Sludge Accumulation at the Wastewater Treatment Plant Pilot – Cuenca Ecuador [1]

[1] *Empresa Pública Municipal de Telecomunicaciones, Agua Potable, Alcantarillado y Saneamiento de Cuenca, ETAPA EP; Calle Benigno Malo 7-78 y Sucre; Phone: 593 2831900; Cuenca, Azuay, Ecuador; www.etapa.net.ec*

1. The Municipality Cuenca

The city of Cuenca is the capital and largest city of the Azuay Province of Ecuador. Cuenca is located in the highlands of Ecuador at about 2,560 meters (8,400 feet) above sea level, with an urban population of approximately 329,928 and 661,685 inhabitants in the larger metropolitan area.

2. Water Supply and Sewage Management

The Municipal Public Telecommunications, Drinking Water, Sewerage and Sanitation Company (ETAPA) was created by municipal ordinance in February 1968. It has jurisdiction in Cuenca, Province of Azuay, Ecuador.

It currently serves 500,000 inhabitants, in an urban area of 24.000 hectares, with 95% coverage in drinking water, 92% in sewerage and maintains 130,000 telecommunications subscribers. In the rural area, it provides drinking water and sanitation services to150,000 inhabitants. The annual budget (2020) amounts to US$ 100,000,000.

3. Wastewater treatment Challenge

Wastewater generated in the city of Cuenca is transported by gravity, through a combined collecting system, to the Ucubamba wastewater treatment plant (PTAR-U). The PTAR-U was designed to treat an average flow rate of 1,860 L/s (2,500 L/s maximum per hour) and has been in operation since 1999, with improvement works that were completed in 2013. The utility is also working on the implementation of a new WWTP: Guangarcucho PTAR, (PTAR-G).

The liquid phase treatment of the PTAR -U includes preliminary treatment (entrance box and by-pass), three parallel automatic screens (e-20 mm), two square horizontal flow grit chambers, flow distribution channel and flow measurement.

There are two biological treatment lines, each composed by an aerated lagoon, (designed for complete mix), a facultative lagoon and a maturation lagoon. Each aerated lagoon is equipped with 10 aerators of 75 HP and 12 aerators of 25 HP (1050 HP).

The total area al water level is 45 hectares: 3 ha (132.000 m^3) per aerated lagoon, 13 ha (aprox 260.0000 m^3) per facultative lagoon, and 7.4 ha (122.000 m^3) and 5.6 ha (104.000 m^3) each maturation lagoon. The total operating volume of the six lagoons is 1.050.000 m^3. The treated effluent is discharged to the Cuenca River.

The average daily flow received by the plant in 2019 was 1.80 m^3/s, and the daily load is 19,000 kg BOD/d.

The lagoons present serious problems of sludge accumulation. According to 2018 data, sludge accumulated in the aerated lagoons reached 33% and 35% of their volume respectively. In the facultative lagoons, 47% and 48%, and in the maturation lagoons, 25% and 18%, totaling around 400.000 m^3 with a solids content of 13%. With an average concentration of 2% during the dredging process, it is necessary to transport 2.600.000 m^3 of sludge.

The sludge extraction and dewatering system features:

1. Two floating dredgers with a capacity of 40 m^3/h
2. Piping system for collecting and conducting the dredging sludge to two pumping stations
3. Two gravity thickeners and thickened sludge storage tank
4. Three 3 m width band filters each for dewatering pre-conditioned sludge by adding polyelectrolyte (a pumping and feeding system to the filters are available), mobile band for the collection of dehydrated sludge and subsequent pumping to a silo for storage. Dryness ranges from 30%MS to 35%MS.
5. Scale weighing and transporting sludge towards final disposal in the city's landfill.

Considering the nominal extraction capacity, the system would require between 10 and 15 years of continuous operation to empty the sludge from the lagoons (without considering the daily entry of solid material). Additionally, the system does not work with its original capacity, due to damage to some equipment. The actual extraction capacity is 400 m^3 per day.

4. General Pilot Design Concept

ETAPA is looking for a technological solution to face the problem described above. Several options for improvement have been identified in the face of the problem, including:

Routine tasks:

- Procure spare parts of equipment, parts, parts and elements, in order to reduce the vulnerability of treatment systems (liquid phase /solid phase) and thus ensure their continuity.
- Recruitment of auxiliary processes of support in management for longer periods of time (3 – 5 years): maintenance of equipment and machinery, transport and evacuation of waste and dehydrated sludge, procurement of chemicals for dehydration and control of water and mud quality in its different phases and states, environmental mitigation and maintenance of complementary civil works.

Specific tasks:

- Extraction, dehydration and transport of dehydrated sludge by alternative methods, currently having a blueprint to dredg the lagoons to filter tubes that would be located on the perimeter of the lagoons, where mud would remain until it reached features that allow it to be moved and enforced by legislation for final disposal.
- Decreased treatment flows and flow derivation to the PTAR-G with emphasis on peak loading hours.

- Training and internships to develop and improve capacity on administration, operation and maintenance of wastewater treatment systems and related.

In the past, ETAPA piloted a solution based on the use of geotubes. Also, several alternatives for the drying of biosolids have been studied, such as: thermo drying, solar drying, incineration, soil improvement, composting and co-disposal in sanitary landfill. These studies require higher level of detail.

ETAPA is seeking:

- New solutions to be pilot preferably in the facility
- and, during the process, to train local operators

Non-Water Reduction (NRW) Pilot – Lima, Peru.

1. **The Municipality of Lima**

   Lima is the capital and the largest city of Peru. It is located in the valleys of the Chillón, Rímac and Lurín rivers, in the central coastal part of the country, overlooking the Pacific Ocean. Together with the seaport of Callao, it forms a contiguous urban area known as the Lima Metropolitan Area. With a population of more than 9 million, Lima is the most populous metropolitan area of Peru and the third-largest city in the Americas.

2. **Overview of the water supply system**

   SEDAPAL, the Potable Water and Sewerage Service of Lima is a state-owned private company, incorporated as a Public Limited Company, and its purpose is to provide public services of Potable Water and Sewerage to Lima and Callao. The water system is pressurized with minimum pressure of 1.0 kg/cm2 and has an estimated 1.3 million connection.

   SEDAPAL aims to serve 100% coverage for 24 hours of drinking water and sewerage service for the city of Lima and Callao. And operates to drastic reduce commercial and operational losses (unbilled water).

   The current drinking water supply system in the Lima Metropolitan Area, Callao and areas of Huarochirí Province, SEDAPAL's area of responsibility consists of surface water use in the units riverbanks of the Rimac and Chillón river basins. the incremental flows that occur during the periods of striate, as a result of the operation of reservoirs in the upper parts of the Mantaro basin, and by the exploitation of aquifers underground Rimac - Chillón and Lurín, in addition to the source provided by the Yuracmayo reservoir and the drain tunnel called Graton, coming from the aquifer in limestone rocks.

3. **Water Supply Challenges**

   In the last 20 years the population of Lima and Callao has increased at a rate of 145 thousand inhabitants per year, which represents approximately an annual requirement of the order of 29 thousand new connections per year. In the same period, SEDAPAL's closing gap investments have allowed an annual increase of 32 thousand connections, which also represents having covered the population growth that has reached 300 thousand people with new connections. It is estimated that at the end of 2018 there are still approximately 500 thousand people who do not have access to permanent water and sewerage services in Lima and Callao.

   Between 2015-2017, SEDAPL manage to reduce the non-revenue water from 34.58% to 25.13%. To continue the reduction of unbilled water, SEDAPAL is looking for innovative technologies and/or intelligent management models, which are currently being used by other water service companies in the world.

4. General Pilot Design Concept

SEDAPAL is looking to Pilot technology to reduce the NRW, specifically they are looking for the following:

- An event management tool that allows to reduce the percentage of unbilled water in the North, Central and South Services Management of SEDAPAL.
- Switch from corrective maintenance to preventive maintenance.
- Reduced leak detection time.
- Reduced analysis time.
- Reduction of collateral damage.
- Early warning to prevent damage and reduce water loss.
- Increased efficiency of network operations.
- Meter failure detection and telemetry.
- Improve customer service and company image.
- Prioritization of actions in the network.

Implementation, installation and testing of the tool

4.1.1 Deploying and installing the tool will then be tested with existing data, data generated with installed hardware, and built-in data.

4.1.2 Issue reports of event management (network detection and incidents), as well as area view (High-level view of sectors and status of other areas: night water flow, open events, water loss, data availability, etc.). Make exposures of the progress of the work carried out to the cut-off date, to the areas involved.

4.1.3 Generation of multiple reports such as:
- Flow increases/decreases
- Leaks, Trends in night lows
- Use
- Increases/Pressure Decreases
- Meter Failures
- Telemetry

LEAKS DETECTION IN WATER AND DRAIN SERVICES PILOT- MONTERREY, I.P.D.

1. The Municipality of Monterrey

Monterrey is the capital and largest city of the northeastern state of Nuevo León, Mexico. The city is anchor to the Monterrey metropolitan area, third largest in the country with an estimated population of 5.1 million people.

The city of Monterrey is 540 meters above sea level. The Santa Catarina River is dry most of the year on the surface but with flowing underground water—bisects Monterrey from east to west, separating the city into north and south halves, and drains the city to the San Juan River and Rio Grande.

Nuevo León has a deep-rooted culture of water reuse since the 50's, which has allowed the subsistence and expansion of industrial activity, and therefore the growth of the capital city and its metropolitan area, which with less than 4% of The country's population generates 11% of gross domestic product (GDP) and all with an extreme, semi-arid climate and whose water sources (superficial and underground) are distant and demand significant energy consumption.

2. Water Supply and Sewage Management

Monterrey Water and Drainage Services (SADM) is responsible for the supply of Drinking Water, Sewerage and Sanitation to the 51 Municipalities of the State of Nuevo León. It serves 1,635,000 users and has a drinking water network of more than 18,000 kilometers. The system is pressurized with pressure of 1.5 kg/cm2. The city has 30,628,119 kms of water pipes from asbestos-cement and pvc-c900.

<u>Coverage and growth-</u>

The utility service 98.96% Sanitary drainage, 99.53% portable water, from which 95% is urban population and 5% rural.

3.Water Supply Challenge

Currently, the water not counted in the water system, is 29.7% and even though great efforts have been made, such as sectorization, pressure modulation, as well as a leak detection. Even though the department responsible for NRW has more than 30 years experience with suitable equipment, the NRW rates are not reduced.

4. General Pilot Design Concept

Having reviewed several options, we believe that the methodology known as **"Microwave leak detection"** is suitable for our needs. The Microwave leak detection provides a network diagnosis by means of images obtained by microwave emission, to identify the areas of the network with leakage of drinking water regardless of the diameter or the material of the pipes, and regardless of the volume of water being transported, and the pressure that it contains, the only condition is that the water has been potabilized.

We are searching for a technology to locate the exact point of leakage in the system. In addition to the technology/application we ask for an in-person training to be provided by the company, in order to use the application for fieldwork detection and to validate the technology and the knowledge acquired.

Water Loss Reduction Pilot - Parauapebas, Brazil

1. The municipality of Parauapebas

The municipality of Parauapebas, established in 1988, is located in the central-east portion of the State of Pará in the center of the largest mineral reserve in the world, Serra de Carajás, operated by vale s/a. The Brazilian Institute of Geography and Statistics (IBGE) estimates that in 2019 208,273 inhabitants lived in an area of 6,886.21 km², with a density of 22.35 inhabitants / km² where 90.1% of the population of Parauapebas lives in the urban area of the municipality (approximately 187,654 people).

The municipality is experiencing rapid growth, without adequate support for infrastructure or control over land occupation, presenting investment deficit in environmental sanitation, education and health infrastructure (Municipal Basic Sanitation Plan - PMSB 2019). This resulted in part of the low-income population living in informal urban settlements, with precarious housing in environmentally vulnerable areas subjecting residents to floods and the permanent risk of contracting diseases. Water and sanitation services are currently provided by the *Parauapebas Autonomous Water and Sewage Service* (SAAEP), an autarchy created by the City Hall through Municipal Law No. 4,385 of August 11, 2009.

2. Water supply and sewage Sector

Currently SAAEP has in its staff 382 employees, among these directors, engineers, administrators, auxiliaries, operators, plumbers, guardians, etc. Today SAAEP operates a system that has 4 water treatment plants (ETA) with surface water uptake, which serve the entire municipality and the sewage treatment and collection system has a total of 7 sewage treatment plants (TeE) and it has an amount of 30,546 meters of collecting network that serves about 15% of the population. Only adduction and intake are pressurized.

Summary of the information of the municipality water and sanitation services.

Water Supply System (SAA)	Water capture	Volume captured (m^3/h)	Treatment method	Average volume of drinking water production (m^3/month)	Populati on served
SAA1	Parauapebas River	1.238	Full cycle (conventional) *	800.000	71.000
SAA2		420	Dual filtration compact	270.000	52.000
SAA3		122	Dual filtration compact	36.000	4.000
SAA4	J. Neighborhood reserve lagoon	122	Dual filtration compact	72.000	7.800
Isolated Systems	69 wells - underground springs	918	Disinfection (chlorination)	590.000	38.000

* Stages of the complete cycle: coagulation, flocculation, decanting, filtration and disinfection.

3. Water Supply Challenge

According to data from the National Sanitation Information System (SNIS) of 2017, SAAEP attended 182,120 inhabitants in Parauapebas with water and 30,901 with sewage system; 90% and 15% coverage respectively, which means that almost 20,000 people do not have drinking water in their homes and more than 170,000 have no sewage. Regarding the efficiency and quality of the water service, the losses are around 76%, where 57% of users receive water less than 24 hours a day and 74.3% classify the water quality as regular (21.7% classify them as bad or terrible).The City's water network has approximately 845,950 m of installed network (SNIS,2018) with diameters that are between 32 mm and 800 mm. The network has no sectorization (objective that will be achieved with the implementation of the Sectorization and Macromeasurement Plan) and no measurement, flow control and pressure control devices installed.

One of the main factors that determine the decline and operational efficiency is water loss in the system, estimated at 76%. invisible leaks (more than 50% of physical losses) cannot be identified and repaired immediately.

Faced with this challenge, in recent years SAAEP has been seeking to implement several control actions and combat invisible losses, such as the use of ultrasound, which in short are not as effective of operational sighting, which hinders services. In recent years several innovative technologies have been developed in the market to detect these types of leaks using artificial intelligence, satellite images and the like, which are more effective, less expensive and with a shorter time of implementation than conventional technologies.

4. General pilot design concept

The municipality of Parauapebas' pilot project will identify invisible leaks, using innovative technologies. The municipality is looking to learn from this experience, in order to implementation the solution in additional areas in the city.