Mandi Bahauddin

District Report

Water Supply, Sewerage & Environment Sector

Gujranwala Regional Development Plan

2020-2030

The Urban Unit

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ACRONYMS

GIS	Geographic Information System
GSTs	Ground Storage Tank
MC	Municipal Corporation
MGD	Million Gallons Per Day
OHRs	Overhead Reservoirs
PHED	Public Health Engineering Department
PVC	Polyvinyl Chloride
SCADA	Supervisory Control and Data Acquisition
TDS	Total Dissolved Solids
TMA	Tehsil Municipal Administration
UGWTs	Underground water tanks
WSS	Water Supply and Sanitation
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

The Mandi Bahauddin District Report is developed using participatory approach combined with the field visits of Gujranwala division and primary & secondary data analysis at local, regional and national level. The planning exercise involved all relevant key stakeholders (including local community) for identification of key projects and their timelines i.e., short-medium-long term investment plan at district and regional level. Number of projects executed in the previous years for the improvement of municipal service delivery and environmental conditions were also assessed. Existing legal landscape, administrative and institutional set-up, along with China Pakistan Economic Corridor (CPEC) and other similar initiatives executed internationally and locally were also considered in the study.

The current report is comprised of six sections. Mandi BahaUddin district profile, current state of water supply and proposed projects for WSS are discussed in sections I, II and III. The district forms a central portion of the Chaj Doab lying between the Jhelum and Chenab rivers. It is bounded on the north by the Jhelum river, which separates it from Jhelum district; on the west by Sargodha district; on the south by the river Chenab (which separates it from the Gujranwala and Hafizabad districts); and on the east by Gujrat district.

With regard to water coverage, it is estimated that MC Mandi Bahauddin serves a water supply coverage area of 28 km^2 to an estimated population of 2, 20,000 in 5 zones. On the whole, the length of water distribution network under MC Mandi Bahauddin is around 7.0 km with the diameter of (PVC) pipes ranging from 3" to 8". Considering the existing disparity in demand and supply and with the aim to improve service delivery, a number of interventions are proposed on short-medium-long term basis for Mandi Bahauddin district in order to make the existing network efficient and enhance the water supply coverage. Likewise, 3 DNI zones are proposed in this regard for safe and reliable supply of water in the district. Most schemes in long term projects will serve the unserved population settlements in the ambit of MC Bahauddin. The total estimated cost of the proposed projects is 1378.3 M rupees.

Likewise, MC Mandi Bahauddin is responsible for Sewerage/Drainage area of around 35 km^2 area, serving a population of approximately 123,000 people. The total length of sewers lines is approximately 24.8 km. For sewerage, the approximate length of covered sewage drains is around 5km. The ultimate discharge points are the seepage drains i.e., Saim Nullah. There is no disposal station or pumping station in the city as such and the system works on the principle of gravity. Recommendations with regard to rehabilitation and extension of the current sewerage system have been prioritized for Short, Medium and Long term in the recommendation section. Safe disposal of wastewater through centralized wastewater treatment plant has also been suggested as a long-term intervention. The total estimated cost of the proposed projects is 2570.87 M rupees. For both Water & Sewerage schemes, draft environmental management plans have been drafted that will possibly help reduce the environmental impact of activities during planning and execution of these schemes.

Section 4 of the report provides current state of environment and public parks. The degradation of environment in Mandi Bahauddin is a major environmental concern these days. Air pollution levels in the urban centers have either crossed safe limits given in the PEQS or have reached the threshold values whereas lack of green spaces is another serious issue that needs to be catered. In order to improve the existing situation, recommendations are forwarded.

Section 5 of the report addresses the key challenges and Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis with reference to WSS service delivery and environmental management while complimentary details to some of the proposed projects are enlisted in Section 6.

Mandi Bahauddin

Gujranwala Regional Development Plan

SECTION 1- DISTRICT PROFILE

1.1. LOCATION

Mandi Bahauddin, a district of the Punjab province of Pakistan, was originally a village called as Chak No. 51. Its name 'Mandi Bahaudin' comes from two sources: **Mandi** (market) was used as a prefix for its flourishing grain market and **Bahauddin** was taken from nearby old village called Pindi Bahauddin. Geographically, Mandi Bahauddin is limited by Jhelum River in the North and North-West side, on the East and North-Eastern boundary lies the Gujrat District, on the South and South-East Chenab River separates it from Gujranwala and Hafizabad districts and on the West and South-West adjoined by Sargodha District.

Mandi Bahauddin is located in the north eastern part of Pakistan. It lies from 30° 8' to 32° 40' N and 73° 36' to 73° 37' E at an altitude of 672 feet (205 m) above sea level.
The figure below gives an overview of the district, along with the relevant settlements.

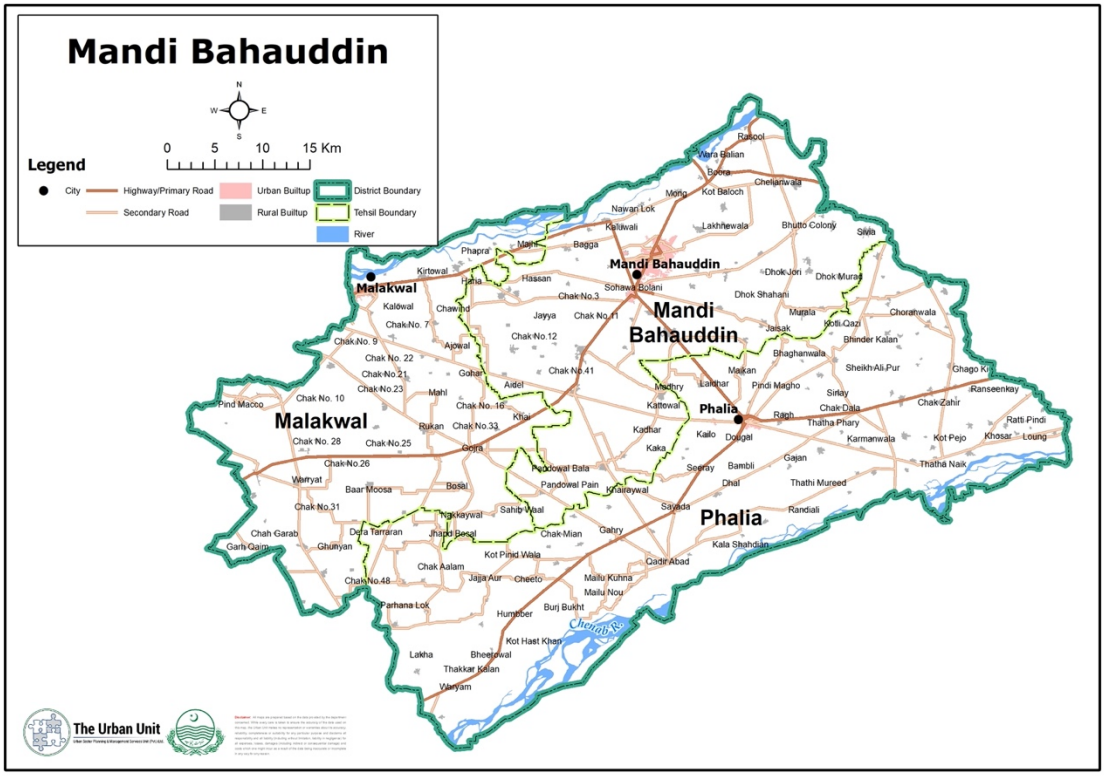

Figure 1: District Mandi Bahauddin at a glance

1.2. BOUNDARY

The district forms a central portion of the Chaj Doab lying between the Jhelum and Chenab rivers. It is bounded on the north by the Jhelum river, which separates it from Jhelum district; on the west by Sargodha district; on the south by the river Chenab (which separates it from the Gujranwala and Hafizabad districts); and on the east by Gujrat district.

1.3. ADMINISTRATIVE STRUCTURE

The administrative structure in the district involves Tehsils, Union Councils, Mauzas, Municipal Committees and Town Committees. The composition of Administrative units in Mandi Bahauddin is shared below.

Sr.no	Tehsil	Number
1	Malakwal	20
2	Mandi Bahauddin	30
3	Phalia	30
Total		80

1.4. DEMOGRAPHY AND SOCIOECONOMIC TRENDS

Mandi Bahauddin district is spread over an area of 2673 km². As per the census of 2017, the population of the district was 1593,292 persons with an average Annual Growth Rate of 1.68% between 1998 and 2017. In line with the reported growth rate, current population can be estimated as 174, 8321 persons.

Other salient Features of the District are:

Table 3- Population Characteristics of District Mandi Bahauddin

Population Characteristics		
Sr.no	Feature	Quantity
1	Households	252120
2	Urban population	20.5 %
3	Rural population	79.5 %
4	Male population	48.7%
5	Female population	51.3%

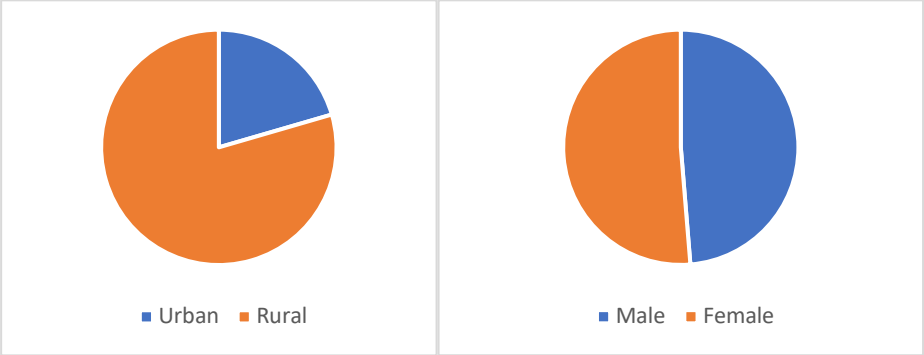

Figure 2: Demographic characteristics of Mandi Bahauddin

For Mandi Bahauddin city, population in 2017 was reported to be 198,609. With regard to city's land use, the city has primarily residential areas and the maps below depict the spatial distribution of residential, commercial, green spaces, health facilities, industries and educational facilities is shown below.

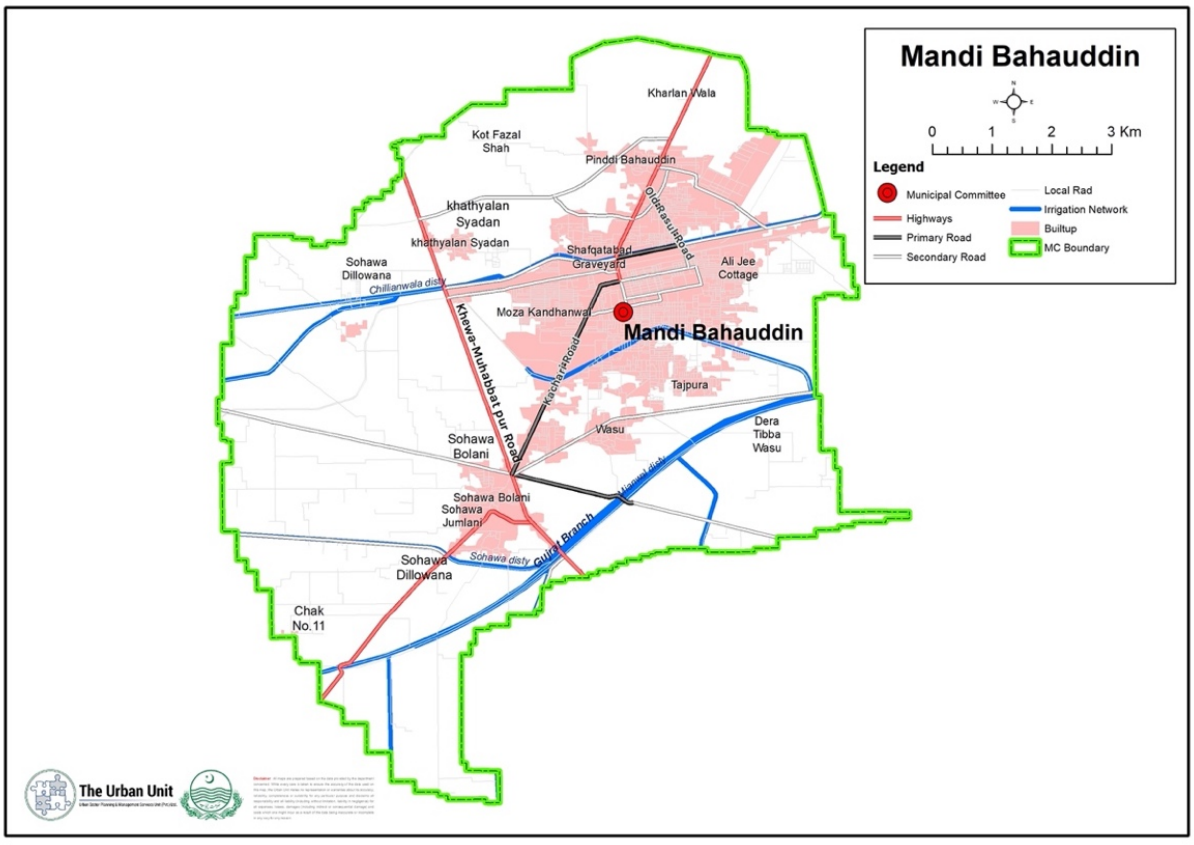

Figure 3: Mandi Bahauddin at a glance

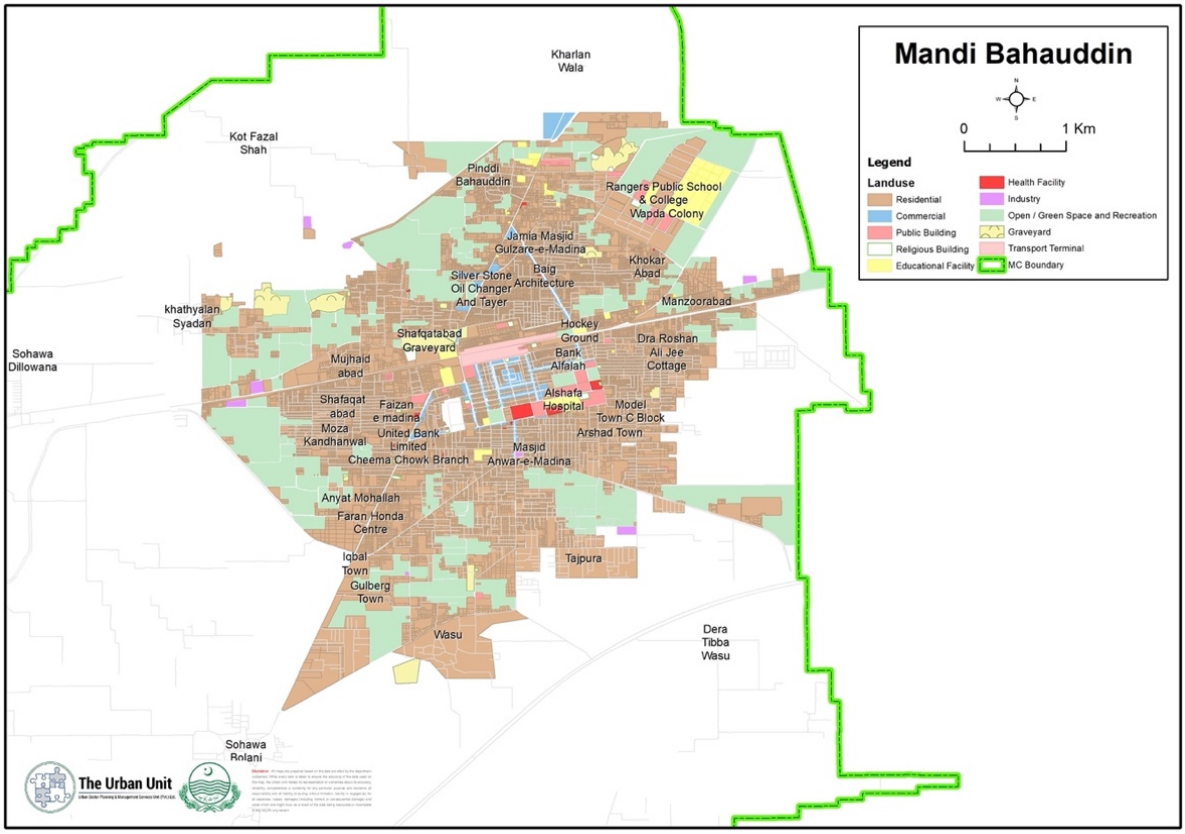

Figure 4: Land Use - Mandi Bahauddin

SECTION 2 – WATER SUPPLY SYSTEM

Nearly 30% of the Mandi Bahauddin City is covered by water supply where as the rest of the population is forced to drink shallow water obtained through privately installed hand pumps/power pumps. The quality of water from these shallow sources has been reported as unreliable multiple times. The following map gives an overview of the current infrastructure in the district of Mandi Bahauddin.

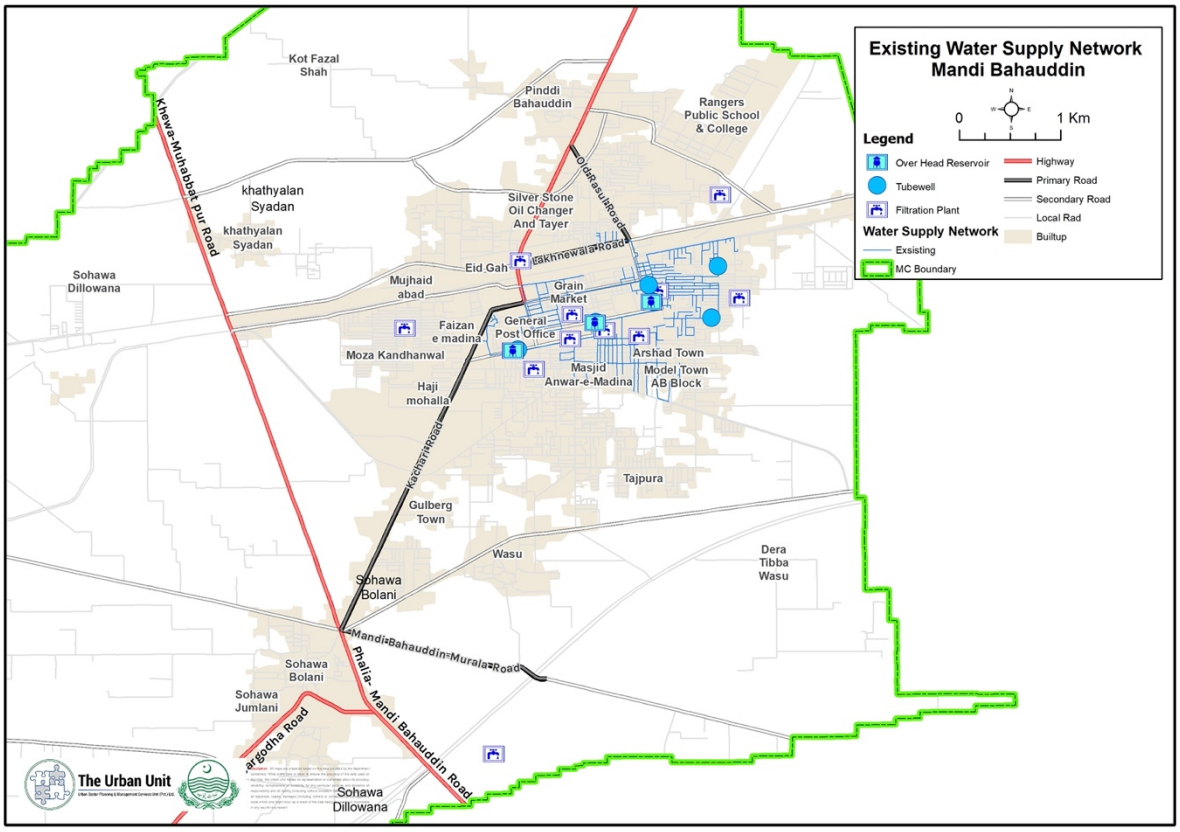

Figure 5: Existing Water Supply System in Mandi Bahauddin

2.1. WATER DEPTH

Mandi Bahauddin City has an undulated surface with a level difference of 22 feet. Water table is 25 feet below the ground level. All tube wells of water supply scheme are installed at a depth of 450 to 500 feet. Presently the city has a limited water supply system and there are many areas that are completely deprived of this supply system with no water supply at all.

2.2. DETAILS OF THE SYSTEM

MC Mandi Bahauddin serves a water supply coverage area of 28 km^2 to an estimated population of 2, 20,000 in 5 zones. On the whole, the length of water distribution network under MC Mandi Bahauddin is around 7.0 km with the diameter of (PVC) pipes ranging from 3” to 8”.

The total water supply demand is estimated to be 14.073 MGD while the total water supply is 10.47 MGD, which reflects the lack of supply against demand. Per capita consumption is estimated to be 180 lpcd. The design criterion of the supply system is based on through pumping and overhead reservoirs.

The unaccounted water in the region is approximated to be 20%. With regards to treatment, the process of ultraviolet filtration process is being employed.

Table 4: Water Coverage System

Sr. #	Feature	Quantity	Capacity/Specification	Remarks (e.g. Functional status)
1	Water filtration plants	14		All are functional, 12 installed under UC/TMA/DG/Provincial or Other Schemes while 2 installed under Clean Drinking Water initiatives are non-functional
2	Tube wells	6	~1.0 cusec each	5 are functional
3	Overhead reservoirs	3	~0.06 M Gallons	All are functional
4	Groundwater storage tanks	Nil		
5	Duration of water supply		16 hours	
6	Hypochlorinators	06		
7	Water Supply connections	1587		Domestic= 1576 Commercial = 11

It must be noted that the total staff responsible for management of the system is 6 personnel only out of which only 1 person is recognized as technical staff while the remaining 5 are non-technical. This shows that 0.02/1000 persons are working for water connections which is an alarming piece of information from the management perspective.

2.2.1. Tube wells

The MC owns 6 tube wells that have been installed previously and are providing portable water to the city. As per the information provided by MC, mechanical and civil structures are in appropriate conditions whereas the average operational time of these tube wells is 8 hours. To avoid bacterial contamination, nine chlorinators were installed out of which two are out of order at the moment. Tube wells are installed in different schemes, detail of installed tube wells is given in Table below:

Table 3: Tube well stations in Mandi Bahauddin

Sr. #	Scheme Name	Discharge Capacity (cusec)	Machinery Condition	Civil Structure Condition	Chlorinator Available	Operational Hours (Avg.)
1	Govt. Children Hospital	1	Good	Good	Yes	6
2	TMA Office	1	Bad	Average	No	
3	Anmol Marriage Hall	1	Good	Good	No	6
4	Gurah Mohala Graveyard	1	Good	Good	No	6
5	Dera Roshan	1	Good	Good	Yes	6
6	Jail Road	1	Good	Fair	No	6

2.2.2. Overhead reservoirs

There are a total of 3 Overhead reservoirs (OHRs) in Mandi Bahuddin City with a total capacity of approximately 120,000 Gallons. According to Municipal Committee staff of Mandi Bahuddin,2 of them are functional while one is non-functional.

Table 4: Overhead Reservoirs in Mandi Bahauddin

Sr. #	Name	Construction Year	Source	Capacity (Gallons)	Type of Construction	Piping Condition	Status
1	TMA Office	1980	TMA Tube well	20,000	Brick	C	Non-Functional
2	Jail Road	2000	Jail Road Tube well	50,000	RCC	B	Functional
3	Govt. Children Hospital	2012	Govt. Children Hospital Tube well	50,000	RCC	A	Functional

2.2.3. Water Supply Pipelines

There is a network of pipeline extended to approximately 7.5 km ranging from 3” dia to 8” dia mainly AC/PVC pipes executed in different phases, mainly by PHED. In addition to above MC/TMA Mandi Bahauddin has also enhanced distribution network of 3” diameter in

different years in the new abadies. The condition map of the pipeline is shown in the figure below and diameter wise length can be seen in the following table.

Table 5: Diameter wise pipeline length

Pipe Dia ("i/d A.C)	Length (Rft)
3	8202.5
4	4921.5
6	6562
8	4921.5

2.2.4. Water Demand

Based on the current and projected populations for the Municipal Corporation and as per design criteria of Public Health Engineering Department, the proposed water demand of 50 gallons per capita per day, the current (2017) water demand and future (2020, 2025 and 2030) water demands are shown in Table below, for the existing and potential future service areas.

Industrial water demand is assumed to be only 15% of the total water consumption as it is assumed that larger industrial establishments have a private water supply. Commercial and institutional demands have been assumed to be 15% and 10% of the total water consumption respectively.

At present, the water losses are estimated to be around 30%. However, the target would be to reduce these losses to around 10% by the year 2030.

Table 6: Water demand in Mandi BahaUddin

	2020	2025	2030
	Existing Urban Boundary	Existing Urban Boundary	Existing Urban Boundary
Population	208,788	226,925	246,639
Domestic (GD)	10,439,400	11,346,273	12,331,926
Commercial (GD)	1,565,910	1,701,941	1,849,789
Institutional (GD)	1,043,940	1,134,627	1,233,193
Industrial (GD)	1,043,940	1,134,627	1,233,193
Losses (GD)	4,227,957	4,595,241	4,994,430
Total (Gallons Per Day)	18,321,147	19,912,709	21,642,530
Total (MGD)	18.32	19.99	21.69

2.3. CHALLENGES FOR SERVICE DELIVERY

Some of the major challenges that were noted as part of the stakeholder consultations and field visits include:

- Coverage of piped water supply is limited in the city and so is the service area
- Poor maintenance of the supply network, including the wear & tear of machinery, impacting the overall efficiency of system
- Present water production is less than the need
- Properly defined service area zones and DNI zones are absent for improved service delivery
- Institutional framework for water governance is weak
- Human resources, including the technical capacity of TMAs and PHED staff is limited
- Resource allocation is not done based on sound planning, need assessment, criteria and/or data
- Evidence based decision making is not taken into consideration

2.4. DESIGN CRITERIA

Design Criteria for water supply system has been based on "Technical and Service Delivery Standards for Water Supply and Sanitation Sectors" by PDSSP and PHED Design Criteria 2008.

2.4.1. Population Projections

As per PHED design criteria 2008, the population projections are to be calculated according to the following expression:

$$P_n = Po\ (1+r)^n$$

where:

Pn = Projected population by the end of nth year
Po = Population of base year, year of known population
r = Population growth rate per year to be taken from related District Census Reports.
n = No. of years, counted from base year i.e. design period

2.4.2. Design Period

Component	Criteria
Tube Well	The former standard for design period of tube wells and treatment work in case of urban and rural water supply schemes was 10 years. However, PHED notes that majority of drinking water tube wells installed in the province, about 15 to 20 years back, are still in satisfactory working condition. For optimal utilization of resources, PHED advises to adopt a design period of 15 years as far as tube wells are concerned. Furthermore, the design of tube wells should be based on maximum day demand.

Slow Sand Filter Plants	According to the guidelines, the design life of slow sand filter plant may be considered around 20 years
Rapid Sand Filter Plants	According to the guidelines, the design life of slow sand filter plant may be considered around 25 years
Tube Well Pump Houses	The design period of tube well pump house is suggested as 25 years
Pumping Machinery	PHED recommends that it is not possible for pumping machinery to work for 10 years without proper maintenance and repair and replacement of the pumping unit is necessary after every 10 years of its operation.
Distribution System	The existing standard for the design period of distribution system is 20 years. It is added that the water distribution network capacities should be based on peak hour demands
Rising Mains	The existing standard for the design period of distribution system is 25 years. Furthermore, the size of rising mains should be based on maximum day demands

2.4.3. Water Consumption

<table>
<tr><th>Component</th><th>Criteria</th></tr>
<tr><td></td><td>In the previous Design Criteria of PHED a figure of 50 gpcd was recommended for all cities exceeding the mark of 100,000 persons. However, in the revised criteria, the standards are listed in the table below:</td></tr>
<tr><td>Domestic Water Consumption</td><td>
<table>
<tr><th>Design Population (Thousands)</th><th>Per Capita Consumption Per Day (Inclusive of unaccounted water)</th></tr>
<tr><td>100,000 – 200,000</td><td>50 gallons</td></tr>
<tr><td>200,000 – 300,000</td><td>55 gallons</td></tr>
<tr><td>300,000 – 400,000</td><td>60 gallons</td></tr>
</table>
</td></tr>
<tr><td>Institutional Water Consumption</td><td>For institutions such as hospitals, hostels, schools etc. an allowance @ 10 gallons per boarder and @ 5 gallons per day scholar is to be made</td></tr>
<tr><td>Maximum Day Demand</td><td>Maximum day demand is to be taken as 1.5 times the average day demand</td></tr>
</table>

Peak Hour Demand	Peak hour demand to be taken as 1.5 times the maximum day demand

2.4.4. Tube Well Design

Component	Criteria
Terminal Pressure	Keeping in view the trends of multistory building construction, PHED recommends to adopt at least 12 meters minimum terminal pressure
Flow Velocity in Pipes	**Distribution Mains** (0.5 to 2 m/s) **Rising Mains** (0.3 to 1.5 m/s)
Minimum Pipe Size	For plain areas the 3 inches (80 mm) standard of minimum pipe size is recommended
Earth Cover on Pipes	An earth cover of 3 feet (about one meter) should be provided over laid water supply pipe lines of all sizes except in hilly areas. Road cuts are to be backfilled with pit/river sand.
Sluice Valves	Sluice valves will be located at main control points for balancing and regulating the flows. These valves are recommended for pipes up to 250mm
Butterfly Valves	For pipes having diameter 300mm and above, butterfly valve shall be used at main control points
Non Return Valve	It is recommended to use Non Return Valves outside delivery main of the tube well and in the rising main after 2000m
Air Valves and Washouts	Air Valves are to be provided at the summits and after 2000m intervals in straight to facilitate escape of trapped air. Washouts are recommended to be used at lowest points to wash out all kinds of debris
Chlorination	0.1 PPM residual at the farthest end of the distribution system should be provided as per PHED design criteria. Hypo-chlorination may be provided where chlorine gas is not easily available

2.4.5. Overhead Reservoirs

According to PHED, overhead reservoir should be provided in all urban and rural water schemes except in cases of hilly/semi hilly areas. Capacity of overhead reservoirs in case of communities having population more than 10,000 persons should be based on around 1/10th of average day demand. Furthermore, minimum capacity of overhead reservoir should be 10,000 gallons.

2.4.6. Water Filtration Plant

<table>
<tr><th>Component</th><th>Criteria</th></tr>
<tr><td>Rate of Filtration</td><td>PHED standard for rate of filtration is 30 gallons per Sq. ft of sand area per day</td></tr>
<tr><td>Filter Sand</td><td>Depth = 30 – 36 inches</td></tr>
<tr><td>Effective Size of Sand (d_{10})</td><td>From top of Gravel to 1 feet =0.30 – 0.35 mm
1 to 2 feet = 0.25 – 0.30 mm
Top Layer 9 inches = 0.18 – 0.22 mm</td></tr>
<tr><td>Uniformity Co-efficient of Sand</td><td>It must not be greater than 2.5 of Sand = (d_{60}/d_{10})</td></tr>
<tr><td>Depth of Water Over Sand</td><td>3 – 4 feet</td></tr>
<tr><td>Velocity of Water</td><td>0.75 ft/sec in drainage system</td></tr>
<tr><td>Sedimentation Tank</td><td>Minimum number of sedimentation cum storage tanks in case of slow sand filtration plant should be two</td></tr>
<tr><td>Filter Gravel</td><td><table><tr><th>Size Range</th><th>Depth</th></tr><tr><td>3 to 1 inches</td><td>6 inches</td></tr><tr><td>1 to 3/8 inches</td><td>3 inches</td></tr><tr><td>3/8 to 3/16 inches</td><td>3 inches</td></tr></table></td></tr>
<tr><td>Outlet System</td><td>The outlet system will be provided with telescopic arrangement of pipes to adjust required flow of filtered water according to varying resistance in filter media. The difference in inlet and outlet will be kept 24 – 30 inches</td></tr>
</table>

2.5. RECOMMENDATIONS – WATER SUPPLY

During the Stakeholder Consultation with the Deputy Commissioner and officers Municipal Committees, Town Committees, Public Health Engineer Department A0 size maps were used to define areas where water supply pipelines are in poor conditions, which areas are unserved at the moment, conditional assessment of infrastructure, future DNI zones, proposed location of infrastructure etc. This exercise helped us in not only understanding the current state but

also envisioning the future state of the respective areas. Some recommendations, in terms of short-, medium- and long-term priority are being forwarded.

2.5.1. SHORT TERM (0-5 YEARS)

S.#	Project	Cost (Million PKR)
1	Construction and Rehabilitation schemes in UCs 2,3, 16, 17, 18	**97.53**
2	Rehabilitation scheme at Dara Roshan, Gurah Mohalla, Usmania Mohalla, School Mohalla, Kashmir Colony	**76.75**
3	Rehabilitation of OHR and Tubewell at TMA Office	**8.010**
4	Rehabilitation of 2 non-functional filtration plants installed under Clean Drinking Water initiative	**10.601**
5	SCADA system for Mandi Bahauddin for effective M&E	**20.00**
	Total	**212.89**

2.5.2. MEDIUM TERM (5-10) years

S.#	Project	Cost (Million PKR)
1	Extension of Water Supply System in unserved areas e.g. Pindi Bahuddin, Rangers Colony, Khokhar Abad, Tariq Abad, Roshanpura, Kandanwala, Sohawa Bolani & District Complex	**217.76**
2	Extension of Water Supply System in unserved areas e.g. Islam Nagar, Wasu, Shafaqabad Mohalla, Haji Mohalla, Sufi Pura Faizabd Mohalla	**159.25**
3	Establishment of Water Quality Lab	**15**
4	Development of 3 DNI zones for safe and reliable supply	**330.270**
5	SCADA system for Mandi Bahauddin for effective M&E	**20.00**
6	Installation of 12 Filtration Plants for the 3 DNI zones	**93.49**
7	Installation of 13 Tube wells for the 3 DNI zones	**103.88**
	Total	**939.65**

2.5.3. LONG TERM (>10 years)

S.#	Project	Cost (Million PKR)
1	Extension of Water Supply System in unserved areas e.g. Pindi Bahuddin, Rangers Colony, Khokhar Abad, Tariq Abad, Roshanpura, Kandanwala, Sohawa Bolani & District Complex	**217.76**
2	Digitized MIS/GIS system for effective monitoring	**8**
	Total	**225.76**

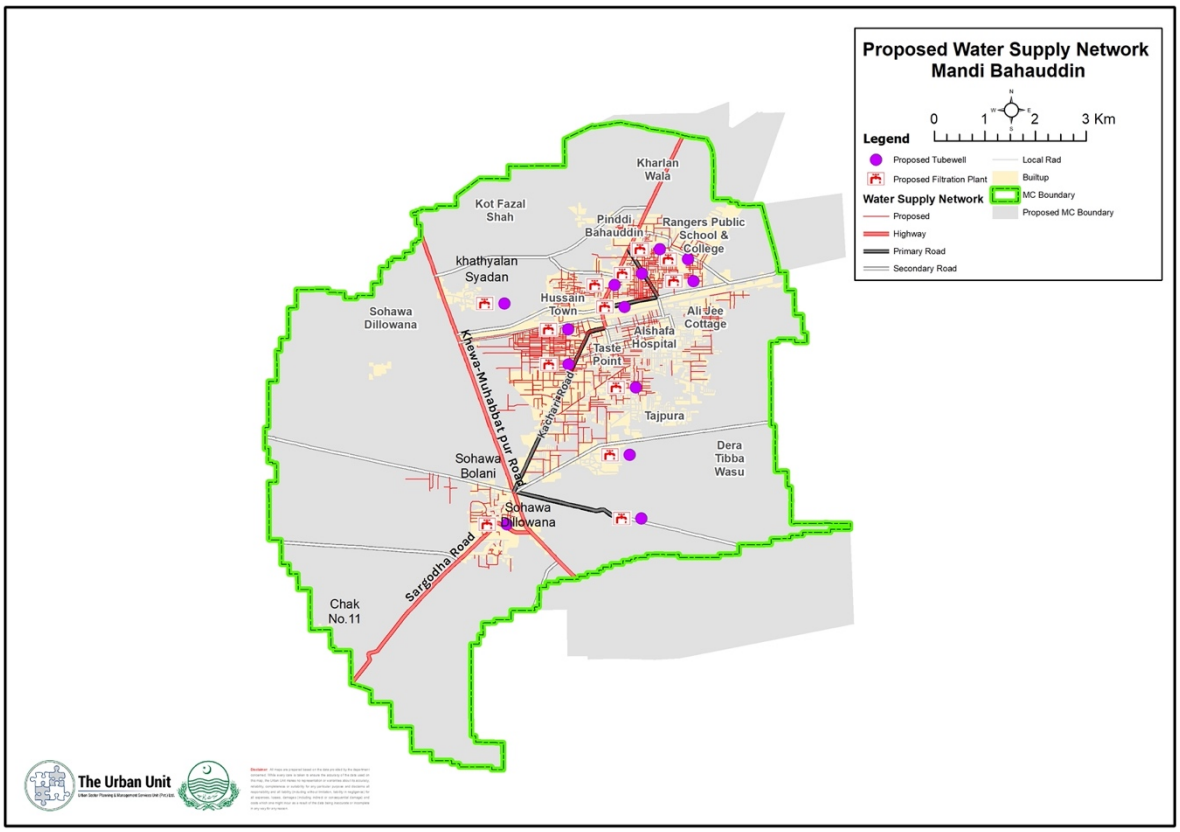

Figure 6: Proposed Water Supply Network in Mandi Bahauddin

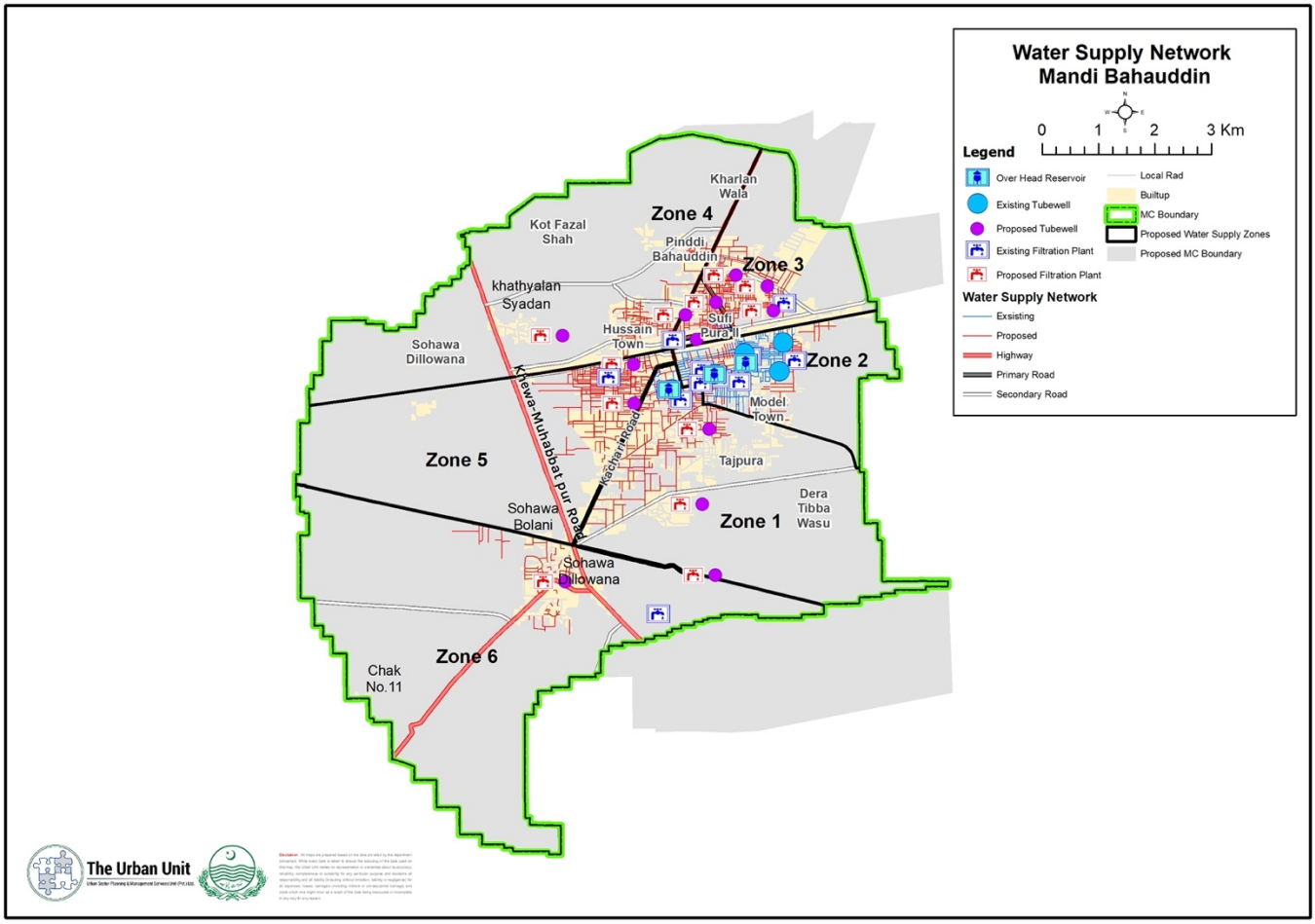

Figure 7: Existing and proposed Water Supply Network in Mandi Bahauddin

2.6. ENVIRONMENTAL MANAGEMENT PLAN OF WATER SUPPLY

A sample Environmental Management Plan is being shared for Water Supply schemes in Mandi Bahauddin. After having weighed the nature of task and designated mandate, the responsibility of implementation may be given to contractors, MC, PHED, EPA etc.

Sr. No.	Component	Description	Recommended Mitigation Measure
1.	Disturbance to existing Utilities	• Disturbance/damage to existing utilities on the sites (Telephone lines, electric poles and wires, water lines within proposed project sites) • Site flooding, nuisance, pollution • Blockage of access	• Identify and include locations and operators of these utilities in the detailed design documents to prevent unnecessary disruption of services during construction phase • Conduct detailed site surveys with the construction drawings and discuss with the respective agencies during the construction phase before ground clearance; • Require construction contractors to prepare a contingency plan to include actions to be done in case of unintentional interruption of services. Where required temporary arrangements will be made to avoid any interruption of utility services.
2.	Dismantling, Excavation, and filling operations	• Dust which may affect visibility • Noise from machineries/ equipments • Soil erosion • Contamination of surface water • Vibration (Shock waves can be produced due to heavy machinery working)	• Waste should be properly disposed off • Updated and tuned machinery should be used to control noise. • Water sprinkling should be carried out at consecutive intervals as per instruction • Provision for personal protective equipment, earmuffs, Mask etc to labour. • Avoiding construction activities during nights. • Use of vibratory roller should be prohibited

Sr. No.	Component	Description	Recommended Mitigation Measure
		• Solid waste may be generated due these activities • Safety hazards to labor and nearby resident population. • Solid waste may cause disturbance in mobility • Temporary blockage of road may restrict mobility • Conflict with public and public complaints • Economic losses • Livelihoods loss. • loss of shopkeepers • Temporary loss of structures and private property • Economic loss of permanent and mobile vendors due to obstruction of passage	• Removal of excess matter/ debris/sludge from the site immediately. • Adequate safety precautions such as helmets, safety shoes, gloves, etc. should be provided to the labor • Provide appropriate signage near the construction activities to sensitize the community and minimize accidents. • Public Consultation to aware nearby residents. • Public must be informed about project major activities, duration of scheme, time and schedule, anticipated impacts and their proposed Mitigation Measures. The contact Nos. of focal person of Grievance Redress Committee should be displayed at different locations and residents should also be informed about it. • Emergency contact numbers should be displayed • Construction work should be done only on 4-5 feet length of street/road, rest of the streets/road should not be affected. In this way the business of the shop's keepers will not be affected. Water supply lines where about 10 days will require to work make a schedule to work in portions so that the alternate road may be used safely. Contractor would be instructed that labor must not damage the property and structures of the residents. In case of damage compensation should be provided.

Sr. No.	Component	Description	Recommended Mitigation Measure
3.	Civil work, Laying of water distribution network/pipes	• Solid wastes • Noise and vibration disturbances to residents and businesses • Road side visibility can be reduced and dusty environment leads to respiratory diseases. • Safety issues • Health problems or immediate risk may take place • Spillage of fuel and oil • Traffic jams and congestion may take place and cause inconvenience to the people where the construction of interchanges will take place. • Reduced pedestrian access to residences and businesses • Temporary Sewer system interruption Conflicts. • Dissatisfaction for the project	• Immediately transport the accumulated construction waste to a site identified by the implementing authority • Broken Pipes should be disposed off properly • Removal of excess materials • Cleaning of sites upon completion of schemes. • Establish schedule and others specific restrictions • Limit work to day light hours as possible • Use of less noise generating equipment • Regular water sprinkling with the help of water bowsers • Cordon off construction area • The Private Contractor should ensure provision of appropriate housing, water supply, and sanitation facilities to construction labor. • PPEs should be provided to workers • Availability of safe drinking water and food for the workers. • Availability of alternate water supply lines • proper maintenance of machinery • Traffic management plan should be prepared in advance of start of work on-site and communicated to the field staff. • Use alternate traffic routing • Establish coordination procedures for cut-off • Alternate water supply line will be make sure and public will be informed about it.

Sr. No.	Component	Description	Recommended Mitigation Measure
4.	Mechanical Works – Pumps replacement and repair	• Design according to approved specification • Handling and storage	• Pump replacement should be installed based on approved design specifications • Pump repairs should be done according to approved design specifications • Waste and redundant material shall be handed over to the Municipality offices / custodian department from which they were issued • General housekeeping shall be observed at site • Record of all wastes should be maintained
5.	Backwash Pipeline Construction	• The backwash pipeline for transportation of backwash to injection wells will be part of construction scope of work.	• It is suggested that backwash from treatment plants should be injected in deep wells, injection depth should be two to three times greater than suction level.
6.	Land Acquisition .	• Land will be acquired within the Mandi Bahauddin city. In case of non-availability of state/ Government Land private land will be required. In this Tehsil, mostly State Lands are available and at remaining locations, donation of private land will be acquired	• Land Acquisition is not done at any site hence no mitigation is required.
7.	Contractor Camps	• Contractor camp will be established near the Project site to carry out	• Ensure that camp size is as per standard specifications

Sr. No.	Component	Description	Recommended Mitigation Measure
		the Project activities. Though the number of labour and size of camp will not be large, even then this will have an impact on the surrounding environment.	• Ensure that Contractor camp is established at least 500m away from settlements to void / minimize the construction impacts • Contractor should ensure provision of appropriate housing, water supply, and sanitation facilities to construction labor.
8.	Installation of Batching Plant	• Batching plant will be installed at Project area for construction activities. Batching plant operation will be a source of nuisance for surrounding community.	• Ensure that location of batching plant must be at least 500 meters away from the settlement. • Ensure that batching plant material is stocked on specified area in compliance with specifications of installation of batching plant. • Ensure that the batching plant is installed with zero emissions. • Ensure that the batching material does not contaminate the land or natural drainage.
9.	Dust	• The earthen portions of road/tracks may prone to dust emissions due to moving machinery. Machinery consisting of bulldozers, dumpers, generators and vehicles will be used during the construction phase. This construction machinery will generate lot of dust, smoke and other potential pollutants in the air.	• All sections of the access tracks that are prone to dust emission and where sensitive receptor are located within 500 m should be identified and marked on the map of the project area. • Wind breaks or barriers (either natural or constructed) should be installed at susceptible • Construction sites that reduce wind velocity and reduce the possibility of suspended particles. Wind breaks can be trees or shrubs left in place during site clearing or constructed barriers such as a wind fence or sediment wall.

Sr. No.	Component	Description	Recommended Mitigation Measure
			• Ensure that the access tracks which are prone to dust emissions and marked on the map should be maintained by water spraying daily. • Ensure that all equipment, generators and vehicles used during the project are properly tuned and maintained in good working condition, in order to minimize the exhaust emissions. Ensure that the batching plant design meets requirements of zero emissions. • Ensure that dust emissions due to vehicular traffic are minimized by reduced speed, vehicular traffic minimized through good traffic management and water sprinkling when required. • Ensure that dust emissions at the construction sites are minimized by implementing best management practices.
10.	Noise	• Noise will be produced from constructional activities. This can disrupt the daily activities of settlements.	• Construction activities should be prohibited from 9pm to 8am. • Noise barriers should be installed where possible to keep the noise levels within permissible limits. • Ensure prohibition of use of vehicle horns anywhere inside the fenced areas or on the access roads is strictly observed. • Noise-reducing devices (silencers and baffles) should be used for the machinery • Engines should be turned off when they are not in use • Contractor obligation is to use appropriate and fit machinery.

Sr. No.	Component	Description	Recommended Mitigation Measure
11.	Vehicle Movements	• Traffic congestion • Conflicts	• Alternative routes should be provided. • Sign boards and posters should also be displayed at project site and adjacent areas as well. Inform the residents about timing, schedule and construction work duration.
12.	Vibration	• Shock waves can be produced due to heavy machinery working. Loss to nearby structures can be resulted.	• Use of vibratory rollers should be prohibited.
13.	Solid Waste Generation	• The Contractor camp will generate solid waste. • Improper disposal of solid waste will contaminate land and can sprout numerous diseases.	• Ensure following steps while disposal of solid waste: – Solid waste should be segregated according to its type. – Material suitable for recycling should be stored separately and sold afterwards. – Combustible waste to be burnt at designated burn pit only as demarcated by Resident Engineer. – Non- combustible, non-recyclable garbage sent to the designated landfill site in Project area as demarcated by Resident Engineer. – Contaminated soil should be sent to burn pit or landfill. – Medical waste (if any) should be transported to nearby hospital incineration plant. – Solid residue from the septic tanks should be transported to municipal sewage facilities as demarcated by Resident Engineer.

Sr. No.	Component	Description	Recommended Mitigation Measure
14.	Waste Water Discharge	• The Contractor camp will produce waste water. • Unmanaged disposal of this water will contaminate land and will lead to water borne diseases.	• Water from washing areas and kitchen is released in sumps. • Ensure septic tanks of appropriate design have been used for sewage treatment and outlets are released into sumps. • Ensure that the outlets released into sumps must not make a pond of stagnant water. • Ensure that latrines, septic tanks, and sumps are built at a safe distance from water body, stream, or dry streambed and the bottom of the sump is above the ground water level. • Ensure that sumps are: – In absorbent soil. – Down slope and away from the camp. – Downstream from the camp water source and above the high watermark of nearby water body (if any). • Ensure that effective drainage is in place at the site.
15.	Construction material storage, handling and use	• Project activities will generate construction waste. Improper disposal of that waste could create nuisance to the surrounding community. • Water may also be contaminated due to the oil spillages if the water source is nearby the storage yard.	• Ensure that the site selected for waste material disposal is demarked by Resident Engineer before starting the work. • Ensure that all trucks used for the transportation of waste material are airtight and watertight. • Loads/heaps shall have appropriate cover to prevent spillage and contractor should be responsible for any clean up resulting from any failure. • Materials shall not be loaded to a higher level than the side and tail boards and shall be covered with a good quality tarpaulin;

Sr. No.	Component	Description	Recommended Mitigation Measure
		• Land accusation for storage of Construction material • Accidents/Injuries expected if neglected	• No land should be acquired for the storage of materials & machinery as no widening of road involved under scope of work. • If land acquired for storage of machinery & materials on temporarily basis: Contractor is liable to compensate the land owner according to market rate. • Ensure that photographs of selected area are taken. • Ensure that the movement of waste lifting machinery and vehicles is limited to the work area. • Ensure that waste material is properly disposed-off in a manner that does not affect the natural drainage. • Ensure that the dumping area has been leveled properly after disposal of waste material. • Contractor should use night vision reflective signboards/ reflective tapes to cordon off the area during construction/demolition activities.
16.	Soil Erosion	• Construction activities will lead to soil erosion. Soil erosion from construction sites can cause pollutants generation and also depletion of the soil quality.	• Ensure that surface run-off controls are installed and maintained so as to minimize erosion. • Ensure adherence to the speed limit of 40 km/hr. at the access roads. • Ensure that vegetation clearing is minimized and no trees are felled without prior permission of Consultant's Environmentalist.

Sr. No.	Component	Description	Recommended Mitigation Measure
			• Loose soil and side slopes will be planted with grass to retain the upper soil and reduce the rainwater velocity.
17.	Land Contamination	• The construction machinery including cranes, trucks, loaders/ dumper and batching plants will be used during the construction period. There are chances of land contamination due to release/ spill of lubricants, oil, chemicals and toxic materials	• Ensure that the maintenance of vehicle and other equipment takes place only in designated areas underlined with concrete slabs and a system to collect runoff in to mud pit. • Ensure that no contaminated effluent is released in to the environment. • Ensure machinery wash and other potentially contaminated effluents are released in mud pit. • Ensure that fuels, oils, and other hazardous substances are handled and stored according to standard safety practices such as secondary containment. Fuel tanks should be labeled according to impervious lining and dykes etc. • Ensure spills are avoided during fuel and oil transfer operations. Appropriate arrangements, such as concrete base or drip pans, should be used to avoid spills. • Ensure fuels, oil and chemical storage are daily checked for leakage. • Ensure that shovels, plastic bags, sand bags and absorbent materials, are kept available near fuel and oil storage areas. • Ensure that operating vehicles are checked regularly for any fuel, oil, or battery fluid leakage.

Sr. No.	Component	Description	Recommended Mitigation Measure
			• Ensure that leak /spill record is maintained for each vehicle and such vehicles are operated after proper repair. • Soil contaminated by minor spill (covering an area up to 01 m^2 and 7.5 mm deep) will be collected and disposed at burn pit. • Ensure that soil contaminated by moderate spills or leaks (up to 200 liters) is controlled using shovels, sand and mud. The contaminated soil if any will be removed from the site and disposed-off at landfill or burn pit as required.
18.	Wastage of Water	• Water may be wasted during daily activities of labour camps.	• Avoiding undue wastage of water through conservation techniques and selection of adequate water supply sources to ensure that water usage does not affect local consumption.
19.	Occupational Health and Safety	• Risk may occur from: – drinking contaminated water – fire hazards – chemical spillages – falls – communicable diseases – Different construction activities – Inadequate Personal Protective Equipment (PPEs)	• Providing basic medical training to specified work staff and basic medical service and supplies to workers; • Work safety measures and good workmanship practices are to be followed by the contractor to ensure no health risks for laborers; • Protection devices (ear muffs) will be provided to the workers operating in the vicinity of high noise generating machines; • Provision of adequate sanitation, washing, cooking and dormitory facilities including lighting up to satisfaction; • Provision of protective clothing for laborers handling hazardous materials, e.g. helmet, adequate footwear for bituminous pavement works, protective goggles, gloves etc.;

Sr. No.	Component	Description	Recommended Mitigation Measure
			• Ensure strict use of wearing these protective clothing during work activities; • Availability of safe drinking water for the workers; • Elaboration of a contingency planning in case of major accidents; • Close consultation with local communities to identify optimal solutions for diversions to maintain community integrity & social links; • Provision of proper safety signage at sensitive/ accident-prone spots; and • Cordon-off the constructed area
20.	Flora	• The construction may involve cutting and removal of trees. • There is no protected or reserved forest in the vicinity of the construction area. Therefore, no effect is envisaged.	• Ensure that during aligning the access roads, minimum vegetation is lost. If any tree is uprooted, ensure that the Contractor has planted at least three-fold of trees lost. • Ensure that endangered trees species (if any) indicated in (EIA) are not cut. • Ensure that trees and shrubs are not used as fuel during construction or operation. • After completion of construction phase the vegetation of the area should be restored through plantation.
21.	Fauna	• The construction activities may disturb the habitats of native animal species.	• Natural habitats should be maintained to the maximum extent and undue interference should be avoided during construction phase of the Project.

Sr. No.	Component	Description	Recommended Mitigation Measure
			• Endangered species if any should be documented and activities should be carried out to reduce negative impacts on endangered species. • Contractor's staff should be strictly prohibited from buying any wild animals/birds. • Ensure that safe driving practices are observed so that the accidental killing of reptiles or small animals crossing the roads could be avoided. • Ensure that damage to the natural topography and landscape is kept as minimum as possible. • Ensure that a no-hunting, no trapping, no harassing wildlife policy is strictly observed. • Ensure that the general awareness of the crew is enhanced regarding the wildlife, through environmental training, notices boards etc.
22.	Agricultural Land and crop destruction.	• No agricultural land is involved anywhere in the Project implementation	• No action is required
23.	Job Opportunities .	• The project will open job opportunities which the local population can avail. Contractor should hire skilled and unskilled	• Ensure that at least up to 95% of unskilled, up to 43% of semi-skilled employment and up to 100% of skilled jobs are provided to people from local communities, provided that the persons with required qualifications are available.

Sr. No.	Component	Description	Recommended Mitigation Measure
		labor force from the local communities.	• Ensure that guidelines are prepared and implemented to sensitize non-local laborers to local norms and customs in order to minimize cultural tensions
24.	Communicable Diseases .	• Presence of labour at Project site may pose hazard of communicable diseases, which can also spread to the surrounding community	• Good design and construction management to avoid stagnant water. • Proper management and disposal of rubbish and wastes from camp site. • Ensure that field crew is medically screened before employed on site. • Ensure Project staff interaction with local community is minimized. • When operating in residential areas, display Project contact details in prominent locations. This will give local residents a point of contact and should allow you to address any nuisance issues that may arise. • Ensure that periodic awareness campaigns for HIV/AIDS are undertaken for the project staff.
25.	Any Discharge or diversion of water to a Graveyard or Archeological area	• If Graveyard/ Archeological sites are found in the Project area then due precautions are necessary.	• If during construction such sites are found and discharge or diversion of water likely to damage the site then it is a Contractor's obligation not to let it happen

Sr. No.	Component	Description	Recommended Mitigation Measure
26.	Public access	• Problems for pedestrians. Normal mode of transport may be disturbed during project execution. • Impediment of access to houses and business	• Alternate access route should be made sure. • Construction should start from middle of the street and later on from either right or left side. • Wooden blocks/ramps shall be provided at door step of each house. Cordon off open Manholes
27.	Water Intake	• Water source for treatment plants will be ground water in Mandi Bahauddin	• The population of Mandi Bahauddin use ground water for their daily activities. The ground water is collected through hand pumps and motor pumps. This water is contaminated by chemical and biological contaminants. Thus, treatment of this water by RO and UF plants will lead a positive impact on health of the local community. Also, water will not be depleted or wasted by installation of water treatment plants. It is proposed that since the community will use this treated water instead of directly using the ground water, this means that the depletion of ground water will be minimal as well.
28.	Water Pollution	• Pollution by Stored Water Treatment Chemicals – Chlorine	• Safe Storage facilities to be provided. Chemical Storage areas to be constructed with hardened cement screed floor finish with approved epoxy floor coating. • Water treatment should be done at a minimum disinfection / chlorination.
29.	Seepage/Spill water	• Increase moisture content in soil which affects the structures /	• Ensure proper technical design, construction and operation of the structure and system to minimize seepage and appropriate implementation techniques. In case of failure of nearby

Sr. No.	Component	Description	Recommended Mitigation Measure
		foundation of buildings in nearby areas. Contaminate the water	building structures, foundation, monetary compensation shall be provided.
30.	Energy Consumption	• Solar panels can be used for power supply along with the option of supply from local grid station (if required). As the solar energy is renewable energy source so no impact is envisaged.	• No action is required
31.	Disposal of Back Wash	• The quantity and composition of the filter backwash water are functions of the process and the efficiency of the treatment units preceding the filter. The backwash generated from the treatment plants may contaminate the receiving body as well as the ground water.	• It is suggested that backwash from treatment plants be injected deep in the aquifer.
32.	Air Emissions	• The air may be polluted due to vehicular emissions and dust producing activities.	• Monitoring of NOx and Total Suspended Particulate (TSP) emissions from air should be carried out effectively.

Sr. No.	Component	Description	Recommended Mitigation Measure
33.	Aesthetic/ Scenic Quality	• The Project construction and operational activities may affect aesthetic/scenic quality of the area.	• The standing lush green crops and trees in filed present a good scenic view of Project area. This should be conserved at all costs.

SECTION 3 – SEWERAGE AND DRAINAGE

3.1. CURRENT STATUS

MC Mandi Bahauddin is responsible for Sewerage/Drainage area of around 35 km^2 area, serving a population of approximately 123,000 people. The total length of sewers lines is approximately 24.8 km. For sewerage, the approximate length of covered sewage drains is around 5km. The ultimate discharge points are the seepage drains i.e. Saim Nullah. There is no disposal station or pumping station in the city as such and the system works on the principle of gravity. The following map depicts the sewerage network of Mandi Bahauddin.

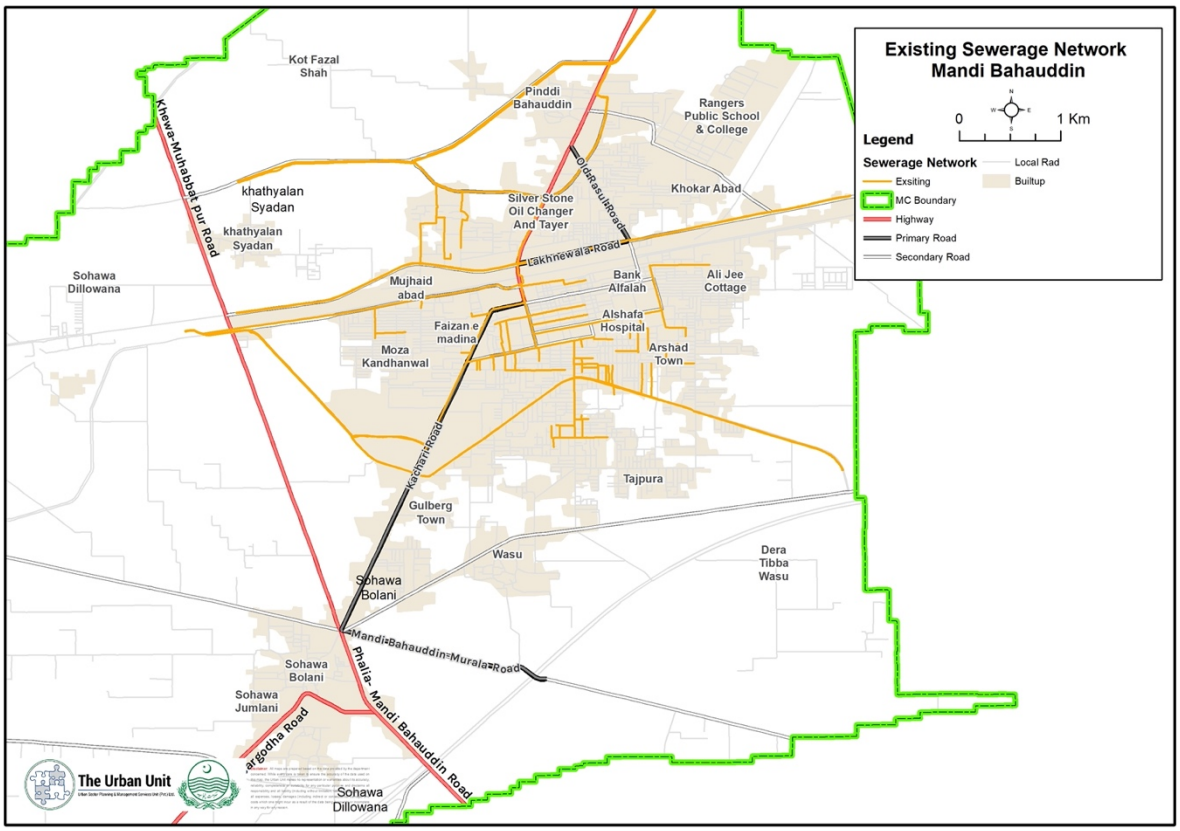

Figure 8: Existing Sewerage Network in Mandi Bahauddin

Salient features of the sewerage system are listed in the table below with respective quantities under MC Mandi Bahauddin.

Table 7: Components of Sewerage network in Mandi Bahauddin

Sr. #	Feature	Quantity	Remarks (e.g. Functional status)
1	Disposal Stations	None	Working on Gravity
2	Pumps	None	

3	Treatment technology	None	
4	Sewerage connections	4080	Domestic= 4000 Commercial= 80

Notably, there is a team of 12 people responsible for the management of system, out of which only one member is technical while the remaining 11 are non-technical. Only 02 persons are dedicated for maintenance. This translates to 0.05 staff/1000 population, which is alarmingly low from the management perspective. 90-100 complaints have been reported per month while around 2-3 cases related to Pipe breakage have been noticed.

3.2. WASTEWATER PRODUCTION

The following table summarizes the projected wastewater production rate till 2030 based on the population of 2017 and average annual population growth rate of 1.68% as reported from 1998-2017.

Table 8: Wastewater Production

	2020	2025	2030
Population	208,788	226,925	246,639
Average Dry Weather Flow (GD)	5,532,882	6,013,525	6,535,921
Non Domestic Flow (GD)	553,288	601,352	653,592
Peak Dry Weather Flow (GD)	18,258,511	19,844,632	21,568,539
Infiltration (GD)	912,926	992,232	1,078,427
Stormwater (GD)	5,477,553	5,953,389	6,470,562
Total (GD)	24,648,989	26,790,253	29,117,528
Total (MGD)	24.6	26.8	29.1

3.3. DESIGN CRITERIA

3.3.1. Components of Sewerage System

1. **Conveyance Network**

   Lateral (smaller) sewer pipes are used to collect the sewage directly from the interception points and convey sewage up to sub-main or main/trunk sewers. As the sewage is conveyed under gravity flow, therefore pipes are sloped towards final disposal point. To raise hydraulic grade line, the sewage is pumped through a disposal/pumping station.

2. **Manholes**
   Manholes are generally provided in the sewer pipes at suitable distances for connection of lateral lines and inspection and maintenance purposes. For closed drains, inspection chambers are provided for removal of sludge and maintenance works.

3. **Pumping/Disposal Stations**
   In plain areas, the trunk sewer lines usually go well beneath the natural surface level (NSL) at the end and sewage is pumped through a pumping/disposal station to dispose of into Sewage Treatment Plant. A disposal/pumping station is generally composed of a collection well and pumps with suction and delivery pipe lines.

4. **Sewage Treatment Plant (STP)**
   Sewage from the Hafizabad city will be collected at disposal stations at different locations as per the master plan. This sewage contains hazardous chemicals and pollutants, so they cannot be disposed of directly into any water body as per provisions of the Pakistan Environmental Protection Laws. This acts as the driving force behind construction of the sewage treatment plants that are to be located after disposal stations and/or sullage carriers. These treatment plants will treat the sewage according to the prescribed standards given in Punjab Environmental Quality Standards (PEQS) and the treated product will be afterwards disposed into the water body.

3.3.2. Design Flows

Flow calculations will be based on the following list of parameters.

1. **Average Domestic Sewage Flow**
   Sewage production is based on the water consumption. The sewage production will be taken as 85% (for population more than 100,000) of the water consumption according to PHED criteria. Water consumption per capita per day for Hafizabad city will be adopted as 55 gallons (PHED).

2. **Peak Flow**
   Peak flow will be estimated by multiplying the average daily flow by the Peak factor to calculate the peak flow. Peak Factor depends upon the population as it decreases with increase in population. The PHED criteria provides different peak factors according to population as shown in **Table 9**.

Table 9: Peak flow according to population

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

3. **Non-domestic Sewage Allowance**
   The non-domestic sewage allowance will be taken as 5% of average sewage flow that will cover institutional, commercial and small industrial discharges.

4. **Storm Water Allowance**
   An allowance of storm water flow will be considered in the partially combined sewerage system which shall be equivalent to the 33% of peak sewage flow as per PHED design criteria.

5. **Infiltration Allowance**
   As per the given PHED criteria, an allowance for infiltration rate equals to 5% of average flow will be used.

6. **Design Calculations**
   Total sewage flow shall be the sum of all the above flows and sewers/conduits shall be designed on this total sewage flow.

   Total flow = *Average domestic sewage flow + Peak flow + Infiltration rate + Non-domestic flow + Storm water flow*

3.3.3. Conveyance Network

Components of sewerage system mentioned previously will be designed considering above design flows and on the criteria listed as follows.

1. **Pipe Materials**
   Selection of a viable pipe material is based on the capital cost to be incurred on the installation of collection network, design life and operation and maintenance expenditure. In this regard, following are the pipe materials which can be considered:

- RCC Sewer Pipes
- RCC Drains/conduits
- High Density Polyethylene (HDPE) Pipes
- Corrugated High Density Polyethylene (HDPE) Pipes

RCC sewer pipes are most commonly used successfully for local sewerage schemes. HDPE pipes are relatively less common for gravity sewers in Pakistan due to higher capital cost and non-availability of larger diameters in local market. However, HDPE pipes are being used for gravity sewerage system in developed countries.

The **Table 10 below** shows the comparison of above-mentioned types used for sewage conveyance.

Table 10: Comparison of types used for sewage conveyance

Sr. No	Evaluation Criteria	RCC Sewer Pipes	RCC Drains/Conduits	HDPE Pipes
1	Available unit Length	2.4 m	Precast conduits up to 1.8 m length are common	6 or 12m
2	Diameters/Sizes Available	225 to 1830 mm	Can be casted in any required size	Available up to 1600 mm
3	Type of Joint	Bell & Spigot Joint, Tongue & Grove Joint	Expansion Joint with Sealant	Butt fusion welding process.
4	Weight	Heavy	Heavy	Light
5	Handling	Difficult due to heavy weight	Precast conduits are difficult to handle due to heavy weight	Easy mobility but jointing requires trained labour
6	Roughness Coefficient	0.011-0.013	0.011-0.013	0.011
7	Corrosion resistance	Subject to H_2S corrosion due to acids, highly septic sewage and by highly acidic sewage.	Subject to H_2S corrosion due to acids, highly septic sewage and by highly acidic sewage.	Highly Corrosion resistant
8	Structural Life	Around 25 years	Around 25 years	More than 50 years
9	Local Availability	Easily available	Easily available	Larger diameters

				are manufactured on special orders or imported
10	Requirements of Special Equipment for Jointing	Not required	Not required	Equipment for Butt fusion welding is required
11	Previous Local Experience	Commonly practiced and successful under many local circumstances for urban sewerage schemes	Commonly practiced when RCC sewer dia. above 72" is required. It is successful for both urban and industrial developments. Used in industrial estates of PIEDMC.	Smaller diameters up to 27" have been successfully used in local projects. Larger diameters are not common.
12	Operational Problems	Effluent may erode and deteriorate the strength and cause crown failures.	Cleaning is relatively easy and repairing work is easier in case of drains/sullage carrier	Resistant against chemicals of industrial effluents and lesser operational problems

2. Manhole

Manholes will be provided at each junction of the sewers with varying diameter, gradient or alignments. As per PHED criteria, size & depths of manholes and spacing of manholes are tabulated within **Table 11** and **Table 12**.

Table 11: Spacing of manholes as per PHED criteria

Sewer Size (mm)	Spacing (m)
310	30
380	45
460	60
530 -610	75

690 -1070	90
1220 -1520	120
Above 1520	150

Table 12: Size & depths of manholes as per PHED criteria

Size of Sewer (mm)	Sewer Depth (m)	Diameter of Manhole (m)	Remarks
225-530	1.25-2.25	1.25 dia	-Masonry 1:3 Cement Sand Mortar -Up to 2.25m depth 225mm Masonry. -From 2.25m to 4.75m Depth 350 to 225mm Masonry -From 4.75m and above 450mm to 350mm.
610-760	2.5-6.0	1.5 dia	
840-1070	2.5-6.0	2 dia	
1220-1370	2.5-6.0	2.25 dia	
1520	2.5-6.0	2.5 dia	
1680	2.5-6.0	2.5 dia	
1830	2.5-6.0	2.75 dia	

For manholes under sub soil water, RCC core-wall will be designed and floor will be designed as per actual depth of water encountered. Furthermore, it may be noted that the traffic flow is also taken into considerations when deciding manhole covers and their designs.

3. Sewer Pipes

i. The Master Plan has been prepared for primary, secondary and tertiary sewer pipes. Primary sewerage network include 72”, 54”, 48” and 36” diameter pipes, secondary sewer pipes are of 30”, 27”, 24” and 18” diameters and tertiary pipes comprise of 15”, 12” and 9”.

ii. Reinforced cement concrete pipes conforming to ASTM Specification C-76 shall be used.

iii. A minimum cover of 1 m over the crown of sewers has been proposed from the finished road level.

iv. Pipe roughness coefficient (n) of RCC pipes will be 0.015 and 0.013 for old and new pipes respectively.

v. Bedding materials for the design of sewers above sub-soil water level having diameter 310mm and greater will be crushing stone (6mm to 25mm). For sewers below sub-soil water level, decision to be taken as per site conditions.

vi. Minimum gradient for sewers will be recommended to attain the self-cleansing velocity (0.75 m/sec).

For sewer joints rubber ring joint in addition to jute wrapping with cement slurry is

recommended.

Table 13: Design criteria for Sequencing Batch Reactors

Description	Unit	Continuously fill Intermittently decent	Intermittently fill Intermittently decent
Number of reactors	Nos	2	2
F/M Ratio		0.05- 0.08	0.05 – 0.30
Hydraulic Retention Time	Hours	18 - 24	18 - 24
Mixed Liquor Suspended Solids (MLSS)	mg/l	3000 - 4500	3000 - 4500
Dissolved Oxygen (DO)	mg/l	0 – 6.50	0 – 6.50
Sludge yield	Kg sludge produced/ kg BOD5 consumed	0.75 – 0.85	0.75 – 0.85
Cycle time	hrs	4 - 8	4 - 8
Waste activated sludge	kg sludge/day	WAS = total sludge/sludge age	WAS = total sludge/sludge age
Decant time	hrs	>1	>1
Decant volume	m^3	Max 0.5	Max 0.5
Decanting device loading rate	m3 /m/hr	≤20 for decant drawdown from TWL	≤20 for decant drawdown from TWL
Minimum number of decanter		2 nos. independent decanter per tank	2 nos. independent decanter per tank
Max decanter length	m	4	4

3.4. CHALLENGES FOR SERVICE DELIVERY

- There is lot of stress on its trunk sewer; especially in monsoon season when flooding occurs in the city
- There is an acute shortage of staff dedicated for sanitation
- Main trunk sewer has small size against the desired capacity
- Lateral sewers need to be provided in different areas and Trunk Sewer size needs to be increased for improved service delivery

- Staff on daily wages is not permanent and lack of motivation has been noticed
- At present no formal Sanitation plan has been developed as such
- There is no separate wing of sanitation staff, the sanitation staff are part of overall MC staff.

3.5. RECOMMENDATIONS – SEWERAGE/SANITATION

During the Stakeholder Consultation with the Deputy Commissioner and officers Municipal Committees, Town Committees, Public Health Engineer Department A0 size maps were used for quantitative and qualitative assessment of the existing infrastructure. This exercise helped us in not only understanding the current state but also envisioning the future state of the respective areas. Some recommendations, in terms of short-, medium- and long-term priority are being forwarded.

3.5.1. SHORT TERM (1-5 years)

S.#	Project	Cost (Million PKR)
1	Rehabilitation scheme at Dara Roshan, Gurah Mohalla, Usmania Mohalla, School Mohalla, Ward #5	**187.602**
2	Urban Sewerage / Drainage / PCC / Tuff Tile / RCC / Nullah and Brick Pavement Scheme at Ghegha Chowk to Wasu Road, Qilla Gujjran, Lillah Town, Ehsan Abad, Taj Pura, Arif Abad, Wasu, Doctor Town, Janjua Town, Sohawa Bolani, Jumlani, Dillowana including development	**369.007**
3	Urban sewerage / drainage / PCC / Tuff tile / RCC and Brick pavement scheme at Ehsan abad, Wasu, Taj pura and Doctor town	**148.269**
	Total	**704.88**

3.5.2. MEDIUM TERM (5-10 years)

S.#	Project	Cost (Million PKR)
1	Urban Sewerage / Drainage / PCC / Tuff Tile / RCC / Nullah a brick pavement scheme at Western Side Phalia Road, Sug Mill Road, Shafqat Abad, Dera Jalal, Khokhar Abad, Faiz Aba Gillani Town, Sufi Pura	**210.145**

2	Extension of Sewerage System in unserved areas e.g. Islam Nagar, Wasu, Shafaqabad Mohalla, Haji Mohalla, Sufi Pura, Faizabd Mohalla	**656.610**
3	Restructuring and Capacity building of TMAs/MC	-
	Total	**866.755**

3.5.3. LONG TERM (>10 years)

S.#	Project	Cost (Million PKR)
1	Extension of Sewerage System in unserved areas e.g. Pindi Bahuddin, Rangers Colony, Khokhar Abad, Tariq Abad, Roshanpura, Kandanwala, Sohawa Bolani & District Complex	**766.09**
2	Establishment of a centralized Wastewater Treatment Plant behind Shahtaj Sugar Mill next to seepage drain	**233.147**
	Total	**999.237**

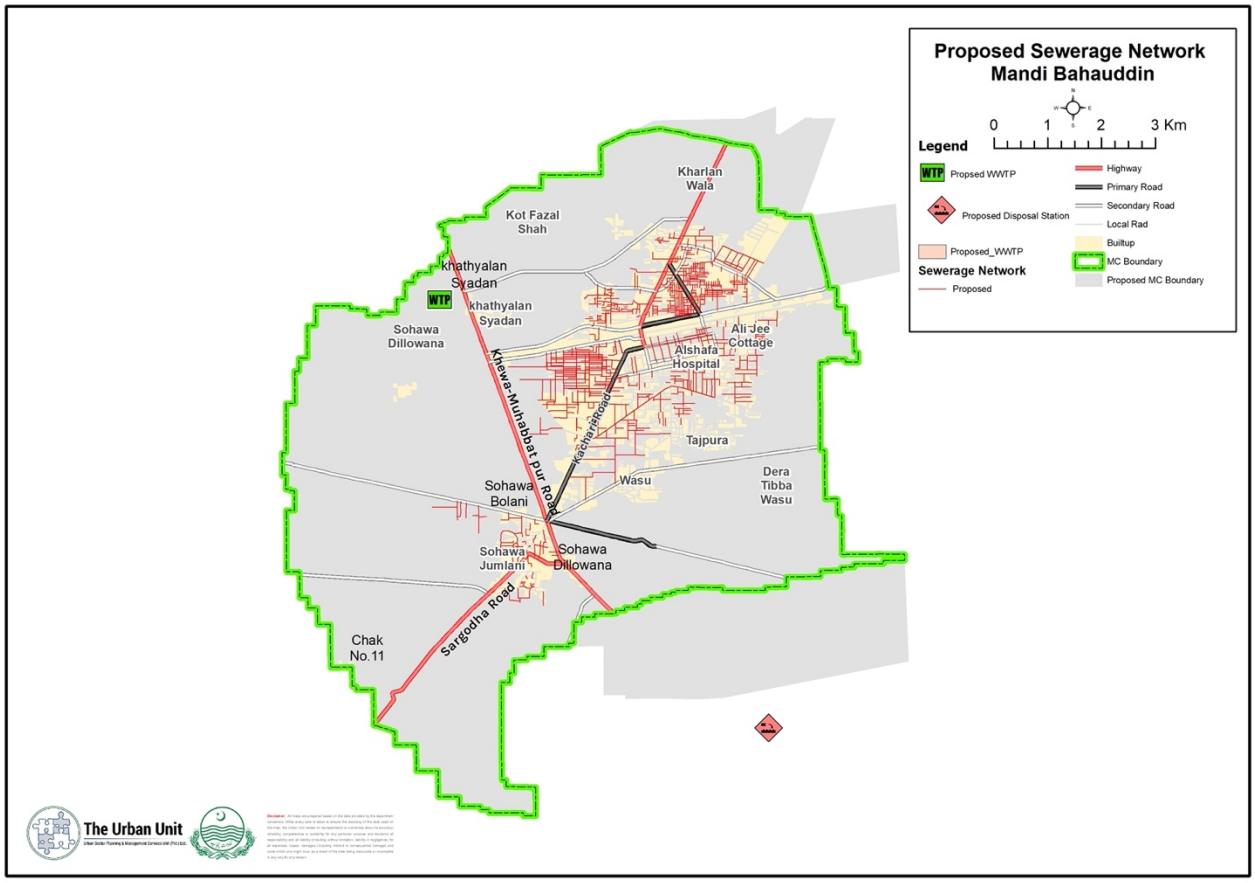

Figure 9: Proposed Sewerage Network for Mandi Bahauddin

3.6. ENVIRONMENTAL MANAGEMENT PLAN FOR SEWERAGE SCHEMES

A sample Environmental Management Plan is being shared for Water Supply schemes in Mandi Bahauddin. Depending upon the nature of task and the designated mandate, the responsibility of implementing various projects maybe given to contractors, MC, PHED, EPA etc.

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
1.	Design	• Inadequate design may not meet the quantity of sewage generated, pumping equipment and accessories, selection of proper pipe material	• Correct generation of wastewater by considering population corresponding to the Project Area • The selection of machinery for at least 10 years for smooth functioning of disposal station. • Sewers shall be laid away from water supply lines and drains (at least 1m, wherever possible); • In all cases, the sewer line should be laid deeper than the water pipeline (the difference between top of the sewer and bottom of water pipeline should be at least 300 mm) • In unavoidable, where sewers are to be laid close to storm water drains or canals or natural streams, appropriate pipe material shall be selected (stoneware pipes shall be avoided) • For shallower sewers, use small inspection chambers in lieu of manholes; • Ensure sufficient hydraulic capacity to accommodate peak flows & adequate slope in gravity mains to prevent buildup of solids and hydrogen sulphide generation • Equip pumping stations with a backup power supply, such as a diesel generator, to ensure uninterrupted operation during power outages, and conduct regular maintenance to minimize service interruptions. • Establish routine maintenance program, including:

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
			– Regular cleaning of grit chambers and sewer lines to remove grease, grit, and other debris that may lead to sewer backups. Cleaning should be conducted more frequently for problem areas. – Inspection of the condition of sanitary sewer structures and identifying areas that need repair or maintenance. Items to note may include cracked/deteriorating pipes; leaking joints or seals at manhole; frequent line blockages; lines that generally flow at or near capacity; and suspected infiltration or exfiltration; – Monitoring of sewer flow to identify potential inflows and outflows • Conduct repairs prioritized based on the nature and severity of the problem. Immediate clearing of blockage or repair is warranted where an overflow is currently occurring or for urgent problems that may cause an imminent overflow (e.g. pump station failures, sewer line ruptures, or sewer line blockages); • Review previous sewer maintenance records to help identify "hot spots" or areas with frequent maintenance problems and locations of potential system failure, and conduct preventative maintenance, rehabilitation, or replacement of lines as needed; • When a spill, leak, and/or overflow occurs, keep sewage from entering the storm drain system by covering or blocking storm drain inlets or by containing and diverting the sewage away from open channels and other storm drain facilities (using sandbags, inflatable dams, etc.). Remove the sewage using vacuum equipment or use other measures to divert it back to the sanitary sewer system

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
			• Develop Emergency Response Plan for all emergencies such as leaks, overflows, bursts
2.	Utilities	• Disturbance/damage to existing utilities on the sites (Telephone lines, electric poles and wires, water lines within proposed project sites)	• Identify and include locations and operators of these utilities in the detailed design documents to prevent unnecessary disruption of services during construction phase • Conduct detailed site surveys with the construction drawings and discuss with the respective agencies during the construction phase before ground clearance; Require construction contractors to prepare a contingency plan to include actions to be done in case of unintentional interruption of services.
3.	Selection of poor construction materials	• Health and hygiene in the service area	• Selection of construction material safe for human use
4.	Inadequate buffer zone	• Noise and vibration due to running of heavy-duty pumps resulting in inconvenience to local people	• Provision of buffer zone in the form of raised walls and plantation and oiling of parts of machinery causing noise and vibration

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
5.	Improper construction techniques and monitoring	• Impacts due to excess excavated earth, excess construction materials, solid waste etc. • Occupational hazards which can occur to workers and public during work. • Public inconvenience, traffic jams.	• Prepare and submit a Method Statement for pipeline and sewer works which cover the following: – Work description; – No. of workers (skilled & unskilled); – Details of Plant, equipment & machinery, vehicles – Work duration (total, and activity-wise, for example for pipe laying, from excavation to road resurfacing/testing) – PPE (helmet, gloves, boots, etc.) details for each type of work – Details of materials at each site (type & quantity) – Risks/hazards associated with the work (for example, Trench excavation will have risks such as trench collapse, persons/vehicles falling into trench, structural risk to nearby buildings, damage to buildings, infrastructure etc.) – Construction waste/debris generated (details & quantity) – Detail the sequence of work process (step-by step) including specific details of each work – Contractor's supervision & management arrangements for the work – Typical site layout plan including pipe trenching, placement of material, excavated earth, barricading etc. • The supervisory/ monitoring staff should be experienced and qualified enough to handle the excavated material and its disposal in designated places without harming local environment. Also, additional training may be provided. Supervision and training for the contractor's staff shall also be required.

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
6.	Dismantling, Excavation, and Filling Operations	• Dust which may affect visibility • Noise from machineries/ equipment • Soil erosion • Contamination of surface water • Vibration (Shock waves can be produced due to heavy machinery working) • Solid waste/ pipe cuttings/ sludge may be generated due these activities • Safety hazards to labor and nearby resident population. • Temporary blockage of road may restrict mobility • Conflict with public and public complaints • Economic losses – Livelihoods loss. – loss of shopkeepers – Temporary loss of structures and private property	• Waste should be properly disposed off • Updated and tuned machinery should be used to control noise. • Water sprinkling should be carried out at consecutive intervals as per instruction • Provision for personal protective equipment, earmuffs, Mask etc. to labor. • Avoiding construction activities during nights. • Use of vibratory roller should be prohibited • Removal of excess matter/ debris/sludge from the site immediately. • Adequate safety precautions such as helmets, safety shoes, gloves, etc. should be provided to the labor • Provide appropriate signage near the construction activities to sensitize the community and minimize accidents. • Public Consultation to aware nearby residents. • Public must be informed about project major activities, duration of scheme, time and schedule, anticipated impacts and their proposed Mitigation Measures. The contact Nos. of focal person of Grievance Redress Committee should be displayed at different locations and residents should also be informed about it. • Emergency contact numbers should be displayed • Construction work should be done only on 4-5 feet length of street, rest of the streets should not be affected. In this way the business of the shops keepers will not be affected. Sewer lines where about 10 days will require to work make a schedule to work in portions so that the alternate road may be used safely. Contractor would be instructed that labor must not damage the property and structures of the residents. In case of damage compensation should be provided.

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
		– Economic loss of permanent and mobile vendors due to obstruction of passage	
7.	Civil work, Laying of sewer lines/ network	• Solid wastes • Noise and vibration disturbances to residents and businesses • Road side visibility can be reduced and dusty environment leads to respiratory diseases. • Safety issues • Health problems or immediate risk may take place • Spillage of fuel and oil • Traffic jams and congestion may take place and cause inconvenience to the people where the construction of interchanges will take place. • Reduced pedestrian access to residences and businesses	• Immediately transport the accumulated construction waste to a site identified by the implementing authority • Broken Pipes should be disposed off properly • Removal of excess materials • Cleaning of sites upon completion of schemes. • Establish schedule and others specific restrictions • Limit work to day light hours as possible • Use of less noise generating equipment • Regular water sprinkling with the help of water bowsers • Cordon off construction area • PPEs should be provided to workers • Availability of safe drinking water and food for the workers. • Availability of alternate sewer lines

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
		• Temporary Sewer system interruption Conflicts. • Dissatisfaction for the project • Scattered construction material may obstruct mobility.	
8.	Civil Works – Rehabilitation and Repair	• Contamination of soil and ground water • Pollution and general nuisance	• Rehabilitation and repair wastes shall be stored at designated site • Recyclable wastes should be recycled as far as reasonably practical • General housekeeping shall be maintained at site • Record of all wastes should be maintained • Trainings should be provided to personnel for identification, segregation and management of solid waste
9.	Air pollution	• Dust and exhaust emissions may cause nuisance to the local resident	**Gaseous Emissions** • All vehicles, machinery, equipment and generators, used during construction activities, shall be in good condition and shall be properly tuned and maintained by the Contractor in order to minimize the exhaust emissions; • Open burning of solid waste from Contractor's camps shall not be allowed. **Dust Emission** • The construction contractor of the proposed Project will ensure regular spraying of water on all temporary service and access roads to minimize the dust generation. • Use tarpaulins to cover sand and other loose material when transported by vehicles;

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
			• Clean wheels and undercarriage of vehicles prior to leaving construction site
10.	Noise and vibration	• Disturbances to local residents in the form of increased noise levels and vibration due to movement of construction machinery	• Selection of upto-date and well maintained plant or equipment with reduced noise levels ensured by suitable in-built damping techniques or with appropriate muffling devices; • Providing the construction workers with suitable hearing protection like ear cap, or earmuffs and training them in its use; • Preferably, restricting construction vehicle movements during night time; • Use Silenced Plants and equipments; • Physically separate the noise sources and the sensitive receivers (both existing and planned) as far as practicable. • Machinery with low noise level or machinery with noise shielding and absorption should be used; • Contractors should comply with submitted work schedule, keeping noisy operations away from sensitive points; • implement regular maintenance and repairs; and employ strict implementation of operation procedures; • Locating the concrete mixing and materials shipment yards away from esidential areas, particularly schools and homes will also help reduce local noise levels. Such activity taking place near or through villages will broadcast continuous noise in the 70–80 dB(A) range or above;

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
			• The plants and equipment used for construction will strictly conform to noise standards specified in the PEQs/ NEQS; • Vehicles and equipment used will be fitted, as applicable, with silencers and properly maintained; • In populated areas, the construction activities will be restricted to be carried out between 6:00 a.m. and 20:00 p.m; • Hedges and high boundary walls should be used as noise barriers in sensitive areas such as schools, hospitals and mosques; • Public hearings should be held to discuss appropriate solutions and materials to control noise (e.g. mud or brick walls, bushes, etc.) ; and • In accordance with the Environmental Monitoring Plan noise measurements will be carried out at locations and schedule specified to ensure the effectiveness of mitigation measures.
11.	Water Quality	• Impacts on surface drainage and water quality due to contaminated runoff from construction areas in monsoon	• Avoid stockpiling of earth fill especially during the monsoon season unless covered by tarpaulins or plastic sheets • Stockpiles shall be provided with temporary bunds • Prioritize re-use of excess spoils and materials in the construction works. If spoils will be disposed, consult with Implementing Agency on designated disposal areas • Install temporary silt traps or sedimentation basins along the drainage leading to the water bodies • Place storage areas for fuels and lubricants away from any drainage leading to water bodies • Dispose any wastes generated by construction activities in designated sites

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
12.	Disposal of soil	• Negative impacts including change of land use and loss of aesthetic values may be caused on the receiving lands due to improper disposal of soil.	• The soil will be disposed of in an environment acceptable manner by transporting in enclosed containers and dumping at sites approved by the executing agency. • Where possible, material should be reused on site for reprofiling to minimize the amount of virgin soil used and soil disposed off. • Prepare and implement Waste Management Plan – it should present how the surplus waste generated will temporarily stocked at the site, transported and disposed properly
13.	Accidental damage to utilities in excavated areas	• Damage to existing utilities like sui gas, telephone etc. causing inconvenience to the local people	• Coordination between different utility departments shall be maintained to get the details of existing underground utilities before starting construction of the proposed Project; • The contractor will also be provided those utility maps and Supervision Consultant will supervise the construction activities to avoid any accidental damage to the lines; • Provision shall be made in the cost estimate for restoration/replacement of damaged utilities and relocation to minimize the negative impact and restoration of excavated road to its original condition.
14.	Nuisance/ disturbance to sensitive areas	Schools, hospitals and religious places) due construction work in the proximity (within 250 m of such place)	• No material should be stocked in this area; material shall be brought to the site as and when required • Conduct work manually with small group of workers and less noise; minimize use of equipment and vehicles at such areas • No work should be conducted near the religious places during religious congregations

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
			• Material transport to the site should be arranged considering school timings; material should be in place before school starts; • Notify concerned schools, hospitals etc. 2 weeks prior to the work; conduct a 30 minutes awareness program at on nature of work, likely disturbances and risks and construction work, mitigation measures in place, entry restrictions and dos and don'ts
15.	Transportation and Access	**Vehicle Traveler's** • Open excavation for laying of Force Main may disrupt the flow of traffic • The operation of excavator and movement of vehicles carrying construction materials hampering the existing traffic movement. **Driver's Stress** • The lower speeds, possible delays and queuing would exacerbate levels of stress	• Inclusion of further access routes to facilitate the accessibility of vehicles and pedestrians to and from the proposed Project site • The construction activities shall be phased to confine the disruption of traffic. Traffic diversion/ re-routine plans, if found necessary, shall be made with the help of traffic police for smooth flow of traffic • The vehicles carrying the construction materials will not be allowed to enter into the Project area during rush hours which could be possible at night hours. Continuous and coordinated monitoring of traffic shall be required to minimize the impact • Contractors to manage their sites, deliveries and waste such that they are reducing the amount of traffic on the local roads
16.	Solid and Hazardous	• Construction activities generating waste materials like	• Construction debris and demolition material will not be allowed to accumulate during construction phase.

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
	Waste	excavated soil and domestic waste from workers.	• All such material is to be disposed off on daily basis.
17.	Fauna	• Construction area may represent a barrier to the species and result in the splitting up of populations	• Special measures will be adopted to minimize impacts on birds, such as avoiding noise generating activities during the critical periods of breeding; • Staff working on the project should be given clear orders, not to shoot, snare or trap any bird; and • The Contractor will make arrangements to minimize the vibration, noise pollution through good engineering practices.
18.	Flora	• Loss of habitat	• It will be appropriate to collect seed and samplings from the plants growing within the proposed Project site prior to site clearance. These will be planted in areas within the proposed disposal station to create areas of natural vegetation as part of the overall landscaping design
19.	Health and Safety of workers	• Construction machinery and equipment and storage of flammable materials may cause minor and severe injuries to workers	• Well-maintained machinery and equipment and training of the workers in the construction safety shall be taken • Provision of protective clothing for laborers handling hazardous materials, e.g. helmet, adequate footwear, protective goggles, gloves etc. • The flammable and combustible substances will be properly stored in designated areas and material safety data sheets (MSDS) will be used for proper handling • Firefighting equipment will be placed at an easily accessible place and inspected on regular basis
20.	Contractor Camps	• Contractor camp will be established near the Project site to carry out the Project	• Ensure that camp size is as per standard specifications • Ensure that Contractor camp is established at least 500m away from settlements to void / minimize the construction impacts

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
		activities. Though the number of labour and size of camp will not be large, even then this will have an impact on the surrounding environment.	• Contractor should ensure provision of appropriate housing, water supply, and sanitation facilities to construction labor.
21.	Public access	• Problems for pedestrians. Normal mode of transport may be disturbed during project execution. • Impediment of access to houses and business	• Leave space for access between mounds of excavated soil • Provide wooden planks/footbridges for pedestrians and metal sheets for vehicles to allow access across trenches to premises where required • Consult affected business people to inform them in advance when work will occur • Address livelihood issues, if any; implement the Resettlement Plan (RP) to address these issues • Provide sign/caution/warning boards at work site indicating work schedule and traffic information; prevent public entry into work sites through barricading and security; • Provide sign boards for pedestrians to inform nature and duration of construction works and contact numbers for concerns/complaints.
22.	Employment	• Employment generation	• Ensure that at least up to 95% of unskilled, up to 43% of semi-skilled employment and up to 100% of skilled jobs are provided to people from local communities, provided that the persons with required qualifications are available. • Ensure that guidelines are prepared and implemented to sensitize non-local laborers to local norms and customs in order to minimize cultural tensions

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
23.	Community Health and Safety	• Danger due to deep excavations, hindrance to traffic and chances of accident • Open Manhole covers	• Provide wooden bracing for all deep excavations (> 2m); identify buildings at risk prior to start of excavation work and take necessary precautions for safe conduct of work • Plan material and waste routes to avoid times of peak-pedestrian activities • Manhole shall not be open more than 24 hrs, during this period barriers should be provided and reflective tapes should be used. Public should be informed timely
24.	O&M deficiencies	• Deficiency in operation and maintenance procedures as well as intrusion of contamination from leaking pipes may cause communicable diseases in the service area, which will be a major public health hazard.	• Regularly checking the water quality at source • Leaking pipes shall be immediately repaired by the TMA staff; • Pumping Machinery shall be maintained properly; • Stagnation of water shall be prevented through an efficient and effective O&M programme. • Generators shall be maintained and tuned properly so that emissions can be controlled.
25.	Air Pollution	• Minor significance of impact on air quality generating from standby generators installed at pumping station	• Air quality monitoring will be carried out on regular basis for parameters like CO, CO_2, NO_2, SO_2 and PM_{10}.
26.	Groundwater	• Contamination of groundwater source may occur in case of corrosion or leakage of Force Main.	• The impact should be minimized by regular checks for leaks and corrosion etc. and maintenance of damaged pipes should be done periodically • Moreover, monitoring of groundwater will be conducted on regular basis.

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
27.	Surface water	• The surface water may get contaminated by disposal of wastewater from the disposal station.	• The water must be treated before disposing according to PEQS. The wastewater will directly go into the Wastewater Treatment Plant before disposing it.
28.	Odour	• Generation of odour which causes nuisance to the residential community in the surroundings of the disposal station and the people passing by this area for schools, mosque and shops etc.	• Screening of wastewater should be regularly done and screening waste should be disposed off safely. • Installation of ventilating shafts after enclosure of collection chambers parallel to the wind direction. • Vegetation barrier may also help reducing odour in the surroundings of the area. • A landscape will be properly designed with provision of new trees/ plantations around the boundary, roadside and stretches of open land. The vegetation for the attenuation of air pollution & Odour Problems would be most needed in the areas where ground level concentrations of the pollutants are expected to rise.
29.	Breeding Ground for Disease Vector	• In Rainy days the wastewater will become stagnant which will be acts as breeding grounds for disease vectors	• After the construction of the Proposed Project, the wastewater will be disposed off properly which will eliminate the breeding grounds for disease vectors. • Regular checks for any spots which may serve as breeding grounds and spray of insecticides if any such spots are found

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
30.	Solid Waste	• Solid waste generating from the screens installed in the disposal station or sludge during maintenance/cleaning of disposal station	• Regular inspection and maintenance will be scheduled and implemented to ensure removal of solid waste and sludge when accumulated • The solid waste shall be disposed off safely and dumping or burning of municipal solid waste in the surroundings should be strictly prohibited • Implementation of sludge handling and storage procedures should be ensured
31.	Occupational Health and Safety Issues	• Operation of machinery and equipment, handling of fuel, noise odor, exposure to disease vectors etc.	• The issues related to operation of machinery and equipment will be controlled by efficient management, staff training, maintenance of machinery and equipment, and other preventive measures • Proper storage and handling of fuel • First Aid Kits should be provided • Provision of safe drinking water • Provision of PPE's to the employees including masks, gloves etc. • The issues related to operation of machinery and equipment will be controlled by efficient management, staff training, maintenance of machinery and equipment, and other preventive measures;

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
32.	Seepage/ Spill water	• Increase moisture content in soil which affects the structures / foundation of buildings in nearby areas. Contaminate the water	• Ensure proper technical design to minimize, the seepage and chances of possible failure of the structure. • Ensure proper design, construction and operation of the structure and system to minimize seepage and appropriate implementation techniques. In case of failure compensation shall be provided to nearby building structures, foundation, monetary
33.	Sewerage	• General maintenance and repair work of sewer system (nuisance and disturbance to people, disruption services etc.)	• Ensure that all necessary equipment and tools are available for regular maintenance, especially for sewer network • Ensure there is no overflow of sewers due to blockages or leaks; in case of occurrence, attend to these at the earliest • Implement all necessary mitigation measures suggested during construction (to avoid disturbance and inconvenience to people, business and traffic) • Ensure operation and maintenance of sewer network as per the standard operating procedures to avoid, over flows, blockages, etc. and immediately conducting the maintenance work in case of such occurrences
34.	Emergency Preparedness and Response	• The operation of the disposal station may encounter emergencies like operation failure	• An Emergency Response Plans for floods, earthquakes, and manmade disasters will be developed by management • Responsible person to implement the Emergency Response Plan should be clearly designated • The staff should be trained timely and concise response procedures • Emergency numbers should be clearly posted so that a quick action is taken when an emergency arises

Sr. No.	Component	Project Impact	Recommended Mitigation Measure
			• Firefighting systems should be calibrated and maintained regularly • Regular drills for fire emergencies should be carried out.

SECTION 4 – ENVIRONMENT AND GREEN SPACES

4.1. CLIMATE

This district has a moderate climate hot in summer and cold in winter. During the peak of summer, the temperature may rise to 45 °C (115 °F) during June, but in the winter months (December & January) the minimum temperature may fall below 5 °C (39 °F). The average rainfall in the district are highest in July with an average of 85 mm followed by August with an average of 63 mm.

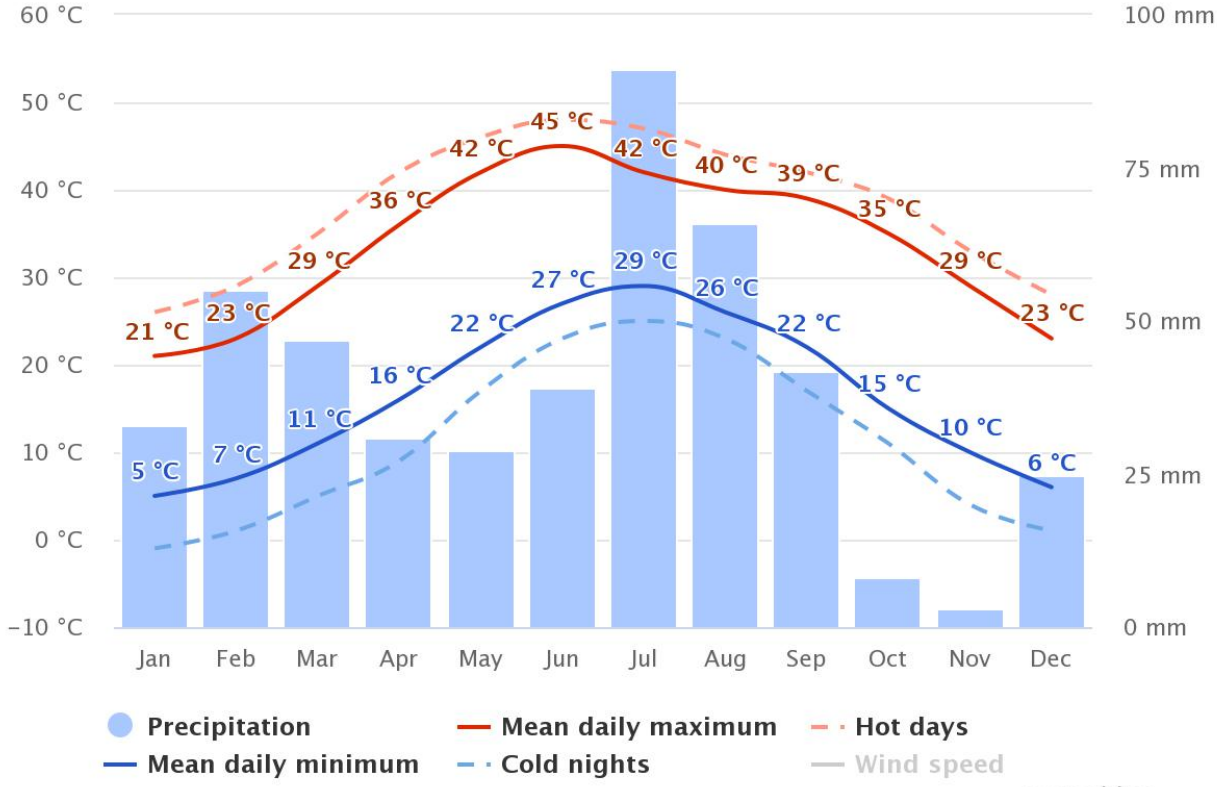

Figure 10: Climatic Conditions of Mandi Bahuddin

4.2. SOIL

The soils of Mandi Bahauddin are free from sodicity and salinity problem. The textural class of soil sample ranged from sandy loam to loam which showed soil is suitable for cultivation of all types of crops. Soil pH is in normal range and did not hamper Zn availability. The electrical conductivity (EC) values are within the range of 0.10 and 3.74 dS/m and soil pH fall between 6.70 and 8.40. Soil organic matter ranged from 0.31 to 0.93%[1].

[1] *Quantification of plant available zinc, copper, iron, manganese, boron, and visualization of their spatial distribution through GIS in district Mandi Bahauddin- Tarar, Khan, et al.*

4.3. WATER QUALITY

Water quality results for Mandi Bahauddin's groundwater as gathered from a research[2] are reflected in the table below.

Table 14: Water Quality results for Mandi Bahauddin's groundwater

Physical parameters	
pH (at 26° C)	8.49
Conductivity	554
TSS	55.1
Microbiological – MPN/100 mL	
Total Colifoms	24
E. coli	23
Chemical (Ionic Concentrations-mg/L)	
HCO_3	229
Cl	27.98
Na	9.25
K	59
Ca	14.06
Mg	2.4
SO_4	11.0

With reference to ground water quality, the distribution of contaminants like Fluoride, Total Dissolved Solids (TDS) and Nitrate are depicted in the following maps. Although there isn't alarmingly high level of either of these contaminants, high Nitrate levels can be noticed in the central and northwestern regions of the district potentially owing to excess groundwater abstraction through tube wells. Since tube wells is considered as the primary source for water, there is a dire need to switch to alternative sources in order to maintain the quality of groundwater.

[2] *Microbiological and Physicochemical assessments of groundwater quality in Punjab, Pakistan* – Ammara Hassan, M. Nawaz

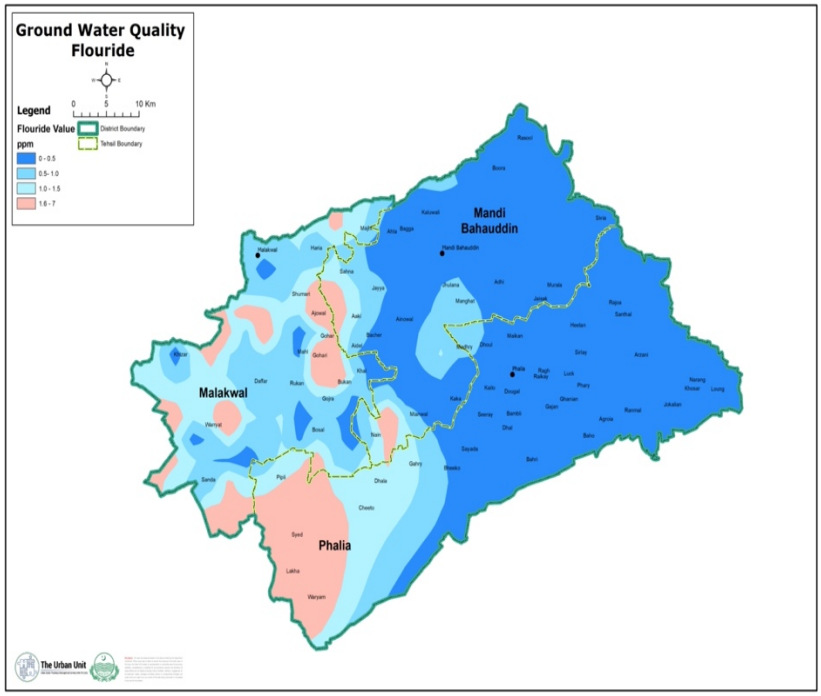

Figure 11: Fluoride Concentration in Mandi Bahauddin District

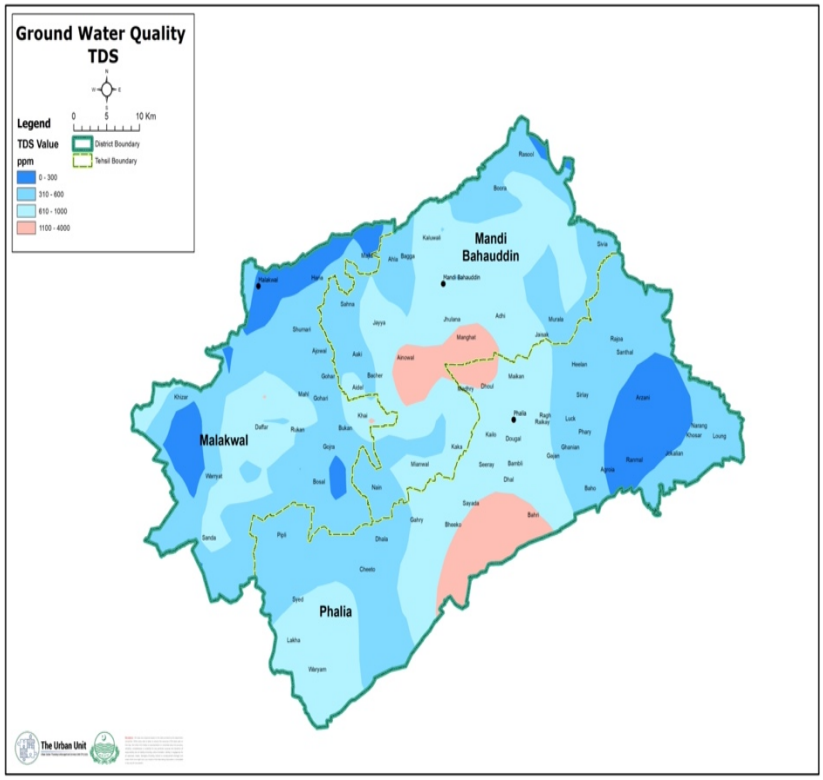

Figure 12: TDS Concentration in Mandi Bahauddin District

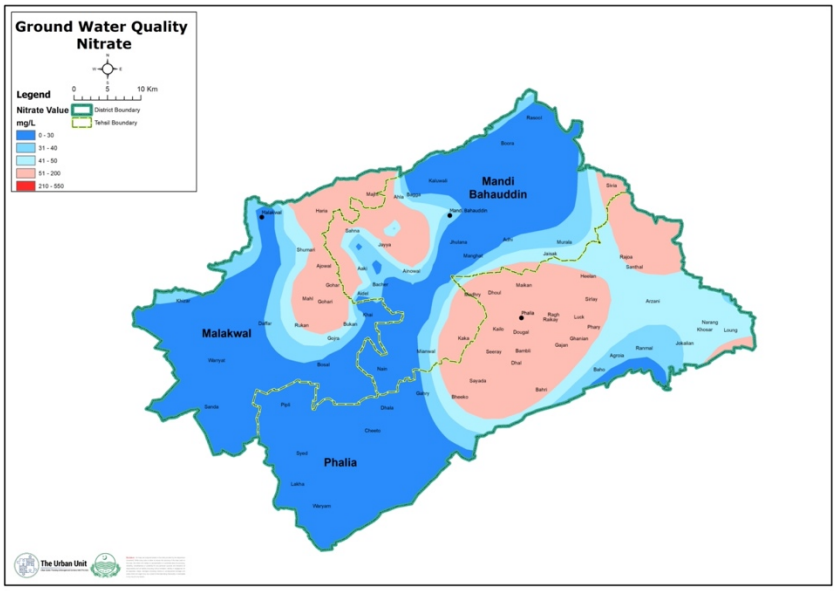

Figure 13: Nitrate Concentration in Mandi Bahauddin District

4.4. PUBLIC PARKS AND GREEN SPACES

Currently there are four parks in Mandi Bahauddin. However, with the growth of population and increased urban transport, the major chowks of the town are congested and contaminated. Therefore, the need for planned open spaces, plantation and parks is indispensable.

4.4.1. Mian Waheed ud Din Park

It is located in UC-1 and covers an area of 4 acres secured by a boundary wall. The park is provided with a jogging track, a canteen where refreshments are available for the visitors. Fountains, lightings and plantation are there for the beautification of park. Electric lights are present for evening and night security.

4.4.2. Children/Ladies Park

The area of Children Park is 10 kanals. The park is lacking play area, swings and other attractions that are likely to be present in a park.

4.4.3. Near Nagina Cinema

This park comprises of 1 acre area. The condition of this park is not good. There are no facilities provided those are supposed to be present in a park. There is only one jogging track and few walk ways.

4.4.4. Canal View Public Park

This park is near District Complex. There is a jogging track and the locals visit the park due to its location being near Canal. The

There are two different spaces proposed for future parks in Mandi Bahauddin.

- Mohallah Nazeerabad has a vacant plot of 1 acre. This land is owned by TMA. The approach road is 60 feet wide and there is no structure present on the plot.
- Kashmir colony has a space of 2 acre along Phalia/Jail road. This is a TMA land. The level is 10-11 feet below ground level. This is currently being used as a dumpsite and posing health risks on the nearby residents. Once the area is cleaned, it will be a good site for parks and hence improved state of environment in the surroundings.
- Mohallah Shafqatabad behind Railway line has an approximate area

4.4.5. Urban Forestation

In order to increase green spaces, Urban forestation can particularly contribute to an improved environmental quality in Mandi Bahauddin.

4.5. PROTECTED AREA AND WILDLIFE

The Daphar Plantation is a reserved forest in Mandi Bahauddin, having an area of 7135 acres. It is being irrigated from Bhalwal distributaries with a sanctioned discharge of 86 cusec.

The soil of Daphar Plantation is in general the gift of river action. It is on the whole alluvium with varying proportions of clay and sand. Technically speaking, the area falls within the true-arid division of the semi-arid climatic zone. The original vegetation mainly consists of:

- Van (Salvadora oleoides Done),
- Jand (Prosopis cineraria Linn.),
- Karir (Capparis decidua Pax.),
- Mallah (Zizyphus nummularia W&A.),
- Ber (Zizyphus mauritiana Lamk.),
- Chamror (Ehretia laevis Roxb.),
- Rehru (Acacia leucophloea Willd.),
- Lahura (Tecoma undulata (Smith Seem.),
- Frash (Tamarix aphylla Karst.),
- Kangu (Lycium europaeum Linn.), etc.

These species occur in groves and patches with sufficient space in between. The general height of the trees varies from 15 feet to 30 feet (4.5m to 9m). Mounds and depressions have also been noticed in the area. The mounds are covered with xerophytic species while Dhak (Butea monosperma, Lamk. Taub.), Lasura (Cordia dichotoma), Jangli-anar (Punica granatum Linn.), Phagwara (Ficus palmata Forsk.) etc. have been found in depressions.

A few trees of kikar and shisham could also be found on relatively favorable sites. Presently, Shisham and Mulberry are the principal species growing in mixture over a major portion of the plantation area. Other species growing are Eucalyptus, hybrid-poplar, semal, bakain and kiker. Bamboo is also grown on experimental basis. Every year about 300 acres is being afforested / regenerated.

Key species of wildlife include, yellow belly common gecko (*Hemidactylus flaviviridis*), Indus valley toad (*Bufo stomaticus*), common mole skink (*Eurylepis taeniolatus*), barhminy blind snake (*Ramphotyphlops braminus*), common krait (*Bungarus caeruleus*), brown cobra (*Naja oxiana*), black cobra (*Naja naja*), Indian flap-shelled turtle (*Lissemys punctata andersoni*), Indian narrow headed soft-shelled turtle (*Chitra indica*), Indian soft shell turtle (*Nilssonia gangeticus*), Peacock soft shell turtle (*Nilssonia hurum*), Spotted pond turtle (*Geoclemys hamiltonii*), spiny-head rock agama (Agama agama) and brilliant ground agama (Trapelus agilis pakistanensis)[3].

4.5.1. Threats to Dhapar Reserved Forest

Major threats to protected area and its biodiversity include:

- Hunting of biodiversity (herpetofauna) for different purposes like expected harm, superstition, narrative, entertainment, ornamental use, magic, religious believe, for food and medicinal value etc.
- Visitors throw garbage in water sources which is causing decrease in diversity, because of water deficiency not just plants are getting effected but as well as biodiversity survival and especially their reproductive sites.
- Animals get feared and try to escape but in mostly cases they are killed as targeted animal in surrounding areas.
- Previously available water sources are depleting in this protected area.
- Increase in pollution level and non-degradable wastage are intensively affecting the forest plantation and biodiversity.

4.6. Recommendations

- Although there are three parks in Mandi Baha ud din but with the growth of population and increase in the urban transport the major chowks of the town are crowded and covered with smoke and dust. Therefore, the need for planned open spaces in the length and breadth of the town is needed.
  An area of around 4 acres was identified during the visit near **Kashmir colony behind District Jail**. This area is currently being used as a dumpsite and contributing to deteriorating environmental and public health impacts to population living nearby.

[3] Diversity of amphibians and reptiles in Daphar Forest Sanctuary, Mandi Bahauddin – Saba Adil, Shermeen Ijaz, et al.

Figure 14: Potential site for Park near Kashmir Colony behind District Jail

- There is potential for forestation along the Sugar mill nullah/drain. The approximate length is of 6km and in addition to improving the air quality, it will add to the aesthetic impact by covering the nullah body.
- In order to maintain the existing beautification works, parks and green belts, and expansion of parks and horticulture, establishment of Parks and Horticulture Authority (PHA) may be considered to develop Mandi Bahauddin as a clean and green district.
- A formal Forest Management Plan is needed to be developed in order to counter the current threats being faced by Dhapar Reserved forest.

SECTION 5 – SWOT ANALYSIS

Based on the current scenario, analysis and the field visits, a table highlighting Strengths, Weaknesses, Opportunities and Threats in the District Mandi Bahauddin with respect to Water and Sanitation is listed below.

STRENGTH

- Relatively better socioeconomic situation than other districts
- Overall good history of utilization of development expenditure and filled MC staff positions
- Better road connectivity

OPPORTUNITIES

- Various upgrades for water supply, sewerage, and solid waste are likely to improve the coverage and quality of service delivery
- With improved services, more accurate billing through private sector participation could be much more profitable
- Restructuring (e.g., establishment of WASAs) can potentially result in improved service delivery
- The ring road project will open new doors for socioeconomic development of region

WEAKNESS

- Lack of training and development for staff and in particular no "in-house" planning and development control capacity
- Low own source revenue generation

THREATS

- Declining growth of National economy can hamper regional development
- Low staff dedication

SECTION 6 - PROJECT DIGEST

6.1. METERED CONNECTION

Metered connection is proposed as one of the recommendations. Advantages of the metered connection would include:

1- Conveyance losses will be less.
2- Water theft/ illegal connections will be minimized.
3- All the connections will be monitored smoothly by Municipal Corporation Mandi Bahauddin
4- Local community will be served efficiently.
5- The own source revenues of MC Mandi Bahauddin will be enhanced.

6.2. SMART WATER MANAGEMENT WITH INTEGRATION OF SCADA

A smart city is a sustainable and efficient urban center that provides a high quality of life to its inhabitants through optimal management of its resources. Energy and water management are one of the most demanding issues within such urban centers owing to the complexity of the energy and water management system.

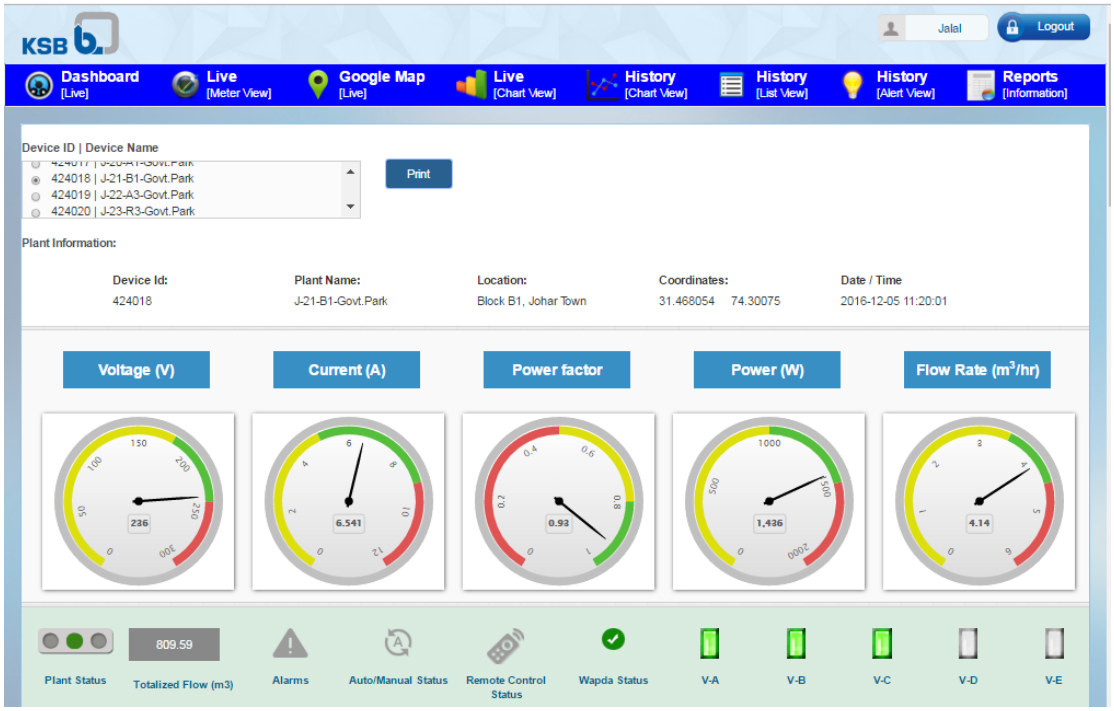

Figure 25: Graphical interface of Water Management System

Water resource management is the activity of planning, developing, distributing and managing the optimum use of water resources. One of the biggest concerns for our water-based resources in the future is the sustainability of the current and future water resource allocation. As water becomes scarce, the importance of how it is managed grows vastly.

Finding a balance between what is needed by humans and what is needed in the environment is an important step in the sustainability of water resources management.

The Water infrastructure installed in Pakistan is several decades old and there are significant water losses. Moreover, a reasonable amount of electricity is being wasted due to traditional management, inaccuracies in metering, aging of equipment used in distribution system and wrong practices. This situation arises a need to monitor water usage data and based upon the data recorded the water supply agency should manage their resources.

Primarily there is need to implement a check and balance system for water supply provider which monitor real time data logging for tube wells and underground reservoirs and can be remotely accessed from web-based server. Secondly the efficiency of water distribution of water distribution needs to be improved via load management.

6.3. IMPLEMENTATION OF SCADA SYSTEM ON TUBE WELLS

Water supply represents a vital problem for people of Mandi Bahauddin, and this imposes the need to know the information regarding consumptions, resources and production. This ensures continuous supervision of the water supply in order to allow any problem while maintaining normal functioning parameters. Proper solutions imply automation and monitoring architectures which contain: a supervision and control system for the real time installation, programmable logic controllers with basic functions (communication, adjusting, measuring, etc.) libraries, communication systems, standard interfaces or dedicated ones with sensors, electrical drive elements, measuring devices, etc. The informatics systems present the possibility of preventing some phenomenon, by analysing and processing the data, leading to an optimum functioning and to important financial economies. A SCADA system for the monitoring and control of Tube wells within the limits of MC Gujrat, which will allow the optimum functioning of the pumping system, safety, obtaining efficient energy usage and optimum administration of the drinkable water.

When it comes to water security and reduction of NRW (Non-Revenue Water) cities face a big challenge which is water metering. Water management can only be achieved once all water connections are metered. With the deployment of bulk flow meters at sources consumption can be remotely monitored by a central computer.

The SCADA system proposed here has sufficient capability to record all electrical parameters of the water resource management and can be logged on to a cloud server. The data can be later analysed for optimum resource management of water system. Specialized energy metering system has also been included to measure energy parameters along with power factor of water system. The main objective is to improve overall water coverage and energy efficiency based on the parameters measured and indicate all deficiencies.

6.4. COMPONENTS OF A BASIC SCADA SYSTEM

A typical SCADA system consists of

- SCADA Master
- Remote Terminal Unit (RTU)
- Sensors
- Valves
- Control Relays

The main functions are:

- Data acquisition
- Data Communication
- Data Presentation
- Control

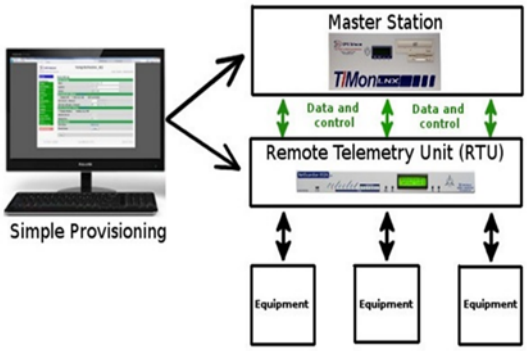

Figure 16: SCADA Architecture

6.4.1. Data acquisition:

It is the process of acquiring real time continuous data from all remote units installed, feeding it to each RTU for processing, transmission and presentation. Sensors monitor inputs and outputs.

Types of Input:

- Discrete Inputs
- Analogue Inputs

6.4.2. Data Communication:

The communication channel exists between RTU and the Master SCADA. SCADA networks communicated over radio, modem or dedicated serial lines. These days the trend is to put SCADA data on Ethernet, Microwave and Optical fiber.

6.4.3. Data Presentation:

SCADA systems report to human operators over a centralized master station. It continuously monitors all sensors and alerts the operator when there is an alarm. It also has the capability to shut down the system in case of a critical failure.

6.4.4. Control:

In a SCADA system the control is with the Master SCADA which serves as the brain of this system. Master SCADA HMI commands the respective RTU to perform a specific action.

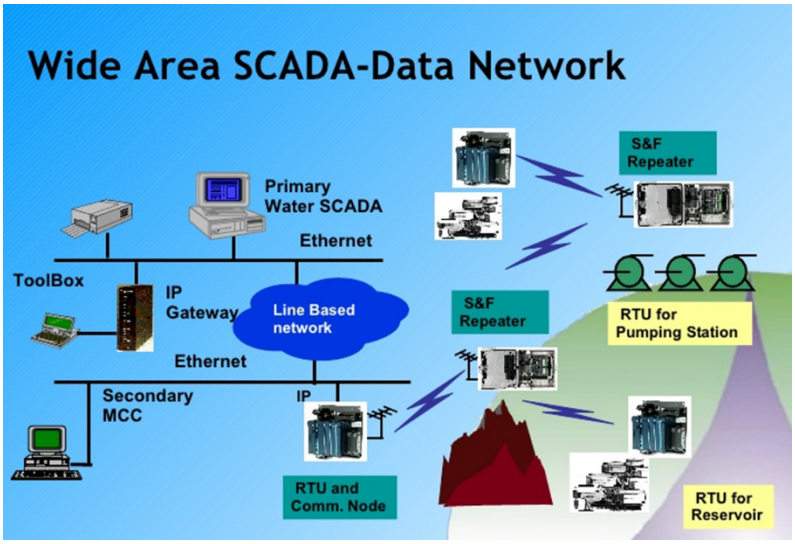

Figure 17: SCADA Network

6.5. WASTEWATER TREATMENT

The majority of households in Punjab have water-borne sanitation and produce wastewater that is then disposed of beyond their property's boundary. Some toilets, mainly in larger towns and cities, are connected to sewers but most households in peri-urban areas, smaller towns and villages discharge wastewater to open drains, with WC wastes routed via fairly crude individual household septic tanks. Because toilets are connected to drains and sewers, wastewater characteristics are essentially those of sewage rather than sullage. A significant proportion of this wastewater is used to irrigate crops, either directly or after being pumped out of the agricultural drains to which it is discharged. The remainder is ultimately discharged to the rivers that traverse the province.

Very little wastewater is treated at present. Islamabad has four diffused-air activated sludge plants while around 20% of Faisalabad's wastewater is treated in a waste stabilisation pond system. Some of the tannery waste from Kasur is also treated. Otherwise, there are currently no operational municipal wastewater treatment plants in Punjab. There are proposals to provide new waste stabilisation ponds to treat Rawalpindi's waste water under the ADB-funded Rawalpindi Environmental Improvement Project (REIP). Several smaller towns will be

provided with treatment facilities under the ADB-funded Southern Punjab Basic Urban Services Project and the World Bank-funded Punjab Municipal Services Improvement Project.

Wastewater treatment may be designed to remove suspended solids and organic material, which would otherwise harm the environment, remove pathogens, which might otherwise infect people who come into contact with wastewater, or both. Most 'conventional' sewage treatment systems are concerned with the first and are less successful in removing pathogens. As a general rule, wastewater treatment technologies with a long retention time, in particular waste stabilisation ponds and constructed wetlands, achieve the best pathogen removal results.

When wastewater is treated, it may provide useful resources. For instance, digested sewage sludge may be used as a soil conditioner while treated wastewater may be used to irrigate crops. This may provide a financial incentive for treatment. However, a fairly high degree of treatment is required to reduce pathogen counts to levels that can 'officially' be considered safe.

6.6. WASTEWATER TREATMENT METHODS

Methods of treatment in which the application of the physical forces predominate are known as "Unit Operations". Methods of treatment in which the removal of the pollutants is brought about the chemical or biological reactions are known as "Unit Processes". Currently, unit operations and processes are grouped together to provide various levels of treatment known as preliminary, primary, advanced primary, secondary(with or without nutrient removal systems) and advanced /tertiary treatment approaches as described follows :

- In ***preliminary treatment***, large and floating particles such as rags and grit are removed that might damage the subsequent equipment especially the screens (if employed). In preliminary treatment, a physical operation usually sedimentation, is used to remove the floating and settle-able materials found in the sewage.
- In ***advanced primary treatment*** chemicals are added to enhance the removal efficiency for floating and settle-able solids and dissolved solids (limited).

  It reduces the Total Suspended Solids (TSS) in the water by about 40 to 60% and reduces the Biochemical Oxygen Demand (BOD) by about 25 to 35%.Some organic nitrogen, organic phosphorous and heavy metal associated with solids are also removed during primary sedimentation but colloidal and dissolved constituents are not affected.
- In ***secondary treatment***, biological and chemical processes are used to remove most of the organic matter.
- In ***advanced treatment***, additional combination of unit operations and processes are added into the treatment line to further remove residual suspended solids, toxic

compounds and any refractory and persistent to degrade pollutants through conventional secondary treatment technologies/approaches. Tertiary treatment/ advanced treatment is done only in case when it is desired to use the resultant treated sewage for recycling/ reuse purposes such as irrigation and groundwater recharge.

A list of unit operations and processes used for the removal of major constituents found in wastewaters given in the Table 15.

Table 15: Unit operations & processes in wastewater treatment (General)

Sewage Constituent	Sub- Constituent	Unit Operation/Processes
Suspended Solids	--	Screening
		Grit removal
		Sedimentation
		High rate clarification
		Flotation
		Chemical precipitation
		Depth filtration
		Surface filtration
Biodegradable Organic	---	Aerobic suspended growth variation
		Aerobic attached growth variation
		Anaerobic suspended growth variation
		Anaerobic attached growth variation
		Lagoon variation
		Physical-chemical systems
		Chemical oxidation
		Advanced oxidation
		Membrane filtration
Nutrients	Nitrogen(N)	Chemical Oxidation
		Suspended growth nitrification & denitrification variation
		Air stripping
		Ion exchange
	Phosphorus (P)	Chemical treatment
		Biological Phosphorus removal variation
	N& P	Biological Nutrients removal variation
Pathogens	---	Chlorine compounds
		Chlorine dioxide
		Ozone
		UV Irradiation

Sewage Constituent	Sub- Constituent	Unit Operation/Processes
Colloidal and Dissolved Matter	---	Membranes
		Chemical treatment
		Activated Carbon
		Ion exchange
Volatile Organic Compounds	---	Air Stripping
		Activated Carbon
		Advanced Oxidation
Odors	---	Wet scrubbers
		Activated Carbon
		Bio filters
		Compost filters

6.7. OVERHEAD RESERVOIRS

Overhead reservoirs have been proposed as one of the recommendations. Their primary functions involve absorbing the hourly variations in demand, to maintain constant pressure in the distribution mains and to store water for emergencies.

Figure 18: Overhead Reservoir in Mandi Bahauddin