season prevails from April to October, with May, June, and July emerging as the hottest months. During these months, temperatures soar between 42 and 48 degrees Celsius. The scorching heat is accompanied by dry, hot, and dusty winds, contributing to the arid climate.

The winter season in Chakwal extends from November to March, with December and January being the coldest months. Temperatures during this period range between 8 and 22 degrees Celsius. Residents of Chakwal experience a noticeable shift in weather dynamics as the region transitions from the searing heat of summer to the relatively cooler temperatures of winter.

DEMOGRAPHIC SITUATION OF CHAKWAL DISTRICT:

Urban Population: Chakwal district exhibits a dynamic demographic landscape with an estimated urban population of 632,450. Within this urban populace, there are 320,175 males and 312,275

females. The district's urban centers have experienced steady growth, reflected in an average annual population growth rate of 2.1%.

Rural Population: In contrast, the rural areas of Chakwal district contribute significantly to its overall population, with an estimated total rural population of 1,953,720. This comprises 992,450 males and 961,270 females. The rural regions maintain a distinct demographic profile, and the average annual growth rate of the rural population stands at 1.75%.

WASTE GENERATION IN CHAKWAL DISTRICT:

Waste generation in Chakwal district is meticulously assessed based on the district's population and real-time field observations. Through extensive field visits and the analysis of waste generation patterns, a waste generation rate (WGR) of 0.42 kg/cap-day has been established for Chakwal city. This rate serves as the basis for calculating the total waste generated in the district.

The calculated waste generation for Chakwal district in the year 2023 is approximately 521 tons per day. This total includes Municipal Solid Waste (MSW) generation of 417 tons per day, constituting 80% of the total waste, and bulk waste generation of 104 tons per day, making up the remaining 20% of the waste stream.

The waste generation graph illustrates the daily waste output for Chakwal district, encompassing its diverse tehsils: Chakwal Tehsil, Talagang Tehsil, Kalar Kahar Tehsil, Choa Saidan Shah Tehsil and Lawa tehsil. The waste generation figures are intricately linked to the projected population estimates for each tehsil, providing valuable insights into the district's waste management needs.

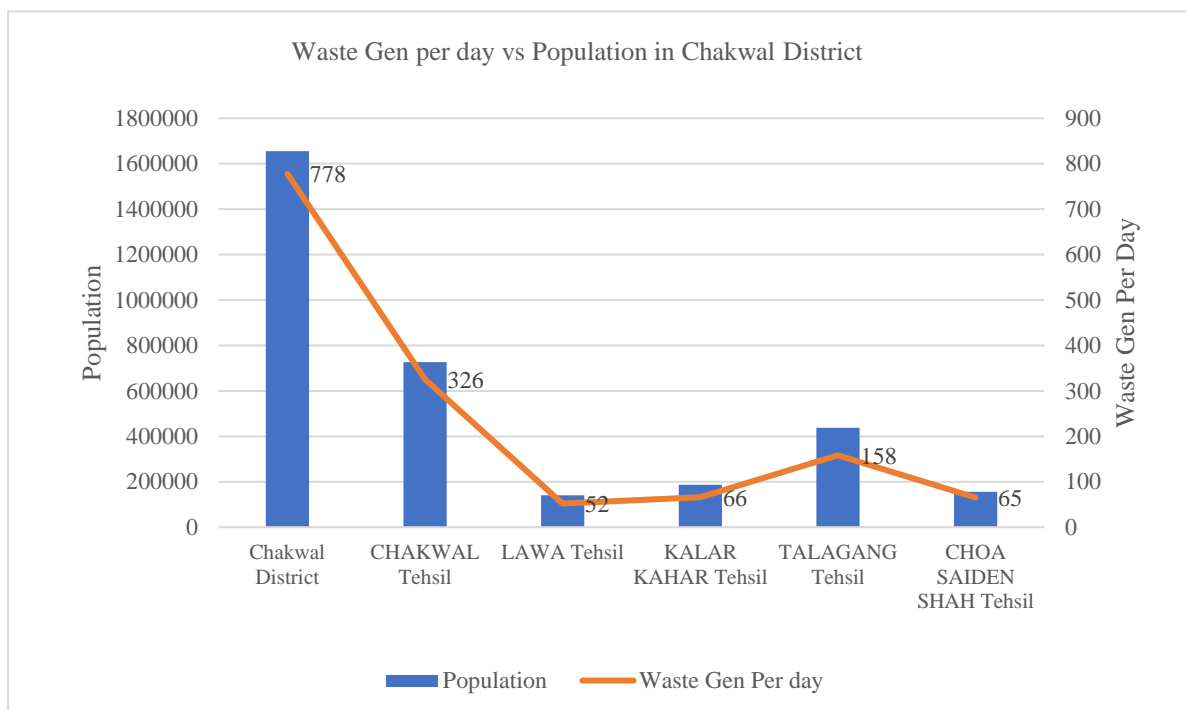


Figure 4.1: population vs Waste Generation in Chakwal

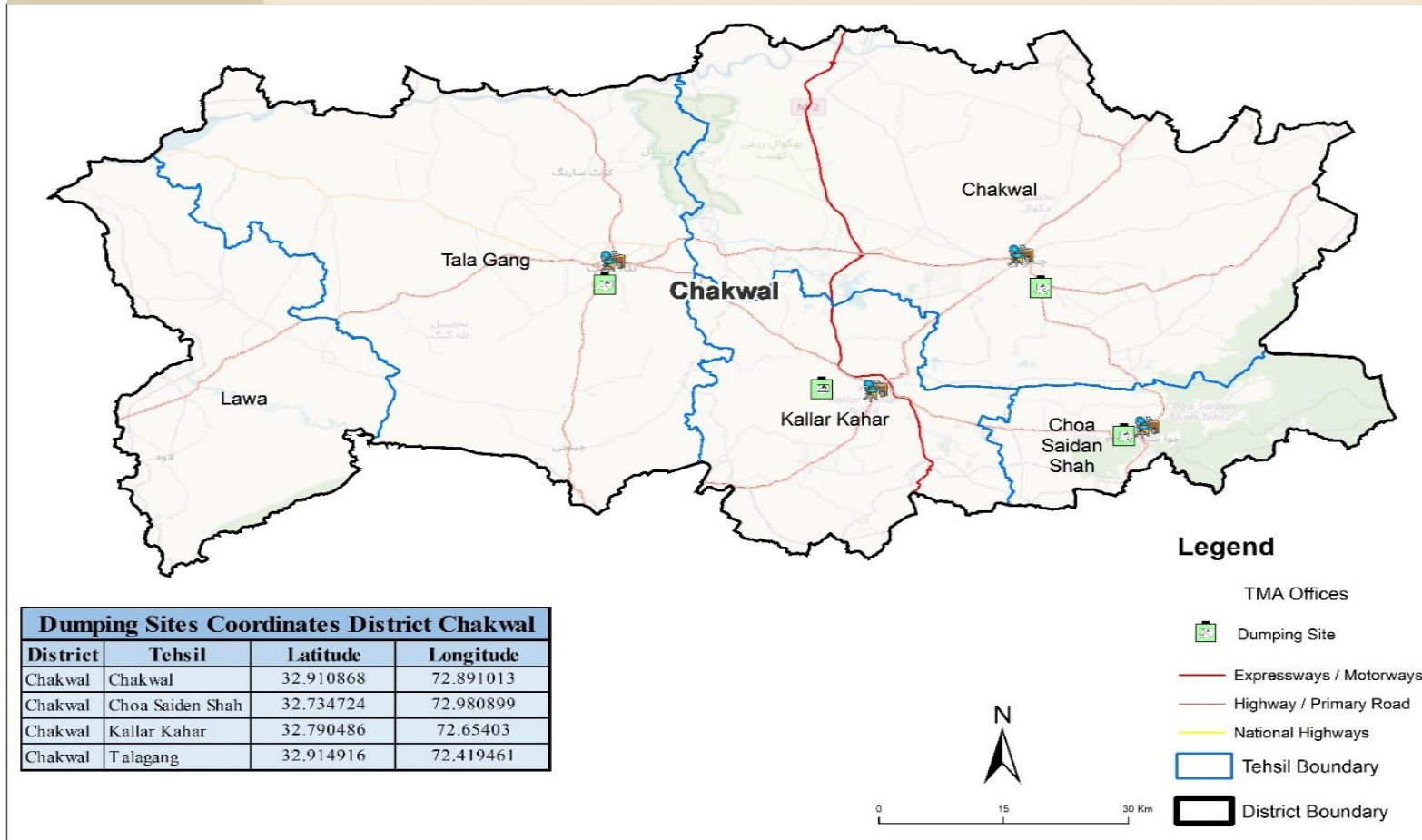
CURRENT WASTE MANAGEMENT IN CHAKWAL

The Municipal Committee (MC) currently manages the solid waste management (SWM) services in Chakwal. However, the MC still relies on outdated methods for waste collection and transportation, leading to inefficiencies in the system. The allocation of sanitary workers for SWM is inadequate, as there is no well-established system in place. Sanitary workers currently sweep streets and roads and collect solid waste from small heaps using brooms, wheelbarrows, and similar tools. They store the waste at permanent and temporary collection points. Unfortunately, this system suffers from poor collection efficiency, as it requires more time and manpower to collect and transport the solid waste to dumpsites. The current approach involves deploying sanitary workers, handcarts, and tractor trolleys for waste collection from households and clearance of open plots and streets. However, door-to-door collection is not practiced in the city.

Secondary waste collection is carried out using tractor trolleys and container carriers. However, the existing machinery is insufficient to meet the needs of Chakwal the city has various open heaps, masonry enclosures, and covered steel containers for secondary waste collection. Daily collection is performed at many of these points, and the waste is stored in 5m³ capacity containers. Transportation of waste is conducted using container carrier vehicles, while tractor trolleys and loaders are used to clear open waste and temporary collection points. Regarding disposal, the waste is currently dumped at designated collection points within the city. From there, it is transported to the dumping site or transfer station using trolleys and dumpers. The TMA (Town Municipal Administration) also has the responsibility of collecting waste from demolition debris, hospitals, slaughterhouses, vegetable markets, and dead animals, which are mixed with municipal waste. Unfortunately, precise data on scavenging and other hazardous wastes is not available with the MC.

The existing dumping site is located approximately 10 kilometres from the city centre and has been operational since 2013. However, there is workshop available for vehicle and container repair and basic maintenance. While a parking lot is available for MC vehicles, there is no proper covering of vehicles during the transportation of waste from the city/transfer station to the dumpsite. This leads to littering by the conveying vehicles along the way. In Choa Saiden Shah tehsil, a dumping site was established in 2019 and its anticipated life is more than 5 years now. Similarly, the dumpsite in Kalar Kahar tehsil is not legal and the depression of mountains are being used for dumping of waste.

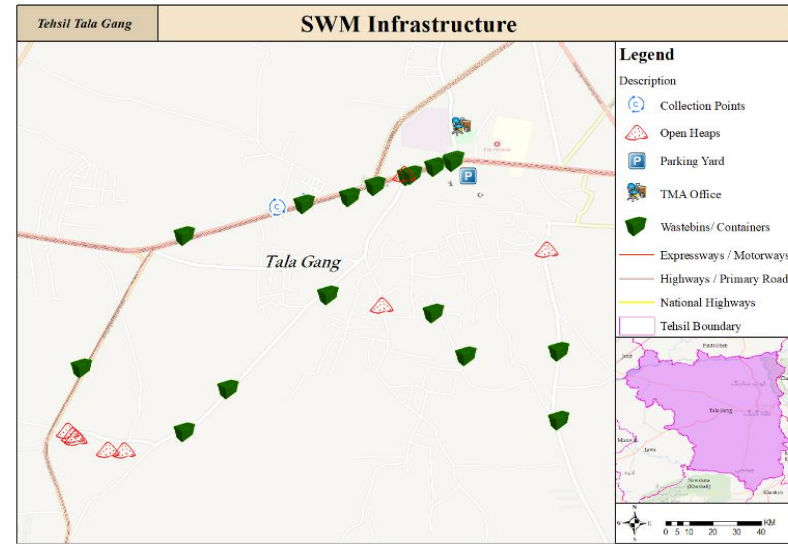
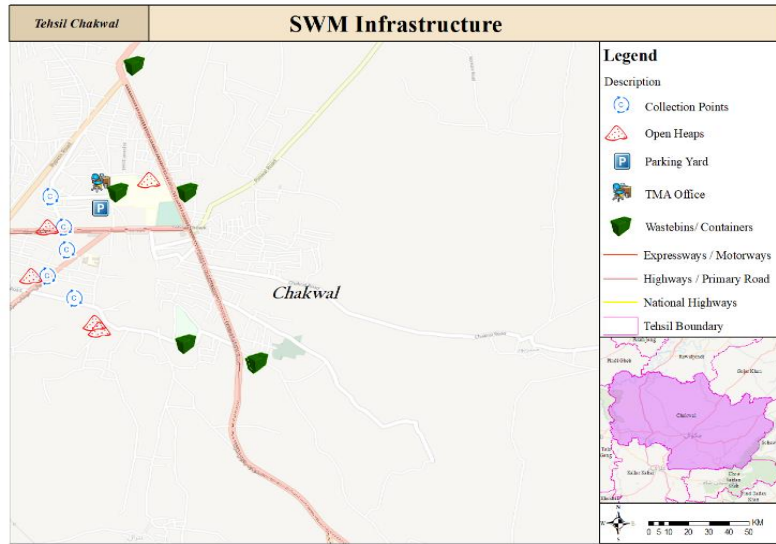
The Lawa tehsil has no proper dumpsite as it is a newly added tehsil in Chakwal But Talagang Tehsil has a 6 kanal proper dumpsite being used by MC for the last 10 years and its anticipated life is 25 years.



Dumping Sites Coordinates District Chakwal			
District	Tehsil	Latitude	Longitude
Chakwal	Chakwal	32.910868	72.891013
Chakwal	Choa Saidu Shah	32.734724	72.980899
Chakwal	Kallar Kahar	32.790486	72.65403
Chakwal	Talagang	32.914916	72.419461

Figure 4.2: SWM infrastructure in District Chakwal

Chakwal



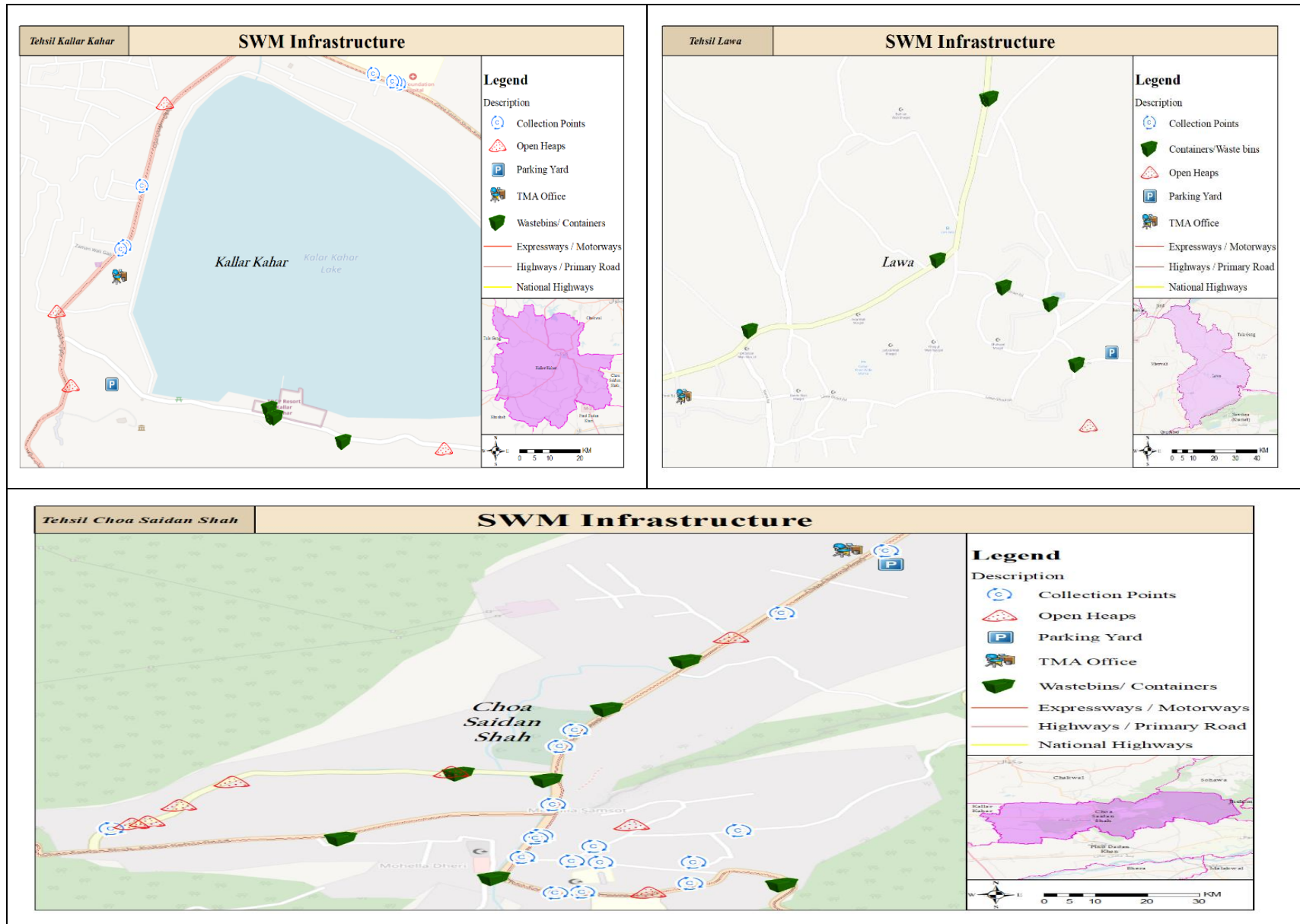


Figure 4.3: SWM infrastructure in Tehsils of Chakwal

Maps of Current SWM Resources in Chakwal District's Tehsils. The infrastructure of SWM of Chakwal district is shown in the above given maps.

Required resources

In urban areas of Chakwal resources allocation categorized depending upon mode of waste collection as Container Based Collection (CBC), Door to Door waste collection (DTD), commercial areas waste collection, private societies waste collection, bulk waste collection, TCPs/ transfer stations, mechanical sweeping & washing. Based on waste load, and area requirements, the number of compactors, arm rolls, mini dumpers, dumpers, loaders, collection containers (having capacities of 0.8m³/ 5m³), mechanical sweeper, and required human resources are proposed.

In rural area of Chakwal, mechanical resources including Raksha loader, tractor loader, tractor trolleys, drum bins, handcart and required human resources are calculated based on waste load and area requirement. The mechanical and HR resources required in urban and rural area of Chakwal details are given in the table below.

Table 4:1: Summary of Proposed resources in District Chakwal

Waste Category	Resources	Chakwal Tehsil	Choa Saidan Shah	Kalar Kahar	Lawa	Talangan	Total Fleet
CBC	Compactor 7cum	2	0	0	1	2	5
	Compactor 13cum	1	0	0	0	1	2
	Chain Arm Roll 5cum	2	1	0	0	1	4
	T Loader (4*4)	0	0	0	0	0	0
	Container 0.8cum	184	0	0	67	196	446
	Container 5cum	11	4	0	0	4	19
	Handcarts	269	58	69	51	166	613
	Drivers	5	1	0	1	4	11
	Helpers	8	1	0	2	7	18
Workers	808	173	208	152	498	1839	
DtD	Compactor 25cum	0	0	0	0	0	0
	Compactor 13cum	1	0	0	0	1	3
	Compactor 7cum	3	1	0	0	2	5
	Mini Dumper 1cum	6	1	1	0	8	16
	Mini Dumper 2.5cum	8	1	1	0	5	15
	Drivers	18	3	2	0	16	39
	Helpers	8	1	1	0	6	16
Commercial	Chain Arm Roll 5cum	2	0	0	0	1	3
	Compactor 25cum	0	0	0	0	0	0
	Compactor 13cum	1	0	0	0	0	1
	Compactor 7cum	1	1	0	0	1	3
	Container 0.8cum	111	36	16	11	67	240
	Container 5cum	10	0.8	1	1	4	16
	Drivers	4	1	0	0	2	7
	Helpers	8	2	0	0	4	14
Societies	Compactor 13cum	1	0	0	0	0	1
	Compactor 25cum	0	0	0	0	0	0

	Compactor 7cum	1	0	0			1
	Container 0.8cum	89	0	0	22	44	155
	Container 5cum	-	0	0	0	0	0
	Drivers	2	-	-	-	-	2
	Helpers	4	-	-	-	-	4
Bulk	Dumper 5cum	7	1	1	1	3	14
	Dumper 10cum	1	0	0	0	0	1
	T Loader (4*4)	5	1	1	1	2	10
	Excavator (Small)	1	0	0	0	1	2
	Trolleys	6	1	1	1	4	14
	Frond End Loader	1	0	0	0	1	2
	Drivers	21	3	4	4	11	43
Helpers	8	1	1	1	3	15	
TCPs	Dumper 25cum (MSW)	2	0	1	0	2	5
	Dumper 25cum (Bulk)	2	0	0	0	1	3
	Excavator (Large)	2	0	0	0	1	3
	Front End Loader	1	0	0	0	0	1
	Drivers	7	0	1	0	4	12
	Helpers	8	0	2	0	6	16
Mechanical Sweeping & Washing	Mech Sweeper 4m3	0	0	0	0	0	0
	Mech Sweeper 6m3	1	0	0	0	0	1
	Mech Washer 4500l	4	0	0	0	0	4
	Mech Washer 8000l	0	0	0	0	0	0
	Mech Sweeper with Washer 4m3	0	0	0	0	0	0
	Drivers	5	0	0	0	0	5
	Helpers	9	0	0	0	0	9

	Chakwal Tehsil	Choa Saidan Shah	Kalar Kahar	Lawa	Talangan	Total Fleet
Total Drivers	62	8	7	5	37	119
Total Helpers	53	5	4	3	26	91
Total Workers	808	173	208	152	498	1839
Grand Total	923	186	220	160	561	2050

Financial Costing:

The total cost for primary and secondary waste collection for the whole district has been calculated using above mentioned resources. The following parameters were considered in costing

- Cost of mechanical resources handcarts, loader rickshaws, containers, compactors, arm roll vehicles, container carrier, Containers), front end loaders.
- Capital cost including R/M cost, registration cost and depreciation cost
- Operational and maintenance Cost.
- Cost of HR for primary, secondary

The detail of each cost has been shown in tables below:

Table 4.2: Summary of Cost Estimates in District Chakwal

Particulars	Chakwal Tehsil		Choa Saidan Shah		Kalar Kahar		Lawa		Talangang	
	Per Month Cost	Per Annum Cost	Per Month Cost	Per Annum Cost	Per Month Cost	Per Annum Cost	Per Month Cost	Per Annum Cost	Per Month Cost	Per Annum Cost
Machinery Operational Cost	35,916,941	431,003,289	3,442,410	41,308,918	2,475,543	29,706,519	2,218,830	26,625,960	6,027,414	72,328,963
Equipment & Continer Cost	945,714	11,348,564	279,013	3,348,160	167,744	2,012,930	474,217	5,690,605	1,153,855	13,846,259
HR Manual work inc Jantorial	10,721,500	128,658,004	7,981,599	95,779,188	5,917,754	71,013,051	18,186,436	218,237,233	39,500,897	474,010,765
Total Operational Cost	47,584,155	571,009,858	11,703,022	140,436,266	8,561,042	102,732,499	20,879,483	250,553,798	46,682,166	560,185,987
Monitoring Cost 4%	1,903,366	22,840,394	468,121	5,617,451	342,442	4,109,300	835,179	10,022,152	1,867,287	22,407,439
Total Annual Cost	49,487,521	593,850,253	12,171,143	146,053,717	8,903,483	106,841,799	21,714,663	260,575,950	48,549,452	582,593,426
Annual Tonnage	10,164	121,969	1,713	20,561	2,059	24,704	1,507	18,079	5,671	68,048
Cost per ton	4,869	4,869	7,104	7,104	4,325	4,325	14,413	14,413	8,562	8,562
Population	726,833	726,833	155,941	155,941	187,361	187,361	137,116	137,116	448,193	448,193
House Hold	115,187	111,307	25,356	23,881	30,317	28,692	22,187	20,998	71,029	68,636
Cost per Person	68	817	78	937	48	570	158	1,900	108	1,300
Cost per Household	430	5,335	480	6,116	294	3,724	979	12,410	684	8,488

Table 4:3: Human Resource cost for Chakwal district

Tehsil	Worke rs	Per month Cost including janitorial	Per Annum Cost	Drivers LTV	Per month Cost	Per Annum Cost	Driver HTV	Per month Cost	Per Annum Cost	Helpe rs	Per month Cost	Per Annum Cost
Chakwal Tehsil	173	6,220,311. 16	74,643,733.97	14	530,60 0	6,367,200	48	2,059,764 .47	24,717,174	53	1,910,8 25	22,929,897
Choa Saidan Shah	208	7,473,633	89,683,592.23	2	75,800	909,600	6	252,272.7 0	3,027,272	5	179,89 4	2,158,724
Kalar Kahar	152	5,469,420	65,633,045.12	2	75,800	909,600	5	223,926.7 1	2,687,121	4	148,60 7	1,783,285
Lawa	498	17,877,934	214,535,208.1 1	-	-	-	5	199,306.2 5	2,391,675	3	109,19 6	1,310,350
Talangang	1,032	37,041,298 .29	444,495,579.4 4	13	492,70 0	5,912,400	24	1,031,058 .22	12,372,699	26	935,84 1	11,230,087
Total	2064	74,082,597	888,991,159	31	1,174,9 00	14,098,800	88	3,766,328	45,195,940	91	3,284,3 62	39,412,343

Table 4:4: Machinery cost Requirement in District Chakwal

Sr. No.	Vehicle Type	Total Quantity Required	Life (in Year)	Cost /Unit	Registration	Gross Cost/Unit	Gross Cost	R&M Cost /year	Insurance / Year	Operating Expense /year	Depreciation / Year (10% Residual Value)	Total Cost / Annual
1	Compactor 7cum	14	7	22,000,000	440,000.00	22,440,000	318,588,947	31,858,894.74	7,964,724	39,823,618	40,961,436	80,785,055
2	Compactor 13cum	7	7	28,000,000	560,000.00	28,560,000	187,425,000	18,742,500	4,685,625	23,428,125	24,097,500	47,525,625
3	Chain Arm Roll 5cum	7	7	18,000,000	360,000.00	18,360,000	128,520,000	12,852,000	3,213,000	16,065,000	16,524,000	32,589,000
4	T Loader (4*4)	10	7	5,500,000	110,000.00	5,610,000	53,648,222	5,364,822	1,341,206	6,706,028	6,897,629	13,603,656
6	Mini Dumper 1cum	16	7	2,620,822	52,416.44	2,673,238	42,771,815	4,277,182	1,069,295	5,346,477	5,499,233	10,845,710
7	Mini Dumper 2.5cum	15	7	5,175,702	103,514.04	5,279,216	79,188,241	7,918,824	1,979,706	9,898,530	10,181,345	20,079,875
8	Dumper 5cum	14	7	20,000,000	400,000.00	20,400,000	276,590,000	27,659,000	6,914,750	34,573,750	35,561,571	70,135,321
9	Dumper 10cum	1	7	28,000,000	560,000.00	28,560,000	40,222,000	4,022,200	1,005,550	5,027,750	5,171,400	10,199,150
10	Trolleys	14	7	4,606,549	92,130.98	4,698,680	64,476,331	6,447,633	1,611,908	8,059,541	8,289,814	16,349,355
11	Fronnd End Loader	3	7	10,000,000	200,000.00	10,200,000	34,585,556	3,458,556	864,639	4,323,194	4,446,714	8,769,909
12	Dumper 25cum (MSW)	8	7	37,000,000	740,000.00	37,740,000	301,920,000	30,192,000	7,548,000	37,740,000	38,818,286	76,558,286
13	Excavator (Large)	5	7	53,000,000	1,060,000.00	54,060,000	291,423,444	29,142,344	7,285,586	36,427,931	37,468,729	73,896,659
15	Mech Sweeper 6m3	1	7	23,000,000	460,000.00	23,460,000	23,460,000	2,346,000	586,500	2,932,500	3,016,286	5,948,786
	Mech Washer 4500l	4	7	24,204,149	484,082.98	24,688,232	98,752,928	9,875,293	2,468,823	12,344,116	12,696,805	25,040,921
Total		119					1,941,572,484	194,157,248	48,539,312	242,696,560	249,630,748	492,327,308

Table 4:5: Operational cot estimates in Chakwal

Vehicle	Number of Machine	Depreciation	Fuel /year	R&M & Insurance	Total Cost	Cost per unit / Annum
Compactor 7cum	14	40,961,436	31,627,194	39,823,618	112,412,248	7,917,823
Compactor 13cum	7	24,097,500	16,933,378	23,428,125	64,459,003	9,822,324
Chain Arm Roll 5cum	7	16,524,000	11,695,320	16,065,000	44,284,320	6,326,331
T Loader (4*4)	10	6,897,629	22,824,880	6,706,028	36,428,536	3,809,336
Mini Dumper 1cum	16	5,499,233	10,183,680	5,346,477	21,029,390	1,314,337
Mini Dumper 2.5cum	15	10,181,345	12,888,720	9,898,530	32,968,595	2,197,906
Dumper 5cum	14	35,561,571	29,124,927	34,573,750	99,260,248	7,320,977
Dumper 10cum	1	5,171,400	4,033,692	5,027,750	14,232,842	10,106,160
Trolleys	14	8,289,814	32,752,200	8,059,541	49,101,555	3,578,251
Fronnd End Loader	3	4,446,714	15,538,598	4,323,194	24,308,507	7,169,085
Dumper 25cum (MSW)	8	38,818,286	42,962,400	37,740,000	119,520,686	14,940,086
Excavator (Large)	5	37,468,729	30,879,888	36,427,931	104,776,547	19,436,391
Mech Sweeper 6m3	1	3,016,286	4,773,600	2,932,500	10,722,386	10,722,386
Mech Washer 4500l	4	12,696,805	9,547,200	12,344,116	34,588,121	8,647,030
Total				230,352,445	733,504,865	104,661,393

5. CHAPTER 4 DISTRICT ATTOCK

DESCRIPTION

Attock is a Historical City on the Banks of the Indus River. Attock, situated on the Rawalpindi-Delhi Road, a historic thoroughfare constructed by the Indian Muslim Emperor Sher Shah Suri, stands as a significant city and the administrative headquarters of Attock District. Positioned between 32°33'N 72°25'E and 33°43'N 72°58'E, the district is steeped in history and strategic importance.

The district of Attock is divided into Five Tehsils, each contributing to the rich tapestry of the region:

- Attock Tehsil.
- Hassan Abdal Tehsil.
- Jand Tehsil.
- Hazro Tehsil.
- Pindi Gheb Tehsil.

Climate: A Tapestry of Seasons

Attock experiences a predominantly hot and dry climate, a characteristic feature of the region. The summer season unfolds in April and lingers until October, with May, June, and July emerging as the hottest months. During this period, the mean maximum temperatures soar to about 47 degrees Celsius, while the minimum hovers around 28 degrees Celsius.

The winter season spans from November to March, with December, January, and February being the coldest months. Temperatures during winter range from a mean maximum of about 22 degrees Celsius to a minimum of approximately 4 degrees Celsius. Rainfall graces the region during the monsoon season from July to September, providing a reprieve from the dry climate.

As Attock, with its historical significance and diverse Tehsils, navigates through the tapestry of seasons, it remains an integral part of the cultural and geographical mosaic of the region.

GEOGRAPHIC AND DEMOGRAPHIC OVERVIEW OF ATTOCK DISTRICT:

Geographic Situation: Attock District, while not vast in terms of its land area, is strategically located in the northern part of Punjab. Encompassing an area of 6,858 square kilometers (2,647 sq. mi), it constitutes about 3.3% of Punjab's total area and approximately 0.8% of Pakistan's overall landmass. The district is approximately 97 kilometers (60 mi) in length and around 44 kilometers (27 mi) in breadth, gently sloping from northeast to southwest.

Demographic Situation:

Urban Population: The urban landscape of Attock District is marked by a total estimated population of 565,210. Within this urban populace, there are 285,110 males and 280,100 females. The district's urban centers have witnessed growth, evidenced by an average annual population growth rate of 2.25%.

Rural Population: In contrast, the rural expanses of Attock District significantly contribute to its overall population, with an estimated total rural population of 2,976,540. Comprising 1,504,210 males and 1,472,330 females, the rural areas maintain a distinct demographic profile. The average annual growth rate of the rural population stands at 1.78%.

Waste generation In Attock District:

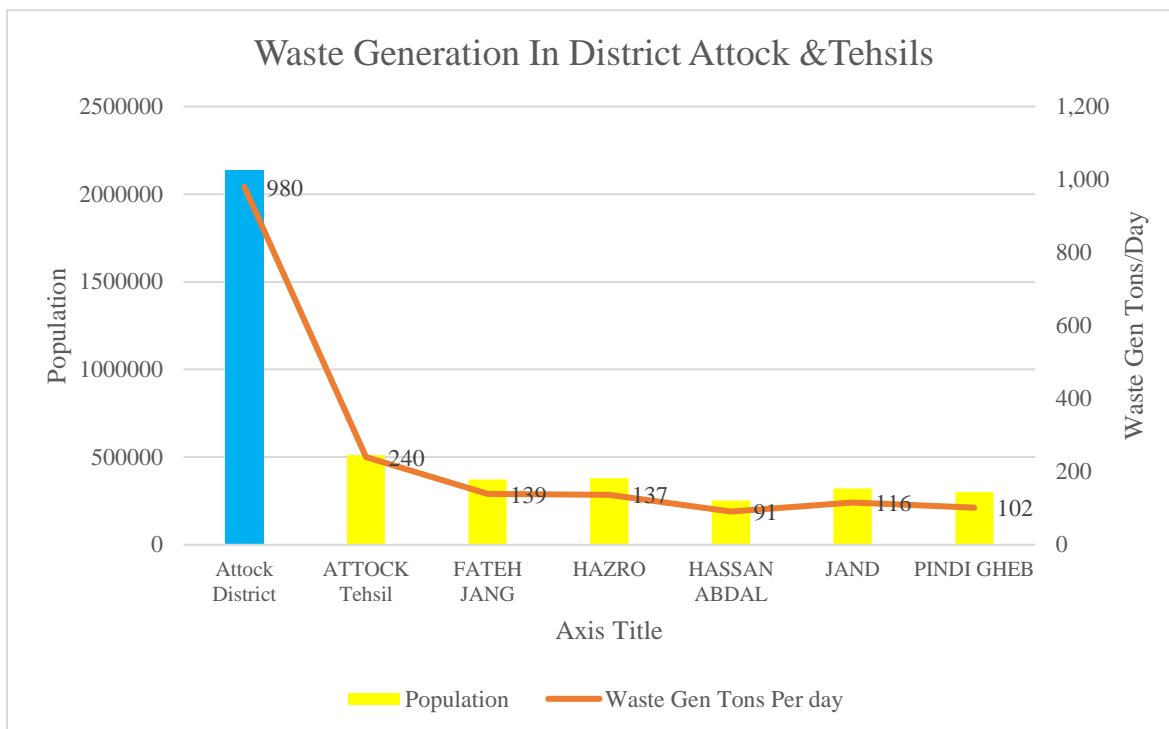


Figure 5.1: Population vs Waste Generation in Attock District

CURRENT WASTE MANAGEMENT IN ATTOCK

The Municipal Committee (MC) currently manages the solid waste management (SWM) services in Attock. However, the MC still relies on outdated methods for waste collection and transportation, leading to inefficiencies in the system. The allocation of sanitary workers for SWM is inadequate, as there is no well-established system in place. Sanitary workers currently sweep streets and roads and collect solid waste from small heaps using brooms, wheelbarrows, and similar tools. They store the waste at permanent and temporary collection points. Unfortunately, this system suffers from poor collection efficiency, as it requires more time and manpower to collect and transport the solid waste to dumpsites. The current approach involves deploying sanitary workers, handcarts, and tractor trolleys for waste collection from households and clearance of open plots and streets. However, door-to-door collection is not practiced in the city.

In Attock district, secondary waste collection is carried out using tractor trolleys and container carriers. However, the current machinery is inadequate to meet the demands of the district. Various methods are employed for secondary waste collection, including open heaps, masonry enclosures, and covered steel containers. Daily collection takes place at multiple points, and the waste is stored in containers with a capacity of 5m³. Transportation of waste is done using container carrier vehicles, while open waste and temporary collection points are cleared using tractor trolleys and loaders. Regarding waste

disposal, the collected waste is currently dumped at designated collection points within the city. From there, it is transported to the dumping site or transfer station using trolleys and dumpers. The responsibility of waste collection also extends to other sources such as demolition debris, hospitals, slaughterhouses, vegetable markets, and dead animals, which are mixed with municipal waste. However, precise data on scavenging and hazardous wastes is not available with the Municipal Corporation (MC).

The existing dumping site in Attock Tehsil is situated approximately 10 kilometres away from the city centre and has been operational for Six Months. However, there is a lack of a workshop for vehicle and container repair and maintenance. Although there is a parking lot for MC vehicles, there is no proper covering during the transportation of waste, leading to littering by the conveying vehicles along the way. In Fateh Jang tehsil, a dumping site was established but has been non-operational for the past year due to inadequate road access. Similarly, the dumpsite in Hazro tehsil is not being utilized according to the proper guidelines. In Pindi Gheb tehsil the dumpsite is approximately 12 km away from tehsil centre and it used properly according to guidelines. In Jand Tehsil there are two dumpsites being operated by the MC Jand for waste dumping and their anticipated life can be said as for 15 more years if properly managed. Below shown maps indicates the location of dumpsites locations in different tehsils of district attock;

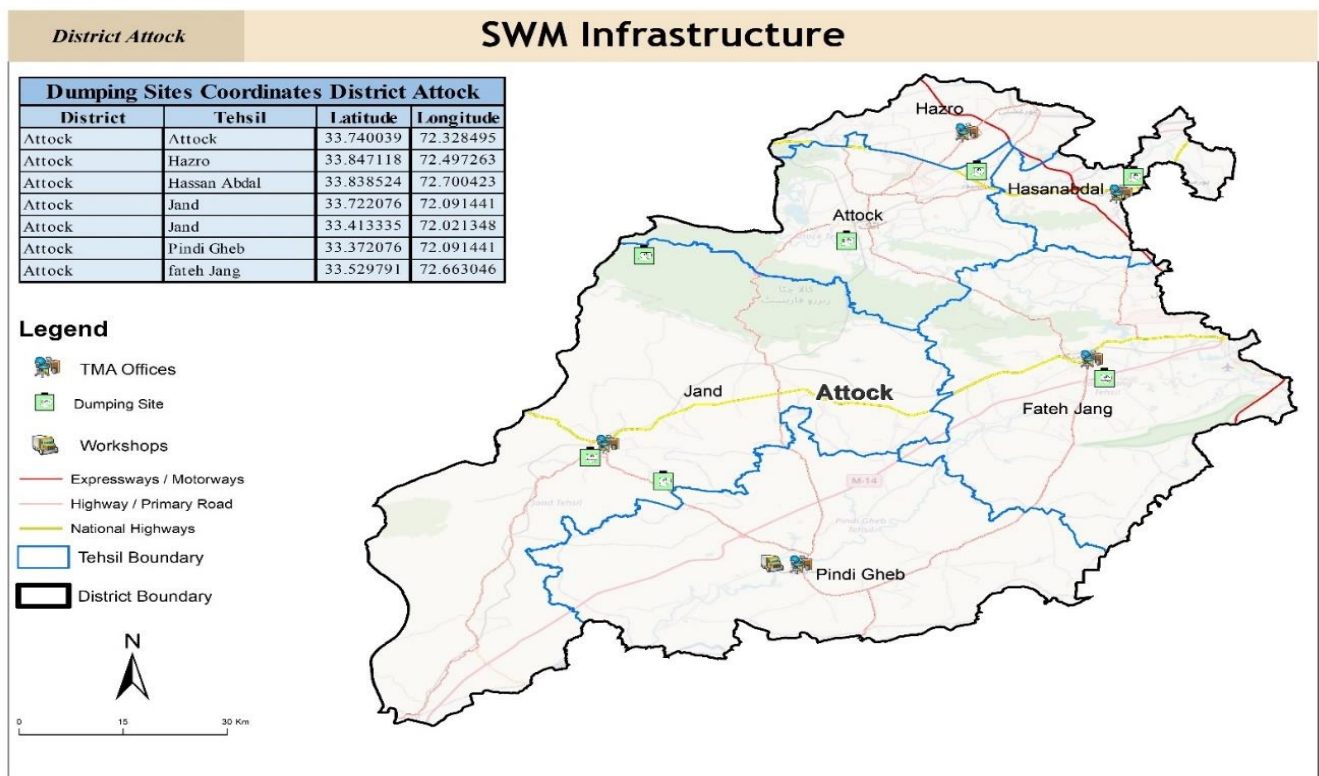


Figure 5.2: SWM infrastructure in District Attock

The below shown Maps will give the information about the existing solid waste management infrastructure in all tehsils of district Attock:

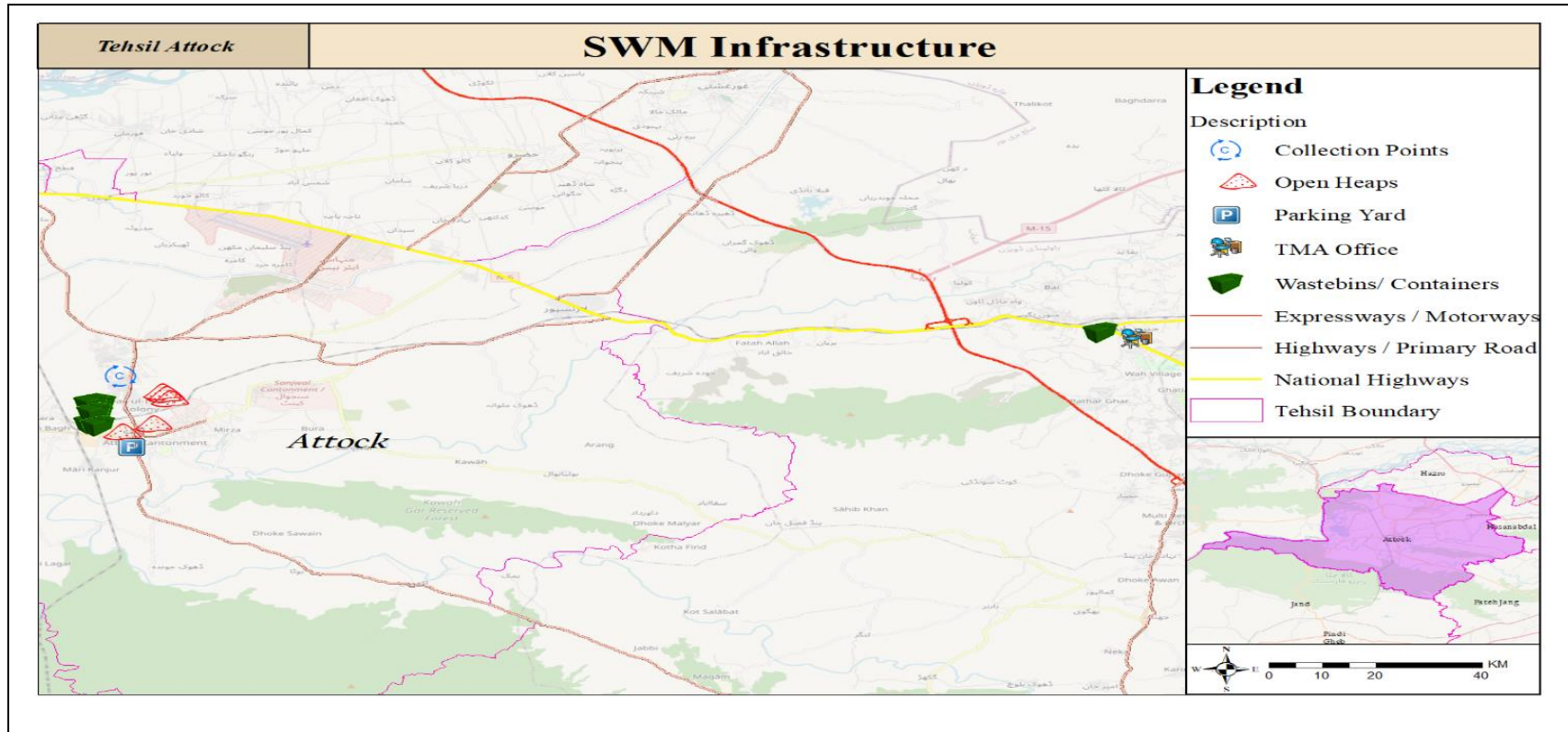
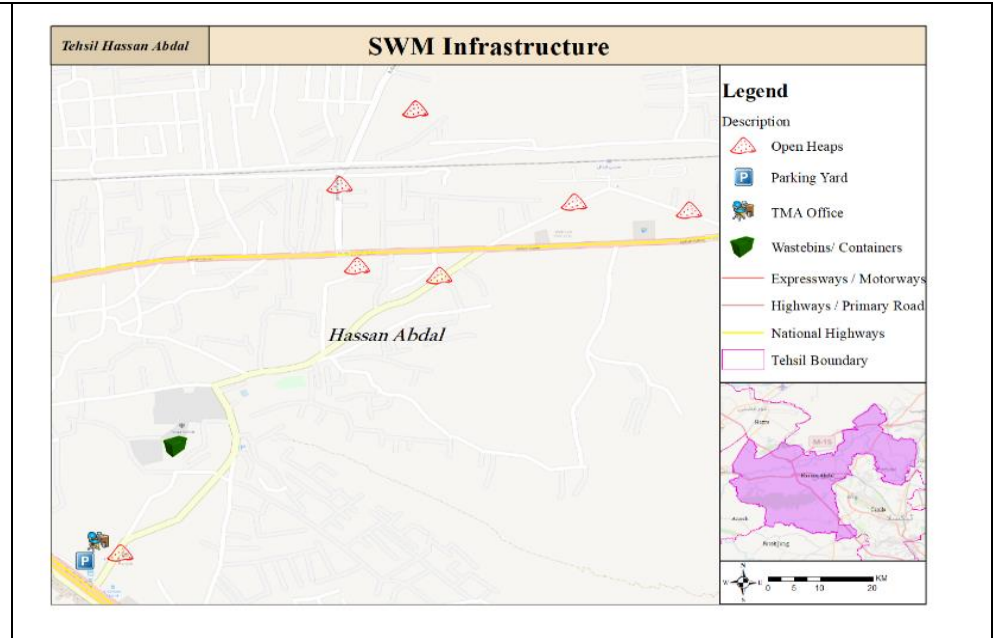
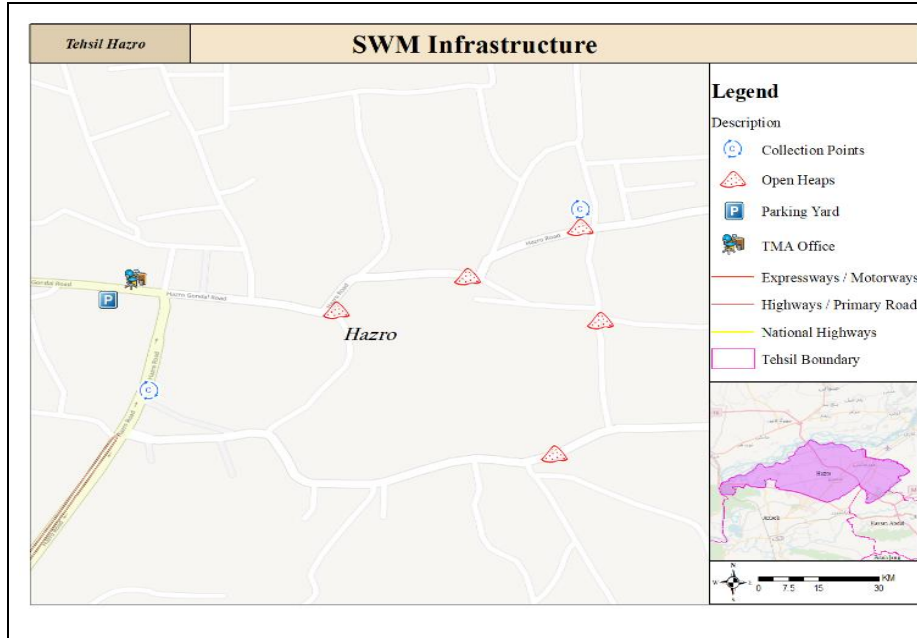
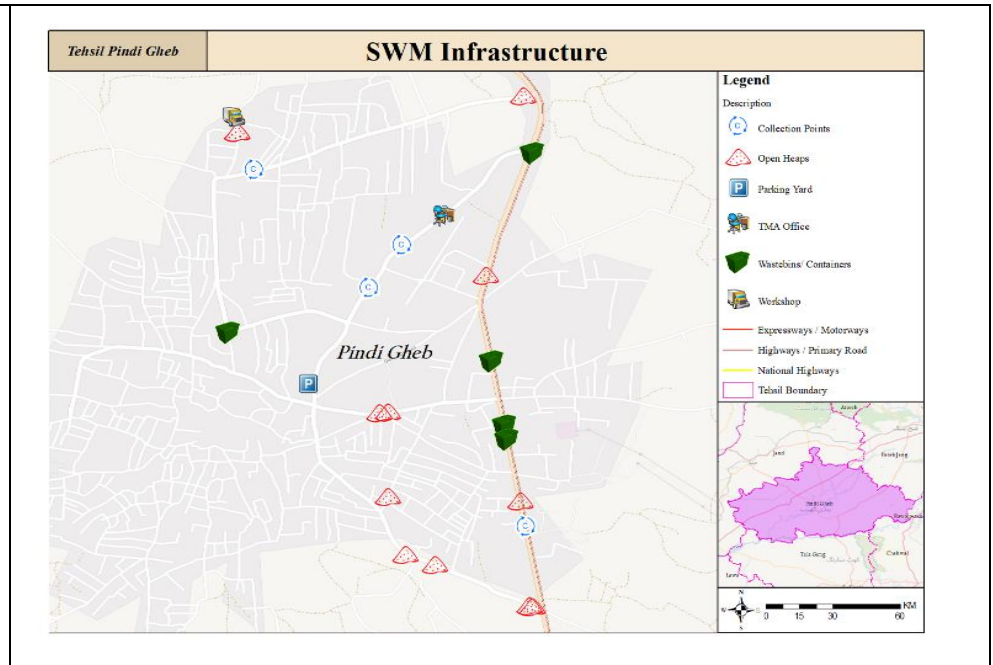
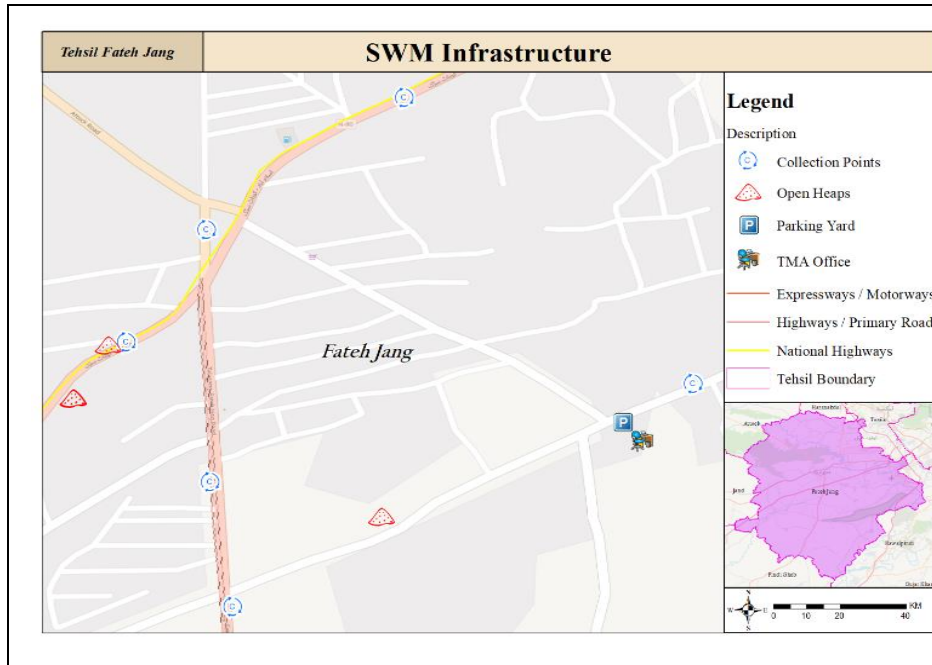


Figure 5.3 Swm Infrastructure In Attock Tehsil





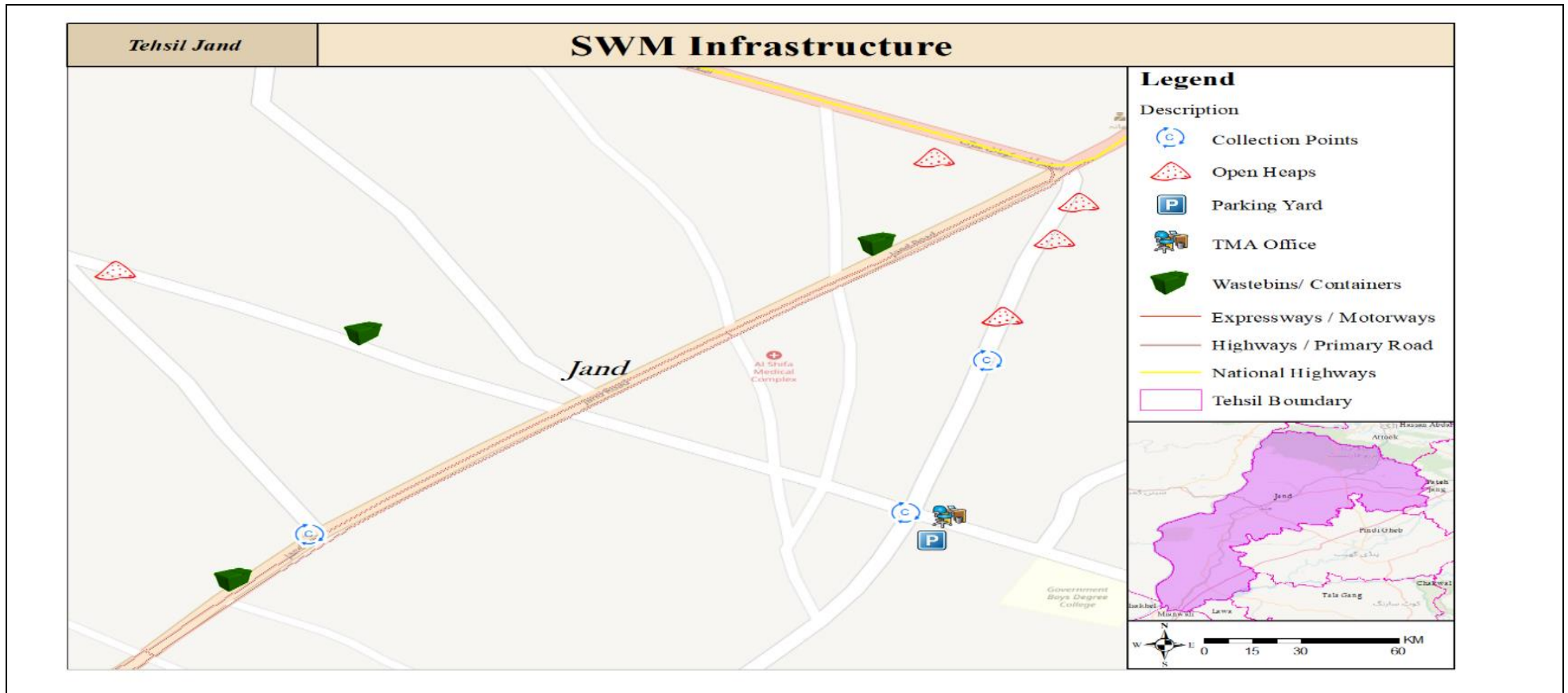


Figure 5.4: SWM infrastructure of Tehsils f Attock

Required resources

In urban areas of Attock resources allocation categorized depending upon mode of waste collection as Container Based Collection (CBC), Door to Door waste collection (DTD), commercial areas waste collection, private societies waste collection, bulk waste collection, TCPs/ transfer stations, mechanical sweeping & washing. Based on waste load, and area requirements, the number of compactors, arm rolls, mini dumpers, dumpers, loaders, collection containers (having capacities of 0.8m³/ 5m³), mechanical sweeper, and required human resources are proposed.

In rural area of Attock, mechanical resources including Raksha loader, tractor loader, tractor trolleys, drum bins, handcart and required human resources are calculated based on waste load and area requirement. The mechanical and HR resources required in urban and rural area of Attock details are given in the table below.

Table 5:1: Proposed Resources of District Attock

Waste Category	Resources	Attock Tehsil	Fateh Jang	Hasan Abdal	Hazro	Jand	Pindi Gheb	Total Fleet
CBC	Compactor 7cum	1	2	1	2	0	1	7
	Compactor 13cum	2	0	0	0	1	0	3
	Chain Arm Roll 5cum	1	2	1	2	1	1	8
	T Loader (4*4)	0	0	0	0	0	0	0
	Container 0.8cum	185	93	88	87	55	62	570
	Container 5cum	4	8	5	8	7	6	39
	Handcarts	189	138	93	141	119	112	792
	Drivers	4	4	2	4	2	2	18
	Helpers	7	6	3	6	3	3	28
Workers	568	414	280	422	356	335	2375	
DtD	Compactor 25cum	0	0	0	0	0	0	0
	Compactor 13cum	2	0	1	1	1	1	5
	Compactor 7cum	5	1	1	2	1	1	10
	Mini Dumper 1cum	17	4	5	11	6	8	51
	Mini Dumper 2.5cum	10	2	0	0	2	0	14
	Drivers	34	7	6	13	10	10	80
	Helpers	13	3	2	4	3	3	29
Commercial	Chain Arm Roll 5cum	1	0	1	0	0	0	2
	Compactor 25cum	0	0	0	0	0	0	0
	Compactor 13cum	0	0	0	0	0	0	0
	Compactor 7cum	1	0	1	1	0	1	3
	Container 0.8cum	80	22	33	27	22	31	167
	Container 5cum	5	2	3	2	2	1	11
	Drivers	2	0	2	1	0	1	5
	Helpers	4	0	4	2	0	2	10
Societies	Compactor 13cum	0	0	0	0	0	0	0
	Compactor 25cum	0	0	0	0	0	0	0

	Compactor 7cum	0	0	1	0	0	1	2
	Container 0.8cum	44	22	36	22	22	146	248
	Container 5cum	-	0	0	0	0	0	0
	Drivers	-	-	1	-	-	1	2
	Helpers	-	-	2	-	-	2	4
Bulk	Dumper 5cum	4	3	2	3	2	2	11
	Dumper 10cum	0	0	0	0	0	0	0
	T Loader (4*4)	3	2	1	2	2	2	8
	Excavator (Small)	1	1	0	1	0	0	2
	Trolleys	5	4	2	4	3	3	14
	Fronnd End Loader	1	1	0	1	0	0	2
	Drivers	14	10	6	10	9	8	38
	Helpers	4	3	2	3	2	2	11
TCPs	Dumper 25cum (MSW)	2	1	1	1	1	1	5
	Dumper 25cum (Bulk)	1	1	0	1	1	1	3
	Excavator (Large)	1	1	0	1	1	1	3
	Front End Loader	0	0	0	0	0	0	0
	Drivers	4	3	1	3	3	3	11
	Helpers	6	4	2	4	4	4	16
Mechanical Sweeping & Washing	Mech Sweeper 4m3	0	0	0	0	0	0	0
	Mech Sweeper 6m3	1	0	0	0	0	0	1
	Mech Washer 4500l	0	0	0	0	0	0	0
	Mech Washer 8000l	0	0	0	0	0	0	0
	Mech Sweeper with Washer 4m3	0	0	0	0	0	0	0
	Drivers	1	0	0	0	0	0	1
	Helpers	1	0	0	0	0	0	1
Total Drivers		59	24	18	31	23	25	126
Total Helpers		35	16	15	19	13	16	82
Total Workers		568	414	280	422	356	335	2375
Grand Total		662	454	313			376	1,805

Financial Costing:

The total cost for primary and secondary waste collection for the whole district has been calculated using above mentioned resources. The following parameters were considered in costing

- Cost of mechanical resources handcarts, loader rickshaws, containers, compactors, arm roll vehicles, container carrier, Containers), front end loaders.
- Capital cost including R/M cost, registration cost and depreciation cost
- Operational and maintenance Cost.
- Cost of HR for primary, secondary

The detail of each cost has been shown in tables below:

Table 5:2: Summary of Cost estimates in District Attock

Particulars	Attock Tehsil		Fateh Jang		Hasan Abdal		Hazro		Jand		Pindi Gheb	
	Per Month Cost	Per Annum Cost	Per Month Cost	Per Annum Cost	Per Month Cost	Per Annum Cost	Per Month Cost	Per Annum Cost	Per Month Cost	Per Annum Cost	Per Month Cost	Per Annum Cost
Machinery Operational Cost	21,735,065	260,820,782	11,888,536	142,662,429	6,808,932	81,707,183	12,650,492	151,805,898	10,675,031	128,100,367	11,428,050	137,136,605
Equipment & Container Cost	2,807,199	33,686,382	1,214,900	14,578,800	1,501,839	18,022,070	1,518,544	18,222,526	474,536	5,694,430	1,243,425	14,921,096
HR Manual work inc Janitorial	24,146,317	289,755,805	16,449,422	197,393,059	11,322,448	135,869,376	17,151,529	205,818,354	14,200,529	170,406,343	13,745,916	164,950,988
Total Operational Cost	48,688,581	584,262,969	29,552,857	354,634,289	19,633,219	235,598,628	31,320,565	375,846,779	25,350,095	304,201,139	26,417,391	317,008,690
Monitoring Cost 4%	1,947,543	23,370,519	1,182,114	14,185,372	785,329	9,423,945	1,252,823	15,033,871	1,014,004	12,168,046	1,056,696	12,680,348
Total Annual Cost	50,636,124	607,633,488	30,734,972	368,819,660	20,418,548	245,022,574	32,573,387	390,880,650	26,364,099	316,369,184	27,474,086	329,689,037
Annual Tonnage	7,145	85,740	4,097	49,158	3,184	38,205	4,177	50,128	3,521	42,253	3,314	39,764
Cost per ton	7,087	7,087	7,503	7,503	6,413	6,413	7,798	7,798	7,488	7,488	8,291	8,291
Population	510,938	510,938	372,837	372,837	251,633	251,633	380,188	380,188	320,462	320,462	301,585	301,585
House Hold	80,973	78,245	60,624	57,096	40,717	38,535	61,519	58,222	51,855	49,075	48,800	46,184
Cost per Person	99	1,189	82	989	81	974	86	1,028	82	987	91	1,093
Cost per Household	625	7,766	507	6,460	501	6,358	529	6,714	508	6,447	563	7,139

Table 5:3: HR cost Requirement for Attock District

Tehsil	Workers	Per month Cost including janitorial	Per Annum Cost	Drivers LTV	Per month Cost	Per Annum Cost	Driver HTV	Per month Cost	Per Annum Cost	Helpers	Per month Cost	Per Annum Cost
Attock Tehsil	568	20,380,752	244,569,018.66	27.00	1,023,300	12,279,600	33	1,398,267	16,779,206	37	1,343,998	16,127,981
Fateh Jang	414	14,872,057	178,464,683.61	6.00	227,400	2,728,800	18	786,886	9,442,629	16	563,079	6,756,947
Hasan Abdal	280	10,037,342	120,448,104.81	5.00	189,500	2,274,000	13	564,191	6,770,297	15	531,414	6,376,974
Hazro	422	15,165,266	181,983,196.37	11.00	416,900	5,002,800	20	875,659	10,507,903	19	693,705	8,324,454
Jand	356	12,782,863	153,394,358.40	8.00	303,200	3,638,400	15	655,166	7,861,989	13	459,300	5,511,595
Pindi Gheb	335	12,029,873	144,358,481.38	8.00	303,200	3,638,400	18	753,337	9,040,046	18	659,505	7,914,061
Total	2375	85,268,154	1,023,217,843	65	2,463,500	29,562,000	117	5,033,506	60,402,071	118	4,251,001	51,012,011

Table 5:4: Machinery cot Requirement for District Attock

Sr. No.	Vehicle Type	Total Quantity Required	Life (in Year)	Cost /Unit	Registration	Gross Cost/Unit	Gross Cost	R&M Cost /year	Insurance / Year	Operating Expense /year	Depreciation / Year (10% Residual Value)	Total Cost / Annual
1	Compactor 7cum	25	7	14,900,000	298,000.00	15,198,000	372,950,921	37,295,092.11	9,323,773	46,618,865	47,950,833	94,569,698
2	Compactor 13cum	8	7	25,800,000	516,000.00	26,316,000	212,172,750	21,217,275	5,304,319	26,521,594	27,279,354	53,800,947
3	Chain Arm Roll 5cum	9	7	1,550,000	31,000.00	1,581,000	14,229,000	1,422,900	355,725	1,778,625	1,829,443	3,608,068
4	T Loader (4*4)	13	7	5,300,000	106,000.00	5,406,000	68,150,639	6,815,064	1,703,766	8,518,830	8,762,225	17,281,055
5	COMP 25cum	-	7	30,000,000	600,000.00	30,600,000	-	-	-	-	-	-
6	Mini Dumper 1cum	51	7	2,650,000	53,000.00	2,703,000	137,853,000	13,785,300	3,446,325	17,231,625	17,723,957	34,955,582
7	Mini Dumper 2.5cum	14	7	5,000,000	100,000.00	5,100,000	71,400,000	7,140,000	1,785,000	8,925,000	9,180,000	18,105,000
8	Dumper 5cum	16	7	12,500,000	250,000.00	12,750,000	206,656,250	20,665,625	5,166,406	25,832,031	26,570,089	52,402,121
9	Dumper 10cum	-	7	23,400,000	468,000.00	23,868,000	-	-	-	-	-	-
10	Trolleys	22	7	4,606,549	92,130.98	4,698,680	101,543,695	10,154,370	2,538,592	12,692,962	13,055,618	25,748,580
11	Fron End Loader	4	7	15,800,000	316,000.00	16,116,000	66,907,514	6,690,751	1,672,688	8,363,439	8,602,395	16,965,834
12	Dumper 25cum (MSW)	12	7	37,000,000	740,000.00	37,740,000	452,880,000	45,288,000	11,322,000	56,610,000	58,227,429	114,837,429
13	Excavator (Large)	8	7	54,900,000	1,098,000.00	55,998,000	456,474,438	45,647,444	11,411,861	57,059,305	58,689,571	115,748,875
14	Mech Washer 4500 L	-	7	23,000,000	460,000.00	23,460,000	-	-	-	-	-	-
15	Mech Washer 8000 L	-	7	27,400,000	548,000.00	27,948,000	-	-	-	-	-	-
16	Mech Sweeper 4m3	-	7	18,000,000	360,000.00	18,360,000	-	-	-	-	-	-
17	Mech Sweeper 6m3	1	7	28,900,000	578,000.00	29,478,000	29,478,000	2,947,800	736,950	3,684,750	3,790,029	7,474,779
Total		182					2,190,696,206	219,069,621	54,767,405	273,837,026	281,660,941	555,497,967

Table 5.5: Operational Cost Requirement for Attock District

Vehicle	Number of Machine	Depreciation	Fuel /year	R&M Insurance &	Total Cost	Cost per unit / Annum	Cost per Unit / Month
Compactor 7cum	25	47,950,833	50,735,853	46,618,865	145,305,550	5,921,299	493,442
Compactor 13cum	8	27,279,354	19,308,162	26,521,594	73,109,109	9,067,797	755,650
Chain Arm Roll 5cum	9	1,829,443	13,955,760	1,778,625	17,563,828	1,951,536	162,628
T Loader (4*4)	13	8,762,225	27,925,878	8,518,830	45,206,933	3,586,007	298,834
Compactor 25cum	0	-	-	-	-	-	-
Mini Dumper 1cum	51	17,723,957	30,126,720	17,231,625	65,082,302	1,276,124	106,344
Mini Dumper 2.5cum	14	9,180,000	11,164,608	8,925,000	29,269,608	2,090,686	174,224
Dumper 5cum	16	26,570,089	32,314,230	25,832,031	84,716,351	5,226,716	435,560
Dumper 10cum	0	-	-	-	-	-	-
Trolleys	22	13,055,618	47,872,933	12,692,962	73,621,513	3,406,651	283,888
Fronnd End Loader	4	8,602,395	17,657,605	8,363,439	34,623,439	8,339,741	694,978
Dumper 25cum (MSW)	12	58,227,429	59,810,400	56,610,000	174,647,829	14,553,986	1,212,832
Excavator (Large)	8	58,689,571	43,337,927	57,059,305	159,086,802	19,515,973	1,626,331
Mech Washer 4500 L	0	-	-	-	-	-	-
Mech Washer 8000 L	0	-	-	-	-	-	-
Mech Sweeper 4m3	0	-	-	-	-	-	-
Mech Sweeper 6m3	1	3,790,029	4,430,400	3,684,750	11,905,179	11,905,179	992,098
Total				273,837,026	914,138,443	86,841,694	7,236,808

6. CHAPTER 5 DISTRICT JHELUM

GEOGRAPHIC AND DEMOGRAPHIC OVERVIEW OF JHELUM DISTRICT:

GEOGRAPHIC SITUATION: Jhelum District, lying at 32°56' North latitude and 73°44' East longitude, Jhelum is located a 1-hour and 30 minutes' drive from the Capital of Pakistan Islamabad, and 3 hours' drive from the heart of Punjab Lahore. Jhelum is linked with these cities through the National Highway N-5. Several cities are within 1 to 2 hours' drive including Gujrat. The district spans an area of approximately 3,587 square kilometers, constituting about 1.7% of Punjab's total area.

DEMOGRAPHIC SITUATION:

Urban Population: Jhelum District is home to a diverse population, with an estimated urban population of 698,521. This urban populace comprises 352,987 males and 345,534 females, reflecting a balanced demographic distribution. The average annual growth rate of the urban population stands at 2.1%.

Rural Population: The rural areas of Jhelum District significantly contribute to its overall population, with an estimated total rural population of 1,827,690. Comprising 924,510 males and 903,180 females, the rural landscape maintains a distinctive demographic profile. The average annual growth rate of the rural population is 1.8%.

As Jhelum District navigates its geographic and demographic intricacies, it stands as a vital part of northern Punjab, offering a blend of urban and rural lifestyles, historical significance, and strategic importance. The district's land area contributes to its role in shaping the larger landscape of the Punjab province in Pakistan.

WASTE GENERATION IN DISTRICT JHELUM:

In Jhelum Current Per capita waste generation is 0.4 kg per capital, which is likely to increase by 1.5% every year.¹¹ Jhelum Tehsil is producing a waste of 203 tons every day and Pind dadan khan is also producing approximately of 150 tonnes on daily basis out of which 80 percent of waste is Municipal waste and 20 percent is referred as bulk waste. Dina and Sohawa Tehsils of District Jhelum are also producing around 200 tons of waste daily and the collections efficiency of MC Dina and MC Sohawa is very low due to financial and technical hindrances.

¹¹ <https://pmdfc.org.pk/Content/Uploads/ISWM-Jhelum.pdf>

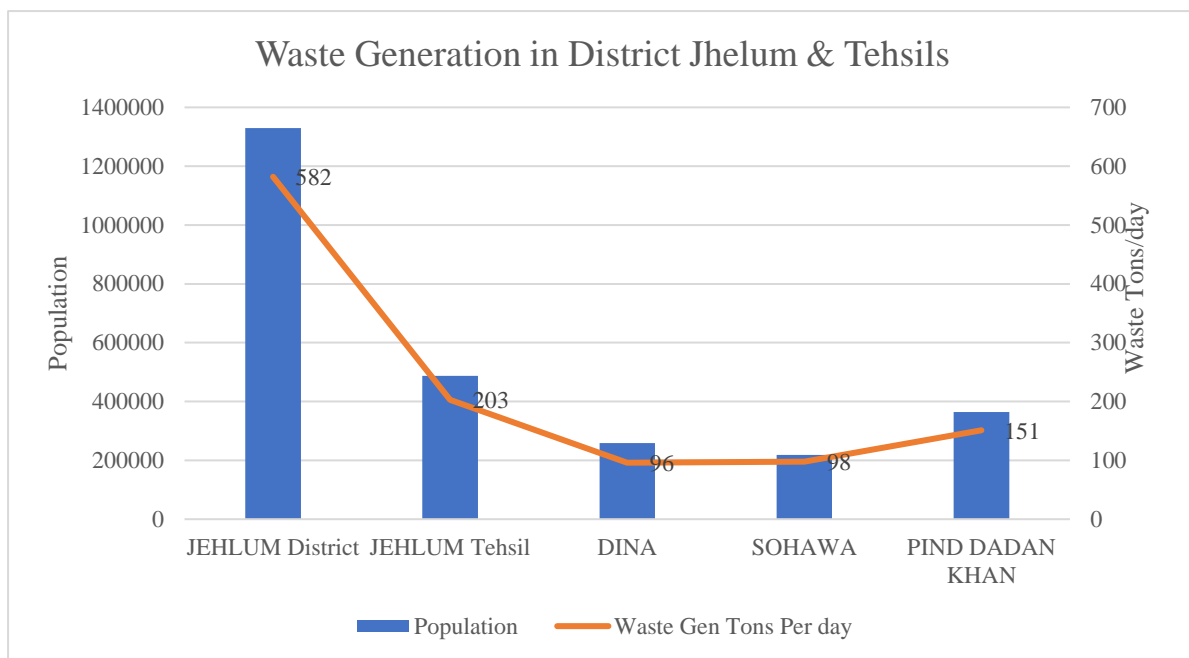


Figure 6.1: Population vs Waste Generation

CURRENT SOLID WASTE MANAGEMENT IN DISTRICT JHELUM:

In Jhelum district, the solid waste management (SWM) services are currently managed by the Municipal Committee (MC). However, there are significant challenges in the existing waste collection and transportation methods, resulting in inefficiencies within the system. The allocation of sanitary workers for SWM is insufficient, and a well-established system is lacking. Currently, sanitary workers in Jhelum district rely on traditional methods for waste collection and transportation. They sweep streets and roads and collect solid waste from small heaps using brooms, wheelbarrows, and similar tools. The collected waste is then stored at both permanent and temporary collection points. However, this system suffers from poor collection efficiency, requiring more time and manpower to collect and transport the solid waste to the designated dumpsites. To manage waste collection in Jhelum district, sanitary workers are deployed along with handcarts and tractor trolleys. They collect waste from households and clear open lots and streets. However, the practice of door-to-door collection is not currently implemented in the city.

In Jhelum district, secondary waste collection is carried out using tractor trolleys and container carriers. However, the existing machinery is insufficient to meet the waste management needs of the district. To facilitate secondary waste collection, Jhelum has established various infrastructure facilities such as open heaps, masonry enclosures, and covered steel containers. These serve as collection points where daily waste collection takes place. The collected waste is stored in containers with a capacity of 5m³ and 0.8m³.

For the transportation of waste, container carrier vehicles are utilized, while tractor trolleys and loaders are employed to clear open waste and temporary collection points. When it comes to waste disposal, the current practice in Jhelum involves dumping the waste at designated collection points within the city. Subsequently, the waste is transported to the dumping site or transfer station using trolleys and

dumpers. The responsibility of waste collection extends beyond municipal waste in Jhelum district. The Town Municipal Administration (TMA) is tasked with collecting waste from sources such as demolition debris, hospitals, slaughterhouses, vegetable markets, and dead animals, which are often mixed with the municipal waste. However, it is worth noting that precise data regarding scavenging and other hazardous wastes is not currently available with the Municipal Committee (MC).

The following maps will show the current infrastructure of dumpsites district Jhelum and its tehsils and the distance of Dumpsites from the city center;

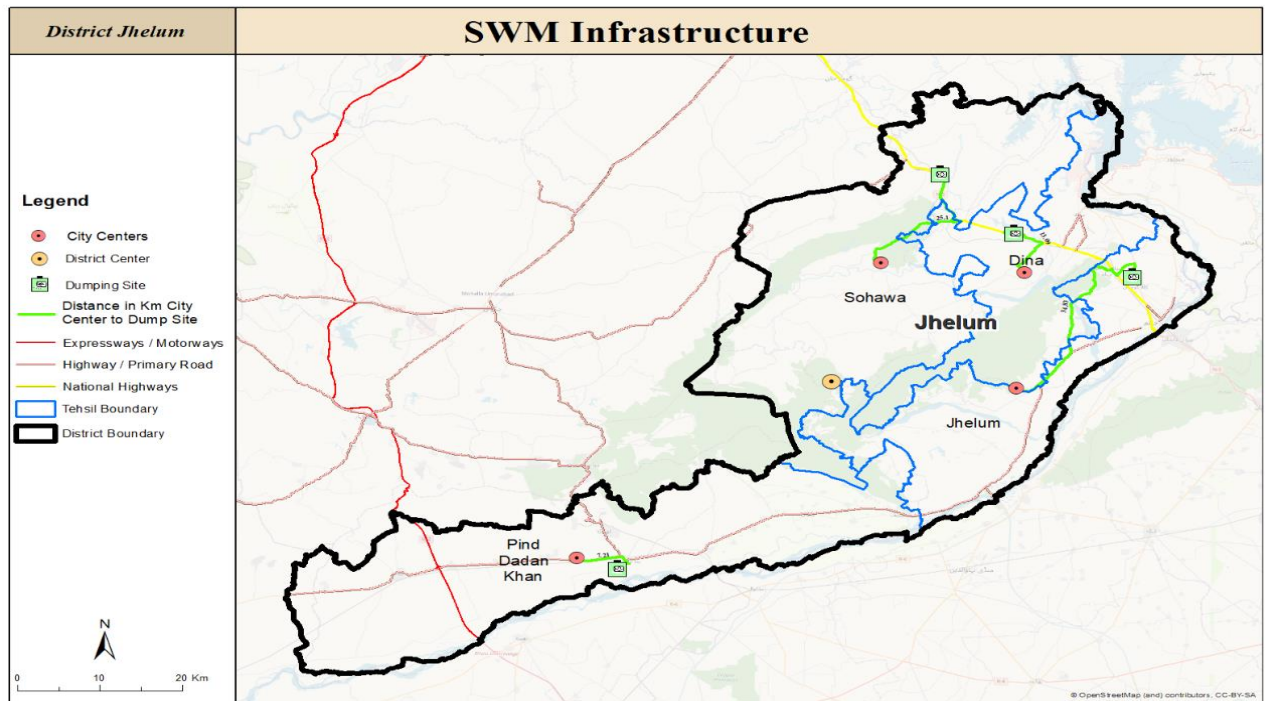
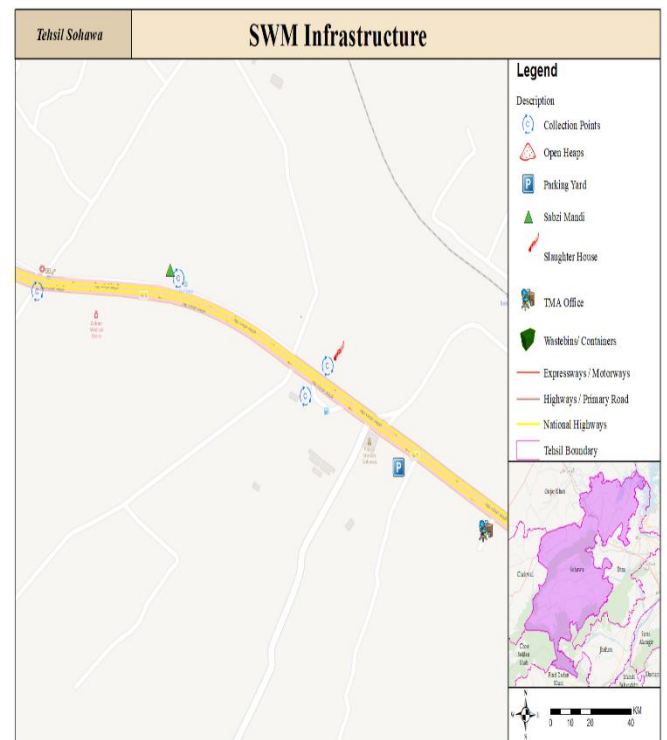
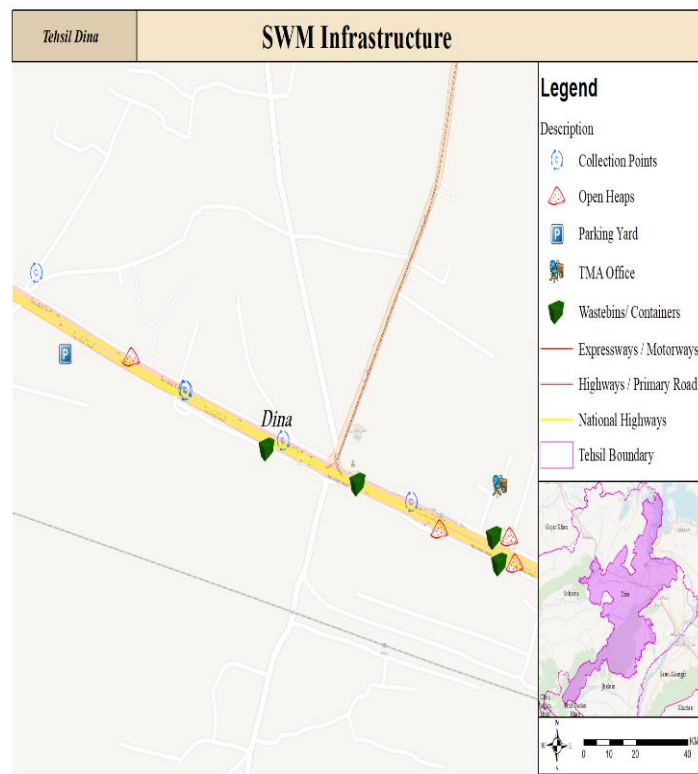
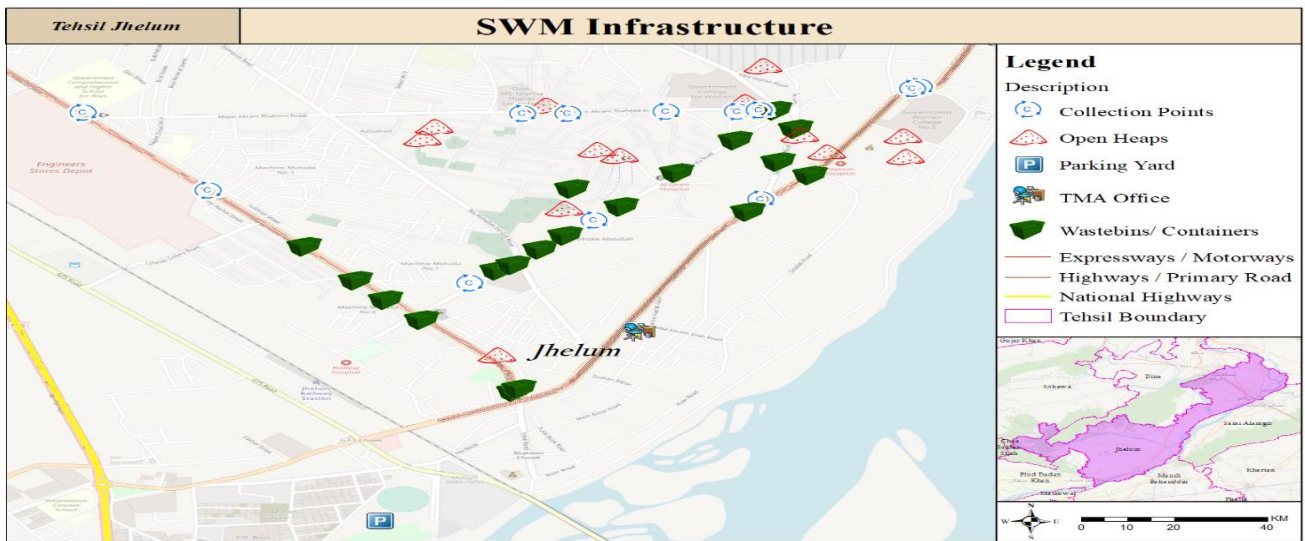


Figure 6.2: SWM infrastructure of Jhelum District

The following given maps will now show the existing infrastructure on tehsil level of district Jhelum;

DISTRICT JHELUM



Required resources

In urban areas of Jhelum resources allocation categorized depending upon mode of waste collection as Container Based Collection (CBC), Door to Door waste collection (DTD), commercial areas waste collection, private societies waste collection, bulk waste collection, TCPs/ transfer stations, mechanical sweeping & washing. Based on waste load, and area requirements, the number of compactors, arm rolls, mini dumpers, dumpers, loaders, collection containers (having capacities of 0.8m³/ 5m³), mechanical sweeper, and required human resources are proposed.

In rural area of Jhelum, mechanical resources including Raksha loader, tractor loader, tractor trolleys, drum bins, handcart and required human resources are calculated based on waste load and area requirement. The mechanical and HR resources required in urban and rural area of Jhelum details are given in the table below.

Table 6:1: Proposed Resources for District Jhelum

Waste Category	Resources	Jhelum Tehsil	Pind Dadan Khan	Sohwa	Total Fleet
CBC	Compactor 7cum	2	0	1	3
	Compactor 13cum	1	1	0	2
	Chain Arm Roll 5cum	2	2	0	4
	T Loader (4*4)	0	0	0	0
	Container 0.8cum	160	75	82	316
	Container 5cum	10	10	2	22
	Handcarts	181	152	91	423
	Drivers	5	3	1	9
	Helpers	8	4	2	14
	Workers	542	455	273	1270
DtD	Compactor 25cum	0	0	0	0
	Compactor 13cum	1	1	0	2
	Compactor 7cum	2	1	0	3
	Mini Dumper 1cum	9	5	0	14
	Mini Dumper 2.5cum	5	1	0	6
	Drivers	17	7	0	25
	Helpers	7	3	1	10
Commercial	Chain Arm Roll 5cum	1	0	0	1
	Compactor 25cum	0	0	0	0
	Compactor 13cum	0	0	0	0
	Compactor 7cum	1	1	4	6
	Container 0.8cum	93	40	62	196
	Container 5cum	6	2.4	2	10
	Drivers	2	1	4	7
	Helpers	4	2	8	14
Societies	Compactor 13cum	0	1	1	2
	Compactor 25cum	0	0	0	0

	Compactor 7cum	0	0	0	0
	Container 0.8cum	67	44	44	155
	Container 5cum	-	0	0	0
	Drivers	-	1	1	2
	Helpers	-	2	2	4
Bulk	Dumper 5cum	3	3	2	8
	Dumper 10cum	1	0	0	1
	T Loader (4*4)	2	2	3	7
	Excavator (Small)	1	1	1	2
	Trolleys	2	4	6	12
	Fronnd End Loader	1	1	1	2
	Drivers	9	11	12	32
	Helpers	4	3	2	9
TCPs	Dumper 25cum (MSW)	2	1	2	5
	Dumper 25cum (Bulk)	1	1	2	4
	Excavator (Large)	1	1	4	6
	Front End Loader	0	0	1	1
	Drivers	4	3	9	16
	Helpers	6	4	8	18
Mechanical Sweeping & Washing	Mech Sweeper 4m3	1	2	0	3
	Mech Sweeper 6m3	1	0	0	1
	Mech Washer 4500l	3	4	0	7
	Mech Washer 8000l	2	0	0	2
	Mech Sweeper with Washer 4m3	0	0	0	0
	Drivers	7	6	0	13
	Helpers	12	10	0	22
Total Drivers		44.66	33	27	104
Total Helpers		40.91	28	22	91
Total Workers		542	455	273	1,270
Grand Total		627	515	323	1,465

Financial Costing:

The total cost for primary and secondary waste collection for the whole district has been calculated using above mentioned resources. The following parameters were considered in costing

- Cost of mechanical resources handcarts, loader rickshaws, containers, compactors, arm roll vehicles, container carrier, Containers), front end loaders.
- Capital cost including R/M cost, registration cost and depreciation cost
- Operational and maintenance Cost.
- Cost of HR for primary, secondary

The detail of each cost has been shown in tables below

Table 6:2: Summary of Costs Requirement in Jhelum District

Particulars	Jhelum Tehsil		Pind Dadan Khan		Sohwa	
	Per Month Cost	Per Annum Cost	Per Month Cost	Per Annum Cost	Per Month Cost	Per Annum Cost
Machinery Operational Cost	23,824,410	285,892,920	19,501,539	234,018,471	30,531,741	366,380,896
Equipment & Continer Cost	1,396,396	16,756,758	769,196	9,230,353	757,482	9,089,785
HR Manual work inc Jantorial	22,768,373	273,220,475	18,695,615	224,347,381	11,774,682	141,296,183
Total Operational Cost	47,989,179	575,870,153	38,966,350	467,596,205	43,063,905	516,766,864
Monitoring Cost 4%	1,919,567	23,034,806	1,558,654	18,703,848	1,722,556	20,670,675
Total Annual Cost	49,908,747	598,904,959	40,525,004	486,300,054	44,786,462	537,437,538
Annual Tonnage	6,820	81,840	4,605	55,262	2,768	33,216
Cost per ton	7,318	7,318	8,800	8,800	16,180	16,180
Population	487,700	487,700	363,983	363,983	218,778	218,778
House Hold	77,290	74,686	59,184	55,740	35,401	33,504
Cost per Person	102	1,228	111	1,336	205	2,457
Cost per Household	646	8,019	685	8,724	1,265	16,041

Table 6:3: Cost requirement for HR in Jhelum

Tehsil	Workers	Per month Cost including janitorial	Per Cost	Annum	Drivers LTV	Per month Cost	Per Cost	Annum	Driver HTV	Per month Cost	Per Cost	Annum	Helpers	Per month Cost	Per Cost	Annum
Jhelum Tehsil	542	19,453,808	233,445,696.88		14.00	530,600	6,367,200		31	1,315,285	15,783,418		41	1,468,680	17,624,160	
Pind Dadan Khan	455	16,333,756.68	196,005,080		6.00	227,400	2,728,800		27	1,137,367	13,648,409		28	997,091	11,965,092	
Sohwa	273	9,817,660	117,811,925		-	-	-		27	1,156,042	13,872,505		22	800,979	9,611,753	
Total	1270	45,605,225	547,262,702		20	758,000	9,096,000		84	3,608,694	43,304,333		91	3,266,750	39,201,005	

Table 6:4: Cost of Machinery Requirement in Jhelum district

Sr. No.	Vehicle Type	Total Quantity Required	Life (in Year)	Cost /Unit	Registration	Gross Cost/Unit	Gross Cost	R&M Cost /year	Insurance / Year	Operating Expense /year	Depreciation / Year (10% Residual Value)	Total Cost / Annual
1	Compactor 7cum	12	7	22,000,000	440,000.00	22,440,000	274,890,000	27,489,000.00	6,872,250	34,361,250	35,343,000	69,704,250
2	Compactor 13cum	6	7	28,000,000	560,000.00	28,560,000	175,287,000	17,528,700	4,382,175	21,910,875	22,536,900	44,447,775
3	Chain Arm Roll 5cum	5	7	18,000,000	360,000.00	18,360,000	91,800,000	9,180,000	2,295,000	11,475,000	11,802,857	23,277,857
4	T Loader (4*4)	7	7	5,500,000	110,000.00	5,610,000	39,994,625	3,999,463	999,866	4,999,328	5,142,166	10,141,494
5	Mini Dumper 1cum	14	7	2,620,822	52,416.44	2,673,238	37,425,338	3,742,534	935,633	4,678,167	4,811,829	9,489,996
6	Mini Dumper 2.5cum	6	7	5,175,702	103,514.04	5,279,216	31,675,296	3,167,530	791,882	3,959,412	4,072,538	8,031,950
7	Dumper 5cum	8	7	20,000,000	400,000.00	20,400,000	158,780,000	15,878,000	3,969,500	19,847,500	20,414,571	40,262,071
8	Dumper 10cum	1	7	28,000,000	560,000.00	28,560,000	32,487,000	3,248,700	812,175	4,060,875	4,176,900	8,237,775
9	Trolleys	12	7	4,606,549	92,130.98	4,698,680	58,576,877	5,857,688	1,464,422	7,322,110	7,531,313	14,853,422
10	Fronnd End Loader	3	7	10,000,000	200,000.00	10,200,000	28,379,375	2,837,938	709,484	3,547,422	3,648,777	7,196,199
11	Dumper 25cum (MSW)	9	7	37,000,000	740,000.00	37,740,000	339,660,000	33,966,000	8,491,500	42,457,500	43,670,571	86,128,071
12	Excavator (Large)	8	7	53,000,000	1,060,000.00	54,060,000	420,710,688	42,071,069	10,517,767	52,588,836	54,091,374	106,680,210
13	Mech Sweeper 6m3	1	7	23,000,000	460,000.00	23,460,000	23,460,000	2,346,000	586,500	2,932,500	3,016,286	5,948,786
14	Mech Sweeper 4m3	3	7	14,000,000	280,000.00	14,280,000	42,840,000	4,284,000	1,071,000	5,355,000	5,508,000	10,863,000
15	Mech Washer 4500l	7	7	24,204,149	484,082.98	24,688,232	172,817,624	17,281,762	4,320,441	21,602,203	22,219,409	43,821,612
16	Mech Washer 8000l	2	7	24,204,149	484,082.98	24,688,232	49,376,464	4,937,646	1,234,412	6,172,058	6,348,403	12,520,461
Total		104					1,978,160,287	197,816,029	49,454,007	247,270,036	254,334,894	501,604,930

Table 6:5: Operational Cot Requirement in Jhelum District

Vehicle	Number of Machine	Depreciation	Fuel /year	R&M & Insurance	Total Cost	Cost per unit / Annum
Compactor 7cum	12	35,343,000	27,289,080	34,361,250	96,993,330	7,917,823
Compactor 13cum	6	22,536,900	15,836,741	21,910,875	60,284,516	9,822,324
Chain Arm Roll 5cum	5	11,802,857	8,353,800	11,475,000	31,631,657	6,326,331
T Loader (4*4)	7	5,142,166	17,015,895	4,999,328	27,157,389	3,809,336
Mini Dumper 1cum	14	4,811,829	8,910,720	4,678,167	18,400,716	1,314,337
Mini Dumper 2.5cum	6	4,072,538	5,155,488	3,959,412	13,187,438	2,197,906
Dumper 5cum	8	20,414,571	16,719,534	19,847,500	56,981,605	7,320,977
Dumper 10cum	1	4,176,900	3,257,982	4,060,875	11,495,757	10,106,160
Trolleys	12	7,531,313	29,755,440	7,322,110	44,608,862	3,578,251
Fronnd End Loader	3	3,648,777	12,750,286	3,547,422	19,946,484	7,169,085
Dumper 25cum (MSW)	9	43,670,571	48,332,700	42,457,500	134,460,771	14,940,086
Excavator (Large)	8	54,091,374	44,579,457	52,588,836	151,259,667	19,436,391
Mech Sweeper 6m3	1	3,016,286	4,773,600	2,932,500	10,722,386	10,722,386
Mech Sweeper 6m3	3	5,508,000	7,160,400	5,355,000	18,023,400	6,007,800
Mech Washer 4500l	7	22,219,409	16,707,600	21,602,203	60,529,212	8,647,030
Mech Washer 8000l	2	6,348,403	-	6,172,058	12,520,461	6,260,230
Total				247,270,036	768,203,652	125,576,454

7. CHAPTER 6 MATERIAL RECOVERY FACILITY

In developed world least, preferred option for SWM is disposal of waste at dumping site or landfill to minimize its Harmful effects on the environment and sustainable use of land. So, we have proposed Material recovery facility for Rawalpindi city. The term **STD** is coined by the Urban Unit, referred to **Segregation, Treatment & Disposal** of the Municipal Solid Waste.

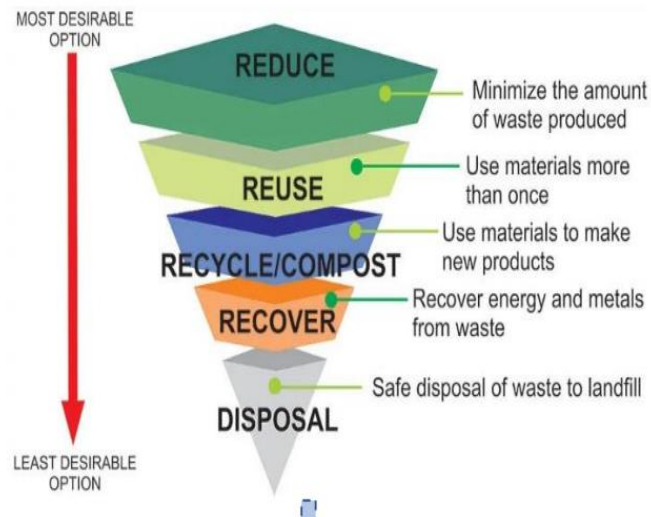


Figure 7.: 7.1 Waste Management Hierarchy

Segregation.

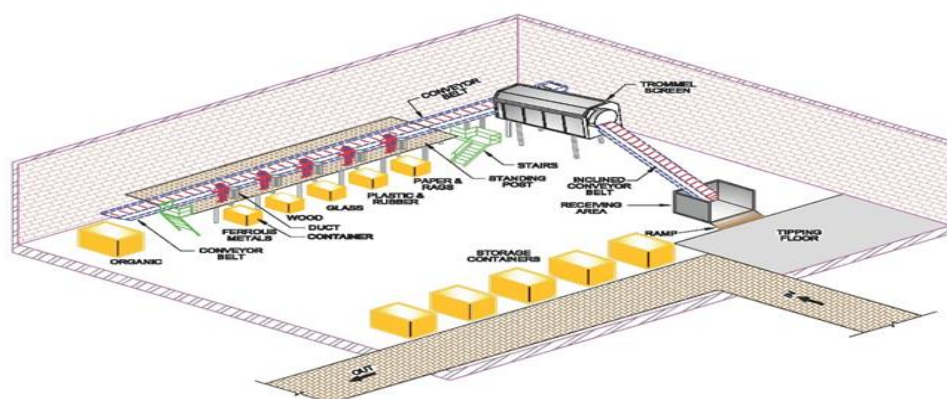
- Material Sorting Facility for recovering of the **Recyclables** (Plastic, Paper, Glass, ferrous Metals, Non-Ferrous Metals, Tetra Pack, cardboard etc.) and **combustibles** for production of Refused Derived Fuels (RDF)

Treatment

- Production of the compost from the **organic/ putrescible** waste.
- Production of RDF which can be used as fuel

Disposal

- Safe disposal of the residual **inert waste** on scientific basis



COMPONENTS OF STD.

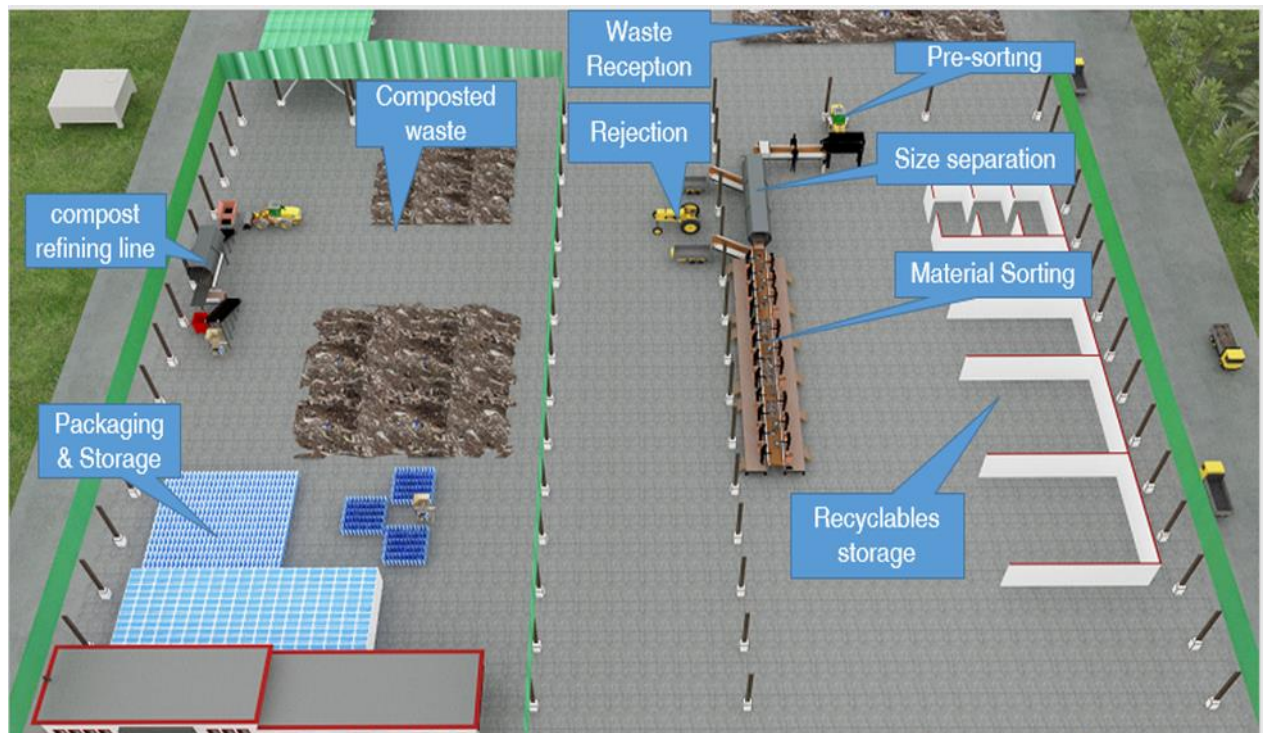


Figure 7.2: Components of Material Recovery Facility

BENEFITS OF THE FACILITY

- Convert Organic Waste to Compost.
- Segregation of Recyclable Material
- Segregation for Refuse-Derived Fuel (RDF) Material.



ENVIRONMENTAL BENEFITS

Improvement in Groundwater Quality

After sorting and treatment, organic material which cause leachate formation will be converted to Compost, thus preventing any further water pollution.

Improvement in Air Quality

Burning of waste produce many toxic compounds which cause air pollution and endanger human health. After processing through this facility most of waste will be utilized and thus preventing the air pollution.

Improvement in Soil Quality

Use of the compost in agriculture as a fertilizer will help soil to retain and absorb nutrients and water. Better water retention means less watering which ultimately help water conservation.

DETAILS OF ACTIVITIES OF STD FACILITY

The different activities performed in Segregation, Treatment and Disposal Facility (STD) Facility depend upon the functions of STD Facility i.e.

- The role that the STD Facility is to serve in the waste management system
- The types of material to be recovered
- The form in which the materials to be recovered will be delivered to the STD Facility
- The containerization and storage of processed materials for the buyer.

In view of the abovementioned functions, the following processing and recovery activities are being formulated for the STD Facility receiving mixed MSW of Rawalpindi City:

- Material Handling (transport and transfer of solid waste)
- Manual Sorting (recovery of recyclable materials from solid waste)
- Size Separation (separation of contraries and organics from the solid waste)
- Size Reduction (removal of bulky items)
- Densification (compaction of recovered materials)

Different operations to be carried out in STD Facility are best described with the help of following process flow diagram shown in below figure

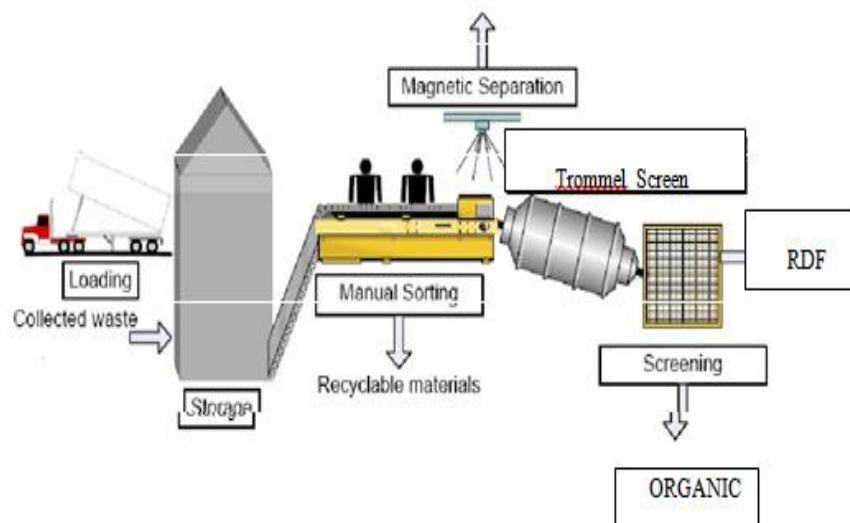


Figure 7.3 Processing Activities At STD

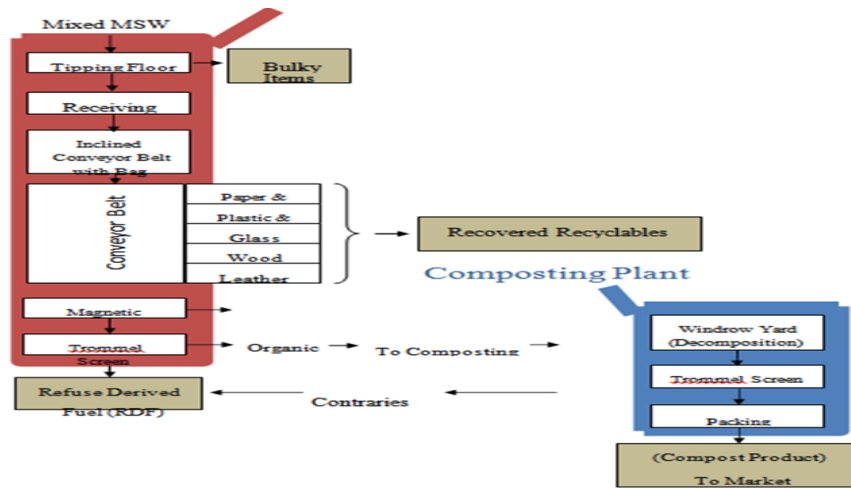


Figure 7.4 Flow Diagram of STD

PROCESS DESCRIPTION OF COMPOSTING

Composting is a biological process which utilizes microorganisms present in organic matter and soil naturally to decompose it into a stable organic material. The raw materials going into the compost are often referred to as “feedstock.” The end product, compost, is a dark brown, humus-like material which can be easily and safely handled, stored, and applied to land as a valuable soil conditioner as shown in below figure



Figure 7.5: Waste to Compost

Windrow Composting

When enough space is available, compost is formed into long, narrow conical piles as shown in figure 6-7. This method is used most often for on-farm composting. Width and height of windrows depends on the equipment used to turn and aerate the piles, and lengths are flexible increasing with the area availability. Windrows can be turned with a frontend loader or tractor. Specialized windrow turners that turn piles in place often require wider, lower piles ranging from 3 - 9 feet high and 9 - 20 feet wide.



Figure 7.6: Windrow Composting

Once the degradation level is achieved, two or more windrows may then be combined to make room for new raw materials. Windrow composting activity spans over the whole year. In winter turning should be done during the days when temperature is relatively higher. In summers turning should be more frequent to avoid excessive leachate formation. Proper drainage for leachate collection and its disposal should be incorporated in the design for environment friendly activity.



Figure 7.7 Windrow Turner

Capital Cost of MRF Facility

Proposed MRF Facility for Rawalpindi City: Unlocking Revenue Potential in the Following Scenario"

- **Daily Capacity:** 350 tons/day
- **Recovery Rate:** 70%
- **Location:** State-owned land with the possibility of additional space acquisition through rental agreements
- **Facility Lifespan:** 20 years

➤ **Capital Cost Recovery:** Recouping Initial Investment within 2.5 Years.

Table 7:1:Capital Cost of Facility (MRF) for Rawalpindi City

Description	Cost (Rs.) S-1	Formulas
Facility installation cost (20 years life)	1,500,000,000	Capital Cost
30% Residual value after 20 years	450,000,000	Residual Cost
70% cost for 20 years - depreciation cost	1,050,000,000	Deprecation Cost
Days in 20 years	7,300	
Capital cost of facility per day	143,836	
Per tons capital cost	996.99	
Rent/ month	2,000,000	
Rent/day	64,516.13	
Rent/ ton	447.19	
Capita + rent/ton	1,444.18	
Shadow cost per day	10,000	Shadow Cost/Day
Maintenance cost/day	80,645	Maintenance/Day
Maintenance cost/ton	558.99	Maintenance Cost/Ton
HR cost per day	82,258	HR Cost/Day
HR cost per ton	570	HR Cost/Ton
Eq.1	381,255	Financial Cost Per Day
Eq.2	2642.65	Financial Cost Per Ton
Eq.8	86,382.46	Revenue/Ton (Compost+ Recyclables +Environmental Benefit cost)
Eq.10	26,152	Cost Benefit Analysis (Avg/Tonn)

Maintenance cost of facility

The maintenance cost of an MRF facility in Rawalpindi encompasses various expenses associated with ensuring the smooth operation, upkeep, and safety of the facility. These costs typically include routine maintenance of equipment and machinery, repairs and replacements of worn-out parts, regular cleaning and sanitation, facility infrastructure maintenance, and compliance with safety regulations. The table below depicts the maintenance cost of MRF per month:

Table 7:2:Maintenance Cost of MRF

Item	Monthly Cost (Rs.)
Repair & Maintenance (or mode via service contract)	500,000
Fuel for Moving Machinery	300,000
Lubricants	30,000
Inventory	10,000
Electricity Bill	1,000,000
Material Transport (Rejection)	500,000
Admin & others expense (Mask, Gloves etc.)	100,000
Lab Equipment	10,000
Research & Experiment	50,000

Total	2,500,000
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HR COST OF MRF FACILITY

The HR (Human Resources) cost for an MRF facility in Rawalpindi encompasses various expenses associated with managing the facility's workforce. These costs include recruitment and hiring expenses, salaries and benefits for employees, training and development programs, employee engagement initiatives, and compliance with labour laws and regulations. The table below represents the HR requirement and the cost required for Rawalpindi city:

Table 7:3:HR Cost of MRF For Rawalpindi city

Human Resource	Required	Salary (Rs.)/ Month
Plant Manager/Overall In charge	1	200,000
Mechanical Engineer & Chemical Engineer	1	200,000
Shift Supervisor	2	200,000
Electrical Engineer	2	100,000
Intake Helper	2	100,000
T Loader Operator/ Trolley Driver	15	480,000
Sorting Labour/ Workers	2	64,000
Windrow Labour	2	100,000
Fitter & Fabricator	2	120,000
Auto Mechanic	2	130,000
Electrician	1	50,000
HSE + Lab Coordinator	1	50,000
Inventory In-charge & Admin & Store	3	96,000
Gate Keeper (3 shifts) for Site	1	32,000
Peon	2	64,000
Gardener	1	45,000
Weighbridge Operator	1	60,000
Accountant	42	2,291,000
Total		

ECONOMIC MODEL OF WASTE TREATMENT FACILITY (MRF)

A Rawalpindi Recycling Facility (MRF) is an economic model that aims to promote sustainable waste management practices and create economic opportunities in the city of Rawalpindi. The MRF facility serves as a centralized hub for collecting, sorting, processing, and redistributing various types of recyclable materials, such as plastics, paper, glass, and metals. The economic model of the MRF facility in Rawalpindi is built on several key components. First and foremost, the facility provides employment opportunities for the local community. Skilled and semi-skilled workers are hired to operate the machinery and carry out the sorting and processing tasks. This not only creates direct jobs but also stimulates the local economy by generating income for individuals and their families. Furthermore, the MRF facility acts as a catalyst for the recycling industry in Rawalpindi. By providing a convenient location for waste drop-off and recycling, it encourages individuals, households, and businesses to participate in recycling initiatives. This leads to increased collection rates of recyclable materials, reducing the amount of waste sent to landfills and promoting a cleaner and greener

environment. The economic model of the MRF facility also relies on partnerships with recycling companies and manufacturers. Once the recyclable materials are sorted and processed, they are sold to these companies, who utilize them as raw materials for producing new products. This creates a market for recycled materials, promoting a circular economy and reducing the dependence on virgin resources. The revenue generated from these sales can be reinvested in the facility's operations and further expansion.

In addition to the direct economic benefits, the MRF facility also has indirect positive impacts on the local economy. By reducing the volume of waste sent to landfills, the facility helps to extend the lifespan of existing landfill sites, reducing the need for new ones, and potentially saving costs associated with their construction and maintenance.

8. WILLINGNESS TO PAY

INTRODUCTION

One of the consequences of the global urbanization is increasing volumes of solid waste. A considerable amount of money goes into managing huge volumes of solid waste. Solid Waste Management can be defined as the discipline associated with the municipal solid waste (MSW) in a way which is governed by the best principles of public health, economics, engineering, aesthetics and other environmental considerations; control of generation, storage, collection, transfer, processing and disposal of Municipal Solid Waste. Due to lack of financial and technical resources, the municipalities in developing countries fail to manage solid wastes in a safe and sustainable way. This raises the important issue of how to deliver quality service in the face of financial and skill constraints of the public sector. Approximately 582 tons of solid waste is generated daily in Jhelum District, 778 tonnes in Chakwal District, 980 tonnes in Attock District and 3429 tonnes in Rawalpindi District. Rapid establishment of new housing sectors and industrial states, construction activity and a variety of institutions contribute to waste generation. The amount of solid wastes is expected to substantially increase with the rapid growth of population and economic activity. It is estimated that by year 2040, the solid waste generation may approach 950 tons in Jhelum District, 1338 tonnes in Chakwal District, 1792 tonnes in Attock District and 6743 tonnes in Rawalpindi District each day. The current poor solid waste mismanagement practices demand needs of developing a mechanism for efficient solid waste management. Lack of planning, inappropriate technology and poor management are obviously the main areas of concern, this requires serious efforts from government authorities and other agencies for effective solid waste management.

The objectives of the study include the following:

- Determine household waste storage methods, social and cultural habits towards waste hygiene and cleanliness. Roles of household members in managing waste, segregation of waste at household level.
- To assess willingness to pay for waste collection services

Methodology

A methodology was developed to conduct the solid waste management baseline study for Rawalpindi. The study comprised of two vital components, the first component comprised of a questionnaire survey. Two different questionnaires including household and commercial level were prepared. The second component comprised of collection and analysis of solid waste from household and commercial levels. 70 households and 30 commercial areas were targeted in this study. The detail of these components is as follows:

HOUSEHOLD SURVEY

In order to fulfil the objectives of this study a questionnaire was designed, below tables represent the statistical summary of questionnaire regarding household waste collection

and management including hygiene, gender and cultural habits that were filled by inhabitants of all districts.

Summary of questionnaire regarding household waste collection and management including hygiene, gender and cultural habits:

Table 8:1: Summary of Questionnaire from Household

S. N	Question	Responses (%)
1	Container size	
	1-3 kg	46
	5-7 kg	42
	7-10 kg	12
	Greater 10	-
2	Who Disposes?	
	Servant	12
	Family member	24
	Local resource (Private sweeper)	20
	City level resource	44
3	Location of waste bin	
	Kitchen	72
	Backyard	16
	Car porch	-
	Any other	12
4	Waste bin cover	
	Yes	32
	No	68
5	Use of plastic bag in waste bin	
	Yes	74
	No	26
6	Waste bin washing	
	Yes	70
	No	30
7	Frequency of waste bin washing	
	Daily	32
	Weekly	40
	Monthly	28
8	Hand washing after giving waste to sweeper	
	Yes	96
	No	4
9	SWM expenses/month	
	Rs. 75	6
	Rs. 250	-
	Rs. 2000	-
	No reply	94
10	Disposal frequency	
	Daily	98
	Every second day	-
	Every third day	-
	Random	2
11	Waste disposal in?	
	Plastic bag	52
	Small bucket	46

	Any other	2
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Summary of questionnaire regarding municipal services

Table 8:2: Summary of Municipal Services

S. N	Question	Responses
1	Level of satisfaction	
	Yes	0
	No	100
2	Problems related to waste disposal	
	Littering on drain	36
	Littering on road	42
	No regular collection	16
	No dustbin, cause nuisance	6
3	Collection frequency	
	Daily	40
	Every second day	-
	Irregularly	30
	Don't know	30
4	Preference for waste collection system	
	Door collection	80
	Disposal at centralized collection	20
	Kerb side collection	-
5	Collection time	
	Morning	50
	Noon	10
	Afternoon	20
	Evening	20
6	Current collection mechanism	
	Donkey cart	-
	Wheel barrow	64
	Cart	6
	Basket	28
	Mini truck	-

Summary of questionnaire regarding waste recycling

Table 8:3: Summary of Waste Recycling questionnaire

S. N	Question	Responses (%)
1	Do you segregate?	
	Yes	86
	No	14
2	Who segregates?	
	Servant	32
	Mother	32
	Father	18
	Daughter	6
	Son	12
3	Where do you sell?	
	Kabari/Junkyard shop	34

	Teen Dabewala	66
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Summary of questionnaire regarding willingness to pay

Table 8:4: Willingness to pay for Services Questionnaire

S. N	Question	Responses (%)
1	Will you pay for SWM Services	
	Yes	60
	No	40
1a	How Much	
	200	30
	300	20
	Depends on Services	10
1b	Why (if no)	
	Its government responsibility (TMA/SWMCs)	
	Never paid before	

COMMERCIAL LEVEL SURVEY

In order to fulfil the object of this study a questionnaire was designed (Annexure). Table represents the statistical summary of questionnaire regarding commercial waste collection and management including hygiene and cultural habits that were filled by employers/owners of commercial outlets. It has been observed that most of the outlets use small sized containers for disposing their solid waste. With regard to hygiene practices it can be seen 80% of the commercial outlets do not use bin covers. Half of the respondents wash their bins regularly while 60% of the respondents do not use bin liners. It was noticed no commercial outlets pay for solid waste disposal.

Summary of questionnaire regarding commercial waste collection and management including hygiene and cultural habits

Table 8:5: Summary of Commercial waste survey

S.N	Questions	% Response	S.N	Questions	% Response
1	Container size		6	Waste bin washing	
	1-3 kg	50		Yes	50
	5-7 kg	30		No	50
	7-10 kg	10			
	Greater 10	10			
2	Who Disposes?		7	SWM expenses/month	
	Worker	100		Less than Rs. 200	50
	Local resource	0		Greater than Rs. 200	40
	City level resource	0		No replies	10
3	Location of waste bin		8	Disposal frequency	
	Inside shop	60		Daily	80
	Outside shop	40		Every third day	10
			Random	10	
4	Waste bin cover		9	Waste disposal in?	
	Yes	20		Plastic bag	10
	No	80		Small bucket	60
			Any other	30	

5	Use of plastic bag in waste bin		10	Disposal time	
	Yes	40		Day time	70
	No	60		Night time	20
				No any	10

Below table shows the statistical summary of questionnaire regarding municipal services. 70% of the commercial outlets were found satisfied with the current municipal services. Also, most of outlets agreed that main problem related to waste disposal were littering on drain, roads and absence of dustbin. All these factors are source of nuisance for the citizens.

Table 8:6: Municipal Services Questionnaire

S. N	Questions	% Response
1	Level of satisfaction	
	Yes No	70 30
2	Problems related to waste disposal	
	Littering on drain Littering on road	10 40
	No dustbin, cause nuisance	50
3	Collection frequency	
	Daily	50
	Every second day Irregularly	10 30
	Don't know	10
4	Preference for waste collection system	
	Door collection	30
	Disposal at centralized collection	40
	Kerb side collection	30
5	Collection time Morning	
	Afternoon	30
	Evening	50 20
6	Current collection mechanism	
	Wheel barrow Basket	40 50
	Mini truck	10

Summary of questionnaire regarding waste recycling

Table 8:7: Questionnaire survey for Waste Recycling

S.N	Question	% Response
1	Do you segregate?	
	Yes No	100 0
2	Who segregates? Sweeper Scavengers at kundi	60
	Transfer station	30
		10
3	Where do you sell?	
	Kabari/Junkyard shop Teen Dabewala	50 50

4	Breakup of recyclable waste	
	Paper PlasticGlass	78
	Miscellaneous	10
		3
		9

Summary of questionnaire regarding willingness to pay

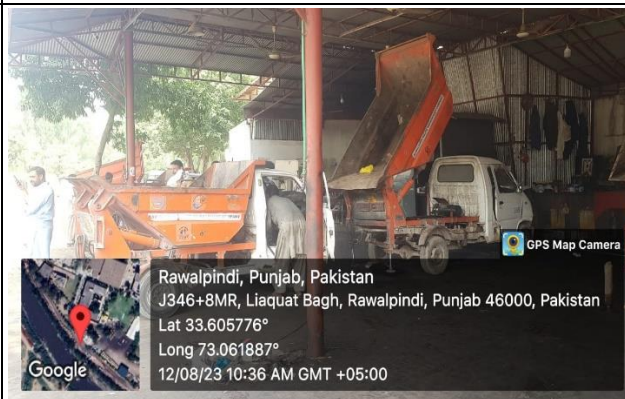
Table 8:8: Willingness to pay survey

S.N	Question	Responses (%)
1	Will you pay for SWM Services	
	Yes	73
	No	27
1a	How Much	
	Depends on Services	70
2	Why (if no)	
	Its government responsibility (TMA/SWMCs)	
	Never paid before	

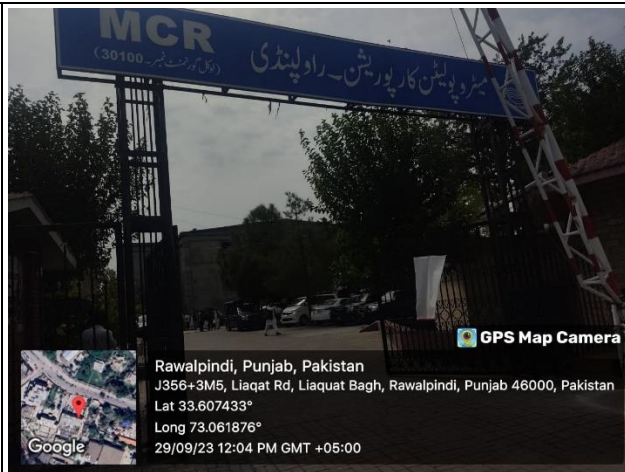
9. CHAPTER 8 APPENDIX

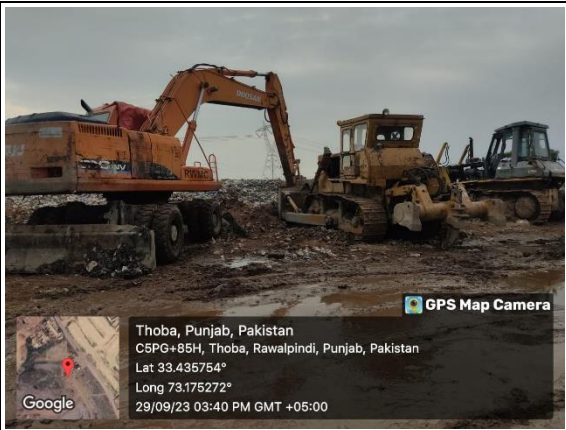
RAWALPINDI DISTRICT

RAWALPINDI TEHSIL (Visit RWMC Head office & Fleet office/Workshop)



RAWALPINDI TEHSIL (Visit MC Rawalpindi & Workers in Field & Losar Dumpsite)





MURREE TEHSIL (Meeting RWMC Officials & Transfer station and Operations)



KALAR SAYEDDAN Tehsil (Visit to MC, Field and Fleet Station)



GUJAR KHAN TEHSIL (Visit to MC Office, Parking Yard, Transfer station & Field)



KOTLI SATTIAN Tehsil (Visit to MC Kotli sattian, dumpsite, machinery and field)



KAHUTA (Visit to MC Office, Field, Parking Yard and Transfer station.)

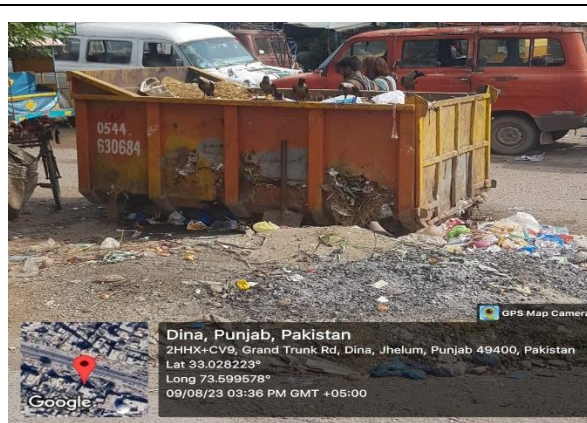


JHELUM DISTRICT

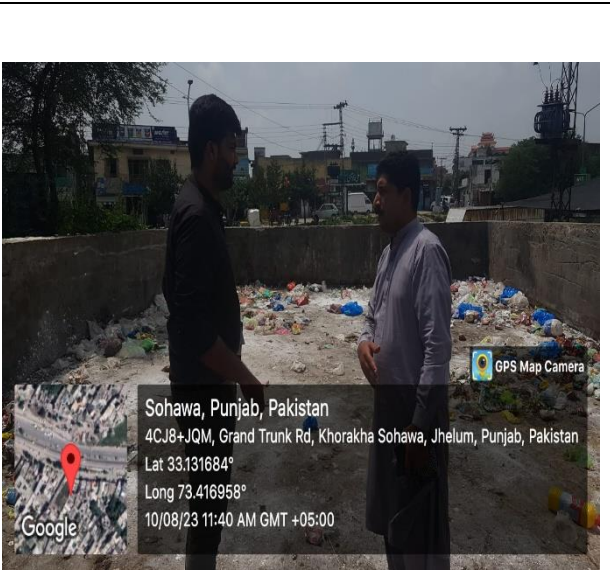
JHELUM TEHSIL(MC Office, Dumpsite Field visit)



DINA TEHSIL(Visit to MC Dina ,Parking Yard And Field Dumpsite)



SOHAWA Tehsil(MC visit ,Field Visit to collection Point and dumping sites)



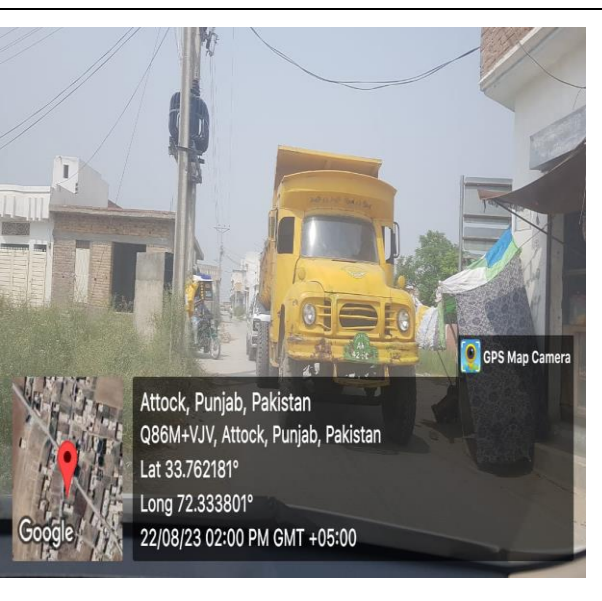
PIND DADAN KHAN (MC Visit ,Field Visits And Dumpsite)



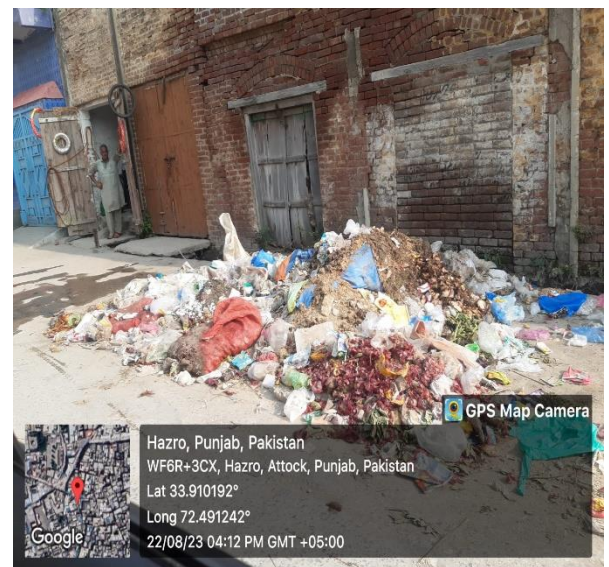


DISTRICT ATTOCK

ATTOCK TEHSIL Visit to MC Office, Field collection points and Dumpsite



HAZRO TEHSIL Visit to MC Office, Field collection points and Dumpsite



FATEH JANG TEHSIL Visit to MC Office, Field collection points and Dumpsite

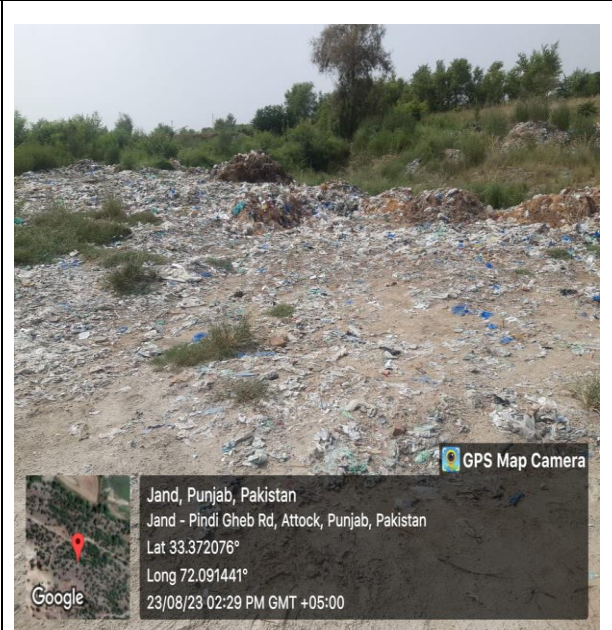
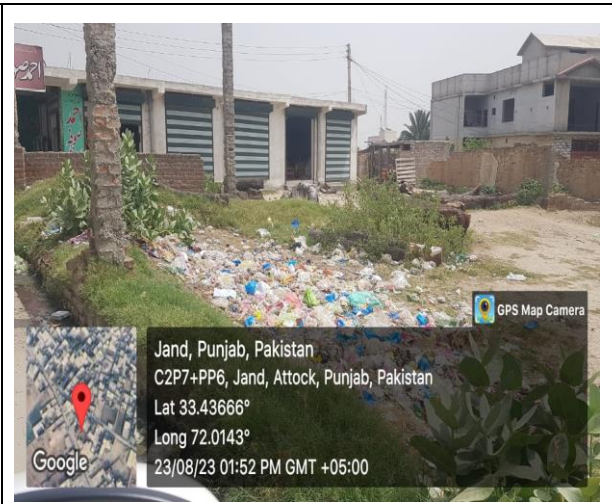




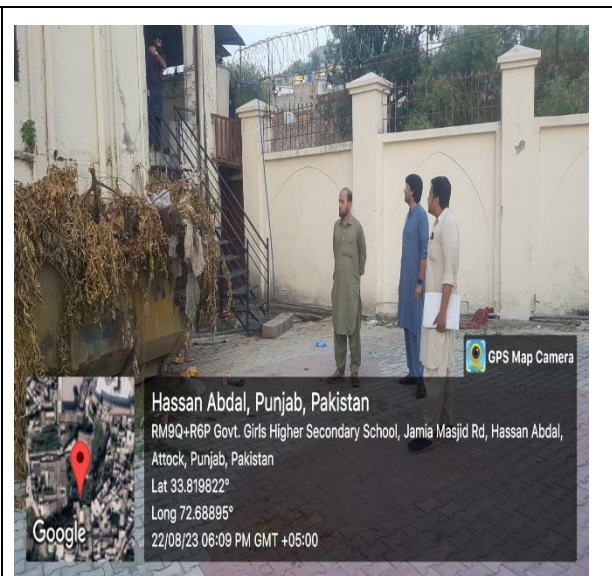
PINDI GHEB TEHSIL Visit To MC Office, Machinery Parking, Collection Points And Dumpsite



JAND TEHSIL Visit to MC Office, Field collection points and Dumpsite



HASSAN ABDAL TEHSIL Visit to MC Office, Field collection points and Dumpsite





DISTRICT CHAKWAL

CHAKWAL TEHSIL Visit To MC Office, Machinery Parking, Collection Points And Dumpsite



TALAGANG TEHSIL Visit To MC Office, Machinery Parking, Collection Points And Dumpsite





CHOA SAIDEN SHAH TEHSIL Visit To MC Office, Machinery Parking, Collection Points And Dumpsite



KALAR KAHAR TEHSIL Visit To MC Office, Machinery Parking, Collection Points And Dumpsite





Kallar Kahar, Punjab, Pakistan
 QPJ6+R8H Fauji Foundation Hospital, Fauji Foundation Colony, Kallar Kahar, Chakwal, Punjab, Pakistan
 Lat 32.782273°
 Long 72.709786°
 11/08/23 11:36 AM GMT +05:00



Kallar Kahar, Punjab, Pakistan
 QPJ6+R8H Fauji Foundation Hospital, Fauji Foundation Colony, Kallar Kahar, Chakwal, Punjab, Pakistan
 Lat 32.782203°
 Long 72.710056°
 11/08/23 11:37 AM GMT +05:00

LAWA TEHSIL Visit To MC Office, Machinery Parking, Collection Points And Dumpsite



Lawa, Punjab, Pakistan
 MWWR+H97, Lawa, Chakwal, Punjab, Pakistan
 Lat 32.696478°
 Long 71.94092°
 28/09/23 01:54 PM GMT +05:00



Lawa, Punjab, Pakistan
 MWWG+3VC, Lawa, Chakwal, Punjab, Pakistan
 Lat 32.695105°
 Long 71.927477°
 28/09/23 02:45 PM GMT +05:00



Lawa, Punjab, Pakistan
 MWWR+G33, Lawa, Chakwal, Punjab, Pakistan
 Lat 32.696145°
 Long 71.94015°
 28/09/23 02:48 PM GMT +05:00



Lawa, Punjab, Pakistan
 MWWG+3VC, Lawa, Chakwal, Punjab, Pakistan
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