Biological Sewage Treatment System (BSTS)

TEMORYAN-H, Ltd
Hanzala Mosque Street, Kandahar Plaza, Beginning of Taimani Street,
Kabul 1003, Afghanistan
T: 0093 799252721, 0093 700 447 077
E: info@temoryan.com
www.temoryan.com

Wastewater management in urban areas- Own sewage treatment systems

Dr. Eng. Mohammad Omar Temori, Doc. Ing. Martina Zeleňáková, PhD

Technical University of Kosice, Faculty of Civil Engineering,
Vysokoškolská 4, 04200 Košice Slovakia
E-mail: omar@temoryan.com, Mobil: 00421 905 238509

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Abstract
Despite the impacts of rising energy costs as major challenge facing water and wastewater utilities there are many opportunities to save money and help the environment by focusing on energy efficient techniques. Wastewater utilities offer innovative approaches for maximizing the sustainable use of energy, water, and waste and improving performance. The planning of sewage treatment systems involves the selection of a satisfactory method of treatment from the available treatment processes at a reasonable or a minimum cost. Every engineer confronted with a design problem is aware that it can usually be solved in a number of different ways. The rapid development of the urbanization is creating problems for the satisfactory treatment of sewage. Buildings have their own disposal systems but much waste is discharged to aquifer after little treatment and not at sufficient quality. Although buildings are now beginning to install their plants which are theoretically capable of producing an acceptable effluent, wide fluctuations of the loading of them do not make for efficiency. The aquifer is endangered as a result.

Introduction of Small sewage treatment plants

Small sewage treatment plant is a sewage treatment plant to 500 of population equivalents. Plant purifies wastewater from buildings such as houses, recreational facilities, restaurants, manufacturing workshops, offices, nurseries.

Small sewage treatment plant is defined as follows:

- Small treatment plant is a sewage treatment plant to 500 of population equivalents.
- Small treatment plant or cesspit is built, where wastewater cannot be discharged into public sewer.
- Small treatment plant or cesspit must be located and designed to allow future connection to public sewer.
- Small treatment plant or cesspit shall be located in a way that its content can be collected.
- Cesspit bottom and walls must be watertight.

- Small treatment plant can only be established where the wastewater can not be discharged into public sewer with treatment plant.
- Small sewage treatment plant can treat only sewage and water of similar nature, not storm water.

- Following initial data are important for plant design and dimensioning:
  - Requirements for the purity of recipient
  - Flow and water quality in the recipient
  - Amount and pollution of wastewater
  - Planimetric, topographic, hydrogeological, geological and climate conditions.
- The amount of waste water is calculated according to water demand. Design of individual structures will be assessed to the largest inflow of wastewater which is determined from the average hourly water demand multiplied by a coefficient of hourly unevenness.
- Treatment utility where the waste water is pumped through must be dimensioned and assessed for the performance and period of the pump.
- The quantity of wastewater pollution which is fed into the treatment plant is calculated according to the number of people connected to the plant. If the number of residents in the building is unknown, four people per each accommodation unit are considered.
- The treatment plant location design must respect sanitary protection zone around the sewage facility which is determined according to local conditions.
- Informative distances of protection zone between the sewage treatment plant and residential buildings are usually proposed:
  - Structures covered and vented above the last floor (e.g. cesspit) - not required
  - Covered structures without venting -20 m
  - Structures with free surface - 50 m.
- In case of adverse conditions (prevailing winds, etc.) protection zone should be extended.
- Non-residential buildings with equipment or material can be positioned in the protection zone and will not be at risk due to treatment plant or its products.
- Land in the protection zone can be used for agriculture.
- Safe distance shall be kept between treatment plant and well, which is according to local conditions and terrain inclination (5-10 m).
- In order to protect surrounding buildings from odours and harmful gases from sewage treatment plant following is recommended:
  - Construction of sewage treatment plant in the direction of prevailing winds from the protected object
  - Planting bushes and trees in the area between the sewage plant and residential buildings
  - Use of barrier effect by non residential buildings (warehouses, garages, outbuildings)
  - Technical use of biogas.
- When designing a small sewage plant, it is important to utilize maximum advantage of local conditions enabling simple design of the plant, restrict the use of machinery as much as possible, to use technology and structures that do not require permanent attendance.
- Recovery and removal of intercepted substances must be addressed at all water treatment facilities. It is necessary to ensure that operating staff would get in contact with these substances as little as possible.
- When removing collected materials, surrounding environment should not be polluted by dripping sludge etc.

- Closable bypasses shall be designed for individual structures, allowing their withdrawal from service for maintenance and repairs.
- Possibility to measure basic values, necessary for managing the operation and to determine the performance of treatment plant, should be available in each sewage treatment plant. There should be at least the possibility to measure the amount of run-off from the plant and wastewater sampling.

Basic characteristics and division of small sewage treatment plants

Small sewage treatment plants treat the waste water by microorganisms, attached firmly to the base in the form of various systems of biofilters and biodisks drenched by sewage and also by activation systems with sludge in the fluid, in which there are flakes of sludge mixed with waste water and air. Most sewage treatment plants work on the principle of an aerobic treatment system where organic matter is decomposed by a mixture of microorganisms which need oxygen from the air to life.

Each treatment plant has usually three objects of purification:

- Primary treatment (coarse solids are separated from the waste water)
- Aerobic level (biological treatment is taking place followed by separation of sludge from treated water)
- Space for storing the products from treatment.

Basic requirements and conditions for small scale sewage treatment plant expected from the design can be summarized as follows:

- Purification efficiency of greater than 95%
- Quiet in operation
- Energy consumption less than 1 kWh/m ^{3} treated water
- Vapour tight excluding odour in the surrounding area
- Long-term functionality without any inflow of sewage
- Ability to handle inrush inflow
- Unattended operation and minimal maintenance costs
- Little or no demand for professional service
- Use of only non-corrosive materials
- Storage of treatment products for at least 3 months of operation.

The degree of biological pollution of wastewater is most commonly expressed by the value of BOD_5 (biological oxygen demand). In common sewage it ranges from 200 to 400 mg/l. Discharge from well-functioning sewage treatment plant has values 15 to 30 mg/l. For discharge into water body are for the household wastewater treatment plant required values below 50 mg/l and for infiltration into the ground it is usually below 8 mg/l.

Figure 1 - Treatment of sewage water in a central water treatment plant

Household sewage treatment plants

From environmental and economical view point are the most suitable mechanical-biological treatment plants. Biological treatment of sewage water is technically the simplest and the least cost-intensive way of disposing of sewage water. It is similar to self-cleaning process of natural waters, but it is controlled and intensified. At an average production of 138 litres of wastewater per person per day a family house with five people produces about 251 m^3 of wastewater per year. Sewage treatment plant recycles this amount of wastewater to 249 m^3 of clean water and only 2 m^3 hygienically harmless sludge. Household sewage treatment plants are designed to size of around 5 to 50 population equivalents.

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Figure 2- Household sewage treatment plants

Figure 3- Household sewage treatment plant into excavated pit

Technology of household sewage treatment plant is placed into tanks, which may be plastic, stainless steel or composite steel-concrete. Products are mostly manufactured from high quality plastic materials (Fig. 3), certified and usable in all industrial areas. Household sewage treatment plants are designed to treat waste water from houses, guest houses, lodges and other establishments for 2 to 50 people. Household treatment plant consists of a tank in which there is a non-aerated zone and a separation. Tremendous advantage is that the cleaning operation is stable and the need for service and maintenance is minimal.

Household sewage treatment plants occupy a minimum area. Thanks to its small size, odourless and noiseless operation it can be installed close to home. The most commonly are plants placed under the ground, but they can be placed also in home basements. A pit of required size is excavated for placement of plastic and steel tanks. Some types of tanks can be placed on to a sand bed. However, usually, a blind concrete is placed at the bottom of the pit. The thickness of the concrete slab shall conform to the soil bearing capacity at the footing bottom, approximately 10 cm. In case of high groundwater level, the tanks must be concrete encased against its buoyancy. Once installed properly, the tank is connected to inflow and outflow pipes, to power source and the blower is connected to air distribution. Backfilling and packing of sewage treatment plant shall be made on the circumference of the tank to a thickness of 30 cm by sand, for the rest of the backfilling the original soil is used and compacted.

It is advisable to invest in sewage treatment plant which already meets the criteria for sewage treatment plants in European Union countries. The assortment of treatment plants varies by technical parameters, design, efficiency and price.

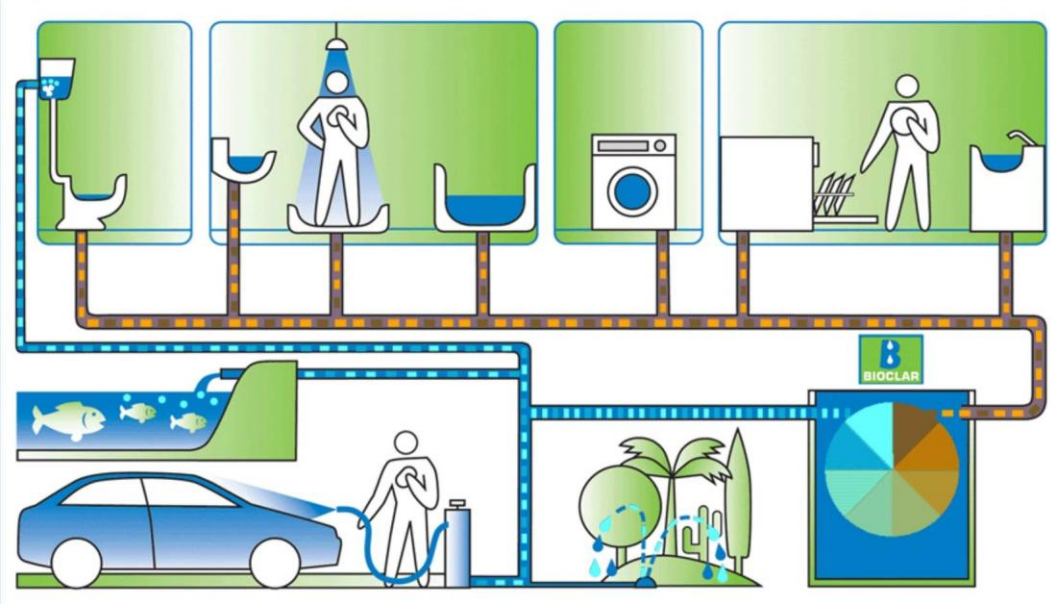
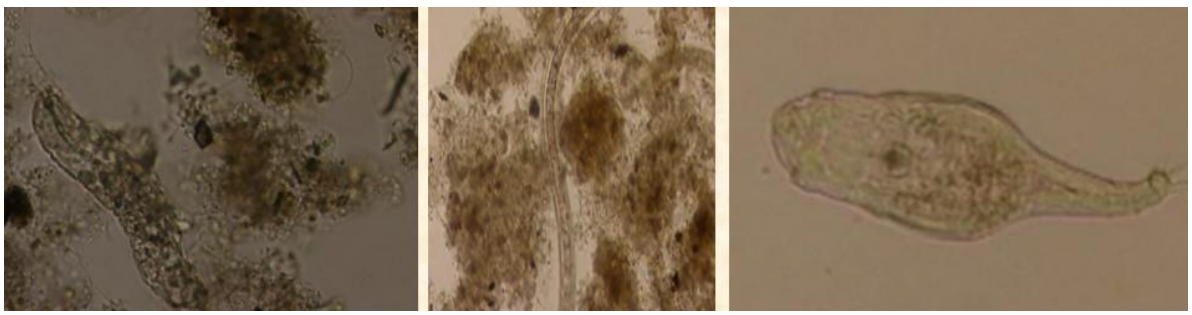


Figure 4. use of treated water recycling system

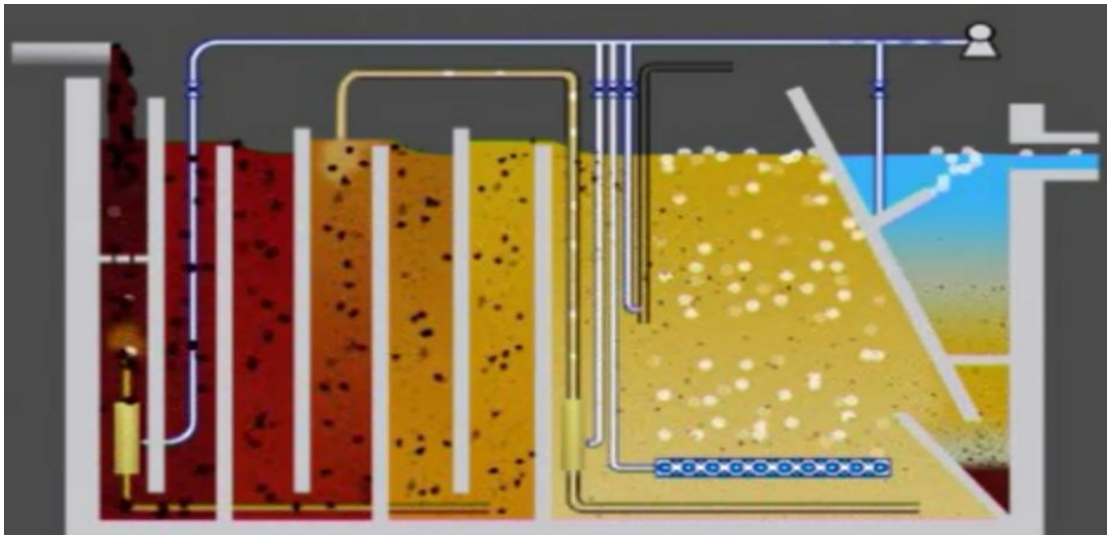
Biological treatment of sewage water treatment technology activities

The basic part of the waste water treatment plant is a biological reactor which accommodates in one vessel all processes of biological treatment of water: carbonization (elimination of organic contaminate matters), nitrification, denitrification (transformation, elimination of nitrogen compounds) and separation of biological activated sludge from treated waste water. Separating areas, using separation through sludge filtration are placed in the activated space, which is divided into sections connected together into one circuit. The arrangement and equipment of the particular sections of the activated space enable to fulfill linking-up functions of biological treatment – biodegradation and nitrification with dynamic more steps denitrification and in the case necessity biological elimination of phosphorus too. Internal circulation fulfils at the same time the function of outflow of the activated sludge from separation space.



Description of the treatment process

The treatment process can be divided into mechanical pre-treatment, biological treatment, pressure air distribution, solids content processing, electric power distribution, control and management systems. In case necessity the tertiary stage of post-treatment can be included.



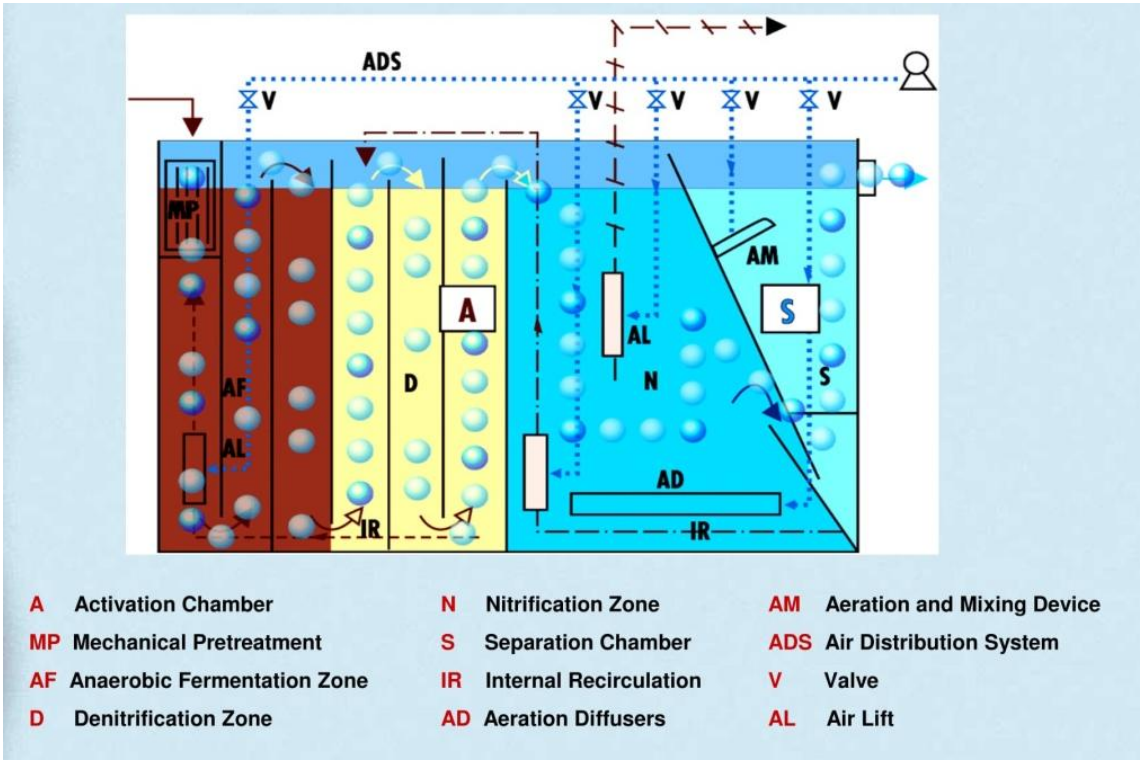


Figure 5. biological waste water treatment

Example Application

For further description of advantages of using Own sewage treatment systems, we selected an example of its use in a hotel with 50 beds in the Capital city of Kabul, Afghanistan. City of Kabul so far has not built a integrated system of centralized urban sewage treatment plants. Hotel accommodations are therefore forced to send waste water into their own sump. Often removal of effluent by fecal cars represent a considerable financial burden on these establishments and not least also have damaging effects on the environment around the city.

With an average production of 112 liters of wastewater per day the hotel facilities with 50 beds will produce approximately 2044 m³ of effluent per year. [Chart 1]
Price for one wastewater removal of fecal vehicle with a capacity of 24 m³ costing :
6000 AFG = 133 USD
During the year, it is necessary to carry out about 85 such removals, with a total cost :
11305 USD. [Chart 2]

Own sewage treatment systems can produced during the year adjusted to approximately 2003 m³ of clean water and only 41 m³ hygienically harmless sludge destined for removal. On the basis of this procedure we can collect 2003 m³of clean water, which can be used for watering lawns and green hotel. For comparison, the cost reduction now represents 98% = 11039 USD in this hotel.

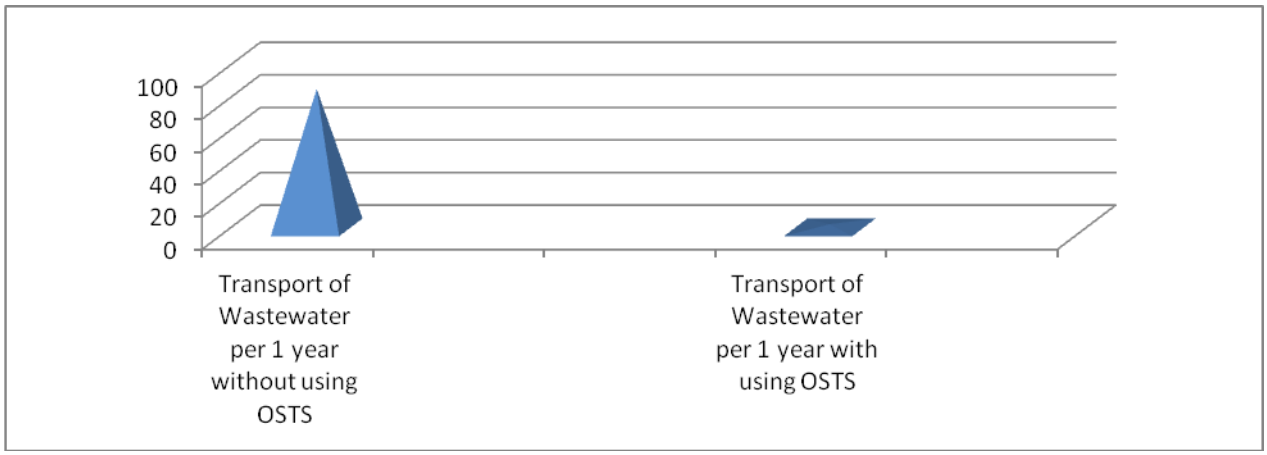


Chart 1. Graphics of the removal of wastewater without the use of Own sewage treatment systems and with using in the hotel service with 50 beds.

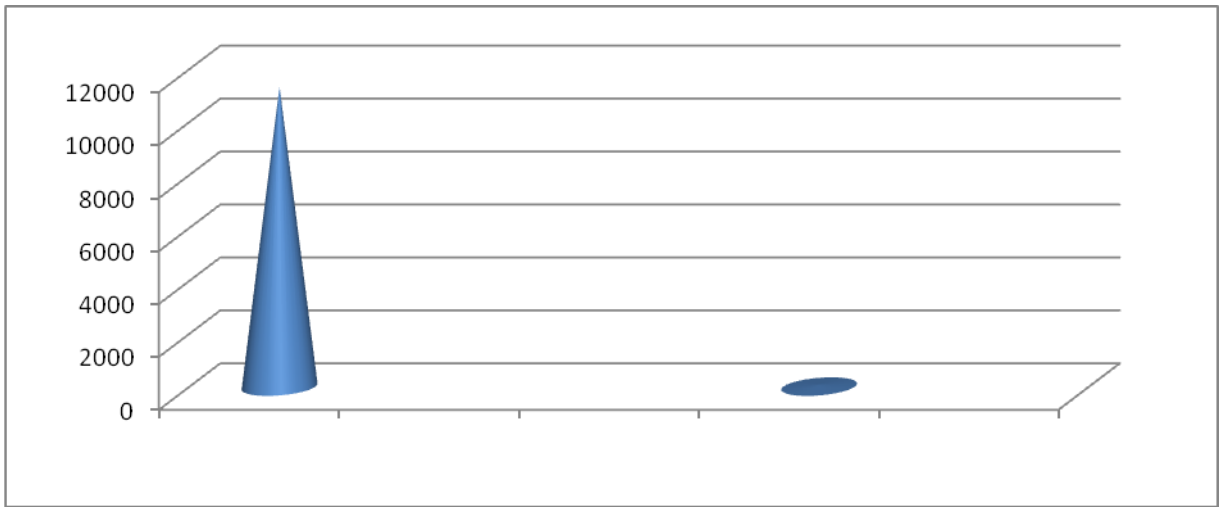


Chart 2. Graphics of the economic effect without the use of Own sewage treatment systems and with using in the hotel service with 50 beds.

The using of Own sewage treatment systems in the underdeveloped system of central wastewater treatment plants have huge advantage for the economy, environmental protection, and not least the health of residents. Environmental advantage of reducing the number of removing waste water in the city of Kabul and near the unprotected landfill can limit adverse health effects on groundwater and inhabitants.

Conclusion

Sewerage and sewage treatment together form an important part of environmental protection. One of the firs indicators of quality of human life is drinking water and its resources and related protection of water resources. The quality of drinking water is significantly affected by wastewater produced by human activity that is discharged into the recipient, and not always properly conveyed from urbanized area and then properly treated in sewage treatment plant. Disposal of waste water, and thus prevention of unpleasant impacts caused by wastewaters in natural waters and natural environment, is based on collection and treatment of waste water to the extent which ensures sustained good quality of surface waters.

Introduce of Biological Sewage Treatment System (BSTS)

Modern Environmental Management and Technologies, academic Conference in Kabul Polytechnic University 2011

Modern Environmental Management and Technologies, academic Conference in Herat 2011

Department of Environment of Afghanistan in Kabul 2011

Faculty of Geology and Water University of Kabul 2012

Salam University in Kabul 2012

Kabul Municipality 2013

Heart Province 2015

Civil Engineers of Ministry of Health 2015

Kabul Polytechnic University 2015

Herat Council of Experts 2015

Kardan University in Kabul 2015

Esteqlal Institute for Higher Education in Kabul 2016

Kabul River Basin 2016

Mazar-e Sharif 2017

Realized BSTS projects in Afghanistan by Temoryan-H, Ltd

No.	Project	Area	Place of work	TYPE	Quantity BSTS	Start
1		Herat	School garden Help	BSTS 25	1	5|2012
2		Herat	Camp Ansar Help	BSTS 25	1	5|2013
3		Herat	Shikiban Help	BSTS 25	1	6|2013
4		Herat	Khalil Jan house	BSTS 25	1	6|2013
5		Kabul	Shrwali Kabul	BSTS 25	1	1|2014
6	100-K	M.Sharif	School	BSTS 25	2	6|2015
7	103-K	Kabul	Khan Agha, Dibori	BSTS 25	1	4|2015
8	108-K	Kabul	Arya Zamin CC.- Karte Mamorin, Shoiab	BSTS 25	1	6|2015
9	109-K	Kabul	Haji Dad Mohammad	BSTS 25	2	6|2015
10	110-K	Kabul	Qasaba	BSTS 25	1	6|2015
11	111-K	Kabul	Abdul Ahmad,Kote Sangai	BSTS 25	1	8|2015
12	113-H	Herat	Mr. Rabani	BSTS 25	1	8|2015
13	112-K 114-K	Kabul	Khatamalnabin	BSTS 25	2	8|2015
14	117-K	Kabul	Khatamalnabin	BSTS 250	2	9|2015
15	119-K	Kabul	Haji Nehmat	BSTS 25	2	10|2015
16	122-K	Kabul	Mr. Ramin	BSTS 25	1	10|2015
17	123-K	Kabul	Said Dawood	BSTS 25	1	10|2015
18	124-K	Kabul	Eng. Matin	BSTS 25	1	11|2015
19	125-K	Kabul	Golden City - Estanegzay	BSTS 250	1	3|2016
20	129-H	Herat	Haji Basir	BSTS 25	1	4|2016
21	131-K	Kabul	Haji Akbar - Kote Sangi	BSTS 25	2	8|2016
22	133-H	Herat	Aya CC-Chasht Sharif	BSTS 25	1	9|2016
23	134-K	Kabul	Abdul Satar Karte Char	BSTS 25	3	9|2016
24	135-K	Kabul	Eng. Mirwais	BSTS 25	1	8|2016
25	137-K	Kabul	Naqibullah -Haji Taqi Dibori	BSTS 25	3	10|2016
26	138-K	Kabul	Dr. Sekandari	BSTS 25	1	11|2016
27	140-K	Kabul	Ahmad Hosain, Kabul, Karta e Sakhi	BSTS 25	3	11|2016
28	143-H	Herat	UNDP, Herat, Jalalabad, Mazar	BSTS 25	3	11|2016
29	144-K	Kabul	Kabul Market	BSTS 250	1	12|2016
30	145-H	Kabul	Netlinks, Shahr e Naw	BSTS 250	1	02|2017
31	146-H	Herat	Ahmad Sah, Herat	BSTS 25	1	1|2017
32	149-K	Kabul	Haji Ahmad Omar, Karta e Chahr	BSTS 25	1	02|2017
33	150-K	Kabul	ACCU, Wazir Akbar Khan	BSTS 25	1	02|2017
34	154-K	Kabul	Kaihan Market, Khairkhana	BSTS 25	2	06|2017
35	157-K	Kabul	Eng. Jamil, Kabul Baharestan	BSTS 25	2	07|2017
36	158-K	Kabul	Eng. Omid, Kabul Wazir Akbar Khan 15st.	BSTS 25	1	07|2017
37	161-K	M.Sharif	DESTINY - Eng. Nakieb	BSTS 25	1	09|2017
38	162-K	Kabul	Farooq Mansoor,Poroja e Timani 5th Street	BSTS 25	1	11|2017
39	163-K	Kabul	Khatamul Anbia Mosque	BSTS 25	1	11|2017
40	166-K	Kabul	Eng. Dawood, Jada e Naader Pashtoon, Bagh e Ali Mardan	BSTS 250	2	12|2017
41	167-K	Kabul	Keeng Global, Darulaman	BSTS 25	2	12|2017
42	168-K	Kabul	Ah. Hosain, Karta e Sakhi	BSTS 25	4	1|2018
43	169-K	Kabul	DSC, Dasht Barchi	BSTS 25	1	1|2018
44	170-K	Kabul	Zadran Group,Charah e Salim Karwan	BSTS 250	1	1|2018
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Videos from our references

https://www.youtube.com/watch?v=QL1kZEt3I80&feature=youtu.be
https://www.youtube.com/watch?v=ueA5Bu0e1n8&t=14s