October 2016 WEFTA Bolivia Country Report

Prepared by Jason Gehrig, PE (water/wastewater) and

Chris Edmundson (parish library computers in Senkata)

WEFTA volunteer engineer Jason Gehrig and Chris Edmundson of Denver, CO spent eight days in the Bolivian Andes, along with Jason's wife Felicia and son Nicholas. Hosted by Braulio Rojas and Basilia Choque of Suma Jayma, they had the opportunity to spend time with James Erario, volunteer engineer from the Northeast US put in touch with Suma Jayma via WEFTA. Highlights also included visiting recently completed water wells and community water supply projects implemented by Suma Jayma, along with preliminary visits with elected officials and community leaders in the rural municipalities of Pucarani, Viacha and Coro Coro to discuss technical collaboration needs for desired water and wastewater treatment. Below is a description in greater detail of visits made and follow-up action items to complete:

Municipality of Pucarani

Local Contacts - Pucarani:

Francisco Hidalgo Condori, Mayor of Pucarani (former Drinking Water Com. Pres. for Machacamarca)

Ing. Reynaldo Quenallata Bernabé; email: rayquenab@gmail.com, cell: 76545386

Ing. Álvaro Carbajal Nina; email: alvaro.acn@gmail.com; cell: 75289276

Overview - Pucarani:

Wastewater Treatment - Pucarani

The town of Pucarani will be contracting with a Spanish Engineering firm through the central govt's ministry office for design of its future WWTP. Design has yet to begin. The mayor was receptive to a "peer review/value engineering" role for WEFTA to play with that design in the months ahead. The project is being funded by the Inter-American Development Bank (B.I.D. in Spanish). Justin Logan of WEFTA had prepared a conceptual wwtp design with alternatives for Pucarani to consider earlier this year which had been presented to municipal staff by Suma Jayma.

There are however five other populated communities in the municipal jurisdiction of Pucarani that have existing sewer collection systems in need of wastewater treatment (currently raw sewage being dumped in small streams). These are:

- Palcoco 2000-2500 habitants
- Patamanta 2000-2500 hab.
- Vilaci 2000-2500 hab.
- Coropata 2000-2500 hab.
- Chojasivi smaller population

The municipality requested WEFTA collaborate with its technical staff to prepare preliminary design reports so that the municipality can pursue funding for final design and construction. It was decided that a local Bolivian environmental engineer be contracted by the municipality to help serve as a technical bridge between the volunteer WEFTA engineers in the US and the communities on the ground. WEFTA will build off the preliminary design work already prepared for Pucarani by WEFTA volunteer engineer Justin Logan to provide site specific preliminary wwtp layouts for the five communities. The Bolivian government also has design criteria and typical construction plans for lagoon systems being built in the Andean Altiplano in autocad that will be of use as a good starting point. WEFTA volunteer engineer James Erario currently serving in Bolivia with Suma Jayma will develop a passive lagoon design worksheet incorporating Bolivian govt design criteria, to be later reviewed/improved upon by WEFTA treatment design engineers.

A visit was made to the Palcoco sewer collection system which is approximately 10 years old, specifically to the existing concrete receiving tank which in theory collects all wastewater and which is then pumped out on a periodic basis into a mobile sump vacuum tank (for later discharge to who knows where?). In current practice the last 100 meters of the 6" collection trunk upstream of the holding tank appears to be plugged, resulting in sewage overflow (see pix) at the manhole upstream of the holding tank. Officials hope to expand the collection system and install a wwtp system in the area immediate adjacent to the holding tank and nearby creek. Flow at the time of inspection (10/10/16) was estimated to be 10 to 20 gpm, with a measured temperature of 9 degrees Celsius (48 degrees Fahrenheit). While land for a lagoon facility appears to be adequate, elevations will need to be carefully examined to make sure adequate fall into the future treatment facility exists.

Palcoco, Bolivia – community of 2,000 residents whose sewer collection system currently dumps into an open populated field. A request has been made by Pucarani officials of WEFTA volunteer engineers to prepare a site-specific conceptual lagoon treatment system design.

Water Supply - Pucarani

On the water supply side, Pucarani officials demonstrated that they completed "their end of the promised bargain" with WEFTA on the past Machacamarca and Palcoco water supply projects designed by Suma Jayma staff and co-funded by WEFTA, the municipality of Pucarani, and the over 400 benefiting families. The system previously supplied by an open irrigation channel is now supplied by a 20+ km 4" & 3" PVC diameter supply line from a small glacial reservoir at the base of the Andean snow-caps. What was very impressive was the social structure established to operate and maintain this entire supply and distribution network, providing safe water for over 800 families in 11 communities supplied by the network. Each family pays 5 Bs per month (approximately 71 US cents per family, which equates to a total of approximately $568 per month) to the water entity "EPSAS Allqa Quta." Though this is still not adequate funding according to the local officials, these water bill receipts allows EPSAS Allqa Quta to keep two operators on duty as well as to dose chlorine solution into the primary 100 cubic meter storage tank supplying multiple communities with water systems funded in the past by WEFTA, including Palcoco, Machacamarca and Vilirico. This type of civic society organization to maintain and properly operate a rural public water system is the first of its kinds that I've encountered in Bolivia.

Ensuring continuous and potable water for the eleven communities served by the drinking water association EPSAS "Allqa Quta" is the mission of its two operators, here seen keeping the chlorine solution drip into the 100 m^3 water supply tank operational.

Looking to the future, an additional water supply network sourced from the Andean snow caps is being projected by the municipality of Pucarani expected to reach another 55 communities. Of these, Suma Jayma and the municipality of Pucarani will explore having Suma Jayma prepare original designs for 3 to 5 communities to benefit from the future supply network.

Finally the municipality of Pucarani presented three existing community water systems that need expansion to other zones or other infrastructure improvements (e.g. install of supply main from new well to recently constructed tank). However, a quick review of the brief proposals appear to show incorrect and incomplete project requirement summaries, with no valid plans for these system expansions appearing to exist. The Pucarani officials were encouraged to consider engaging the services of Suma Jayma to perform the required designs to better define project requirements. Once completed, there might be a possibility that these expansions merit submittal to WEFTA as future projects for consideration to be funded along with local sources. The three community names are: Ancocagua, Caviña and Chipamaya.

Follow-Up Actions for Pucarani

From the Municipality of Pucarani

For wastewater treatment (Pucarani):

1. Official letter signed by Municipality of Pucarani requesting technical collaboration from WEFTA to prepare preliminary design docs for wastewater treatment for five communities (approximately 2000 people each) in order that the municipality can proceed with looking for govt funding to proceed with final design and construction.
2. Identification of a Bolivian Environmental/Civil Engineer with wastewater treatment experience, with whom WEFTA will coordinate. Municipality to contract services of this engineer. (Suma Jayma prefers with this municipality to play a reduced level until they get more up to speed on wastewater treatment.)
3. Scanned plans of existing sewer collection systems for the five communities
4. Provide data requested by WEFTA for performing preliminary wwtp lagoons design

For water supply (Pucarani):

1. Clarification of Ancocauga community water supply technical design memo that appears to have left out the cost of 1094 meters of new 2" pvc pressure pipe. See Appendix A – Tech Memo for Ancocauga Water Supply System Completion prepared by Pucarani officials.
2. Decision whether or not to fund Suma Jayma to prepare original design for the three communities needing their existing water supply system expanded to other zones. See Appendix B - Summary of three communities (Ancocauga, Caviña, Chipamaya) requiring expansion of water system
3. Identification of three to five communities for Suma Jayma to design new water distribution networks being supplied by the future water supply line from the cordillera (multi-year effort given early stages of major supply network to be built to supply 55 communities).

From WEFTA/Suma Jayma

For wastewater treatment (Pucarani):

1. Provide list of required data to Pucarani in order to perform preliminary design for five communities
2. Develop GIS exhibits for siting of the five community wwtp locations, with existing sewer collection system overlays
3. Develop excel design worksheets for lagoon system treatment plants. Provide Bolivian design norms for passive treatment lagoon systems to Jim Erario, volunteer engineer collaborating with Suma Jayma, to prepare design calcs excel worksheet for varying parameters (populations, etc). Once reality checked with WEFTA treatment engineer specialists, can use for various future lagoon-system based wastewater treatment alternatives in Andean altiplano.
4. Prepare preliminary construction plans in autocad. Use as a basis Bolivian treatment plant construction plans in autocad, improving them based on WEFTA treatment engineer experience, to be included in the preliminary design engineering report.
5. Identify WEFTA treatment engineer willing/able to visit these five communities in the coming 6 months.

For water supply (Pucarani):

1. Help EPSAS Allqa Quta operators better understand chlorine dosing. EPSAS Allqa Quta operators, though feeding a chlorine solution of one drip per second in each of the two halves of the 100 m^3 storage tank, noted they do not have a full grasp of chlorine concentrations in dosing and chlorine residuals in the distribution system (desired/minimum residuals; how to measure residual chlorine levels in mg/l). Arrange for next WEFTA engineer to visit Bolivia to bring related materials in Spanish and chlorine concentration testing strips.

Municipality of Viacha

Local Contacts:

Arquitecto Nando Gutiérrez, Director de Obras Rurales (Rural Public Works Director), Viacha (Distrito 3)

Cell: 70133566; email: arquitectonaldo@hotmail.com

(It should be noted that Nando has served in this role for nine years, despite political party changes in the municipal mayor's office (a rarity in Bolivia's political machine structure), having been ratified each year by the community leaders (mallkus). Nando and Suma Jayma have an excellent working relationship, with Jaime Rosa of Suma Jayma frequently helping resolve technical problems with other Viacha municipal water projects not even related to WEFTA projects.)

Doctor Williams Condori, Director de Gobernalidad, Viacha

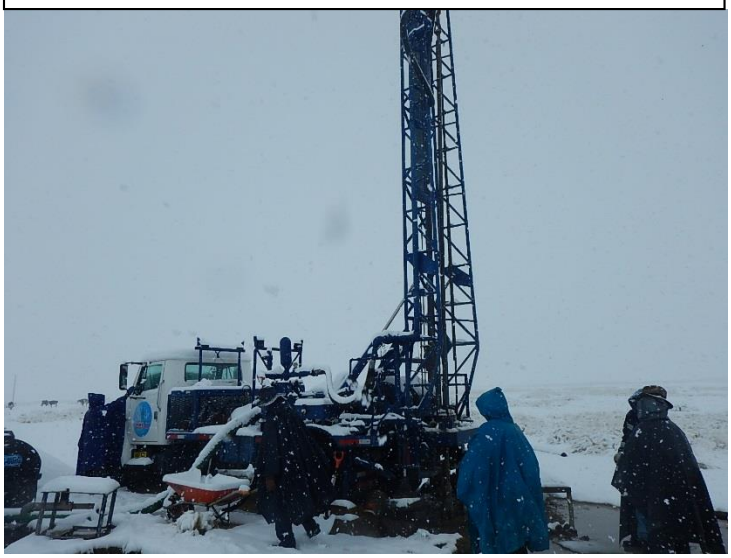
Cell: 60584109, 70514134

Overview:

Three Viacha area sites were visited:

- Chacoma Irpa Grande's 47 meter deep, 6" cased water well, recently drilled by Suma Jayma
- Wastewater contamination at the Qalauma Juvenile Delinquent Rehabilitation Center
- Wastewater contamination at the Chonchocoro Maximum Security Prison

Suma Jayma drilling Chacoma Irpa's well in the snow



Chacoma Irpa Grande Water Well – Suma Jayma drilling

Suma Jayma completed a WEFTA funded water well in Chacoma Irpa Grande, and will soon submit to WEFTA a project completion report. Suma Jayma "double drilled" this water well - first with a 7 ½" drill bit to the full depth and then with an 11" diameter drill bit, in order to be able to case with a 6" diameter PVC piping instead of a normal 4"diameter. Attempting to drill directly with an 11" bit would likely lead to shearing Suma Jayma's relatively small drilling pipe. The well turned out to be artesian in nature, with flow to the surface currently occurring with no additional pumping installed. Jaime explained how over the three days of drilling, with the groundwater reaching the surface after the first day, they had to thicken up their drill mud with additional bentonite. Instead of viscosities in the 32-38 seconds per liter, they went up to 54 second per liter viscosities, allowing for the successful completion of the 47 meter (155 foot) water well. Suma Jayma's drilling skills have improved greatly, through their own learned experience over the past three years as well with the WEFTA facilitated hands-on drilling and drilling mud training first by Dale White and Matt Muller of north Texas, followed by a Halliburton rep from Chile funded by WEFTA who traveled to Bolivia and finally by accompanying John of Rogers Drilling out of Albuquerque, New Mexico.

Such continued and consistent support by WEFTA together with a technically sharp group of water works specialists in Suma Jayma staff are paying off, with Suma Jayma drilling water wells on the tune of one to two wells per month, some funded by WEFTA and a growing number of wells funded by the municipal governments. Viacha has municipal funds to pay for two community water wells to be drilled by Suma Jayma in the coming months, with the first well starting in the second half of October. During this visit, Suma Jayma was also approached by the municipality of Comanche to drill irrigation wells to be funded by the govt's Bartolina Sisa indigenous fund. They were told that the municipal officials wanted Suma Jayma to do the work, as "all of Suma Jayma's past water supply projects (the majority with WEFTA technical and financial support) continue to function to this day!" Suma Jayma and WEFTA have built a reputation of successfully following through with their well-designed projects.

Community Leader of Chacoma Irpa Grande enjoying fresh water from new water well drilled by Suma Jayma

Next for this expansive rural community of Chacoma Irpa Grande, with its 250 listed families (160 of whom live there consistently) comes the final design and implementation of the water supply system by the Viacha government, with the first phase being the storage tank and principal supply and distribution mains. That construction work is expected to begin in 2017. There is a possibility that Suma Jayma will drill a second water well in the future to provide adequate supply for the large water system.

If this community's name sounds familiar, it is because WEFTA and Suma Jayma have worked together over the past many years to install three phases of hand pumps for Chacoma Irpa Grande, with 30 hand pumps per project phase for a total of 90 household pumps. These hand pumps continue functioning to this day, providing a vital supply of safe water for the families and for their dairy cattle which sustains the majority of the rural families' population. Even after the eventual construction of the water well-sourced distribution system, these hand pumps will provide access to improved water for the families' dairy cattle. Local community members note that the milk supply company Pil now tests the milk collected from the families, and rejects milk from cows that drink contaminated superficial (and often brackish) water. Working together, livelihoods continue to improve.

Qala Uma Juvenile Delinquent Rehabilitation Center – Wastewater Contamination Mitigation

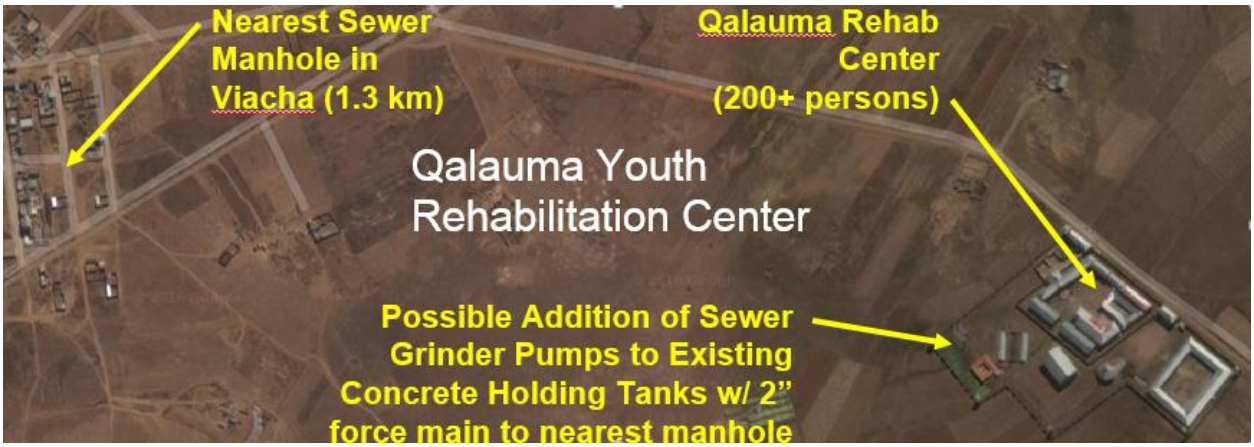
Just outside the city of Viacha to its southeast is a rehabilitation center for youth who have committed crimes, called Qala Uma (which means bringing forth water from rocks). There are approximately 220 youth to and security staff on the site.

The wastewater from the facility is piped to the northwest corner inside the fenced facility, to a couple concrete holding tanks which are completely full, resulting in ponding of contaminated water in various

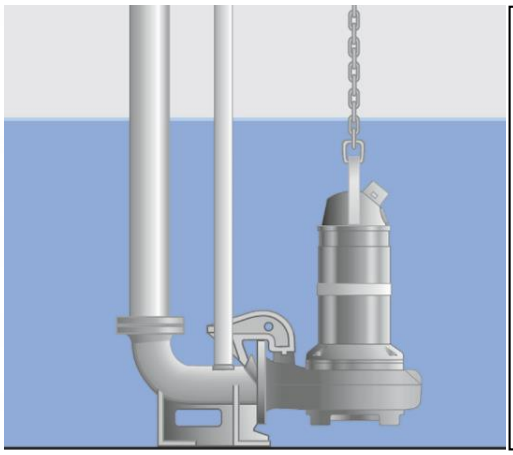
areas of this part of the detention facility which is primarily dedicated to some agricultural initiatives. One disturbing observation was the use of the untreated wastewater being gravity fed back into some of the green houses on site. Adjacent landowners also complain of the ponding of wastewater on the site that eventually makes it way outside the facility's grounds.

Two alternatives were discussed:

The first would be some kind of passive wastewater treatment scheme; however available land is very limited within the facility's fenced in borders for a lagoon-type treatment system.



The second alternative discussed seemed much more viable: the use of a sewage lift station and approximately 1.3 km, 2"-3" diameter force main to pump the facility's wastewater to the nearest manhole in the town of Viacha's sewer collection system, comprised of minimum 6" diameter sewer piping. The installation of submersible wastewater pumps on vertical rails in the existing concrete holding tank with an access hatch cut into the top concrete slab would appear to work. Those present were unaware of the frequent use of lift stations in the US for pumping wastewater, and were eager to obtain more information on these types of pumps and to whether or not they could currently be found in Bolivia. A pair of pumps with high and low level controls would be ideal for increased redundancy. Meanwhile, the city of Viacha which is located at an elevation slightly higher than this facility, is currently awarding a construction contract to build its wastewater treatment plant facility through which this center's wastewater would eventually be treated.



Examples of submersible sewage pumps that could be used at Calauma's Rehab Center to move sewage via pressure force main (via 2" or 3" pvc or hdpe) uphill 1.3 km to Viacha's nearest manhole.

Chonchocoro Maximum Security Prison – Wastewater Contamination Mitigation

We then traveled to the Chonchocoro maximum security prison, located to the north of Viacha. The facility houses 250+ staff and prisoners. The sewer collection main passes directly below the front of the prison, discharging into a nearby stream. Being much more remote from Viacha, a passive treatment system of lagoons appears to be the best alternative. Land is also available for such an installation.

The Chonchocoro situation is doubly troubling. Not only is a nearby spring-fed stream being contaminated, but approximately a quarter mile downstream of the Chonchocoro wastewater discharge point is the community water well supplying the rural village that goes by the same name Chonchocoro. The fear – appropriately so, by the community members is that the wastewater from Chonchocoro is infiltrating into their relatively shallow aquifer which supplies their community water system. Even further downstream from the community water well, farmers are using the contaminated water in the stream to irrigate their crops and water their livestock. The local residents are upset with the current situation.

Viacha officials, Braulio Rojas & Jaime Rosa of Suma Jayma, and James Erario volunteer engineer, in front of Chonchocoro maximum security prison where future wwtp lagoons to be installed.

Viacha Overview Summary

Given the close relationship between Viacha and Suma Jayma, Suma Jayma staff feel confident in co-participating with WEFTA volunteer engineers in developing viable wastewater solutions for the Qala Uma rehabilitation center as well as for the Chonchocoro maximum security prison. The goal being to have preliminary design report for both facilities by the end of the 2016 calendar year.

Of the three municipal jurisdictions visited, these two wastewater projects are considered the highest priority in terms of scheduling WEFTA technical support. The Director of Governance for Viacha, Dr. Condori, made it sound like this could serve as a model for other prisons throughout the country, most all of which to date have no treatment of their wastewater discharges. Funding for implementation appeared to be available.

It should also be noted that the City of Viacha has a major wastewater treatment plant designed and currently being advertised for bid; it appears the opportunity for any kind of technical peer review by WEFTA engineers for that major project has already passed.

Follow-Up Actions for Viacha

Qala Uma Juvenile Delinquent Rehabilitation Center – Wastewater Contamination Mitigation (Viacha)

From the Municipality of Viacha

1. Official request for Suma Jayma/WEFTA to support Viacha officials with wastewater solution
2. Additional information on Qala Uma Facility, Wastewater flow data, existing collection tank dimensions; elevations; proposed routing of force main, etc

From WEFTA/Suma Jayma

1. Provide information on typical lift station installations (provided to Suma Jayma Nov 26, 2016)
2. Prepare exhibit showing proposed routing of force main and lift station installation (" ")
3. Look into adequate space for on-site wwtp for Qala Uma facility (not viable alternative)
4. Once response received from Viacha officials, prepare preliminary engineering report preferably by the end of calendar year 2016.

Chonchocoro Maximum Security Prison (Viacha)

From the Municipality of Viacha

1. Official request for Suma Jayma/WEFTA to support Viacha officials with wastewater solution
2. Additional information on the Chonchocoro prison, specifically total number of persons on site, land ownership verification of proposed wwtp site in front of prison.

From WEFTA/Suma Jayma

1. Prepare aerial exhibit showing proposed layout of wastewater treatment system
2. Perform preliminary lagoon system calculations for sizing facility, per Bolivian design guidelines reality checked by WEFTA engineers
3. Once response received on initial layout from Viacha officials, prepare preliminary engineering report preferably by the end of calendar year 2016.

Municipality of Coro

Local Contacts:

Environmental Engineer with Coro Copper Mining Co.

Sandy Rodríguez Castellón; email: sandy.rodriguez.c@gmail.com; tel 591-2-2750346; cel. 591-67152281

(Sandy is an environmental engineer with the mining company which operates an open pit copper mine on the outskirts of the city, reactivated in 2009. She speaks English and has been in the community for about a year. She has offered to support any treatment improvement efforts by WEFTA and is quite familiar with water quality testing.)

Agustín Pío Quispe – Mayor of Coro Coro	cel 71299588
Clara Candia - Coro Coro City Council Member	cel 71299792, clari.jdac2012@gmail.com
Eloy Aliaga – Arquitect for Coro Coro	cel 71228535
Teodoro Mayta Oscori – Coro Coro City Council Member	71299792

Overview of Coro Coro:

Coro Coro, "La Ciudad de Cobre" is a town of 2000 people located another half hour to the south of Comanche where Suma Jayma has completed various projects with WEFTA over the years. Recently, in four rural communities that belong to the Coro Coro municipal jurisdiction, Suma Jayma built and installed 94 family hand pumps, with funding from the municipal government and from a donation channeled through the Maryknoll Fathers to Suma Jayma thanks to Fr. Juan Zuniga and Jason Obergfell, a former Maryknoll lay missioner who continues to live and serve in Bolivia.

That later afternoon we visited with members of Coro Coro's municipal government, as well as with the environmental engineer Sandy Rodriguez mentioned above, to discuss treatment needs of Coro Coro.

Visit with municipal officials and mining environmental engineer (with safety vest) Sandy Rodriguez and volunteer engineer James Erario (rt) in Coro Coro, about to enjoy a dessert with whipped cream.

Coro Coro Wastewater Treatment Plant – possible operations optimization support

In recent years, the Bolivian Ministry of Government had built a wastewater treatment plant for Coro Coro that included headworks with bar screens, two parallel imhoff tanks, and two covered clarifier tanks downstream before discharging to the adjacent stream. Two sets of sludge drying beds had also been built though not used yet according to the operator due to the solids not having accumulated

enough to warrant their use. Overall it was a well-kept wwtp site, enclosed by barbed wire fence. However, the community members expressed concern about the odors coming off the wwtp, and were doubtful as to how much treatment of the wastewater actually was occurring before the effluent was discharged into the stream (Rio Sicuypata).

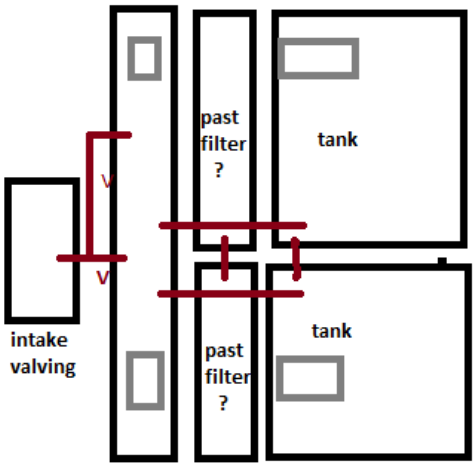
It was discussed that WEFTA would provide input as to what type of water quality testing is recommended on the influent and effluent, and that Sandy would see to it that samples be sent to a certified lab in Oruro for testing. The municipal officials were to round up the plans of the wwtp and provide to WEFTA volunteer treatment engineers for review and possible recommendations for process improvements and operations optimization. Given the terrain of the site, there appeared to be no additional room for polishing ponds.

Coro Coro wastewater treatment plant, recently constructed with funding from the Bolivian government. Local operator Don Ramón, in green overalls, is quite familiar with the treatment processes, having received operator training in Cochabamba.

Don Ramón, the operator of the WWTP, received operator training in Cochabamba and seemed quite familiar with what was required to run the plant. He too would be a good resource for any future collaborative efforts, including potentially serving as the operator for a refurbished potable water treatment plant only superficially in use currently. More on that below.

Coro Coro Water Treatment – possible rehabilitation of former WTP to improve water quality

While visiting with the community representatives of Coro Coro, the problem of water quality in the town's water supply being distributed to the houses arose. They noted that at their taps, they are seeing algae, a lot of suspended solids, even small minnows at times since the community's water comes directly from a river with no treatment whatsoever. The interesting issue is that a water treatment plant was built to supply the mining staff with potable water in the 1970s, which could possibly be refurbished and equipped to be put in use for the town of Coro Coro. The concrete structures appear to be solid (see pix and sketch of facility below). A treatment engineer could perhaps look at the available infrastructure and layout a conceptual plan for bringing it back on-line with clarification/settlement, filtration and chlorination capabilities.



Coro Coro Water Treatment Plant, built in 1976 and essentially abandoned since 1985, though water for mining activities still passes through the storage tanks. Surface water from a stream above bypasses this WTP and is fed to community of Coro Coro with no treatment. Tanks inside WTP building below.

Follow-Up Actions for Coro Coro

Wastewater Treatment Plant – Review for any potential operations improvements

From the Municipality of Coro Coro & Mining Company

1. Provide scanned copy of wwtp plans to WEFTA.
2. Arrange for water quality sampling of wwtp influent and effluent parameters and provide results to WEFTA.

From WEFTA/Suma Jayma

1. Communicate influent and effluent wastewater parameters to Coro Coro officials to determine how effectively the WWTP is operating, and to make any follow up recommendations.

Water Treatment Plant Refurbish for community of Coro Coro and Mining Company

From the Municipality of Coro Coro & Mining Company

1. Provide letter from municipality and mining company soliciting technical support for improvements to the water treatment plant, or other means for improving potability of water being provided to the community.
2. Provide scanned copy of plans of the 1970's era WTP facility, and if not available (likely the case), take dimensions of the concrete structure and piping to be provided to WEFTA.
3. Obtain water quality data of sample from surface water being used by Coro Coro

From WEFTA/Suma Jayma

1. Provide list of water quality parameters for Coro Coro to have analyzed for existing water supply to help determine treatment requirements.
2. If above requirements met, tap water treatment expertise available among WEFTA volunteer engineers to make recommendations for refurbishing and returning to treatment purposes the existing water treatment plant for Coro Coro.

Other topics and desired next steps by Suma Jayma

A. Suma Jayma initiated existing community water well cleaning and restoration services. Their hope is to obtain a more substantial air compressor for this purpose.
B. Suma Jayma initiated hand pump repair services out of their workshop. They have had about a dozen family members come by the workshop to make adjustments to the valve/piston assemblies for a reasonable cost.
C. WEFTA donated Drilling Rig in Good Hands:

   "Little Red" – Dale White's former drilling rig is in good hands with the Suma Jayma team of Bolivia. In addition to putting it to good use drilling community water wells, they have also made several improvements to the rig using their own funds. These include:

   1. Four new tires
   2. Rebuilt diesel motor
   3. Replaced transmission box

4. Newly upholstered truck seats and new floorboard along with new door locks
5. Another coat of white paint on the truck cab with the "White Water Well" logo (and Suma Jayma's phone number) on the side of the door. They noted the blue paint on the rig itself by Eagle Scout John Paul Hesse from Muenster, Texas has held up great.
6. Mud pump piston ring and hydraulic arm seal replacements (parts fabricated in Bolivia)
7. And preventative maintenance such as changing the mud pump oil. They have also installed lights on the drill rig tower and back of the rig for increased safety, and have begun wearing steel-toed boots and hard hats during drilling operations.
8. Currently in process of squaring up the Kelly drive table.

A few pix of improvements Suma Jayma made to their water well drilling rig

D. Suma Jayma's water well drilling is gathering steam, to the tune of one to two community water wells per month recently, with some of these being funded locally with municipal funds. Suma Jayma is looking to improve their drilling capabilities through additional equipment acquisitions, with the intent of being able to drill in a single pass and case up to 8" diameter water wells. During Braulio Rojas' visit to Texas and New Mexico in the second half of October, spending time with driller Dale White, he was introduced to the possibility of foam/compressed air water well drilling as an alternative to drilling mud well drilling. To eventually achieve these two goals, Suma Jayma is hoping to acquire the following equipment in the coming half year:
    - Air compressor – used, trailer mounted (min 165 cfm/120 psi unit)
    - Pneumatic pump (for drilling with foam/air eventually)
    - 160 meters of thicker drill pipe
    - Larger Kelly drive turn table to pass 8" casing, if possible

- Used Kelly bar
- Additional large diameter bits
- Commercial generator
- Portable Water Quality Analysis Equipment
- Additional machine shop tools for the Suma Jayma fabrication workshop

In 2017, Suma Jayma plans on purchasing another $10,000 worth of bentonite and gel plug for well sealing (300 bags of bentonite; 200 bags of well sealer). Each bag of bentonite was costing $16.50 U.S. out of Chile (price to be checked again by Braulio). Suma Jayma would like to explore the cost of purchasing directly in the US and shipping to Bolivia (Suma Jayma covering the cost, but hoping WEFTA volunteers can help with the procurement/transportation logistics coordination).

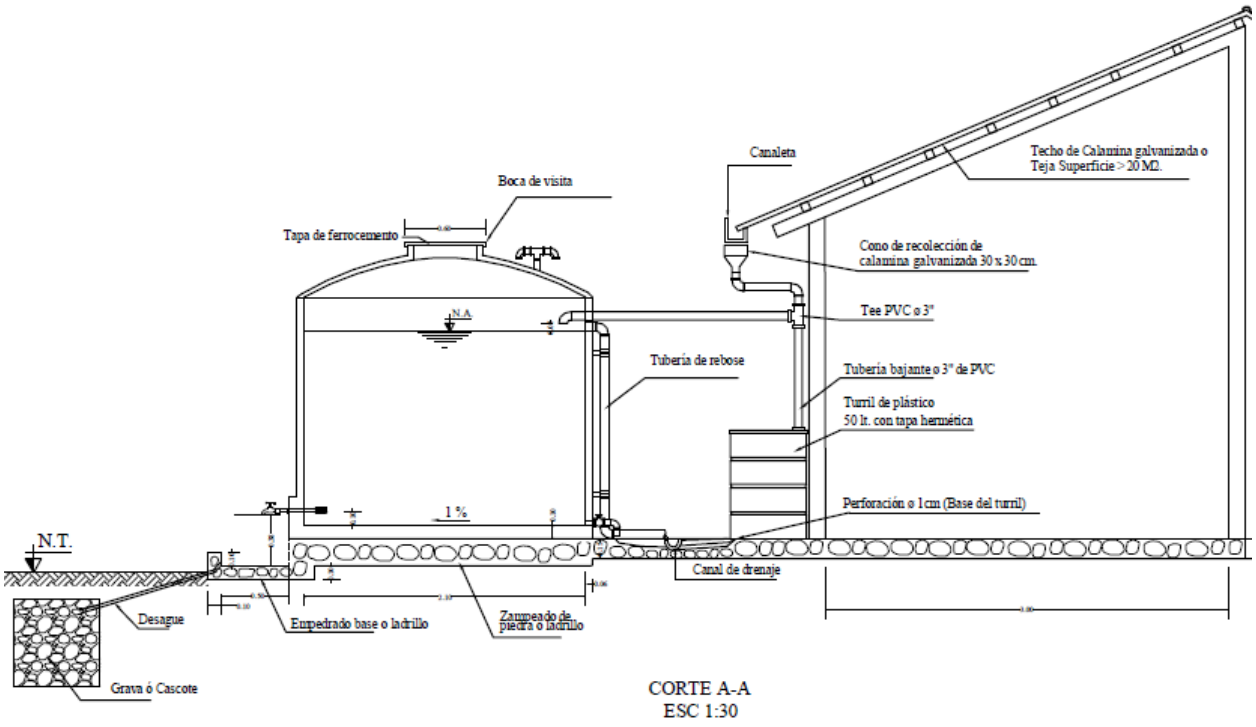
During Braulio's visit to Texas and New Mexico in mid-October, he was introduced to foam drilling by Dale White, shown here. Dale explained the stops that would be needed if desired by Suma Jayma to retrofit their own drilling rig to be able to use compressed air/foaming agent in lieu of drilling mud with bentonite.

E. El Chorro Rain Catchment: Follow-up on proposed projects for three communities downstream of Huanuni mining contamination

In 2013, members of WEFTA and Suma Jayma visited communities downstream of the Huanuni mine contaminating the watershed below. Three communities were identified. There are 15 families in El Chorro who could benefit from a rain catchment system, and two other communities that could benefit from family hand pumps. These 15 families have had tin roofs installed and a rain catchment for each of them would also serve 3 to 5 families near each location.

Next steps for El Chorro include having Suma Jayma follow-up with a visit to verify the houses have had tin roofs installed, to determine what contributions have been made by local families and what additional contributions can be made, and then to start with a pilot project for one family which if successful and if interest from the rest in terms of contributing to the project, then install for the remaining 14 families.

Below is an excerpt of a typical construction plan from the Bolivian govt for rain catchment, including a "dirty" barrel with a small opening on the bottom for taking the first rain carrying the debris/dust from the roof. The size of the tank shows to be 5000 liters, which needs to be verified. Typical house roof dimensions in this area of Bolivia are 6 meters by 2.5 meters wide, sloped in a single direction.



F. Update on volunteer Jim Erario

James Erario, mechanical engineer out of Connecticut, has spent the last couple months working alongside the Suma Jayma team in the Bolivian altiplano. Here pictured assembling hand pump components.

Larger Context of Bolivian Andes Water Resources Situation

Bolivia is currently suffering an intense drought (other regions such as Cochabamba area even worse than the La Paz department). Might get some relief with changing pacific ocean temps away from El Niño conditions that have been at play over the past year plus. In the past year, Lake Poopo has completely dried up – a first in modern history. Causes range from decreased rainfall/runoff to over irrigation upstream and diversion for mining purposes. Lake Titicaca on the Peru-Bolivia border is at its lowest level since 1949. A month after this country visit, the capital city of La Paz entered into extreme water rationing as its reservoirs are at approximately 5% capacity, with some one hundred neighborhoods in La Paz only receiving three hours of water once every three days. Immediate govt responses to the urban water shortage has been rationing and trucking in water.

Substantial public works are taking place throughout the countryside, although major new water supply infrastructure projects for the twin cities of La Paz and El Alto (estimated population 2+ million) are lacking.

Government appears to be willing to lift 19% customs tax on productive equipment for developing water resources, such as importing drilling rigs

Appears to be a growing awareness and allocation of public funds to address contamination of rivers due to wastewater discharges.

Computers with Internet in Senkata Parish Libraries, thanks to Spirit of Christ Parish grant from Denver, Colorado in coordination with WEFTA

Spirit of Christ Parish of Denver, CO grant via WEFTA to install ten computers with internet along with a new printer in each of the two libraries located in Zona Senkata, El Alto, which were installed with local participation under the guidance of IT specialist Chris Edmundson (see report provided by Chris Edmundson in Appendix A).

Appedix A

“¡Viva Bolivia!”, in my own words…by Chris Edmundson

With some apprehension, excitement, and desire to succeed with the installation of the 10 computers for the two libraries in the Senkata zone, Jason, Felicia, Nicholas, and I landed at the El

Alto International Airport which is at approximately 13,323 feet in altitude on Thursday, October 5th, 2016. My initial reaction after passing through customs was mostly the physical, attempting acclimate to the dramatic change in altitude while being astounded by the grace and beauty of the mighty Andes mountain range. We were greeted by Father Alfonso, Josu, and Braulio who immediately made us feel welcome. Although some my initial apprehension was starting to fade, I had no idea what would follow next in my adventure.

Bolivians are well known for their resistance to the government when they are troubled by the decisions of the bureaucrats. We experienced this resistance through blockades in the Senkata zone where our objective was to install 10 computers for 2 of the libraries associated with the Red de Senkata Biblioteca or Senkata Library Network. While meandering our way from the airport, our host Josu from the Comunidad Adsis (our first host) made several strategic turns though the Senkata zone around the blockades to their community. With plenty of adrenaline and enthusiasm, Jason and I along with Josu made our way on foot to the first of the libraries with computers/associated equipment in backpacks which allowed us to bypass the blockades. We made additional trips on the following day, with the assistance of Nicholas using further alternative means for the additional computers and their monitors. With our first challenge of getting the equipment to the locations completed, our next challenge was to setup the computers and associated equipment while making certain to provide the proper training to the local administrators – essentially to ensure the sustainability of the project.

Starting with the “Navidad” Biblioteca then continuing the work at the “San Francisco” Biblioteca- Josu, Ruthie, and other members of the community were trained on the installation and configuration of the computer systems. Additionally, a system installation guide and software installation guide were provided with an English to Spanish translation for the Windows Embedded operating system and the software installation for Acrobat Reader, Libre Office, and the Chrome browser – all of which were setup in the Spanish language set. A unique feature of the computers or also known as “thin clients” provide a small footprint while also utilizing a built in feature to “freeze” the system where when restarted returns the system to its original setup. Thus, the system can be maintained with ease by the local administrators. Due to excellent pricing and some additional funding by others, we were able to extend the purchase of 10 computers – originally 5 computers were allocated - and the associated equipment for 2 libraries for the Red de Senkata Biblioteca. The additional equipment included wireless networking equipment and a printer for each location.

Also, I was so astounded by the hospitality from so many persons. In countless situations, I was welcomed as if I were a one of their closest family members. Although my Spanish is far from fluent, so many showed incredible patience with my lack of fluency.

In addition to the primary project of installing the computer systems, I was fortunate to have the time to be exposed to the water projects sponsored by the Water Engineers for the Americas (WEFTA) organization. Braulio and Jaime provided tours to a well that was recently drilled and a water collection facility. These water projects provide water for a

wide variety of purposes, primarily for drinking water and for agricultural purposes in the regions. Braulio also provided a tour of their local workshop, where he and his team fabricate parts including manual pumps for the regions they serve. With strong conviction, I truly believe Braulio and his team have a deep sense of compassion ("sharing the suffering") and passion for delivering clean water systems to those Bolivians in need of such assistance.

It would be very remiss of me not to mention a sincere gratitude for all of the parties who made this project possible. First and foremost, WEFTA and the Spirit of Christ Catholic Community were gracious to provide the financial support for the project – and for them "¡Muchas gracias!" Arisant (via Niklas Iveslatt) provided 50 USB flash drives and a wireless router for the project – again "¡Muchas gracias!". Kensington (via David Peterson) donated 10 locks to secure the computers and their associated equipment – "¡Muchas gracias!". The Comunidad Adsis (Maria, Josu, Ruthie, and Javier) graciously provided our home away from home along with a stay with Braulio's family residence – "¡Muchas gracias!". Many other individual contributors, including Eusebio, Carlos, Jason, Felicia, Nicholas, Padre Pablo and Padre Alfonso, and others were key to making this project successful – "¡Muchas gracias!"

Finally, I was so very lucky to have a little free time to see my first international soccer game and so I end simply with "¡Viva Bolivia!"… "¡Hasta Luego!" … "¡Vaya Con Dios!".

Appendix B

RESUMEN EJECUTIVO

1. NOMBRE DEL PROYECTO:	**COMPLEMETACION SISTEMA DE GAU POTABLE CHIPAMAYA".**
2. TIPO DE PROYECTO:	• Ampliación del sistema existente.
3. UBICACIÓN POLITICA	• Municipio de Pucarani Prov. Los Andes del Departamento de La Paz.
4. UBICACIÓN GEOGRAFICA(UTM): **DATUM WGS-84 ZONA 19 SUR** • ESTE (X): • NORTE(Y):	561309 8188559
6. COSTO:	50.000.00

1. NOMBRE DEL PROYECTO:	**COMPLEMETACION SISTEMA DE GAU POTABLE CAVIÑA".**
2. TIPO DE PROYECTO:	• Ampliación del sistema existente.
3. UBICACIÓN POLITICA	• Municipio de Pucarani Prov. Los Andes del Departamento de La Paz.
4. UBICACIÓN GEOGRAFICA(UTM): **DATUM WGS-84 ZONA 19 SUR** • ESTE (X): • NORTE(Y):	561309 8188559
6. COSTO:	75.200.00

1. NOMBRE DEL PROYECTO:	**MEJORAMIENTO SISTEMA DE AGUA POTABLE ANCOCAGUA".**
2. TIPO DE PROYECTO:	• Ampliación del sistema existente.
3. UBICACIÓN POLITICA	• Municipio de Pucarani Prov. Los Andes del Departamento de La Paz.
4. UBICACIÓN GEOGRAFICA(UTM): **DATUM WGS-84 ZONA 19 SUR** • ESTE (X): • NORTE(Y):	561309 8188559
6. COSTO:	25.00.00

INFORME

CITE: GAMP/ SMOP-U-ZC/INF - 043 / 2016

A : Francisco Hidalgo Condori
HONORABLE ALCALDE MUNICIPAL
G.A.M. - PUCARANI

Vía : Ing. Reynaldo Quenallata Bernabé
STRIO. MUNICIPAL DE OBRAS PÚBLICAS Y URBANISMO
G.A.M. - PUCARANI

De : Ing. Álvaro Carbajal Nina
SUPERVISOR DE OBRA ZONA CENTRO SMOP-U
G.A.M. - PUCARANI

Ref. : **INFORME TECNICO SISTEMA DE AGUA POTABLE ANCOCAGUA**

Fecha : 27 de ABRIL de 2016

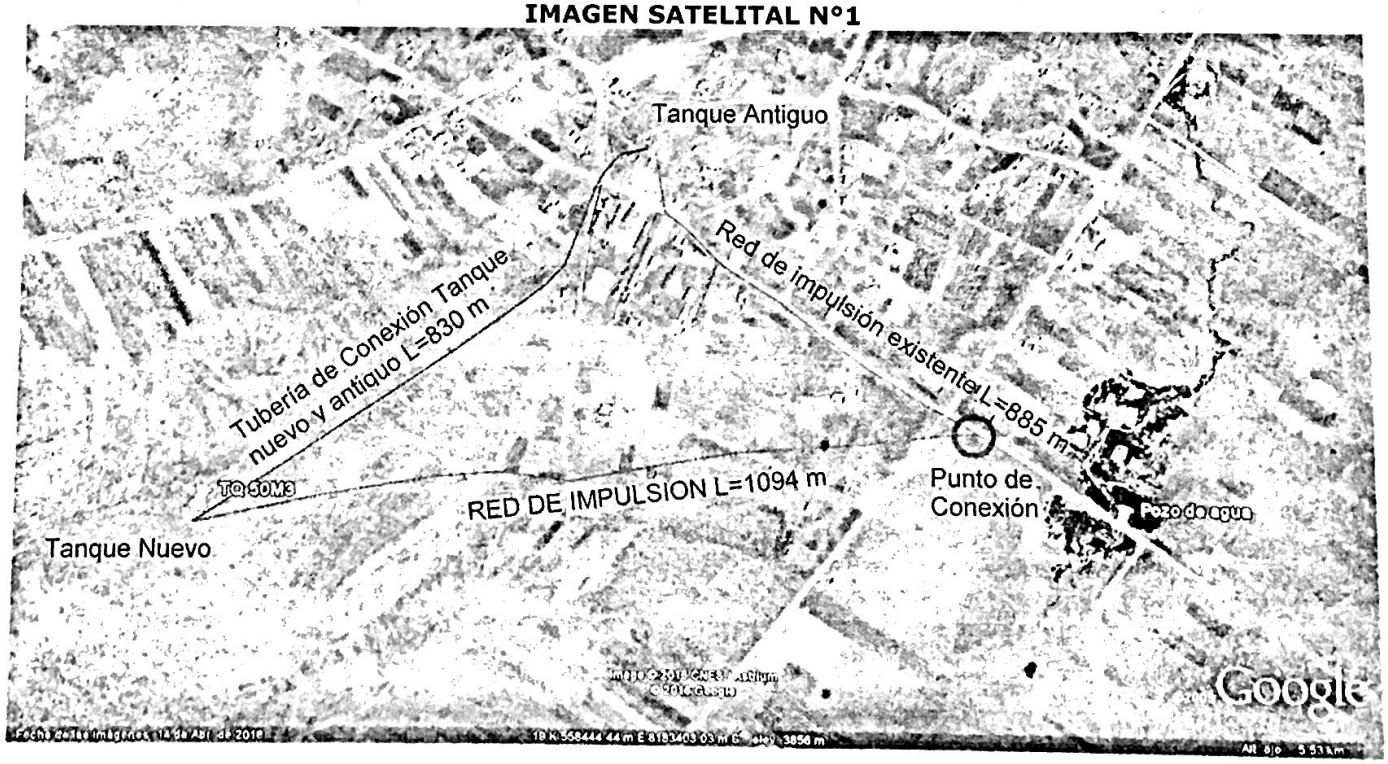
Honorable Alcalde:

De acuerdo a inspección realizada en fecha 20 de abril de 2016 en la comunidad de Ancocagua al sistema de agua potable en construida en la comunidad se pudo constatas las siguientes observaciones.

1. RED SISTEMA DE AGUA POTABLE

La imagen 1 muestra la línea de impulsión realizada por parte del programa mi agua mediante el cual se realizó la implementación del sistema de agua potable.

IMAGEN SATELITAL N°1



2. SISTEMA DE CONEXIÓN NUEVA

Tal como se muestra en la imagen satelital N°1, se tiene las tuberías de impulsión y de interconexión entre tanque nuevo y antiguo las cuales se encuentran dispuestas en el terreno pero no estas completadas mediante la conexión al sistema existente de la comunidad.

En el punto de interconexión entre las tuberías de impulsión existente y nueva se evidencia que no existe accesorios que conecten estos dos sistemas, la cual es imprescindible para poder realizar la alimentación del agua hacia el tanque nuevo, debido a la falta de esta conexión el tanque nuevo construido no se encuentra en funcionamiento.

En cuanto a la tubería de conexión entre el tanque nuevo y el tanque antiguo la misma cuenta con todos los accesorios de salida desde el tanque nuevo y así como también se tiene el tendido de la tubería hasta las proximidades del tanque antiguo pero no cuenta con un sistema de conexión hacia la entrada al tanque antiguo por lo cual este sistema no entraría en funcionamiento.

En cuanto al pozo de agua existente la misma cuenta con una bomba de agua de pequeña capacidad la misma no podría realizar el bombeo del agua hacia el tanque nuevo por la distancia que se tiene hacia este y el desnivel existente entre el pozo y el tanque, por lo cual es necesario realizar la implementación de una comba de agua de mayor capacidad para poder realizar el bombeo correspondiente hacia los dos tanque de agua.

3. COSTO DE ADQUISICION DE LOS MATERIALES

Para poner en funcionamiento el nuevo sistema de almacenamiento de agua construido por el FPS, es necesario realizar la adquisición de los siguientes materiales y posterior implementación para la distribución de agua.

LISTA DE MATERIALES				
ITEM	**DESCRIPCION**	**UNIDAD**	**CANTIDAD**	**PRECIO**
1	BOMBA SUMERGIBLE DE 5 HP + TABLEDO DE CONTROL	GLB	1	21000.00
2	ACCESORIOS DE CONEXIÓN TUBERIAS DE IMPULSION E INGRESO A TANQUE	GLB	1	1200.00
3	TUBERIA DE 2" E-40 L=6M	PZA	8	985.00
	COSTO TOTAL DE LOS ACCESORIOS			**23185.00**

El costo de los materiales para la puesta en funcionamiento del tanque de agua asciende a un monto de **Bs. 23 185.00 (Veintitrés mil ciento ochenta y cinco con 00/100 bolivianos),**

6. CONCLUSIONES Y RECOMENDACIONES

Conclusiones

Realizado el análisis del problema existente para el funcionamiento del sistema de agua en la comunidad de Ancocagua, es requiere un monto de **Bs. 23 185.00 (Veintitrés mil ciento ochenta y cinco con 00/100 bolivianos),** para que el sistema entre en operación, así también no se cuenta con los documentos técnicos de la construcción de este sistema de agua por lo cual es necesario contar con este para ver los alcances del proyecto y si estos trabajos no estaban contemplados en el costo de la obra.

Es cuanto se informa para fines consiguientes de la institución.

c.Arch.
GAMP/SMOP-U

PRESUPUESTO GENERAL

PROYECTO: SISTEMA DE AGUA POTABLE CAVIÑA

Moneda: Bolivianos

ÍTEM	DESCRIPCIÓN	UND.	CANTIDAD	PRECIO UNITARIO LITERAL	PRECIO UNITARIO	COSTO PARCIAL	COSTO TOTAL
01.	**TENDIDO DE TUBERIA**						
1	TUBERIA DE PVC DE 3"	ML	0.00	Cincuenta y cinco 17/100 Bo	55.17	0.00	
2	PROVISION Y TENDIDO DE TUBERIA PVC E-40 2" J.E.	ML	342.00	Veinticuatro 42/100 Bolivian	24.42	8 351.64	
3	ACCESORIOS POZO SURGENTE	PZA	0.00	Doscientos ochenta y seis 81	286.81	0.00	
	SUBTOTAL TENDIDO DE TUBERIA						**8 351.64**
02.	**TANQUE DE ALMACENAMIENTO**						
4	HORMIGON ARMADO H-21	M3	22.24	Tres mil trecientos ochenta y	3 382.84	75 234.32	
5	ACCESORIOS DE INGRESO Y REBALSE	PZA	1.00	Dos mil novecientos noventa	2 997.91	2 997.91	
6	REVOQUE INTERIOR CON IMPERMEABILIZANTE	M2	85.29	Ciento ochenta y uno 49/100	181.49	15 479.62	
	SUBTOTAL TANQUE DE ALMACENAMIENTO						**93 711.85**
03.	**SISTEMA DE BOMBEO**						
7	MURO DE LADRILLO DE 6 H	M2	16.96	Ciento cuarenta y nueve 96/	149.96	2 543.32	
8	CUBIERTA DE CALAMINA N°28 INCLUYE MADERAMEN	M2	4.62	Ciento ochenta y uno 46/100	181.46	838.35	
9	PUERTA METALICA DE 0.80 X 1.80	PZA	1.00	Novecientos cuarenta y tres	943.08	943.08	
10	PROV. E INST. ACCESORIOS DE SALIDA Y LIMPIEZA	GLB	1.00	Dos mil cuatrocientos novent	2 490.68	2 490.68	
11	INSTALACION DE BOMBA 5 HP CENTRIFUGA	PZA	1.00	Veintiun mil seiscientos seis	21 606.09	21 606.09	
	SUBTOTAL SISTEMA DE BOMBEO						**28 421.52**
04.	**SISTEMA ELECTRICO**						
12	ACOMETIDA MEDIDOR Y OTROS ACCESORIOS	PZA	1.00	Un mil trecientos ochenta y t	1 383.98	1 383.98	
13	PLANTADO Y COMPACTADO DE POSTE 10 M CLASE 6	PZA	1.00	Un mil quinientos sesenta y c	1 562.36	1 562.36	
14	CABLEADO Y FLECHADO ACSR N°4	KM	0.20	Cinco mil ochocientos setenta	5 870.82	1 174.16	
15	INS. TRANFORMADOR MONOFASICO DE 5 KVA	PZA	1.00	Ocho mil doscientos cincuent	8 255.67	8 255.67	
	SUBTOTAL SISTEMÁ ELECTRICO						**12 376.17**
	COSTO TOTAL DEL PROYECTO						**142 861.18**

PRESUPUESTO DE MATERIALES

PROYECTO: SISTEMA DE AGUA POTABLE CAVIÑA

Moneda: Bolivianos

ITEM	DESCRIPCIÓN	UND.	CANTIDAD	PRECIO UNITARIO	COSTO TOTAL
1	ACCESORIOS DE CONEXION	GLB	1.00	1 500.00	1 500.00
2	ACERO ESTRUCTURAL	KG	2 001.60	8.25	16 513.20
3	ALAMBRE DE AMARRE	KG	44.48	13.00	578.24
4	ALAMBRE DE COBRE RECOCIDO SD Nº6	PZA	3.00	20.40	61.20
5	ARENA FINA	M3	14.95	140.00	2 093.13
6	BOMBA CENTRIFUGA DE 5 HP	PZA	1.00	12 000.00	12 000.00
7	CABLE DUPLEX N°4 AWG	PZA	10.00	7.20	72.00
8	CALAMINA ONDULADA N. 28	M2	4.85	45.00	218.30
9	CEMENTO	KG	9 318.24	1.25	11 647.80
10	CLAVOS	KG	45.17	13.00	587.25
11	CLAVOS DE CALAMINA	KG	0.92	15.00	13.86
12	CODO 45 CAMPANA 3"	PZA		42.00	
13	CODO 90 CAMPANA 3"	PZA	2.00	36.00	72.00
14	CODO 90 FG 2"	PZA	10.00	36.00	360.00
15	COLADOR BR 2"	PZA	1.00	148.00	148.00
16	CONTROLADOR ELECTRONICO	PZA	1.00	1 000.00	1 000.00
17	GRAVA	M3	20.02	140.00	2 802.24
18	LADRILLO DE 6 H 24*15*11 CM	PZA	407.04	1.50	610.56
19	LIMPIADOR DE PVC PARABOND	LT	2.74	95.00	259.92
20	LLAVE DE PASO BR 2" CORTINA	PZA	4.00	362.00	1 448.00
21	MADERA DE CONSTRUCCION	P2	1 556.80		
22	MADERA SEMIDURA	P2	16.17	8.00	129.36
23	MALLA PREFOR FIN DE LINEA NEUTRO ACSR 4	PZA	2.00	7.10	14.20
24	MEDIDOR MONOFASICO 220 V - 15A (100A)	PZA	1.00	650.00	650.00
25	NIPLE HEXAGONAL FG 2"	PZA	11.00	34.00	374.00
26	PEGAMENTO PARA PVC (ALTA DENSIDAD)	LT	0.34	120.00	41.04
27	POSTE DE EUCALIPTO DE 10M	PZA	1.00	1 100.00	1 100.00
28	PUERTA DE PLANCHA METALICA E=1 MM	PZA	1.00	750.00	750.00
29	REDUCCION FG 1 1/2 -2"	PZA	2.00	24.00	48.00
30	REDUCCION PVC AG.TU 3"X 2 1/2"	PZA		35.00	
31	REDUCCION PVC AG.TU 4"X 3"	PZA		35.00	
32	SIKA 1	KG	25.59	14.00	358.22
33	TABLERO DE CONTROL	PZA	1.00	5 000.00	5 000.00
34	TEE FG 2"	PZA	2.00	66.00	132.00
35	TEE PVC 3" CA	PZA		47.00	
36	TEFLON DE 3/4"	PZA	10.00	2.00	20.00
37	TRANSFORMADOR DE 5 KVA	PZA	1.00	5 265.00	5 265.00
38	TUBERIA DE F.G. 2"	ML	12.00	71.00	852.00
39	TUBERIA DE PVC 2" E-40 J.E.	ML	359.10	18.00	6 463.80
40	TUBERIA DE PVC 3" C-15	ML		39.80	
41	UNION UNIVERSAL FG 2"	PZA	6.00	101.00	606.00
42	VALVULA DE RETENCION BR DE 2"	PZA	1.00	300.00	300.00
43	BASTON METALICO 1" X 3	PZA	1.00	95.00	95.00
44	CABLE DE ALUMINIO ACSR N°4 AWG	ML	200.00	4.30	860.00
45	CONECTOR DE BR ELECTRODO PUESTO TIERRA	PZA	1.00	7.68	7.68
46	VARILLA DE TIERRA 5/8" X 8"	PZA	1.00	73.25	73.25
	TOTAL				**75 125.24**