Project Note on
MUET Clean Water Project: Localizing Water SDG at MUET Campus

Project Context

Water is essential for life, but access to safe drinking water is turning out to be a national crisis in Pakistan. Poor water quality continues to pose a major threat to human health. Several sources indicate that, in Pakistan, 30% of all diseases and 40% of all deaths are due to poor water quality. The primary cause of water quality degradation include indiscriminate disposal of industrial, domestic and municipal waste in water bodies. Additionally, physical degradation of water supply distribution system is also a major source of pollution by intrusion of contaminated waste water or groundwater in the distribution network.

Ensuring provision of safe drinking water to population remains a top priority for the Federal and Provincial Governments of Pakistan for several reasons, but most importantly because access to safe drinking water: (i) is a human right, (ii) is a prerequisite to the sustainable growth and development, (iii) constitutes an important goal of the Sustainable Development Goals (SDGs) Framework, and (iv) yields positive impact on health and economic livelihoods. Against this background, the Mehran University of Engineering and Technology (MUET), Jamshoro, has planned to ensure "access to safe drinking water for all at campus" in the context of a broader initiative to become a laboratory for SDG on water. This project brief presents key features of this initiative.

MUET Becoming a National Laboratory for SDG on Water

*Successful implementation of SDGs will require translating global agenda into national contexts and then turning national agenda into specific goals and targets at the local level. Even at local level, different institutions and communities could contribute in diverse ways to advance the implementation and accelerate the progress. T*he academic and education community will need to play a major role in the implementing the SDGs by contributing to the evidence-based policy making through applied policy research. This is more so in the case of water, as tackling water challenges requires innovative scientific approaches to deploy sustainable solutions and appropriate technologies.

Against this background, the MUET has decided to serve as a national laboratory for applied policy research to support the implementation of water SDG. To this end, MUET is capitalizing on the opportunity created by the establishment of US-Pakistan Center for Advanced Studies (USPCAS) in Water to which technical assistance is being provided by the University of Utah, USA. Fortunately, Center's academic and research program bears close linkages to the targets established under the water SDG on which Center's faculty and graduate students are already engaged in conducting research. These areas, for example, include research on improving water quality, increasing water use efficiency, promoting integrated water resources management, wastewater treatment among others.

In addition to policy research, MUET has decided to ensure campus wide provision of safe drinking water through considerable upgrading of the existing system. This will be an effort to localizing target 1 (safe drinking water for all) of water SDG at campus level. Improving water and sanitation, like several other goals, requires significant investments in physical infrastructure. These investments can yield sustained returns only if duly supported by efficient management and service delivery systems. So this particular part of the initiative will serve as test bed for exploring a number of research ideas within the context of water-health nexus, as well management options for delivery of services.

Description of Existing Water Treatment and Supply System

MUET campus in Jamshoro covers an area of 500 acres. It has 17 departments offering degree programs at undergraduate level, and 5 institutes offering degrees at graduate level. There are 6,000 and 1,200 students enrolled in undergraduate graduate degree programs, respectively. Out of these 7200 students, around 2000 reside on campus in 12 hostels. Additionally, there are 400 faculty, 130 officers and 1100 supporting staff working in the university. There are two residential complexes on campus having 25 and 40 houses for officers/faculty and supporting staff, respectively. On an average, 5 persons live in the officers/faculty residences and 7 in the supporting staff residences. The students, faculty, officers and supporting staff not residing on campus remain there on average of 8 hours a day.

Current water supply system is designed to handle a volume of 1 million gallon per day (MGD). Water supply source is the Indus River. A canal, KB feeder, takes off at the right bank of river Indus at Kotri Barrage. MUET has an intake and pumping station to take water from the KB feeder. This station has 2 main and 2 backup pumps that lift water from KB feeder and deliver it to MUET water treatment plan (WTP) at a distance of approximately 1.5 miles (7638 ft). Water is delivered to WTP in 12 inch diameter steel pipe. There is no on site storage near intake and pumping station. This system was originally installed in 1987-1988 and upgraded in 2012. Upgrading involved installation of 12 in diameter steel pipe and adding 2 new pumps in the system (1000 GPM, 250 ft TDH).

The treatment train at MUET water plant consists of coagulation, sedimentation, filtration and disinfection. This plant was built in late 1980's (1987-1988).

Figure 1. Treatment processes currently in use at MUET water treatment plant

Treated water from MUET's WTP is delivered to MUET campus using two pipes. First, 8 inch diameter steel pipe was laid out in 1987-1988. The system was later expanded by adding a 10 inch diameter steel pipe in 2012. Expansion involved 6798 ft of 10 inch diameter steel pipe from WTP to Industrial Engineering Department at MUET campus, and 1400 ft of 6 inches diameter steel

pipe to hostels. There are 4 pumps (2 main and 2 back-up) that deliver water from WTP to MUET campus. Two of these pumps (1000 GPM flow, 250 ft TDH, 80 HP 440 V, 50 Hz motor) were added when the system was expanded in 2012. The water is delivered to storage tanks located near all major building on campus. These storages tanks are either located on top of building or underground. In the case of underground tanks, water is then pumped from these storage tanks to point of use within buildings. Wastewater is collected in septic tanks near each building. There is no centralized collection and treatment system for wastewater at MUET campus.

Municipal and irrigation are major uses of water. For approximately 2,400 people who live on camps in student, staff, and faculty residences water supply is needed 24 hours. For remaining, population of approximately 6,800 most of the water demand is during normal business hours. Since water supplied to the campus comes through the WTP, water used for both drinking and irrigation purposes can be considered as treated, though quality remains an issue of concern.

Lay out of current water supply system, from source to treatment plant and onwards to distribution system is show in Figure 2.

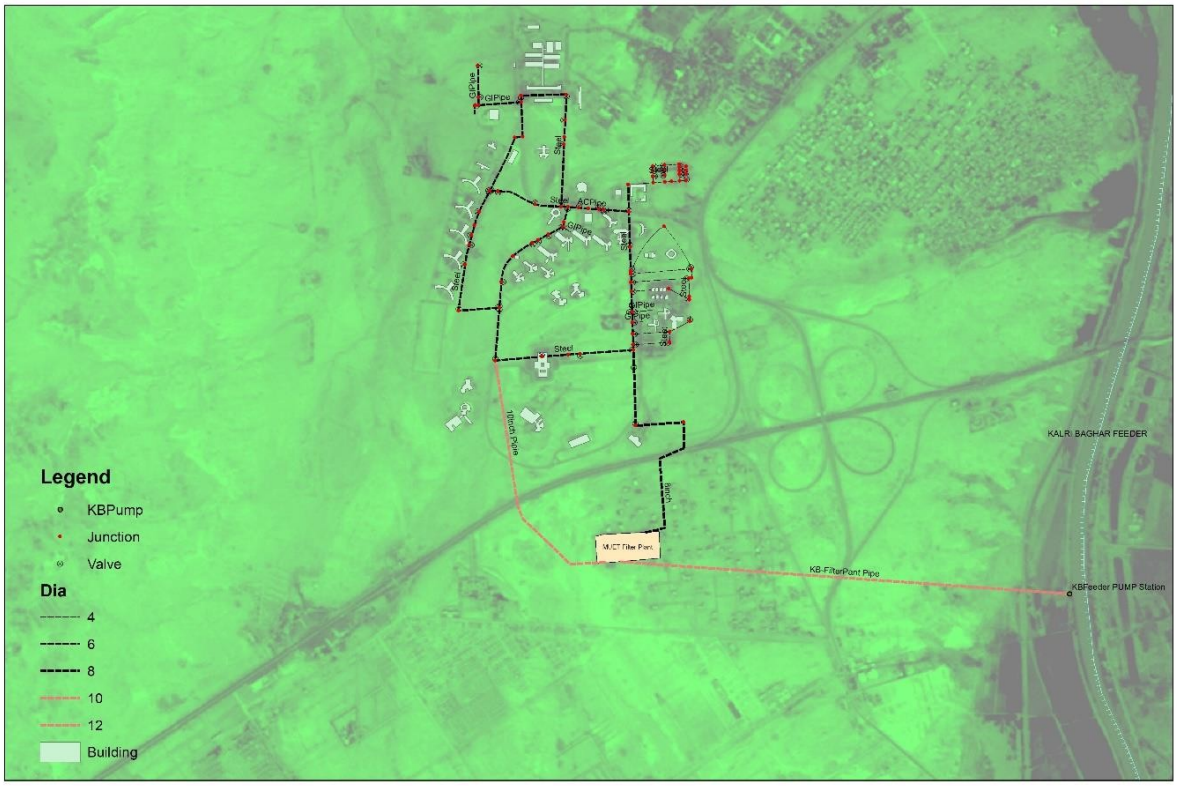

Figure 2. Layout of water supply system for MUET

Current water system has been able to meet the water demands of campus community in terms of quantity most of the year, with the exception of 2-3 weeks period in winter when KB feeder is closed for maintenance. However, quality of supplied water is poor for drinking purposes. Several water quality tests, including tests done by experts from the University of Utah, USA have shown that water is E-coli positive and does not meet drinking water quality standards established by the World Health Organization (WHO).

Project Objectives

The broader objective of the project is to making MUET as a "National Laboratory for SDG on Water" with the mandate to work on solutions and applications that will contribute towards achieving different targets set under the water SDG, including some targets under the health SDG.

To this end, three specific objectives are: (i) to ensure campus wide provision of safe drinking water; (ii) to strengthen the institutional and regulatory capacity for managing and operating the water supply and distribution system; and (iii) to complement policy research leading to analysis of pathways for achieving various targets included under the water SDG. This project brief outlines the scope of work to be completed under the first two objectives, while the US-PCASW has already initiated work on the third objective, which will be extended to the present water supply treatment and distribution system with reference to water quality. In summary, the idea is to create a model of how to retrofit existing failing systems (and design new systems) throughout Pakistan.

Project Description

To bring the water to WHO drinking quality standards, a complete redesign of the intake system, and treatment train in the WTP may be required. Current distribution system will also need an overhaul. The following steps will be followed for evaluating and redesigning of the system.

- *Base line water quality assessment:* Process of improving water quality at MUET will start with better understanding of source water quality using a series of tests for physical, chemical, and biological characterization of water. These test will be performed regularly over a period of time, during both high and low flow seasons, to understand variation in contaminants.

  Physical parameters will include Temperature, pH, Dissolved Oxygen (DO), Total Dissolved Solids (TDS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Salinity and Electrical Conductivity (EC). Chemical parameters will include chloride, total alkalinity and total hardness. The concentration of trace metals including iron, zinc, copper, lead, mercury and cadmium will be determined. The Coliform Bacterial concentrations will also be determined. MUET and USPCAS-W laboratories have the equipment to perform these tests.

- *Understanding water demand:* Currently, flow is not measured anywhere in the water distribution system on MUET campus. To better understand water demand and variation with time at different nodes in the distribution system, flow meters will be installed. This will provide a better understanding of water demands and will help in evaluating and redesigning the distribution system.

- *Selection of treatment options:* Several treatment trains will be evaluated for their ability to remove target contaminants. Final selection will be made based on removal efficiency of target contaminants, ease of operation and maintenance and cost.

- *Centralized vs point of service treatment:* **E**valuating the feasibility of centralized water treatment option for entire campus *vis-à-vis* localized treatment options for individual buildings will be an important criterion in selecting the final option.

- *All vs drinking water only treatment:* Currently, all water used on campus, both for municipal and irrigation purposes, is treated. This is so because the system by default is

designed in that manner. Options will be explored how to separate these systems to ensure: (i) water used for irrigation purposes is not treated, (ii) water used for drinking purposes is treated to meet WHO standards, and (iii) increased use of wastewater for irrigation purposes.

Research Possibilities

The goal from the research perspective is to create a unique integrated community water system for research – the MUET Water System Test Bed. The system includes water supply, wastewater management, and graywater. Ideas for research questions include:

- System transformation – integrated infrastructure-community solutions
- Centralized vs. Distributed vs. Hybrid considerations
- Water quality characterization, relationships, patterns, effects, health-education connections
- Best practices for operating strategies and management systems
- Optimization of integrated operation-infrastructure-user solutions
- Optimization of system design and maintenance practices – new strategies for optimization using sustainability and resiliency multi-objective approaches
- Analysis of real-time water market
- Feasibility of reuse technologies
- Practicability of point of use treatment technologies
- Assessment of water quality monitoring technologies
- Reusing graywater/wastewater reuse
- Informatics and database

Cost Estimates and Phasing

Actual cost estimates will depend upon the final selection of water treatment design option and level of treatment after the completion of baseline work outlined above. However, preliminary estimates suggest an amount of PKR 110 million as per the following distribution: 10 million for baseline analysis and system's design; 80 million for system's rehabilitation and upgrading; and 20 million for capacity building and strengthening management systems. Capacity building efforts will focus on developing core competencies, such as, regulations, management procedures, water quality standards, monitoring systems—all geared towards ensuring long-term sustainability of the project. The project implantation will be completed in two years (July 2016 to June 2018). Funding requirements for the first year are estimated to be PKR 10 million.

Next Steps

After the approval of this Concept Note by the competent authority, a detailed PC-1 will be prepared and submitted to the Government of Sindh. This process is expected to be completed in June 2016.