

Preliminary Engineering Report
Cooperativa de Servicios Publicos, Florida Ltda.
Samaipata, Bolivia

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Submitted to:

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WATER ENGINEERS FOR THE AMERICAS

Water Engineers for the Americas (WEFTA) is a 501(c)(3) non-profit organization that seeks to help alleviate the problem of unsafe water supplies and inadequate sanitation in the western hemisphere. WEFTA provides technical and administrative support to needy communities for the construction of drinking water and wastewater systems by working with local non-profit organizations and promoting community-based projects.

Souder, Miller & Associates is a civil engineering firm based out of Santa Fe, New Mexico, that works closely with WEFTA, and provides the majority of WEFTA's volunteer engineers, including two of those who worked on this project in Samaipata.

EXECUTIVE SUMMARY

It is the initiative of the Cooperativa de Servicios Publicos 'Florida' Ltda ('the Cooperative') that serves the municipality of Samaipata, to provide potable water to all of its users. The existing Samaipata water system includes six (6) primary sources of water – three (3) are surface water ('tomas') sources, and three (3) are groundwater wells ('pozos'). Two of these six sources are currently treated at the Sotopollerudo Water Treatment Plant (WTP), which began operation in June 2017. However, the treated water is discharged back into the distribution system where it mixes with the other non-potable sources. Thus, no part of the system is currently potable.

The Cooperative began initial contact with WEFTA in 2016 for consultation, examination, and proposition of needed improvements for Samaipata's water system. Ingenieros Lam Ho and Jason Obergfell were the initial WEFTA technical assessment team that conducted an overview assessment of the water and wastewater system in July 2017 to identify needs and priorities. Ingeniera Emily Sotelo and Ingeniero Jason Obergfell were the second WEFTA technical assessment team that conducted an in-depth assessment of the water system in November 2017 to further identify needs and provide recommendations to make the water distribution system potable. They also used GPS units to store locations of key infrastructure components in order to make a digital map of the Samaipata water system.

This planning study evaluates the existing water system infrastructure, identifies current issues, and provides recommendations to the Cooperative. The foremost priority of the Cooperative, and that which this report focuses on, is making the existing distribution system potable.

A three-phase approach to making the Samaipata water system potable is proposed. Phases are:

1. Potability for the northeast sector served by Tambillo – installation of 1 chlorinator.
2. Potability for the central sector served by Chorrillos, WTP, Cementerio and Sauce Pozo – installation of a new storage tank, 2 chlorinators, and increased efficiency of the existing Sotopollerudo Water Treatment Plant (WTP).
3. Potability for the homes connected directly to the El Fuerte transmission line – reconnection to the potable water system of as many homes as possible that are currently connected to the 8-inch transmission line from the El Fuerte tomas to the WTP.

Other general and long-term recommendations are also made.



BACKGROUND

Samaipata Background

Situated in the heart of South America, Samaipata is a town of about 5,000 inhabitants that sits at the convergence of the Amazon and Andes in eastern Bolivia. The municipality of Samaipata, which includes another 5,000 inhabitants in more rural settings (total population 10,000), is a 2.5 hour drive from the eastern low-land 'private sector' capital of Santa Cruz (population 2.1 million) and borders on the expansive National Park Amboró which is five times the size of Yellowstone. The town of Samaipata is known as a tourist destination, not only for its eco-touristic access to *Parque Amboró* but also because it is situated just under the pre-Incan (Incan, and Spanish) archaeological site of *El Fuerte* which includes the largest carved rock in the world. A few hours beyond Samaipata, in the town of Vallegrande, is the site of Che Guevara's 'trail' and where he was captured and died. Also within close reach are numerous waterfall destinations and hiking opportunities. The 'valleys' (*Los Valles*) – the subtropical region that includes Samaipata, Vallegrande and neighboring communities - have a distinct culture and is known for its pleasant climate. Samaipata is home to some 300 foreigners of all generations, hailing from around 33 different countries, something that gives the town a 'cosmopolitan' feeling.

The municipality has been named one of Bolivia's 32 'eco-municipality' by the national government, under Evo Morales, and the current Mayor has several initiatives to encourage organic agriculture and sustainable tourism and energy. In its recent 15-year planning process, water access and quality was identified as a top priority.

Water Cooperative Background

Founded in August 1972, the Cooperativa de Servicios Publicos 'Florida' Ltda provides water and sewage services to some 1800 connections (~5000 persons) in the town of Samaipata. The Cooperative's mandate is to service those within the urban area of Samaipata, an area that is just being redefined by the current municipal administration as part of its 15-year municipal plan.

The Cooperative currently operates with the following structure. The Directorate, elected publicly by its members every two years, includes two committees with five members each: the Administrative Committee and the Vigilance Committee. An Administrator oversees the financial books and records and the workers, of which there are five technicians, one night watchman, and one cleaner.

The Administrative Committee has the responsibility of ensuring that the Cooperative is run smoothly, overseeing the finances, personnel and major decisions around expansion and service provision. The Vigilance Committee is mandated to supervise all work by the Administration Committee and the Cooperative, with specific powers to review financial expenditures and address major complaints.

Population Trends

The purpose of this section is to briefly estimate water demand over a 20-year planning period. Data provided by the cooperative indicates that approximately an average of 1,247 residential connections and 247 commercial connections. This report uses a growth rate of 0.06% for the local permanent population and growth rate of 7.31% for the influx of tourists a figure which is endorsed by the Water Cooperative. In 2017, the coop estimated that 54,271 tourists visited the town for an average of 4 days each, which results in a floating average population of 595.



Table 1.1 – Population Projections for Samaipata

Year	Permanent Population	Floating Population	Peak Floating Population
2017	4,398	595	9,986
2020	4,401	638	10,078
2025	4,403	685	10,177
2030	4,406	735	10,282
2035	4,409	789	10,395
2040	4,411	847	10,516

Water Demand and Consumptive Use Statistics

I. Average Water Demand:

Data provided from the Cooperative, for 2017 (up to October) indicates an average monthly usage of 17.1-m³/month/connection, which gives an average daily use of 0.57-m³/month/connection. These figures could be even higher, since at the time of writing, usage data had not been published for November-December 2017, which are some of the peak tourist months in Samaipata. See table 2.2 for 2017 year-to-date usage data from the Cooperative.

Table 2.2 – Samaipata Water Usage Data, Year-to-Date

Month	Total Users	Total Monthly Usage (m ³)	Total Monthly Cost (Bs.)	Average Total Monthly Use (m ³ /user)	Average Total Daily Use (m ³ /user)	Total Monthly Unit Cost (Bs/m ³)
Enero	1,553	28,238	67,552	18.2	0.61	2.39
Febrero	1,389	23,365	57,791	16.8	0.56	2.47
Marzo	1,763	28,821	71,453	16.3	0.54	2.48
Abril	1,569	24,469	62,179	15.6	0.52	2.54
Mayo	1,578	22,673	60,007	14.4	0.48	2.65
Junio	1,580	26,240	65,494	16.6	0.55	2.50
Julio	1,601	27,303	68,153	17.1	0.57	2.50
Agosto	1,600	29,781	71,482	18.6	0.62	2.40
Septiembre	1,601	31,183	73,784	19.5	0.65	2.37
Octubre	1,601	29,329	71,127	18.3	0.61	2.43
Average	1,584	27,140	66,902	17.1	0.57	2.47

II. Peak-Day Factor:

Peak use factors are used in water demand studies and infrastructure design to determine the consumers' peak usage month and day in a year. In peak times of the year, (Carnival, Beginning of November, All Souls, Christmas/New Year, School Breaks, and other holiday seasons), the total population doubles based on information provided by the coop for a brief time creating a large water demand typically over the course of 4 days. It is calculated that the peak-day factor is **2.22** times the daily average during these peak times.

SYSTEM ASSESSMENT

Location Map

A general project location map is provided in Appendix A.

Existing System

I. Water Supply

The Samaipata water system is primarily supplied by surface waters from several tomas (surface water catchments) and pozos (wells). The surface water supply from the tomas is the primary source for the system, but decreases during the dry season between June-September. The pozos are used primarily for secondary supply, and usage varies throughout the year. Refer to Table 2.2 for a summary of the sources.

The Municipality of Samaipata and the Cooperative are in the process of designing a new supply source that collects water from 3 new tomas- referred to generally as the El Astillero tomas. The project also includes a new water storage tank, and serves additional homes via a future extension of the distribution system as well as tying-in to the existing distribution system. The potential project is included in Table 2.2 and 2.3.

Table 2.1 Water Source Summary

Elev. (m)	Water Source	Supply (L/s)	Supply to:	Connections/users between source and tanque?
1767	Tambillo (1 toma)	2.5 - 3.0	Tambillo Tanque	No
1828	El Fuerte (3 tomas)	5.0 - 10.0	Sotopollerudo Tanque	Yes, ~45
1845	Chorrillos (5-6 tomas) ¹	~3.0	Rompe de presion, and then distribution system	Yes, there is no tanque between the source and distribution system
1668	Carretera Pozo ²	9.0	Sotopollerudo Tanque	No
1672	Cementerio/Estadium Pozo ²	2.5	Cancho 8 Tanque, and a second discharge line directly to higher-elevation homes	Yes, ~5 connections between the pozo and Cancho 8 Tanque, and a secondary discharge line from the bomba (pump) de pozo to higher-elevation homes ³
1682	Sauce Pozo ²	3.5	Tie-in to the discharge pipe of the Cementerio Pozo, and a second discharge line directly to higher-elevation homes	No connections between the Sauce pozo and Cementerio pozo, but there is a secondary discharge line from the bomba de pozo to higher-elevation homes (different than those served by the bomba de pozo de la Cementerio) ³
U/K	Potential New El Astillero (3 tomas)	4.5	Potential new El Astillero Tanque	No

¹There were 6 Chorrillos tomas being used at the time of WEFTA's initial visit in June 2017, but one has since been taken off-line per WEFTA's initial recommendation after review of the individual Chorrillos toma water quality reports.

² All pozos (wells) are primarily secondary sources used especially in the dry season (between June and September) when the surface water supplies of the tomas decrease.

³ There are no storage tanques on the pipelines between each pozo and the higher elevation homes they serve via their secondary discharge line; however, it is assumed, and should be verified by the Cooperative, that most, if not all, of the higher elevation homes have small private tanques.

II. Water Storage

The Samaipata water system has four existing concrete water storage tanks (aka 'tanques'), and two proposed. A new water tank would be included in the El Astillero project that is being planned, and there are also plans for a sixth storage tank that would intersect the transmission line between the Chorrillos tomas and distribution system. There is currently only a rompa de prescion (pressure break box) between the Chorrillos sources and system, situated at an elevation of 1748-m. The existing storage tanks do not have any controls, and direct excess water to the overflow outlet, which drains away from the tanks. Refer to Table 2.3 for a summary of the water storage – existing and proposed.

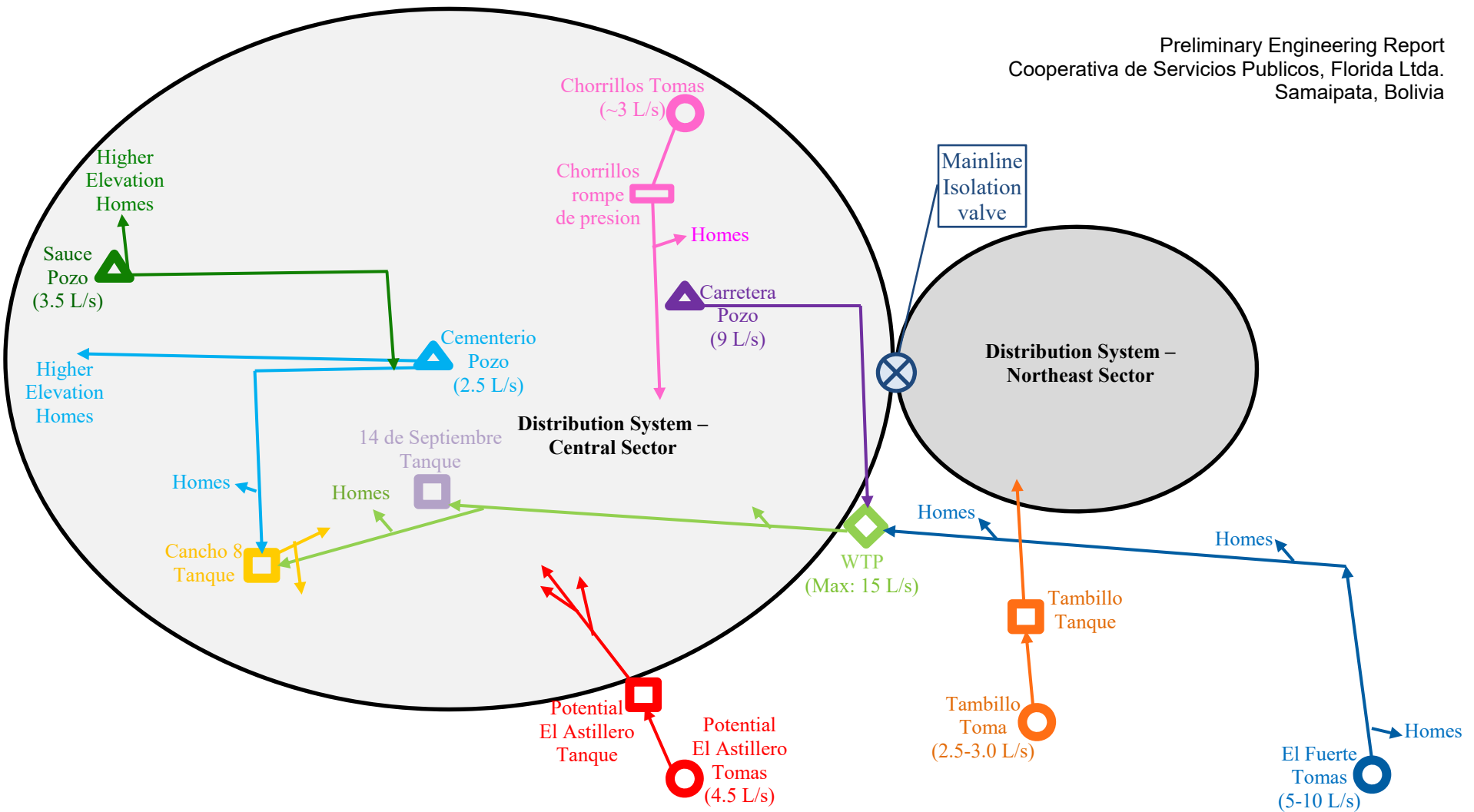
Table 2.3 Storage Tank Summary

Elev. (m)	Tanque	Capacity (kL)	Intake from:	Outlet to:
1730	Tambillo	100	Tambillo Toma	Distribution system
1710	Sotopollerudo (storage tanque at the WTP)	180	Treated water from El Fuerte Tomas and Carretera Pozo	14 de Septiembre Tanque, Cancho 8 Tanque, and homes in between
1688	14 de Septiembre ¹	75	Sotopollerudo Tanque	Private pumps to higher elevation homes
1700	Cancho 8 (#1 & #2)	2 x 75	Sotopollerudo Tanque and pozo de la Estadium	Distribution system
1757	Potential new Chorrillos Tanque	100	Chorrillos Tomas	Distribution system
1831	Potential new El Astillero Tanque	100-200	Potential New El Astillero Tomas	Distribution system - new and existing

¹ The 14 de Septiembre Tanque is in poor condition. It has two 75-kL cells (for a total volume of 150-kL), but one cell is not used anymore, and the tanque no longer discharges directly into the distribution system. Instead, there are approximately four private pumps to higher elevation connections.

III. System Operation

On the following page is a schematic flow diagram that shows how the existing Samaipata system operates.



Note: The existing Samaipata system can be operated as 2 essentially separate systems. The northeast sector of the water system, which encompasses the barrios of Villa Merced (aka Sutidor) and Castilla, is served primarily by Tambillo. There is a 2" mainline isolation valve (located at where Calle Bolivar intersects with Av. Aranciba, lat. 18.177333°W, long. 63.869920°S) that essentially separates this sector from the rest of the central system. It is currently kept shut, and can be opened if needed to allow water to flow either direction. However, there are approximately 45 – 50 homes (shown in blue above) in this area of Samaipata that are serviced off the 8" transmission line from the El Fuerte tomas to the WTP.

IV. Water Treatment

Minimum Control Parameters from the Reglamento Nacional Para El Control de la Calidad Del Agua Para Consumo Humano NB – 512 (Bolivia’s drinking water standards), are shown in the below figure.

Tabla N° 1. PARÁMETROS DE CONTROL MÍNIMO

Parámetro	Valor máximo aceptable
pH	6,5 – 9,0
Conductividad	1.500 $\mu\text{S}/\text{cm}^*$
Turbiedad	5 UNT
Cloro residual	0,2 – 1,0 mg/l
Coliformes termoresistentes	0 UFC/100 ml

Recent water quality test reports conducted for the Cooperative are provided in Appendix B, and key results are shown in Table 2.5. The results that do not meet NB–512 standards are highlighted in red; those that do are in green.

Table 2.5 Recent Water Quality Test Results of the Samaipata Water System

Date of Sampling	Supply Name	Coliform (UFC/100mL)		Turbidity ¹ (UNT)	pH
		Fecal	Total		
8/21/2017	Chorillos No. 1	23	27	0.8	6.61
8/21/2017	Chorillos No. 2	NSD	2	2.5	6.46
8/21/2017	Chorillos No. 3	26	37	1.1	6.62
8/21/2017	Chorillos No. 4	2	5	0.4	7.18
8/21/2017	Chorillos No. 5	43	460	1.0	7.33
8/21/2017	Chorillos No. 6	15	1100	1.3	7.11
7/12/2017	El Fuerte Toma	9	240	2.4	7.21
7/12/2017	Tambillo Toma	4	75	1.6	7.37
10/30/2017	Pozo Carretera	NSD	4	0.6	8.57
7/12/2017	Pozo Cementerio	4	43	1.3	7.48
7/12/2017	Pozo Sauce	NSD	NSD	0.5	6.74
10/30/2017	Treatment Plant	NSD	1	1.0	8.4
7/12/2017	Cancho 8 Tanque	4	23	1.1	7.35
7/12/2017	Tanque 14 de Septiembre	4	15	2.9	7.4
7/12/2017	Tambillo Tanque	NSD	23	1.6	7.35

¹ Turbidity is noted to increase in the tomas during the rainy season (approximately November – February) when there is more watershed runoff. The results above were the most recent at the time of writing, and do not encompass the rainy season months.

The pH of the Carretera Pozo and WTP are significantly high, though still technically within NB-512 standards. The efficiency of disinfection is known to decrease with increased pH. See the below figure – provided by WEF SUPER AGUA representative - as a reference.

Eficiencia desinfectante del cloro a diferentes pH del agua

pH del agua	4,0	4,5	5,0	5,5	6,0	6,5	7,0	7,5	8,0	8,5
Eficiencia del Cloro	100%	100%	100%	99%	97%	95%	92%	85%	18%	6%
Medio	Ácido						Neutro	Alcalino		

During 2016 – 2017, through partnership of the *Gobernacion* (Santa Cruz state-level government), Spanish – Bolivian NGO APEP (Asociacion Para la Eradicacion de la Pobreza), Samaipata Municipality, and the Cooperative, the Sotopollerudo Water Treatment Plant (WTP) was constructed at the site of the pre-existing Sotopollerudo storage tank. The WTP treats two of the six existing water sources – the El Fuerte tomas, and the Carretera Pozo (which operates primarily as a secondary source during the dry season when the El Fuerte tomas' flow rate is decreased).

The WTP has a 1.2M-L/day capacity, which is equal to the full flow of its two sources during the dry season (approximately 5-L/s for El Fuerte in the dry season, and maximum production of approximately 9-L/s for the Pozo de la Carretera). The WTP uses the following processes:

- 1.) Pre-sedimentation: Surface water is captured from the three El Fuerte tomas – Principal, Alisos, and La Figurita. Dams approximately 1.0 - 1.5 meters in height span across the narrow canyons to accumulate a reservoir of water which then passes through geotextile mesh on perforated pipes. Large solids drop from the source by gravity, but smaller sediments pass through. The water is collected from the three springs and are plumbed into a 5.6-mile 8-in ductile iron pipe that conveys the water via gravity into the WTP.
- 2.) Deaeration: The waters from the springs and pozo discharge onto a multi-step concrete splash structure which assists in the removal of nitrogen and ammonia from the water
- 3.) Coagulation: Alum is injected into the feed water using an 18.3 L/hr peristaltic pump. The dose rate is currently set at 25% of maximum capacity.
- 4.) Mix, flocculation, and sedimentation: The feed water then flows into two 90 kL basins in parallel. The basins are not equipped with mixers which assist in floc formation and rely on gravity for primary floc removal. The residuals accumulated in the basins are drained into a clearwell and are disposed of on-site.
- 5.) Filtration: Granular sand filters remove the smaller flocs through two vessels in series. The first vessel uses a coarser media than the second. The vessels are backwashed in 12-hour intervals, but the design backwashing schedule was originally 15 days.
- 6.) Total Organic Carbon abatement: A single granular activated carbon (GAC) vessel removes any remaining organic carbon content from the water.
- 7.) Disinfection: A peristaltic pump injects sodium hypochlorite for bacteriological inactivation.
 - a. It has been mentioned that the efficiency of the WTP's chlorination system is questionable, possibly due to the high pH of the water coming in to the WTP.

At the time of WEFTA's initial visit in July 2017, none of the other sources had any kind of treatment or disinfection. However, at the time of WEFTA's second visit in November 2017, a representative from WEF SUPER AGUA was installing a Gutwasser chlorination test-unit on the downstream side of where the Sauce Pozo connects to the discharge pipe of the Cementerio

Pozo. The representative also had plans to install Kobras test-units downstream of the Chorrillos tomas and at the Tambillo Tanque. These units were being installed pro-bono, and were to serve as test-units prior to the Cooperative's decision if they wanted to purchase these, or similar, chlorination units. Both of the kinds of test-units use organic Trichloro tablets, and do not require electricity in order to operate. They are summarized below:

Tricloro Dispensing Unit	Design maximum flow rate	Cost
Gutwasser	20 L/s	28,000-Bs (\$4000)
Kobras	2 L/s	5,000-Bs (~\$715)

Further research into the type and make of chlorination equipment should be done by the Cooperative before final installation in the Samaipata system.

It has been suggested in the past that the other sources be piped to the WTP, but it is not recommended by WEFTA that the Chorrillos or Tambillo tomas be connected to the WTP, since the WTP is lower in elevation than the existing Chorrillos rompe de presion (pressure breaker box) and proposed future Chorrillos storage tank, and the existing Tambillo Tanque. Thus, some of the higher elevation homes currently served by these sources may not be sufficiently supplied or have acceptable pressures if the sources were piped to the WTP.

PRIORITIES IDENTIFIED

At the time of the initial visit to Samaipata by WEFTA in July 2017, the Cooperative's Committees placed their priority in the following order:

- 1.) Potable water service: Currently the water system is not potable since it contains a high amount of total coliform and fecal coliform. It is a top priority of the Cooperative to provide potable water service to all "socios" (members) of the Cooperative.
- 2.) Water supply and storage: During the peak seasons, water service is sometimes not available at all connections. This may be due to lack of sufficient water supply and storage, or just lack of efficient usage of the existing supply and storage.
- 3.) Wastewater Improvements: The wastewater holding lagoons are unlined, near full, and discharge directly to the river. The discharge contaminates the river for downstream users. Although this practice is typical for Bolivia, it is out of compliance by environmental regulations.

Asset Mapping: It was recognized by the Cooperative that prior to any major improvements in the above-stated priorities, an accurate, current map of the existing system is needed. Locations of valves, meters, and other control systems were not mapped out prior to WEFTA's visits, and knowledge was only institutionally contained by a few people, which are close to retirement age. If the engineer or operators were to leave the Cooperative, acquiring the location of these assets would be difficult in most cases if not impossible.

Thus, Asset Mapping was begun during WEFTA's second visit to Samaipata, and critical parts of the system were located and marked by a high-accuracy Trimble GPS and an ArcGIS phone app. The new Samaipata ingeniera, Johana, was also trained in Asset Mapping during the time of WEFTA's second visit, and will continue and finish the in-field mapping of the entire system. This data is being processed into Google Earth and GIS. An initial map of the Samaipata system is provided in Appendix C.

ISSUES IDENTIFIED

In addition to the previously stated priorities of the Cooperative, unique issues of the Samaipata water system were identified by WEFTA, and include the following:

- The Carretera pozo pH (8.57) is high, which results in a high pH at the WTP (8.4). This may be a contributing factor to the reported low efficiency of the existing chlorination system at the WTP.
- There is currently no tanque between the Chorrillos tomas and distribution system. It is usually considered best-practice in water distribution systems to have a tanque to serve as a buffer between a source and the distribution system, as well as to provide storage capacity in case the source needs to be taken offline. Additionally, chlorination systems are usually installed immediately upstream of a tanque to provide the required contact time for chlorine to have optimal effectiveness.
- There are user connections between the Cementerio Pozo (which is also the Sauce Pozo's point of connection to the distribution system) and the Cancho 8 Tanque. This may limit or otherwise deter the required contact time of the water supplying those homes.
 - This assumes chlorination is installed immediately downstream of where the Cementerio Pozo and Sauce Pozo merge and connect to the distribution system, which is recommended else the homes between the Pozos and Cancho 8 tanque would not receive any means of disinfection unless a new tank be installed at a higher elevation, or chlorination at the point of use is used.
 - If there are private tanques at each user's homes, this could provide sufficient means of chlorine contact time. The presence of tanques at each home should be verified by the Cooperative.
- The Cementerio Pozo has a secondary transmission line that branches off the discharge line immediately downstream of the pozo's pump, and pumps directly to higher elevation homes during the night. There is no storage tanque on the line, though there may be private tanques at each user's home, which may likewise provide sufficient chlorine contact time. The presence of tanques at each home should be verified by the Cooperative.
- The Pozo de la Sauce likewise has a secondary transmission line that branches off the discharge line immediately downstream of the pozo's pump, and pumps directly to higher elevation homes (different homes than those pumped to by the Cementerio Pozo). There is no storage tanque on the line, though there may be private tanques at each user's home, which may likewise provide sufficient chlorine contact time. The presence of tanques at each home should be verified by the Cooperative.
- The northeast area of the system which encompasses the barrios of Villa Merced and Castilla, is served primarily by Tambillo, and is essentially separated from the rest of the system due to a valve on the 2" mainline that connects the mainline of this portion of the central system, and is currently kept closed. However, there are approximately 45 – 50 homes in this area of Samaipata that are serviced off the 8" transmission line from the El Fuerte tomas to the WTP. There is currently no way to provide disinfection for these homes without new connections, or point of use disinfection.

ANALYSIS

One of the Cooperative's proposed improvements that WEFTA analyzed during its two visits to Samaipata was to create isolated sectors of the system that are solely supplied by one or two individual sources, and then work on making the system potable one sector at a time. This sectoring of the system would be done by determining the existing 'service zones' of the system (which parts of the system are served by which sources), and then determining which existing isolation valves should be shut, or if new isolation valves are needed. This was the primary purpose of WEFTA's second visit and the asset mapping of the system.

During WEFTA's second visit to Samaipata, in November 2017, it was noted that an existing 2" mainline valve can, and currently is, essentially creating two sectors of the system – the northeast portion primarily serviced by Tambillo (though there are ~45 – 50 homes in that geographic area that are not served by Tambillo, and would require reconnection to a chlorinated portion of the system), and the central portion primarily serviced by the treated water from the Sotopollerudo WTP, the combined Cementerio and Sauce Pozos, and the Chorrillos tomas. A map of the approximated service zones and existing sectors of the system is provided in Appendix D. It was also determined that further sectoring of the central region of the system is possible (ie. an area served solely by Chorrillos, by the WTP, and the pozos), though it may require the installation of several new isolation valves. However, further sectoring of the central part of the system is not WEFTA's recommended long-term solution for the following primary reasons:

- Potential supply/demand issues: further analysis would be required if to ensure that the sources serving each sector are sufficient.
- Potential pressure issues: the system's pressures may increase or decrease after further sectoring, which could be problematic for the existing pipes, and house pressures.
- Potential differences in the water quality in the various sectors based on source quality.
 - This may prove to be an additional area of complaint by the community. WEFTA thus recommends keeping the system supplied by the current different sources and intermixed so as not to change the overall quality dispersion.

Instead, it is the recommendation of WEFTA to use the two existing, and currently-used, sectors, and focus on making each potable as soon as funding permits. The ultimate goal is that both sectors be made potable, and thus the isolation valves that separates them could be opened if needed, which is how the system is currently operated. In the future, the ~45 – 50 homes within the northeast area that are connected to the untreated 8" transmission line from El Fuerte to the WTP would ideally be reconnected to the potable system. However, depending on location of the homes, the resulting service pressures after reconnection, and the cost of reconnections, it may not be feasible for all homes to be made potable.

Further recommendations, and proposed next steps are given in the following section.

RECOMMENDATIONS

Immediate Priorities:

- I. Finish system mapping:
 - a. This can be done concurrently with the other immediate priorities based on availability of the Cooperative's staff. Certain members of the Cooperative's staff now know the process, and are not dependent on WEFTA to collect the rest of the GPS data required to finish the system asset mapping. WEFTA will continue to be responsibility for organizing the GPS data in Google Earth and/or GIS. When the mapping of the existing system is done, WEFTA will deliver the files to the Cooperative for further manual-updates as the system expands.

- II. Make Water Distribution System Potable:
(A map of potability recommendations, with all Phases shown, is provided in Appendix E)
 - a. Phase 1: The northeast sector served by Tambillo
 1. A chlorination system should be added immediately upstream of the existing Tambillo Tanque in order to make the northeast sector served by Tambillo potable.
 - b. Phase 2: The central sector served by Chorrillos, WTP, Cementerio and Sauce Pozos
 1. Construct a new tanque for the Chorrillos tomas to serve as additional storage, a buffer between the source and system, and a point of injection for chlorine.
 - i. Note: Should be constructed at a site as close to the same elevation as the existing Chorrillos rompe de presion (1748-m) as possible to not increase pressures in the distribution system significantly.
 2. Chlorination systems should be added immediately-upstream of the proposed new Chorrillos Tanque, and immediately-downstream of where the Sauce Pozo merges with the discharge pipe of the Cementerio Pozo in order to make the water from these sources potable.
 - i. Note: chlorination at the location immediately-downstream of where the pozos merge will disinfect the water from both wells at this location and the line that goes from the Cementerio Pozo to higher elevation homes. This will not chlorinate the water that is conveyed directly from Pozo Sauce to higher elevation homes, however at this time, water quality reports show no Coliform in the Pozo Sauce water, so no direct treatment is needed. This pozo should continue to be monitored in the future, and if Coliform shows up in the results, chlorination at the pozo should be added upstream of any distribution into the system, including the individual pipeline to higher elevation homes.
 - ii. Note: the homes between the Cementerio Pozo and the Cancho 8 Tanque, and the higher elevation homes served by the Cementerio Pozo's secondary transmission line that branches off the discharge line immediately downstream of the pozo's pump, should be checked as soon as possible by the Cooperative to verify they each have a private tanques so that chlorine contact time may be increased. After Phase 2 chlorination is implemented, some of these homes should have water quality tests taken at the faucet to ensure that no coliforms are present, and that residual chlorine is within regulation standards (between 0.2 – 1.0 ppm).

3. Increase the efficiency of the WTP's chlorination system:
 - i. Further water quality testing should be done immediately downstream of the Sotopollerudo storage tank to verify the report that the existing chlorination at the WTP is inefficient. The claim will be true if there are still coliforms present in the water, or if the residual chlorine is relatively low and therefore not high enough to provide residual chlorine at homes within regulation standards (between 0.2 – 1.0 ppm).
 - ii. If this is the case, it is possible that a different coagulant (such as Ferric Chloride) can be tried in the flocculation/ coagulation process (which is currently using Alum) that may lower the water's pH, which may help increase the efficiency of the chlorination process. Ferric Chloride is a coagulant known to lower the pH of the water, and may be tried if it is available, and depending on the type of sand media used in the filtration processes at the WTP.
 1. The type of sand media used in in the filtration processes at the WTP should be sent to WEFTA to determine if Ferric Chloride is compatible.
 2. The availability and cost of Ferric Chloride should be checked by the Cooperative.
 3. The Cooperative should check to see if APEP is still the Owner of the WTP, and therefore should be responsible for ensuring it works effectively.
 - c. Phase 3: The homes connected directly to the El Fuerte transmission line
 1. The homes that are directly tapped onto the transmission line between the El Fuerte tomas and the WTP should be reconnected, where possible, to a treated waterline such as downstream of the Tambillo Tanque (after Phase 1 implementation) in order to make them potable.
 - i. Note: If homes cannot be reconnected to the Tambillo line conveniently, other options should be researched, but it may be possible that some of these homes may not be feasible to make potable.
- III. Improve existing source quality:
- a. Ensure proper protection from external contamination at all points of exposure of water to the environment, including all rompe de presion (pressure break) chambers, tanques, and tomas/intake structures.
 - i. Note the Chorrillos rompe de presion has a new lid on it per WEFTA's recommendation at the time of the initial visit in July 2017.
 - b. Chorrillos Springs Improvements:
 1. The filtration tank is only covered with a geotextile mesh which has holes, at the time of inspection leaves and spiders were found in the waters. WEFTA recommends that a covering is constructed which effectively covers the entire filtration tank.
 2. Chorrillos Spring 4 should have a screen or mesh covering which prevents organic matter from falling into the spring
 3. Chorrillos Spring 5 should have a screen or mesh covering the catchment basin which prevents organic matter from falling into the spring and prevents people from bathing in the water.
 4. Lock should be installed on the vault which joins the flow of spring 4 and 5.

Long-Term Plans

- I. Water quality testing at key points:
 - a. To ensure disinfection is being effective (ie. no coliforms present, and residual chlorine at points of use within the regulation standards). This should be done especially at:
 1. The Sauce Pozo – currently, water quality reports show no Coliform in this source, but it should continue to be monitored in the future, and if coliforms become present, chlorination at the pozo should be added upstream of any distribution into the system, including the individual pipeline to higher elevation homes.
 2. The homes between the Cementerio Pozo and the Cancho 8 Tanque, and the higher elevation homes served by the Cementerio Pozo's secondary transmission line that branches off the discharge line immediately downstream of the pozo's pump. Not all homes require testing at once, but should be alternated with each test.
 3. Homes that are a long distance from the points of chlorination.
- II. Water supply improvements:
 - a. For all future additional tomas:
 1. Include a Tanque between the toma(s) and point of entrance into the distribution system, and chlorinate the water immediately upstream of this tanque.
 2. Do not allow homes to be connected between the toma and point of disinfection (tanques).
 3. Make sure to sufficiently protect all areas of exposure.
 - b. If needed, construct filtration systems at the toma-intakes or storage tanques if turbidity during the rainy season proves to be too much for consumptive preference, or interferes with proper chlorination
 - c. If needed, replace existing pipe in the system to increase water quality.
 1. The Cooperative is concerned about the quality of the pipe that composes the 5.8-mile-long 8" cast iron transmission line from El Fuerte to the WTP, and think that it may be contributing to poor water quality due to material build-up on pipe walls. This concern should be reassessed after the potability recommendations have been implemented.
 - d. Possibly take the other Chorrillos Toma that had especially high coliform offline in the future due to high total coliform if operation of this toma proves to increase the amount of chlorine (and therefore cost) used at the Chorrillos Tanque.
 - i. Note: per WEFTA's recommendation at the time of the initial visit in July 2017, one of the Chorrillos tomas has already been taken offline.
 - e. Possibly take the Carretera pozo offline in the future due to high pH, which increases the pH at the WTP too. There is also a bad perception of the quality of the Carretera pozo water by the community.
- III. Water storage optimization:
 - a. WEFTA thinks it may be that the storage throughout the Samaipata system is being utilized inefficiently, with the water from the Sotopollerudo tanque discharging into the system quickly due to its large discharge piping (two 4" pipes that combine into one 8" pipe before going into the distribution system), and its high elevation (currently the highest-elevation tanque that serves the central region of the system). Additionally, it is thought that the Tambillo, and Cancho 8 tanques may be overflowing frequently due to

too much supply coming in relative to the demand going out.

1. Further analysis should be conducted to analyze how effectively each storage tanque is being used relative to the demand it supplies for.
2. Float valves or other controls may be required in order to better regulate flow coming into the tanques, namely, the Cancho 8 tanque which overflows regularly.
3. The overall consideration should be whether the storage tanques have effective utilization based on their outlet designs and the interconnection of all the sources in one system.

IV. Water treatment plant improvements:

a. Operational:

1. The WTP solid residuals are currently being disposed of on-site. WEFTA recommends that the residuals be dewatered and hauled off-site at a designated area that is easy to access. The location should be able to contain 20 years-worth of residuals. Typically, the solids are dewatered using a filter or belt press and hauled to a landfill.

b. Optimization:

1. Typically, after coagulants are injected, a rapid mix process is used to disperse it uniformly through the solution. This can be achieved through installation of an inline static mixer or a pad placed at the outfall which splashes the solution prior to entering the sedimentation basin. This may reduce the amount of coagulant that has to be injected.
2. Installation of slow paddle mixers in the sedimentation basins will increase floc sizes which will cause more of the flocs to drop out in the sedimentation process and reduce the amount of flocs that are removed in the filtration process. Reducing the floc load on the sand filters will increase the amount of time that backwashes would need to be initiated and increase water efficiency. In addition, improving coagulant efficiency will increase the amount of organic removal in the sedimentation and filtration processes which decrease the removal load on the GAC filter, increasing the media life.

V. Wastewater system improvements:

1. Installation of an additional cell with geotextile liner and floating aerators.

VI. Complete system replacement

1. It is the observation of WEFTA that the Samaipata has been continually added onto as the community has grown, and not all parts of it are coherent. It is the advisement of WEFTA that at some point in the future, especially if Samaipata's population grows significantly, that the water system should be completely replaced in order for it to continue functioning satisfactorily into the long-range future.

CONCLUDING REMARKS

In closing, as the Cooperative pursues potability for the Samaipata water system, the following messages have been recommended to be communicated by the Cooperative to its members:

1. Potability will take time to establish, and may include some time for trial and error while chlorine injection concentrations are being established.
2. The cost per cubic-meter of water will increase.
3. The water will taste different.



APPENDICES

- A. Project Location Map
- B. Water Quality Testing Results
- C. Map of Samaipata System
- D. Map of Approximated Service Zones
- E. Map of Potability Recommendations

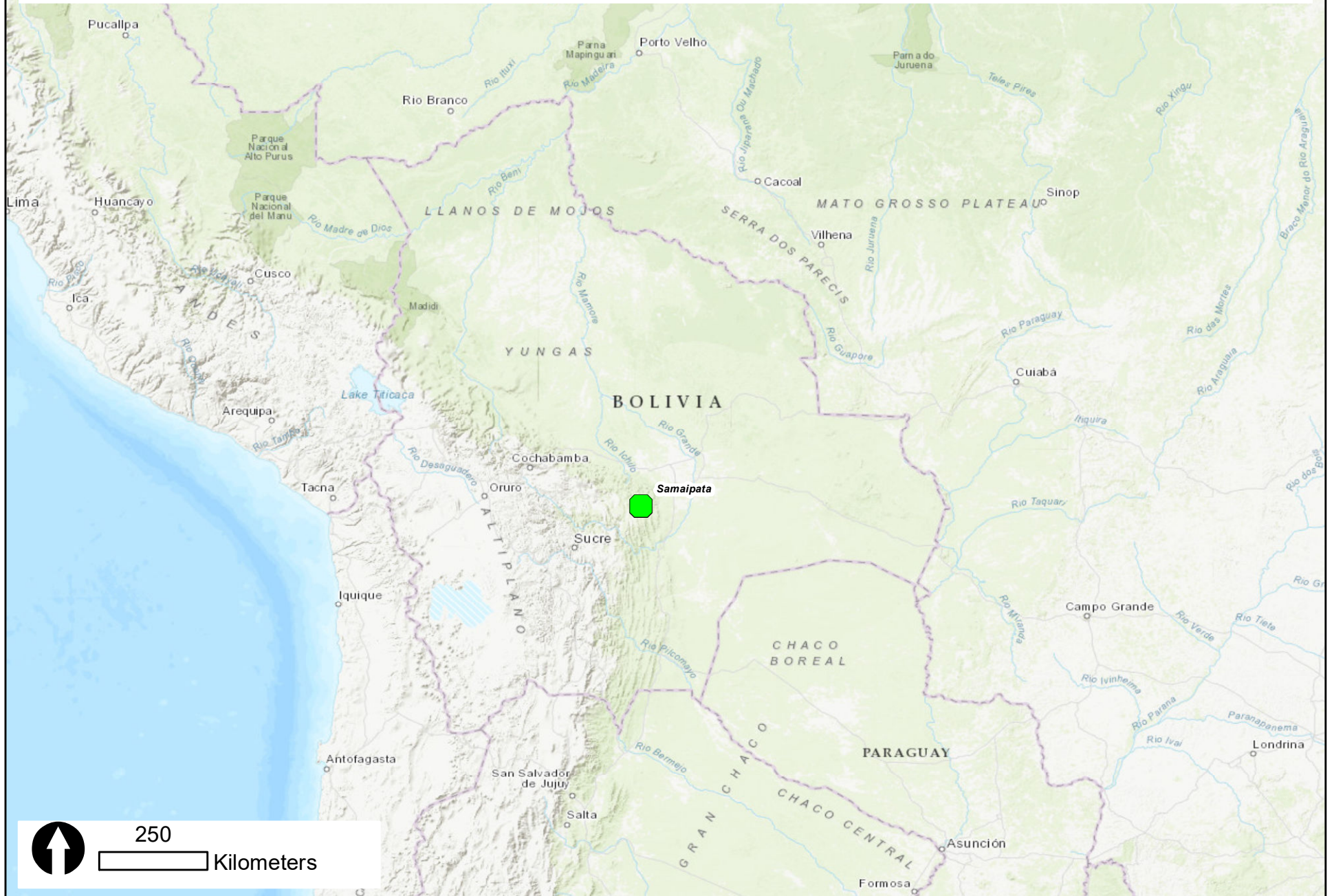


Appendix A

Project Location Map



Project Location



Appendix B

Water Quality Testing Results

1. Tanque Soto Pollerudo
2. Tanque El Tambillo
3. Tanque 14 de Septiembre
4. Tanque Cancha 8
5. Fuente El Chorrillo
6. Toma El Fuerte
7. Toma El Tambillo
8. Grifo Entrada Planta de Tratamiento
9. Grifo de la Red de la Cooperativa Florida Ltda.
10. Pozo Estadio
11. Pozo El Sauce
12. Pozo La Carretera
13. Sistema El Chorrillo Toma 1
14. Sistema El Chorrillo Toma 2
15. Sistema El Chorrillo Toma 3
16. Sistema El Chorrillo Toma 4
17. Sistema El Chorrillo Toma 5
18. Sistema El Chorrillo Toma 6
19. Red de Distribucion de la Cooperativa Florida Ltda.
20. Pozo Carretera
21. Salida de la Planta de Tratamiento



SAGUAPAC	REPORTE DE ANALISIS BACTERIOLOGICO Y FISICO-QUIMICO	Rep N° 131 /2017
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1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Tanque "Soto Pollerudo"
Responsable del muestreo	Personal de la Cooperativa Florida Ltda.
Fecha y hora del muestreo	12-7-2017 06:10
Fecha del Análisis	12-7-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	9	< 1	Filtro de Mem. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	NSD	< 1	Filtro de Mem. (9222 D)	1
Pseudomonas	UFC/100 ml	---	< 1	Filtro de Mem. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	---	500	Placa Fluida (9216-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	24,9	---	Termómetro	
pH		8,07	6,5 a 9,0	Potenciométrico (4500-H ⁺ B)	1,0 a 13,0
Color	UCV	---	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	2,7	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	---	200	Titulación con EDTA (3500-Ca-D)	1
Magnesio	mg/l	---	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	---	0,3	Colorimétrico (3500-Fe D)	0,01
Manganeso	mg/l	---	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₂ /Ca	mg/l	---	500	Titulación con EDTA (2340-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ /Ca	mg/l	---	---	Titulación (2320-B)	1
Alcalinidad total c. CO ₂ /Ca	mg/l	---	370	Titulación (2320-B)	1
Cloruros c. Cl	mg/l	---	250	Titulación (4900-Cl C)	0,5
Sulfatos c. SO ₄	mg/l	---	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	---	1,5	Colorimétrico (4500-F D)	0,1
Nitratos c. NO ₃	mg/l	---	45	Colorimétrico (4500-NO ₃ E)	0,05
Nitritos c. NO ₂	mg/l	---	0,1	Colorimétrico (4500-NO ₂ B)	0,005
Conductancia específica	µmhos/cm	619	1500	Conductivímetro (2610-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	---	---	Cálculo (4500-CO ₂ D)	
Sólidos totales disueltos a 180 °C	mg/l	---	1000	Gravimetría (2540 C)	10
Índice de Langelier		---	-0,5 a +0,5	Cálculo (2330 B)	

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	NSD	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	---	---	Electrodo de Membrana (4500-O G)	0,1
Amoniaco c. NH ₃	mg/l	---	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	---	---	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	---	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	---	0,01	Abs. Atómica (3500-As B)	0,003
Cadmio	mg/l	---	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	---	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	---	---	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	---	0,05	Abs. Atómica (3500-Cr B)	0,05
Plomo	mg/l	---	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	---	---	Abs. Atómica (3500-K B)	0,1
Silice c. SiO ₂	mg/l	---	---	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	---	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	---	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	---	0,001	Abs. Atómica (3500-Hg B)	0,002
Niquel	mg/l	---	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	---	---	Colorimetría (4800-S D)	0,01
Cobalto	mg/l	---	---	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	---	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	---	0,30	Colorimetría (10061-Hach)	0,05

3.- OBSERVACIONES:

UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.

* Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.


 JEFE SECCION CONTROL DE CALIDAD AGUA POTABLE
 SAGUAPAC

SAGUAPAC	REPORTE DE ANALISIS BACTERIOLOGICO Y FISICO-QUIMICO	Rep N° 134 /2017
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1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Tanque "El Tambillo"
Responsable del muestreo	Personal de la Cooperativa Florida Ltda.
Fecha y hora del muestreo	12-7-2017 07:30
Fecha del Análisis	12-7-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	23	< 1	Filtro de Memb. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	NSD	< 1	Filtro de Memb. (9222 D)	1
Pseudomonas	UFC/100 ml	---	< 1	Filtro de Memb. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	---	500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	25,1	---	Termómetro	---
pH	---	7,35	6,5 a 9,0	Potenciómetro (4500-H ⁺ B)	1,0 a 13,0
Color	UCV	---	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	1,6	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	---	200	Titración con EDTA (3500-Ca-D)	1
Magnesio	mg/l	---	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	---	0,3	Colorimétrico (3500-Fe D)	0,01
Manganeso	mg/l	---	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₂ Ca	mg/l	---	500	Titración con EDTA (2940-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ Ca	mg/l	---	---	Titración (2320-B)	1
Alcalinidad total c. CO ₂ Ca	mg/l	---	370	Titración (2320-B)	1
Cloruros c. Cl	mg/l	---	250	Titración (4500-Cl C)	0,5
Sulfatos c. SO ₄	mg/l	---	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	---	1,5	Colorimétrico (4500-F D)	0,1
Nitratos c. NO ₃	mg/l	---	45	Colorimétrico (4500-NO ₃ E)	0,05
Nitritos c. NO ₂	mg/l	---	0,1	Colorimétrico (4500-NO ₂ B)	0,005
Conductancia específica	µmhos/cm	86	1500	Conductivímetro (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	---	---	Cálculo (4500-CO ₂ D)	---
Sólidos totales disueltos a 180 °C	mg/l	---	1000	Gravimetría (2540 C)	10
Índice de Langelier	---	---	-0,5 a +0,5	Cálculo (2330 B)	---

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	NSD	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	---	---	Electrodo de Membrana (4800-O G)	0,1
Amoníaco c. NH ₃	mg/l	---	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	---	---	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	---	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	---	0,01	Abs. Atómica (3500-As B)	0,003
Cadmio	mg/l	---	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	---	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	---	---	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	---	0,05	Abs. Atómica (3500-Cr B)	0,05
Plomo	mg/l	---	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	---	---	Abs. Atómica (3500-K B)	0,1
Silice c. SiO ₂	mg/l	---	---	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	---	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	---	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	---	0,001	Abs. Atómica (3500-Hg B)	0,002
Niquel	mg/l	---	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	---	---	Curometría (4500-S D)	0,01
Cobalto	mg/l	---	---	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	---	0,10	Colorimétrica (3500-Al D)	0,02
Boro	mg/l	---	0,30	Colorimétrica (10061-Hach)	0,05

3.- OBSERVACIONES:

UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.
 * Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.


 Ing. Elias Avila Castellón
 JEFE SECCION CONTROL DE CALIDAD AGUA POTABLE
 "SAGUAPAC"

SAGUAPAC	REPORTE DE ANALISIS BACTERIOLOGICO Y FISICO-QUIMICO	Rep N° 133 /2017
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1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Tanque "14 de Septiembre"
Responsable del muestreo	Personal de la Cooperativa Florida Ltda.
Fecha y hora del muestreo	12-7-2017 07:00
Fecha del Análisis	12-7-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	15	< 1	Filtro de Memb. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	4	< 1	Filtro de Memb. (9222 D)	1
Pseudomonas	UFC/100 ml	---	< 1	Filtro de Memb. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	---	500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	25,0	---	Termómetro	
pH		7,40	6,5 a 9,0	Potenciométrico (4500-H ⁺ B)	1,0 a 13,0
Color	UCV	---	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	2,9	5	Nefelómetro (2130 B)	0,3
Calcio	mg/l	---	200	Titulación con EDTA (3500-Ca-D)	1
Magnesio	mg/l	---	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	---	0,3	Colorimétrico (3500-Fe D)	0,01
Manganeso	mg/l	---	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₂ Ca	mg/l	---	500	Titulación con EDTA (2940-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ Ca	mg/l	---	---	Titulación (2320-B)	1
Alcalinidad total c. CO ₂ Ca	mg/l	---	370	Titulación (2320-B)	1
Cloruros c. Cl	mg/l	---	250	Titulación (4500-Cl C)	0,5
Sulfatos c. SO ₄	mg/l	---	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	---	1,5	Colorimétrico (4500-F D)	0,1
Nitratos c. NO ₃	mg/l	---	45	Colorimétrico (4500-NO ₃ E)	0,05
Nitritos c. NO ₂	mg/l	---	0,1	Colorimétrico (4500-NO ₂ B)	0,005
Conductancia específica	µmhos/cm	74	1500	Conductivímetro (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	---	---	Cálculo (4500-CO ₂ D)	
Sólidos totales disueltos a 180 °C	mg/l	---	1000	Gravimetría (2540 C)	10
Índice de Langelier		---	-0,5 a +0,5	Cálculo (2330 B)	

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	NSD	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	---	---	Electrodo de Membrana (4500-O G)	0,1
Amoniaco c. NH ₃	mg/l	---	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	---	---	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	---	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	---	0,01	Abs. Atómica (3500-As B)	0,003
Cadmio	mg/l	---	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	---	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	---	---	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	---	0,05	Abs. Atómica (3500-Cr B)	0,05
Piomo	mg/l	---	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	---	---	Abs. Atómica (3500-K B)	0,1
Silice c. SiO ₂	mg/l	---	---	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	---	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	---	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	---	0,001	Abs. Atómica (3500-Hg B)	0,002
Niquel	mg/l	---	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	---	---	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	---	---	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	---	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	---	0,30	Colorimetría (10061-Hach)	0,05

3.- OBSERVACIONES:

UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.
 * Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.


 José Efraim Gullis Castellón
 JEFE SECCION CONTROL DE CALIDAD AGUA POTABLE
 "SAGUAPAC"

1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Tanque "Cancha 6"
Responsable del muestreo	Personal de la Cooperativa Florida Ltda
Fecha y hora del muestreo	12-7-2017 06:30
Fecha del Análisis	12-7-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	23	< 1	Filtro de Membr. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	4	< 1	Filtro de Membr. (9222 D)	1
Pseudomonas	UFC/100 ml	---	< 1	Filtro de Membr. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	---	500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	25,0	---	Termómetro	
pH		7,35	6,5 a 9,0	Potenciométrico (4500-H ⁺ B)	1,0 a 13,0
Color	UCV	---	15	Espectrofotómetro (2120 C)	5
Turbiedad	NTU	1,1	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	---	200	Titulación con EDTA (3500-Ca-D)	1
Magnesio	mg/l	---	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	---	0,3	Colorimétrico (3500-Fe D)	0,01
Manganeso	mg/l	---	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₂ Ca	mg/l	---	500	Titulación con EDTA (2340-C)	1
Alcalinidad a la fenoftaleína c. CO ₂ Ca	mg/l	---	---	Titulación (2320-B)	1
Alcalinidad total c. CO ₂ Ca	mg/l	---	370	Titulación (2320-B)	1
Cloruros c. Cl	mg/l	---	250	Titulación (4500-Cl ⁻ C)	0,5
Sulfatos c. SO ₄	mg/l	---	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	---	1,5	Colorimétrico (4500-F D)	0,1
Nitratos c. NO ₃	mg/l	---	45	Colorimétrico (4500-NO ₃ E)	0,05
Nitritos c. NO ₂	mg/l	---	0,1	Colorimétrico (4500-NO ₂ B)	0,005
Conductancia específica	µmhos/cm	491	1500	Conductímetro (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	---	---	Cálculo (4500-CO ₂ D)	
Sólidos totales disueltos a 180 °C	mg/l	---	1000	Gravimetría (2540 C)	10
Índice de Langelier		---	-0,5 a +0,5	Cálculo (2330 B)	

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	NSD	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	---	---	Electrodo de Membrana (4500-O G)	0,1
Amoníaco c. NH ₃	mg/l	---	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	---	---	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	---	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	---	0,01	Abs. Atómica (3500-As B)	0,003
Cadmio	mg/l	---	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	---	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	---	---	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	---	0,05	Abs. Atómica (3500-Cr B)	0,05
Plomo	mg/l	---	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	---	---	Abs. Atómica (3000-K B)	0,1
Silice c. SiO ₂	mg/l	---	---	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	---	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	---	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	---	0,001	Abs. Atómica (3500-Hg B)	0,002
Níquel	mg/l	---	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	---	---	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	---	---	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	---	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	---	0,30	Colorimetría (10061-Hach)	0,05

3.- OBSERVACIONES:

UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.

* Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.

SAGUAPAC
 SERVICIO DE AGUA POTABLE
 DEPARTAMENTO DE CONTROL DE CALIDAD DE AGUA POTABLE
 SAGUAPAC

SAGUAPAC	REPORTE DE ANALISIS BACTERIOLOGICO Y FISICO-QUIMICO	Rep N° 125 /2017
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1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Fuente "El Chorrillo"
Responsable del muestreo	Personal de la Cooperativa Florida Ltda.
Fecha y hora del muestreo	12-7-2017 06:42
Fecha del Análisis	12-7-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	9	< 1	Filtro de Memb. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	NSD	< 1	Filtro de Memb. (9222 D)	1
Pseudomonas	UFC/100 ml	---	< 1	Filtro de Memb. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	---	500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	24,6	---	Termómetro	
pH		7,10	6,5 a 9,0	Potenciométrico (4500-H' B)	1,0 a 13,0
Color	UCV	NSD	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	0,8	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	7	200	Titulación con EDTA (3500-Ca-D)	1
Magnesio	mg/l	2,9	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	NSD	0,3	Colorimétrico (3500-Fe D)	0,01
Manganeso	mg/l	NSD	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₂ /Ca	mg/l	30	500	Titulación con EDTA (2340-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ /Ca	mg/l	NSD	---	Titulación (2320-B)	1
Alcalinidad total c. CO ₂ /Ca	mg/l	48	370	Titulación (2320-B)	1
Cloruros c. Cl	mg/l	0,5	250	Titulación (4500-Cl' C)	0,5
Sulfatos c. SO ₄	mg/l	NSD	400	Turbidimétrico (4500-SO ₄ ' E)	4
Fluoruros c. F	mg/l	---	1,5	Colorimétrico (4500-F D)	0,1
Nitratos c. NO ₃	mg/l	0,9	45	Colorimétrico (4500-NO ₃ ' E)	0,05
Nitritos c. NO ₂	mg/l	NSD	0,1	Colorimétrico (4500-NO ₂ ' B)	0,005
Conductancia específica	µmhos/cm	97	1500	Conductivímetro (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	7,6	---	Cálculo (4500-CO ₂ ' D)	
Sólidos totales disueltos a 180 °C	mg/l	56	1000	Gravimetría (2540 C)	10
Índice de Langelier		-1,70	-0,5 a +0,5	Cálculo (2330 B)	

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	---	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	---	---	Electrodo de Membrana (4500-O G)	0,1
Amoniaco c. NH ₃	mg/l	NSD	0,5	Colorimétrico (4500-NH ₃ ' C)	0,04
Fosfatos c. PO ₄	mg/l	---	---	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	---	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	---	0,01	Abs. Atómica (3500-Ar B)	0,003
Cadmio	mg/l	---	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	---	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	---	---	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	---	0,05	Abs. Atómica (3500-Cr B)	0,05
Plomo	mg/l	---	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	---	---	Abs. Atómica (3500-K B)	0,1
Silice c. SiO ₂	mg/l	---	---	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	9,9	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	---	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	---	0,001	Abs. Atómica (3500-Hg B)	0,002
Níquel	mg/l	---	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	---	---	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	---	---	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	---	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	---	0,30	Colorimetría (10061-Hach)	0,05

3.- OBSERVACIONES:

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UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.

* Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.


 Ing. Elias Pablo Castellón
 JEFE SECCION CONTROL DE CALIDAD AGUA POTABLE
 "SAGUAPAC"

1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Toma "El Fuerte"
Responsable del muestreo	Personal de la Cooperativa Florida Ltda.
Fecha y hora del muestreo	12-7-2017 07:10
Fecha del Análisis	12-7-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	240	< 1	Filtro de Memb. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	9	< 1	Filtro de Memb. (9222 D)	1
Pseudomonas	UFC/100 ml		< 1	Filtro de Memb. (9213 E)	1
Bacterias mesófilas totales	UFC/ml		500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	25,1	—	Termómetro	
pH		7,21	6,5 a 9,0	Potenciométrico (4500-H ⁺ B)	1,0 a 13,0
Color	UCV	24	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	2,4	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	4	200	Titulación con EDTA (3500-Ca-D)	1
Magnesio	mg/l	2,4	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	0,47	0,3	Colorimétrico (3500-Fe D)	0,01
Manganeso	mg/l	0,01	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₂ /Ca	mg/l	20	500	Titulación con EDTA (2340-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ /Ca	mg/l	NSD	—	Titulación (2320-B)	1
Alcalinidad total c. CO ₂ /Ca	mg/l	26	370	Titulación (2320-B)	1
Cloruros c. Cl	mg/l	0,5	250	Titulación (4500-Cl ⁻ C)	0,5
Sulfatos c. SO ₄	mg/l	NSD	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	—	1,5	Colorimétrico (4500-F ⁻ D)	0,1
Nitratos c. NO ₃	mg/l	NSD	45	Colorimétrico (4500-NO ₃ ⁻ E)	0,05
Nitritos c. NO ₂	mg/l	NSD	0,1	Colorimétrico (4500-NO ₂ ⁻ B)	0,005
Conductancia específica	µmhos/cm	50	1500	Conductivímetro (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	3,2	—	Cálculo (4500-CO ₂ D)	
Sólidos totales disueltos a 180 °C	mg/l	29	1000	Gravimetría (2540 C)	10
Índice de Langelier		-2,19	-0,5 a +0,5	Cálculo (2330 B)	

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	—	0,2 a 1,0	Colorimétrico (4500-Cl ⁻ G)	0,03
Oxígeno Disuelto	mg/l	—	—	Electrodo de Membrana (4500-O ₂ G)	0,1
Amoniaco c. NH ₃	mg/l	NSD	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	—	—	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	—	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	—	0,01	Abs. Atómica (3500-As B)	0,003
Cadmio	mg/l	—	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	—	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	—	—	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	—	0,05	Abs. Atómica (3500-Cr B)	0,05
Piomo	mg/l	—	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	—	—	Abs. Atómica (3500-K B)	0,1
Silice c. SiO ₂	mg/l	—	—	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	4,8	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	—	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	—	0,001	Abs. Atómica (3500-Hg B)	0,002
Níquel	mg/l	—	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	—	—	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	—	—	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	—	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	—	0,30	Colorimetría (10061-Hach)	0,05

3.- OBSERVACIONES:

UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.

* Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.

[Firma]
 Ing. Elías Ángel Castellón
 JEFE DE CONTROL DE CALIDAD AGUA POTABLE
 "SAGUAPAC"

1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Toma "El Tambillo"
Responsable del muestreo	Personal de la Cooperativa Florida Ltda.
Fecha y hora del muestreo	12-7-2017 06:30
Fecha del Análisis	12-7-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	75	< 1	Filtro de Memb. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	4	< 1	Filtro de Memb. (9222 D)	1
Pseudomonas	UFC/100 ml		< 1	Filtro de Memb. (9213 E)	1
Bacterias mesófilas totales	UFC/ml		500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	25,1	—	Termómetro	
pH		7,37	6,5 a 9,0	Potenciométrico (4500-H ⁺ B)	1,0 a 13,0
Color	UCV	6	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	1,6	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	6	200	Titulación con EDTA (3500-Ca-D)	1
Magnesio	mg/l	2,9	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	0,10	0,3	Colorimétrico (3500-Fe D)	0,01
Manganeso	mg/l	NSD	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₂ /Ca	mg/l	26	500	Titulación con EDTA (2340-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ /Ca	mg/l	NSD	—	Titulación (2320-B)	1
Alcalinidad total c. CO ₂ /Ca	mg/l	44	370	Titulación (2320-B)	1
Cloruros c. Cl	mg/l	0,5	250	Titulación (4500-Cl ⁻ C)	0,5
Sulfatos c. SO ₄	mg/l	NSD	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	—	1,5	Colorimétrico (4500-F ⁻ D)	0,1
Nitratos c. NO ₃	mg/l	NSD	45	Colorimétrico (4500-NO ₃ ⁻ E)	0,05
Nitritos c. NO ₂	mg/l	NSD	0,1	Colorimétrico (4500-NO ₂ ⁻ B)	0,005
Conductancia específica	µmhos/cm	85	1500	Conductivímetro (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	3,8	—	Cálculo (4500-CO ₂ D)	
Sólidos totales disueltos a 180 °C	mg/l	50	1000	Gravimetría (2540 C)	10
Índice de Langelier		-1,73	-0,5 a +0,5	Cálculo (2330 B)	

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	—	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	—	—	Electrodo de Membrana (4500-O G)	0,1
Amoníaco c. NH ₃	mg/l	NSD	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	—	—	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	—	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	—	0,01	Abs. Atómica (3500-As B)	0,003
Cadmio	mg/l	—	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	—	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	—	—	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	—	0,05	Abs. Atómica (3500-Cr B)	0,05
Plomo	mg/l	—	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	—	—	Abs. Atómica (3500-K B)	0,1
Silice c. SiO ₂	mg/l	—	—	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	9,1	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	—	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	—	0,001	Abs. Atómica (3500-Hg B)	0,002
Niquel	mg/l	—	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	—	—	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	—	—	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	—	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	—	0,30	Colorimetría (100E1-Hach)	0,05

3.- OBSERVACIONES:

UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.

* Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.


 Ing. Elio María Castellón
 JEFE SECCION CONTROL DE CALIDAD AGUA POTABLE
 "SAGUAPAC"

1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Grifo - entrada Planta de Tratamiento
Responsable del muestreo	Personal de la Cooperativa Florida Ltda.
Fecha y hora del muestreo	12-7-2017 06:00
Fecha del Análisis	12-7-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	4	< 1	Filtro de Memb. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	NSD	< 1	Filtro de Memb. (9222 D)	1
Pseudomonas	UFC/100 ml	---	< 1	Filtro de Memb. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	---	500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	24,9	---	Termómetro	---
pH		7,55	6,5 a 9,0	Potenciométrico (4500-H ⁺ B)	1,0 a 13,0
Color	UCV	9	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	1,7	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	6	200	Titulación con EDTA (3500-Ca-D)	1
Magnesio	mg/l	1,9	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	0,29	0,3	Colorimétrico (3500-Fe D)	0,01
Manganeso	mg/l	NSD	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₂ Ca	mg/l	22	500	Titulación con EDTA (2540-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ Ca	mg/l	NSD	---	Titulación (2320-B)	1
Alcalinidad total c. CO ₂ Ca	mg/l	116	370	Titulación (2320-B)	1
Cloruros c. Cl	mg/l	30,0	250	Titulación (4500-Cl ⁻ C)	0,5
Sulfatos c. SO ₄	mg/l	NSD	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	---	1,5	Colorimétrico (4500-F D)	0,1
Nitratos c. NO ₃	mg/l	0,5	45	Colorimétrico (4500-NO ₃ E)	0,05
Nitritos c. NO ₂	mg/l	NSD	0,1	Colorimétrico (4500-NO ₂ B)	0,005
Conductancia específica	µmhos/cm	320	1500	Conductivímetro (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	6,5	---	Cálculo (4500-CO ₂ D)	---
Sólidos totales disueltos a 180 °C	mg/l	186	1000	Gravimetría (2540 C)	10
Índice de Langelier		-1,15	-0,5 a +0,5	Cálculo (2330 B)	---

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	---	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	---	---	Electrodo de Membrana (4500-O G)	0,1
Amoníaco c. NH ₃	mg/l	NSD	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	---	---	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	---	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	---	0,01	Abs. Atómica (3500-As B)	0,003
Cadmio	mg/l	---	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	---	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	---	---	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	---	0,05	Abs. Atómica (3500-Cr B)	0,05
Piomo	mg/l	---	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	---	---	Abs. Atómica (3500-K B)	0,1
Silice c. SiO ₂	mg/l	---	---	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	81,5	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	---	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	---	0,001	Abs. Atómica (3500-Hg B)	0,002
Níquel	mg/l	---	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	---	---	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	---	---	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	---	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	---	0,30	Colorimetría (10061-Hach)	0,05

3.- OBSERVACIONES:

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UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.

* Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.


 JEFE SECCION CONTROL DE CALIDAD AGUA POTABLE
 "SAGUAPAC"

1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samsipata - Cooperativa Florida Ltda
Clase de fuente	Grifo de la Red de la Cooperativa Florida Ltda.
Responsable del muestreo	Personal de la Cooperativa Florida Ltda.
Fecha y hora del muestreo	12-7-2017 08:10
Fecha del Analisis	12-7-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	93	< 1	Filtro de Memb. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	9	< 1	Filtro de Memb. (9222 D)	1
Pseudomonas	UFC/100 ml	---	< 1	Filtro de Memb. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	---	500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	24,9	---	Termómetro	
pH		7,14	6,5 a 9,0	Potenciométrico (4500-H ⁺ B)	1,0 a 13,0
Color	UCV	---	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	1,0	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	---	200	Titulación con EDTA (3500-Ca-D)	1
Magnesio	mg/l	---	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	---	0,3	Colorimétrico (3500-Fe D)	0,01
Manganeso	mg/l	---	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₃ Ca	mg/l	---	500	Titulación con EDTA (2340-C)	1
Alcalinidad a la fenolftaleína c. CO ₃ Ca	mg/l	---	---	Titulación (2320-B)	1
Alcalinidad total c. CO ₃ Ca	mg/l	---	370	Titulación (2320-B)	1
Cloruros c. Cl	mg/l	---	250	Titulación (4500-Cl C)	0,5
Sulfatos c. SO ₄	mg/l	---	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	---	1,5	Colorimétrico (4500-F ⁻ D)	0,1
Nitratos c. NO ₃	mg/l	---	45	Colorimétrico (4500-NO ₃ E)	0,05
Nitritos c. NO ₂	mg/l	---	0,1	Colorimétrico (4500-NO ₂ B)	0,005
Conductancia específica	µmhos/cm	107	1500	Conductivímetro (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	---	---	Cálculo (4500-CO ₂ D)	
Sólidos totales disueltos a 180 °C	mg/l	---	1000	Gravimetría (2540 C)	10
Índice de Langelier		---	-0,5 a +0,5	Cálculo (2330 B)	

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	NSD	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	---	---	Electrodo de Membrana (4500-O G)	0,1
Amoniaco c. NH ₃	mg/l	---	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	---	---	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	---	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	---	0,01	Abs. Atómica (3500-As B)	0,003
Cadmio	mg/l	---	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	---	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	---	---	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	---	0,05	Abs. Atómica (3500-Cr B)	0,05
Piomo	mg/l	---	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	---	---	Abs. Atómica (3500-K B)	0,1
Sílice c. SiO ₂	mg/l	---	---	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	---	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	---	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	---	0,001	Abs. Atómica (3500-Hg B)	0,002
Niquel	mg/l	---	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	---	---	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	---	---	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	---	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	---	0,30	Colorimetría (100E1-Hach)	0,05

3.- OBSERVACIONES:

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UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.

* Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.


 SAGUAPAC
 CALIDAD AGUA POTABLE
 SAGUAPAC

1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Pozo "Estadio"
Responsable del muestreo	Personal de la Cooperativa Florida Ltda.
Fecha y hora del muestreo	12-7-2017 07:53
Fecha del Análisis	12-7-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	43	< 1	Filtro de Memb. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	4	< 1	Filtro de Memb. (9222 D)	1
Pseudomonas	UFC/100 ml	—	< 1	Filtro de Memb. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	—	500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	24,8	—	Termómetro	
pH		7,48	6,5 a 9,0	Potenciométrico (4500-H ⁺ B)	1,0 a 13,0
Color	UCV	NSD	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	1,3	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	19	200	Titulación con EDTA (3500-Ca-D)	1
Magnesio	mg/l	10,7	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	0,10	0,3	Colorimétrico (3500-Fe D)	0,01
Manganeso	mg/l	0,03	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₂ Ca	mg/l	92	500	Titulación con EDTA (2040-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ Ca	mg/l	NSD	—	Titulación (2320-B)	1
Alcalinidad total c. CO ₂ Ca	mg/l	226	370	Titulación (2320-B)	1
Cloruros c. Cl	mg/l	2,5	250	Titulación (4500-Cl ⁻ C)	0,5
Sulfatos c. SO ₄	mg/l	NSD	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	—	1,5	Colorimétrico (4500-F ⁻ D)	0,1
Nitratos c. NO ₃	mg/l	0,1	45	Colorimétrico (4500-NO ₃ ⁻ E)	0,05
Nitritos c. NO ₂	mg/l	NSD	0,1	Colorimétrico (4500-NO ₂ ⁻ B)	0,005
Conductancia específica	µmhos/cm	423	1500	Conductivímetro (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	15,0	—	Cálculo (4500-CO ₂ D)	
Sólidos totales disueltos a 180 °C	mg/l	245	1000	Gravimetría (2540 C)	10
Índice de Langelier		-0,32	-0,5 a +0,5	Cálculo (2330 B)	

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	---	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	---	---	Electrodo de Membrana (4500-O G)	0,1
Amoniaco c. NH ₃	mg/l	NSD	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	---	---	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	---	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	---	0,01	Abs. Atómica (3500-As B)	0,003
Cadmio	mg/l	---	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	---	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	---	---	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	---	0,05	Abs. Atómica (3500-Cr B)	0,05
Plomo	mg/l	---	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	---	---	Abs. Atómica (3500-K B)	0,1
Silice c. SiO ₂	mg/l	---	---	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	61,2	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	---	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	---	0,001	Abs. Atómica (3500-Hg B)	0,002
Níquel	mg/l	---	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	---	---	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	---	---	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	---	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	---	0,30	Colorimetría (10001-Hach)	0,05

3.- OBSERVACIONES:

UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.
 * Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.


 DIRECCIÓN GENERAL DE
 REGULACIÓN Y CONTROL DE
 CALIDAD DEL AGUA POTABLE
 "SAGUAPAC"

1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Pozo "El Sauce"
Responsable del muestreo	Personal de la Cooperativa Florida Ltda
Fecha y hora del muestreo	12-7-2017 07:42
Fecha del Análisis	12-7-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	NSD	< 1	Filtro de Memb. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	NSD	< 1	Filtro de Memb. (9222 D)	1
Pseudomonas	UFC/100 ml	---	< 1	Filtro de Memb. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	---	500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	24,4	---	Termómetro	
pH		6,74	6,5 a 9,0	Potenciométrico (4500-H ⁺ B)	1,0 a 13,0
Color	UCV	NSD	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	0,5	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	40	200	Titulación con EDTA (3500-Ca-D)	1
Magnesio	mg/l	13,1	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	NSD	0,3	Colorimétrico (3500-Fe D)	0,01
Manganeso	mg/l	NSD	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₂ /Ca	mg/l	154	500	Titulación con EDTA (2340-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ /Ca	mg/l	NSD	---	Titulación (2320-B)	1
Alcalinidad total c. CO ₂ /Ca	mg/l	224	370	Titulación (2320-B)	1
Cloruros c. Cl	mg/l	1,0	250	Titulación (4500-Cl C)	0,5
Sulfatos c. SO ₄	mg/l	1,4	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	---	1,5	Colorimétrico (4500-F D)	0,1
Nitratos c. NO ₃	mg/l	3,6	45	Colorimétrico (4500-NO ₃ E)	0,05
Nitritos c. NO ₂	mg/l	NSD	0,1	Colorimétrico (4500-NO ₂ B)	0,005
Conductancia específica	µmhos/cm	425	1500	Conductivímetro (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	81,5	---	Calculo (4500-CO ₂ D)	
Sólidos totales disueltos a 180 °C	mg/l	247	1000	Gravimetría (2540 C)	10
Índice de Langelier		-0,76	-0,5 a +0,5	Calculo (2330 B)	

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	---	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	---	---	Electrodo de Membrana (4500-O G)	0,1
Amoniaco c. NH ₃	mg/l	NSD	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	---	---	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	---	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	---	0,01	Abs. Atómica (3500-As B)	0,003
Cadmio	mg/l	---	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	---	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	---	---	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	---	0,05	Abs. Atómica (3500-Cr B)	0,05
Piomo	mg/l	---	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	---	---	Abs. Atómica (3500-K B)	0,1
Silice c. SiO ₂	mg/l	---	---	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	37,2	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	---	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	---	0,001	Abs. Atómica (3500-Hg B)	0,002
Niquel	mg/l	---	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	---	---	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	---	---	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	---	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	---	0,30	Colorimetría (10061-Hach)	0,05

3.- OBSERVACIONES:

UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.
 * Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.


 JEFE SECCION CONTROL DE CALIDAD AGUAPAC
 SAGUAPAC

1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Pozo "La Carretera"
Responsable del muestreo	Personal de la Cooperativa Florida Ltda.
Fecha y hora del muestreo	12-7-2017 07:11
Fecha del Análisis	12-7-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	NSD	< 1	Filtro de Memb. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	NSD	< 1	Filtro de Memb. (9222 D)	1
Pseudomonas	UFC/100 ml	---	< 1	Filtro de Memb. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	---	500	Placa Fluida (9218-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	24,4	---	Termómetro	---
pH		7,50	6,5 a 9,0	Potenciométrico (4500-H ⁺ B)	1,0 a 13,0
Color	UCV	NSD	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	1,2	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	10	200	Titración con EDTA (3500-Ca-D)	1
Magnesio	mg/l	10,7	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	0,17	0,3	Colorimétrico (3500-Fe D)	0,01
Manganeso	mg/l	0,02	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₂ Ca	mg/l	68	500	Titración con EDTA (2340-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ Ca	mg/l	NSD	---	Titración (2320-B)	1
Alcalinidad total c. CO ₂ Ca	mg/l	626	370	Titración (2320-B)	1
Cloruros c. Cl	mg/l	150,0	250	Titración (4500-Cl ⁻ C)	0,5
Sulfatos c. SO ₄	mg/l	NSD	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	---	1,5	Colorimétrico (4500-F ⁻ D)	0,1
Nitratos c. NO ₃	mg/l	NSD	45	Colorimétrico (4500-NO ₃ ⁻ E)	0,05
Nitritos c. NO ₂	mg/l	NSD	0,1	Colorimétrico (4500-NO ₂ ⁻ B)	0,005
Conductancia específica	µmhos/cm	1.574	1500	Conductímetro (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	39,6	---	Cálculo (4500-CO ₂ D)	---
Sólidos totales disueltos a 180 °C	mg/l	913	1000	Gravimetría (2540 C)	10
Índice de Langlier		-0,20	-0,5 a +0,5	Cálculo (2330 B)	---

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	---	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	---	---	Electrodo de Membrana (4500-O G)	0,1
Amoníaco c. NH ₃	mg/l	0,52	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	---	---	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	---	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	---	0,01	Abs. Atómica (3500-As B)	0,003
Cadmio	mg/l	---	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	---	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	---	---	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	---	0,05	Abs. Atómica (3500-Cr B)	0,05
Piombo	mg/l	---	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	---	---	Abs. Atómica (3500-K B)	0,1
Sílice c. SiO ₂	mg/l	---	---	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	406,0	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	---	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	---	0,001	Abs. Atómica (3500-Hg B)	0,002
Níquel	mg/l	---	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	---	---	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	---	---	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	---	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	---	0,30	Colorimetría (10061-Hach)	0,05

3.- OBSERVACIONES:

UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.

* Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.


 Luis Estrella
 JEFE DE SECTOR CONTROL DE CALIDAD AGUA POTABLE
 SAGUAPAC

1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Sistema "El Chorrillo" Toma 1
Responsable del muestreo	Tco. José Ortiz
Fecha y hora del muestreo	21-8-2017 08:38
Fecha del Análisis	21-8-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	27	< 1	Filtro de Memb. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	23	< 1	Filtro de Memb. (9222 D)	1
Pseudomonas	UFC/100 ml	---	< 1	Filtro de Memb. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	---	500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	21,5	---	Termómetro	---
pH		6,61	6,5 a 9,0	Potenciométrico (4500-H' B)	1,0 a 13,0
Color	UCV	---	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	0,8	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	---	200	Titulación con EDTA (3600-Ca-D)	1
Magnesio	mg/l	---	150	Abs. Atómica (3600-Mg B)	0,1
Hierro total	mg/l	---	0,3	Colorimétrico (3600-Fe D)	0,01
Manganeso	mg/l	---	0,1	Abs. Atómica (3600-Mn B)	0,01
Dureza total c. CO ₂ Ca	mg/l	---	500	Titulación con EDTA (2340-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ Ca	mg/l	---	---	Titulación (2320-B)	1
Alcalinidad total c. CO ₂ Ca	mg/l	---	370	Titulación (2320-B)	1
Cloruros c. Cl	mg/l	---	250	Titulación (4500-Cl' C)	0,5
Sulfatos c. SO ₄	mg/l	---	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	---	1,5	Colorimétrico (4500-F' D)	0,1
Nitratos c. NO ₃	mg/l	---	45	Colorimétrico (4500-NO ₃ E)	0,05
Nitritos c. NO ₂	mg/l	---	0,1	Colorimétrico (4500-NO ₂ B)	0,005
Conductancia específica	µmhos/cm	89	1500	Conductivímetro (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	---	---	Cálculo (4500-CO ₂ D)	---
Sólidos totales disueltos a 180 °C	mg/l	---	1000	Gravimetría (2540 C)	10
Índice de Langelier		---	-0,5 a +0,5	Cálculo (2330 B)	---

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	---	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	---	---	Electrodo de Membrana (4500-O G)	0,1
Amoniaco c. NH ₃	mg/l	---	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	---	---	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	---	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	---	0,01	Abs. Atómica (3500-As B)	0,003
Cadmio	mg/l	---	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	---	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	---	---	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	---	0,05	Abs. Atómica (3500-Cr B)	0,05
Piomo	mg/l	---	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	---	---	Abs. Atómica (3500-K B)	0,1
Silice c. SiO ₂	mg/l	---	---	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	---	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	---	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	---	0,001	Abs. Atómica (3500-Hg B)	0,002
Niquel	mg/l	---	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	---	---	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	---	---	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	---	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	---	0,30	Colorimetría (10061-Hach)	0,05

3.- OBSERVACIONES:

UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.

* Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.


Ing. Elias Ayala Castellón
 JEFE SECCION CONTROL DE CALIDAD AGUA POTABLE
 "SAGUAPAC"

SAGUAPAC	REPORTE DE ANALISIS BACTERIOLOGICO Y FISICO-QUIMICO	Rep N° 166 /2017
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1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Sistema "El Chorrillo" Toma 2
Responsable del muestreo	Tco. José Ortiz
Fecha y hora del muestreo	21-8-2017 08:50
Fecha del Análisis	21-8-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	2	< 1	Filtro de Membr. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	NSD	< 1	Filtro de Membr. (9222 D)	1
Pseudomonas	UFC/100 ml	—	< 1	Filtro de Membr. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	—	500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	21,4	—	Termómetro	
pH		6,46	6,5 a 9,0	Potenciométrico (4500-H ⁺ B)	1,0 a 13,0
Color	UCV	—	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	2,5	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	—	200	Titración con EDTA (3500-Ca-D)	1
Magnesio	mg/l	—	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	—	0,3	Colorimétrico (3500-Fe D)	0,01
Manganeso	mg/l	—	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₂ Ca	mg/l	—	500	Titración con EDTA (2340-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ Ca	mg/l	—	—	Titración (2320-B)	1
Alcalinidad total c. CO ₂ Ca	mg/l	—	370	Titración (2320-B)	1
Cloruros c. Cl	mg/l	—	250	Titración (4500-Cl ⁻ C)	0,5
Sulfatos c. SO ₄	mg/l	—	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	—	1,5	Colorimétrico (4500-F ⁻ D)	0,1
Nitratos c. NO ₃	mg/l	—	45	Colorimétrico (4500-NO ₃ ⁻ E)	0,05
Nitritos c. NO ₂	mg/l	—	0,1	Colorimétrico (4500-NO ₂ ⁻ B)	0,005
Conductancia específica	µmhos/cm	101	1500	Conductivimetro (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	—	—	Cálculo (4500-CO ₂ D)	
Sólidos totales disueltos a 180 °C	mg/l	—	1000	Gravimetría (2540 C)	10
Índice de Langelier		—	-0,5 a +0,5	Cálculo (2330 B)	

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL


Cloro residual libre	mg/l	—	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	—	—	Electrodo de Membrana (4500-O G)	0,1
Amoniaco c. NH ₃	mg/l	—	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	—	—	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	—	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	—	0,01	Abs. Atómica (3500-Ar B)	0,003
Cadmio	mg/l	—	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	—	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	—	—	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	—	0,05	Abs. Atómica (3500-Cr B)	0,05
Plomo	mg/l	—	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	—	—	Abs. Atómica (3500-K B)	0,1
Silice c. SiO ₂	mg/l	—	—	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	—	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	—	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	—	0,001	Abs. Atómica (3500-Hg B)	0,002
Níquel	mg/l	—	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	—	—	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	—	—	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	—	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	—	0,30	Colorimetría (10061-Hach)	0,05

3.- OBSERVACIONES:

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UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.

* Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.


Ing. Eneas Avila Castellón
 JEFE SECCIÓN CONTROL DE CALIDAD AGUA POTABLE
 "SAGUAPAC"

1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Sistema "El Chorrillo" Toma 3
Responsable del muestreo	Tco. José Ortiz
Fecha y hora del muestreo	21-8-2017 08:58
Fecha del Análisis	21-8-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	37	< 1	Filtro de Memb. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	26	< 1	Filtro de Memb. (9222 D)	1
Pseudomonas	UFC/100 ml	---	< 1	Filtro de Memb. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	---	500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	21,0	---	Termómetro	---
pH		6,62	6,5 a 9,0	Potenciométrico (4800-H ⁺ B)	1,0 a 13,0
Color	UCV	---	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	1,1	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	---	200	Titulación con EDTA (3600-Ca-D)	1
Magnesio	mg/l	---	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	---	0,3	Colorimétrico (3600-Fe D)	0,01
Manganeso	mg/l	---	0,1	Abs. Atómica (3600-Mn B)	0,01
Dureza total c. CO ₂ Ca	mg/l	---	500	Titulación con EDTA (2340-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ Ca	mg/l	---	---	Titulación (2320-B)	1
Alcalinidad total c. CO ₂ Ca	mg/l	---	370	Titulación (2320-B)	1
Cloruros c. Cl	mg/l	---	250	Titulación (4500-Cl C)	0,5
Sulfatos c. SO ₄	mg/l	---	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	---	1,5	Colorimétrico (4500-F D)	0,1
Nitratos c. NO ₃	mg/l	---	45	Colorimétrico (4500-NO ₃ E)	0,05
Nitritos c. NO ₂	mg/l	---	0,1	Colorimétrico (4500-NO ₂ B)	0,005
Conductancia específica	µmhos/cm	104	1500	Conductivímetro (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	---	---	Cálculo (4500-CO ₂ D)	---
Sólidos totales disueltos a 180 °C	mg/l	---	1000	Gravimetría (2540 C)	10
Índice de Langelier		---	-0,5 a +0,5	Cálculo (2330 B)	---

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	---	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	---	---	Electrodo de Membrana (4500-O G)	0,1
Amoníaco c. NH ₃	mg/l	---	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	---	---	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	---	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	---	0,01	Abs. Atómica (3500-As B)	0,003
Cadmio	mg/l	---	0,005	Abs. Atómica (3600-Cd B)	0,03
Cobre	mg/l	---	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	---	---	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	---	0,05	Abs. Atómica (3600-Cr B)	0,05
Plomo	mg/l	---	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	---	---	Abs. Atómica (3500-K B)	0,1
Silice c. SiO ₂	mg/l	---	---	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	---	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	---	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	---	0,001	Abs. Atómica (3500-Hg B)	0,002
Níquel	mg/l	---	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	---	---	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	---	---	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	---	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	---	0,30	Colorimetría (10061-Hach)	0,05

3.- OBSERVACIONES:

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UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.

* Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.


Ing. Elias Avila Castellón
 JEFE SECCION CONTROL DE CALIDAD AGUA POTABLE
 "SAGUAPAC"

SAGUAPAC	REPORTE DE ANALISIS BACTERIOLOGICO Y FISICO-QUIMICO	Rep N° 167 /2017
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1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Sistema "El Chorrillo" Toma 4
Responsable del muestreo	Tco. José Ortiz
Fecha y hora del muestreo	21-8-2017 09:07
Fecha del Análisis	21-8-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	5	< 1	Filtro de Memb. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	2	< 1	Filtro de Memb. (9222 D)	1
Pseudomonas	UFC/100 ml	---	< 1	Filtro de Memb. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	---	500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	21,0	---	Termómetro	
pH		7,18	6,5 a 9,0	Potenciométrico (4500-H ⁺ B)	1,0 a 13,0
Color	UCV	---	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	0,4	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	---	200	Titulación con EDTA (3600-Ca-D)	1
Magnesio	mg/l	---	150	Abs. Atómica (3600-Mg B)	0,1
Hierro total	mg/l	---	0,3	Colorimétrico (3600-Fe D)	0,01
Manganeso	mg/l	---	0,1	Abs. Atómica (3600-Mn B)	0,01
Dureza total c. CO ₂ /Ca	mg/l	---	500	Titulación con EDTA (2340-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ /Ca	mg/l	---	---	Titulación (2320-B)	1
Alcalinidad total c. CO ₂ /Ca	mg/l	---	370	Titulación (2320-B)	1
Cloruros c. Cl	mg/l	---	250	Titulación (4500-Cl ⁻ C)	0,5
Sulfatos c. SO ₄	mg/l	---	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	---	1,5	Colorimétrico (4500-F ⁻ D)	0,1
Nitratos c. NO ₃	mg/l	---	45	Colorimétrico (4500-NO ₃ ⁻ E)	0,05
Nitritos c. NO ₂	mg/l	---	0,1	Colorimétrico (4500-NO ₂ ⁻ B)	0,005
Conductancia específica	µmhos/cm	180	1500	Conductivímetro (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	---	---	Cálculo (4500-CO ₂ D)	
Sólidos totales disueltos a 180 °C	mg/l	---	1000	Gravimetría (2540 C)	10
Índice de Langelier		---	-0,5 a +0,5	Cálculo (2330 B)	

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL


Cloro residual libre	mg/l	---	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	---	---	Electrodo de Membrana (4500-O G)	0,1
Amoníaco c. NH ₃	mg/l	---	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	---	---	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	---	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	---	0,01	Abs. Atómica (3500-Aa B)	0,003
Cadmio	mg/l	---	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	---	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	---	---	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	---	0,05	Abs. Atómica (3500-Cr B)	0,05
Plomo	mg/l	---	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	---	---	Abs. Atómica (3500-K B)	0,1
Silice c. SiO ₂	mg/l	---	---	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	---	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	---	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	---	0,001	Abs. Atómica (3500-Hg B)	0,002
Níquel	mg/l	---	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	---	---	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	---	---	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	---	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	---	0,30	Colorimetría (10061-Hach)	0,05

3.- OBSERVACIONES:

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UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.

* Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.


Ing. Elías Ariza Castellón
 JEFE SECCIÓN CONTROL DE CALIDAD AGUA POTABLE
 "SAGUAPAC"

1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Sistema "El Chorrillo" Toma 5
Responsable del muestreo	Tco. José Ortiz
Fecha y hora del muestreo	21-8-2017 09:15
Fecha del Análisis	21-8-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	460	< 1	Filtro de Memb. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	43	< 1	Filtro de Memb. (9222 D)	1
Pseudomonas	UFC/100 ml	---	< 1	Filtro de Memb. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	---	500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	21,5	---	Termómetro	---
pH		7,33	6,5 a 9,0	Potenciométrico (4500-H" B)	1,0 a 13,0
Color	UCV	---	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	1,0	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	---	200	Titulación con EDTA (3500-Ca-D)	1
Magnesio	mg/l	---	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	---	0,3	Colorimétrico (3500-Fe D)	0,01
Manganeso	mg/l	---	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₂ Ca	mg/l	---	500	Titulación con EDTA (2340-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ Ca	mg/l	---	---	Titulación (2320-B)	1
Alcalinidad total c. CO ₂ Ca	mg/l	---	370	Titulación (2320-B)	1
Cloruros c. Cl	mg/l	---	250	Titulación (4500-Cl" C)	0,5
Sulfatos c. SO ₄	mg/l	---	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	---	1,5	Colorimétrico (4500-F" D)	0,1
Nitratos c. NO ₃	mg/l	---	45	Colorimétrico (4500-NO ₃ E)	0,05
Nitritos c. NO ₂	mg/l	---	0,1	Colorimétrico (4500-NO ₂ B)	0,005
Conductancia específica	µmhos/cm	65	1500	Conductivimétrico (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	---	---	Cálculo (4500-CO ₂ D)	---
Sólidos totales disueltos a 180 °C	mg/l	---	1000	Gravimetría (2540 C)	10
Índice de Langelier		---	-0,5 a +0,5	Cálculo (2330 B)	---

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	---	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	---	---	Electrodo de Membrana (4500-O G)	0,1
Amoniaco c. NH ₃	mg/l	---	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	---	---	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	---	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	---	0,01	Abs. Atómica (3500-Aa B)	0,003
Cadmio	mg/l	---	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	---	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	---	---	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	---	0,05	Abs. Atómica (3500-Cr B)	0,05
Plomo	mg/l	---	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	---	---	Abs. Atómica (3500-K B)	0,1
Silíce c. SiO ₂	mg/l	---	---	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	---	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	---	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	---	0,001	Abs. Atómica (3500-Hg B)	0,002
Níquel	mg/l	---	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	---	---	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	---	---	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	---	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	---	0,30	Colorimetría (10051-Hach)	0,05

3.- OBSERVACIONES:

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UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.

* Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.


Ing. Eneas Arila Castellón
 JEFE SECCION CONTROL DE CALIDAD AGUA POTABLE
 "SAGUAPAC"

1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Sistema "El Chorrillo" Toma 6
Responsable del muestreo	Tco. José Ortiz
Fecha y hora del muestreo	21-8-2017 09:25
Fecha del Análisis	21-8-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	1100	< 1	Filtro de Memb. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	15	< 1	Filtro de Memb. (9222 D)	1
Pseudomonas	UFC/100 ml	—	< 1	Filtro de Memb. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	—	500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	21,7	—	Termómetro	
pH		7,11	6,5 a 9,0	Potenciométrico (4500-H' B)	1,0 a 13,0
Color	UCV	—	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	1,3	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	—	200	Titulación con EDTA (3500-Ca-D)	1
Magnesio	mg/l	—	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	—	0,3	Colorimétrico (3500-Fe D)	0,01
Manganeso	mg/l	—	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₂ /Ca	mg/l	—	500	Titulación con EDTA (2340-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ /Ca	mg/l	—	—	Titulación (2320-B)	1
Alcalinidad total c. CO ₂ /Ca	mg/l	—	370	Titulación (2320-B)	1
Cloruros c. Cl	mg/l	—	250	Titulación (4500-Cl' C)	0,5
Sulfatos c. SO ₄	mg/l	—	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	—	1,5	Colorimétrico (4500-F D)	0,1
Nitritos c. NO ₂	mg/l	—	45	Colorimétrico (4500-NO ₂ E)	0,05
Nitros c. NO ₂	mg/l	—	0,1	Colorimétrico (4500-NO ₂ B)	0,005
Conductancia específica	µmhos/cm	109	1500	Conductivímetro (2610-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	—	—	Cálculo (4500-CO ₂ D)	
Sólidos totales disueltos a 180 °C	mg/l	—	1000	Gravimetría (2540 C)	10
Índice de Langelier		—	-0,5 a +0,5	Cálculo (2330 B)	

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	—	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	—	—	Electrodo de Membrana (4500-O O)	0,1
Amoniaco c. NH ₃	mg/l	—	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	—	—	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	—	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	—	0,01	Abs. Atómica (3500-As B)	0,003
Cadmio	mg/l	—	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	—	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	—	—	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	—	0,05	Abs. Atómica (3500-Cr B)	0,05
Plomo	mg/l	—	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	—	—	Abs. Atómica (3500-K B)	0,1
Silice c. SiO ₂	mg/l	—	—	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	—	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	—	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	—	0,001	Abs. Atómica (3500-Hg B)	0,002
Níquel	mg/l	—	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	—	—	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	—	—	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	—	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	—	0,30	Colorimetría (10061-Hach)	0,05

3.- OBSERVACIONES:

UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.

* Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.

Ing. Elias Avila Castellón
JEFE SECCION CONTROL DE CALIDAD AGUA POTABLE
"SAGUAPAC"

1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Red de distribución de la Cooperativa Florida Ltda.
Responsable del muestreo	Tco. José Ortiz
Fecha y hora del muestreo	21-8-2017
Fecha del Análisis	21-8-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	6	< 1	Filtro de Memb. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	5	< 1	Filtro de Memb. (9222 D)	1
Pseudomonas	UFC/100 ml	---	< 1	Filtro de Memb. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	---	500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	21,4	---	Termómetro	
pH		7,48	6,5 a 9,0	Potenciómetro (4500-H ⁺ B)	1,0 a 13,0
Color	UCV	NSD	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	1,7	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	32	200	Titulación con EDTA (3500-Ca-D)	1
Magnesio	mg/l	10,7	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	0,08	0,3	Colorimétrico (3500-Fe D)	0,01
Manganeso	mg/l	NSD	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₂ Ca	mg/l	124	500	Titulación con EDTA (2340-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ Ca	mg/l	NSD	---	Titulación (2320-B)	1
Alcalinidad total c. CO ₂ Ca	mg/l	252	370	Titulación (2320-B)	1
Cloruros c. Cl	mg/l	32,0	250	Titulación (4500-Cl C)	0,5
Sulfatos c. SO ₄	mg/l	NSD	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	---	1,5	Colorimétrico (4500-F D)	0,1
Nitratos c. NO ₃	mg/l	3,8	45	Colorimétrico (4500-NO ₃ E)	0,05
Nitritos c. NO ₂	mg/l	NSD	0,1	Colorimétrico (4500-NO ₂ B)	0,005
Conductancia específica	µmhos/cm	556	1500	Conductivimétrico (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	16,7	---	Cálculo (4500-CO ₂ D)	
Sólidos totales disueltos a 180 °C	mg/l	322	1000	Gravimetría (2540 C)	10
Índice de Langelier		-0,22	-0,5 a +0,5	Cálculo (2330 B)	

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	---	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	---	---	Electrodo de Membrana (4500-O G)	0,1
Amoniaco c. NH ₃	mg/l	---	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	---	---	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	---	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	---	0,01	Abs. Atómica (3500-As B)	0,003
Cadmio	mg/l	---	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	---	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	---	---	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	---	0,05	Abs. Atómica (3500-Cr B)	0,05
Piomo	mg/l	---	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	---	---	Abs. Atómica (3500-K B)	0,1
Silice c. SiO ₂	mg/l	---	---	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	---	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	---	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	---	0,001	Abs. Atómica (3500-Hg B)	0,002
Níquel	mg/l	---	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	---	---	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	---	---	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	---	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	---	0,30	Colorimetría (10081-Hach)	0,05

3.- OBSERVACIONES:

UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.

* Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.

Ing. Eneas Avila Castellón
 JEFE SECCION CONTROL DE CALIDAD AGUA POTABLE
 "SAGUAPAC"

SAGUAPAC	REPORTE DE ANALISIS BACTERIOLOGICO Y FISICO-QUIMICO	Rep N° 230 /2017
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1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipate - Cooperativa Florida Ltda
Clase de fuente	Pozo Carretera
Responsable del muestreo	José Ortiz
Fecha y hora del muestreo	30-10-2017 10:00
Fecha del Análisis	30-10-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformos totales	UFC/100 ml	4	< 1	Filtro de Memb. (9222 B)	1
Coliformos Termoresistentes (fecales)	UFC/100 ml	NSD	< 1	Filtro de Memb. (9222 D)	1
Pseudomonas	UFC/100 ml	---	< 1	Filtro de Memb. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	---	500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO


Temperatura	°C	25,2	---	Termómetro	
pH		8,57	6,5 a 9,0	Potenciométrico (4500-H ⁺ B)	1,0 a 13,0
Color	UCV	NSD	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	0,6	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	10,4	200	Titulación con EDTA (3500-Ca-D)	1
Magnesio	mg/l	5,3	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	0,04	0,3	Colorimétrico (3500-Fe D)	0,01
Manganeso	mg/l	0,01	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₃ Ca	mg/l	48	500	Titulación con EDTA (2340-C)	1
Alcalinidad a la fenolftaleína c. CO ₃ Ca	mg/l	NSD	---	Titulación (2320-B)	1
Alcalinidad total c. CO ₃ Ca	mg/l	754	370	Titulación (2320-B)	1
Cloruros c. Cl	mg/l	330,0	250	Titulación (4500-Cl ⁻ C)	0,5
Sulfatos c. SO ₄	mg/l	NSD	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	---	1,5	Colorimétrico (4500-F D)	0,1
Nitratos c. NO ₃	mg/l	NSD	45	Colorimétrico (4500-NO ₃ ⁻ E)	0,05
Nitritos c. NO ₂	mg/l	NSD	0,1	Colorimétrico (4500-NO ₂ ⁻ B)	0,005
Conductancia específica	µmhos/cm	2.400	1500	Conductivímetro (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	4,1	---	Cálculo (4500-CO ₂ D)	
Sólidos totales disueltos a 180 °C	mg/l	1.392	1000	Gravimetría (2540 C)	10
Índice de Langelier		0,97	-0,5 a +0,5	Cálculo (2330 B)	

2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	---	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Origeno Disuelto	mg/l	---	---	Electrodo de Membrana (4500-O G)	0,1
Amoniaco c. NH ₃	mg/l	0,77	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	---	---	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	---	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	NSD	0,01	Abs. Atómica (3500-As B)	0,003
Cadmio	mg/l	NSD	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	NSD	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	---	---	Currim. (Difenilcarbazide)	0,05
Cromo total	mg/l	NSD	0,05	Abs. Atómica (3500-Cr B)	0,05
Plomo	mg/l	---	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	4,3	---	Abs. Atómica (3500-K B)	0,1
Silice c. SiO ₂	mg/l	---	---	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	515,0	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	NSD	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	---	0,001	Abs. Atómica (3500-Hg B)	0,002
Niquel	mg/l	NSD	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	---	---	Curimetría (4500-S D)	0,01
Cobalto	mg/l	---	---	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	---	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	---	0,30	Colorimetría (10061-Hach)	0,05

3.- OBSERVACIONES:

UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.
 * Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.


Ing. Elias Arilla Castellón
 JEFE SECCION CONTROL DE CALIDAD AGUA POTABLE
 "SAGUAPAC"

1.- DATOS DE LA MUESTRA

Lugar de procedencia	S.C. Samaipata - Cooperativa Florida Ltda
Clase de fuente	Salida de la Planta de tratamiento
Responsable del muestreo	José Ortiz
Fecha y hora del muestreo	30-10-2017 10:00
Fecha del Análisis	30-10-2017

2.- RESULTADOS

PARAMETROS	UNIDADES	RESULTADOS	** MAXIMO ACEPTABLE	METODO APHA-AWWA-WPCF	LIMITE DE CUANTIFICACION
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2.1.- ANALISIS BACTERIOLOGICO

Coliformes totales	UFC/100 ml	1	< 1	Filtro de Membr. (9222 B)	1
Coliformes Termoresistentes (fecales)	UFC/100 ml	NSD	< 1	Filtro de Membr. (9222 D)	1
Pseudomonas	UFC/100 ml	---	< 1	Filtro de Membr. (9213 E)	1
Bacterias mesófilas totales	UFC/ml	---	500	Placa Fluida (9215-B)	1

2.2.- ANALISIS FISICO - QUIMICO BASICO

Temperatura	°C	25,1	---	Termómetro	
pH		8,40	6,5 a 9,0	Potenciométrico (4500-H ⁺ B)	1,0 a 13,0
Color	UCV	NSD	15	Espectrofotométrico (2120 C)	5
Turbiedad	NTU	1,0	5	Nefelométrico (2130 B)	0,3
Calcio	mg/l	10,4	200	Titración con EDTA (3500-Ca-D)	1
Magnesio	mg/l	4,9	150	Abs. Atómica (3500-Mg B)	0,1
Hierro total	mg/l	0,24	0,3	Colorimétrico (3600-Fe D)	0,01
Manganeso	mg/l	0,02	0,1	Abs. Atómica (3500-Mn B)	0,01
Dureza total c. CO ₂ /Ca	mg/l	46	500	Titración con EDTA (2340-C)	1
Alcalinidad a la fenolftaleína c. CO ₂ /Ca	mg/l	NSD	---	Titración (2320-B)	1
Alcalinidad total c. CO ₂ /Ca	mg/l	458	370	Titración (2320-B)	1
Cloruros c. Cl	mg/l	195,0	250	Titración (4500-Cl C)	0,5
Sulfatos c. SO ₄	mg/l	NSD	400	Turbidimétrico (4500-SO ₄ ²⁻ E)	4
Fluoruros c. F	mg/l	---	1,5	Colorimétrico (4500-F D)	0,1
Nitratos c. NO ₃	mg/l	2,3	45	Colorimétrico (4500-NO ₃ E)	0,05
Nitritos c. NO ₂	mg/l	0,16	0,1	Colorimétrico (4500-NO ₂ B)	0,005
Conductancia específica	µmhos/cm	1,468	1500	Conductímetro (2510-B)	0,5
Dióxido de carbono libre c. CO ₂	mg/l	3,6	---	Cálculo (4500-CO ₂ D)	
Sólidos totales disueltos a 180 °C	mg/l	851	1000	Gravimetría (2540 C)	10
Índice de Langelier		0,60	-0,5 a +0,5	Cálculo (2330 B)	


2.3.- ANALISIS FISICO - QUIMICO ESPECIAL

Cloro residual libre	mg/l	---	0,2 a 1,0	Colorimétrico (4500-Cl G)	0,03
Oxígeno Disuelto	mg/l	---	---	Electrodo de Membrana (4500-O G)	0,1
Amoniaco c. NH ₃	mg/l	0,05	0,5	Colorimétrico (4500-NH ₃ C)	0,04
Fosfatos c. PO ₄	mg/l	---	---	Colorimétrico (4500-P E)	0,05
Cianuro	mg/l	---	0,07	Destilación (4500-CN C)	0,01
Arsénico	mg/l	NSD	0,01	Abs. Atómica (3500-As B)	0,003
Cadmio	mg/l	NSD	0,005	Abs. Atómica (3500-Cd B)	0,03
Cobre	mg/l	NSD	1,0	Abs. Atómica (3500-Cu B)	0,02
Cromo hexavalente	mg/l	---	---	Colorim. (Difenilcarbazida)	0,05
Cromo total	mg/l	NSD	0,05	Abs. Atómica (3500-Cr B)	0,05
Plomo	mg/l	---	0,01	Abs. Atómica (3500-Pb B)	0,05
Potasio	mg/l	5,9	---	Abs. Atómica (3500-K B)	0,1
Silice c. SiO ₂	mg/l	---	---	Colorimétrico (4500-Si D)	0,1
Sodio	mg/l	318,0	200	Abs. Atómica (3500-Na B)	0,1
Cinc	mg/l	NSD	5,0	Abs. Atómica (3500-Zn B)	0,01
Mercurio	mg/l	---	0,001	Abs. Atómica (3500-Hg B)	0,002
Niquel	mg/l	NSD	0,05	Abs. Atómica (3500-Ni B)	0,05
Sulfuros	mg/l	---	---	Colorimetría (4500-S D)	0,01
Cobalto	mg/l	---	---	Abs. Atómica (3500-Co B)	0,05
Aluminio	mg/l	---	0,10	Colorimetría (3500-Al D)	0,02
Boro	mg/l	---	0,30	Colorimetría (10061-Hach)	0,05

3.- OBSERVACIONES:

UFC = Unidad Formadora de Colonias. NSD = No se detecta o menor al límite de cuantificación.

* Mediciones in situ. **Máximo aceptable según Norma Boliviana NB-512 y valor Guía OPS/OMS.

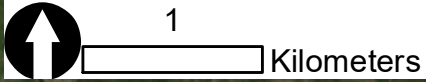

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 JEFE SECCION CONTROL DE CALIDAD AGUA POTABLE
 "SAGUAPAC"

Appendix C

Map of Samaipata System









Samaipata System Map



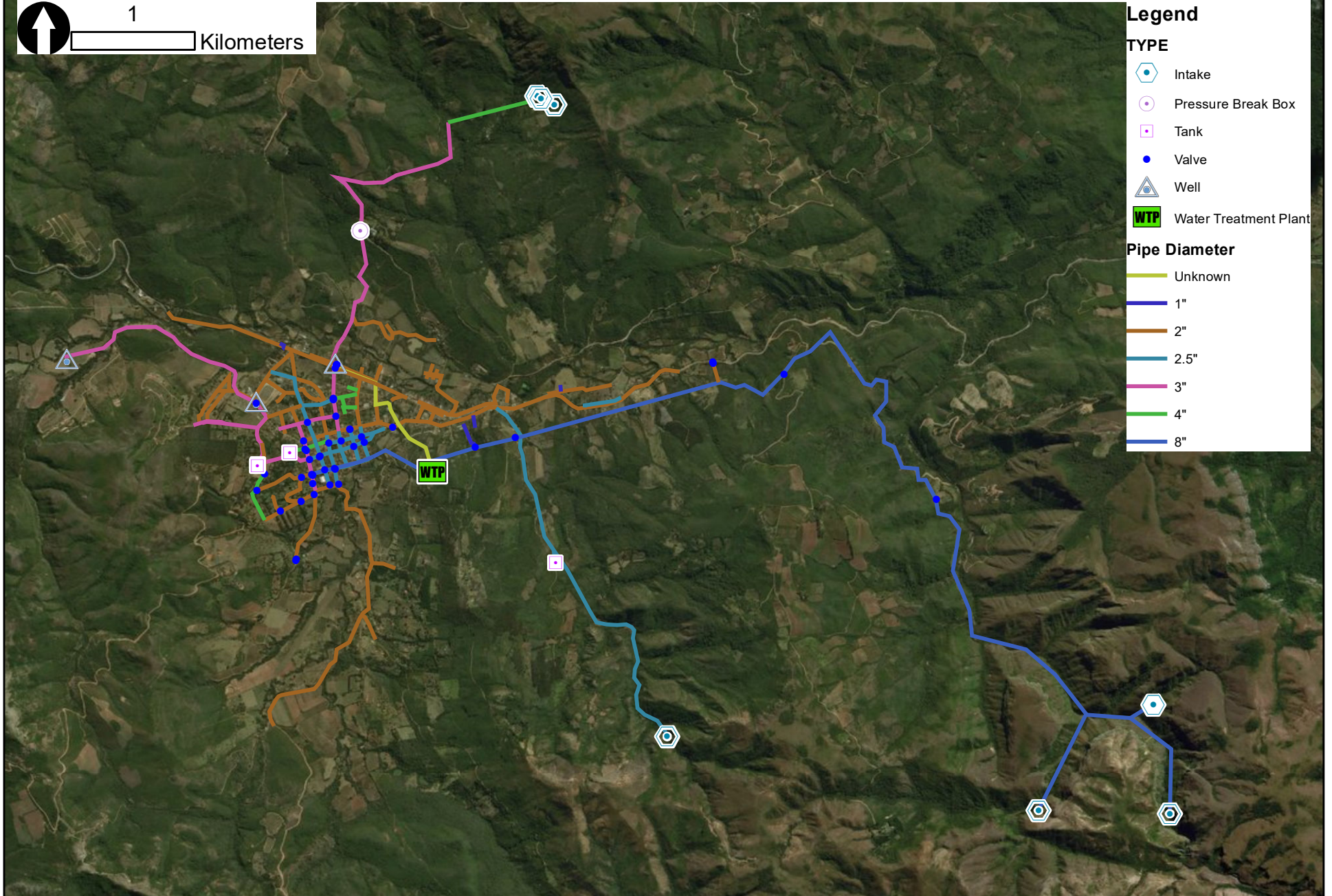
Legend

TYPE

-  Intake
-  Pressure Break Box
-  Tank
-  Valve
-  Well
-  Water Treatment Plant

Pipe Diameter

-  Unknown
-  1"
-  2"
-  2.5"
-  3"
-  4"
-  8"

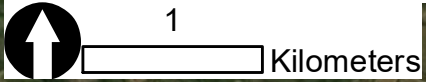


Appendix D

Map of Approximated Service Zones

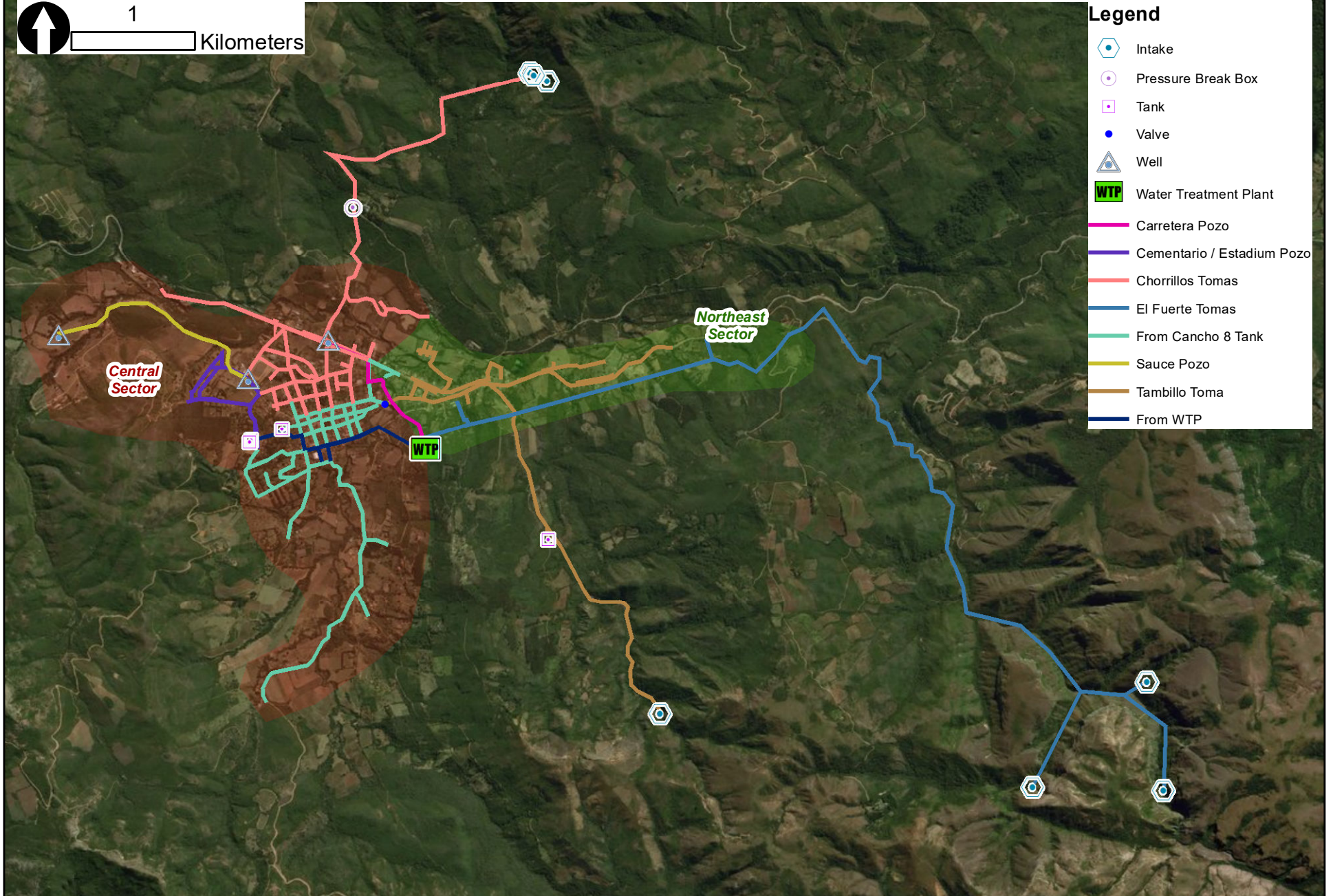


Approximated Service Zones



Legend

- Intake
- Pressure Break Box
- Tank
- Valve
- Well
- Water Treatment Plant
- Carretera Pozo
- Cementario / Estadium Pozo
- Chorrillos Tomas
- El Fuerte Tomas
- From Cancho 8 Tank
- Sauce Pozo
- Tambillo Toma
- From WTP



Appendix E

Map of Potability Recommendations



Potability Recommendations



1

Kilometers

Phase 2
New Chorrillos Tank and Chlorinator
Chlorinator at Cementerio Well
Improve WTP Chlorination Efficiency

Phase 1
Chlorinator at Tambillo Tank

Phase 3
Reconnect
Homes on
El Fuerte

Legend

- Intake
- Pressure Break Box
- Proposed Intake
- Proposed Tank
- Tank
- Valve
- Well
- Water Treatment Plant
- Carretera Pozo
- Cementerio / Estadium Pozo
- Chorrillos Tomas
- El Fuerte Tomas
- From Cancho 8 Tank
- Potential El Astillero Pozos
- Sauce Pozo
- Tambillo Toma
- From WTP

