Design Updates

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Abstract

The following report documents the changes made to the AguaClara Automated Design Tool during the Summer 2014 program. The first changes were the result of the work done by the Design Team during the Spring 2014 semester, including the additon of the chamical Dose Controller Manifold and the Weir Control System for the Stacked Rapid Sand Filter. Lastly is a list of minor changes to the design tool for the purpose of upcoming low flow plant requests from Honduras.

Updates from Spring 2014

This section details the addition of the updates completed in Spring 2014 to the AutoCAD scripts referenced by the Master EtFlocSedFi File.

Chemical Dose Controller

During the Spring 2014 semester, Zeyu Yao and Chenxi Wen worked on updates to the CDC code based on the fabrication done by the research team in the Lab and the information from on site. the two most significant changes are the inclusion of the lever arm and the manifold. Their report can be found here. The flexible tubing, however, was not completed and is not included in the current drawings.

Lever Arms

The lever arms had to be moved so that the L brackets which connect them to the side of the Entrance tank are in the center of the wall, and the conection to the float had to be shifted so that it began at the center of the two lever arms. This adjustment only required shifting the origin point of the first lever arm.

Manifold

The Manifold used to deliver coagulant and chlorine to the influent water was a new addition to the plant drawint, though it had been previously inplemented in

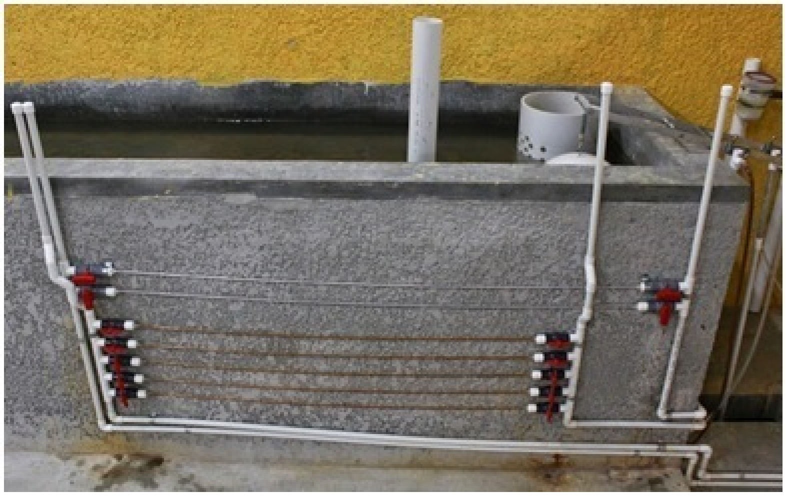

Figure 1: CDC Manifold in San Nicholas

Honduras at the San Nicolas Plant. In Zeyu and Chenxi's design, the Manifold intersected with the lever arm at lower flow rates which had more dosing tubes and back up dosing tubes. Also, the top of the manifold stuck out above the top of the entrance tank wall. Concerns with their design are as follows:

- Interaction with the lever arm
- Vertical space on the entrance tank wall

Moving the Manifold out from under the Lever Arm

This simple change only involved moving the origin of the first manifold component listed, namely the Chlorine delivery pipe origin.

Stacking the Deliver Pipes to Reduce Space

In order to insure that the manifold was supported by the entrance tank wall, the fabrication team in San Nicholas designed the CDC Manifold so that the two delivery pipes are stacked directly on top of one another and the rigid vertical pipes bend out from the wall to accommodate dosing tubes. The set up at San Nicholas is shown below in Figure 1.

In order to create this in the design tool, the places where the vertical pipe bends out over the dosing tubes are ignored, and we assume that the engineers on site will construct the pipes similar to Figure . In the design tool, the vertical pipes intersect with the dosing tubes. To determine which deliver pipe is on top, the lengths of the delivery pipes are compared so that the shorter tube is on top. The dosing tubes are always constructed so that the chlorine dosing system sits on the wall above the coagulant dosing system. While, for

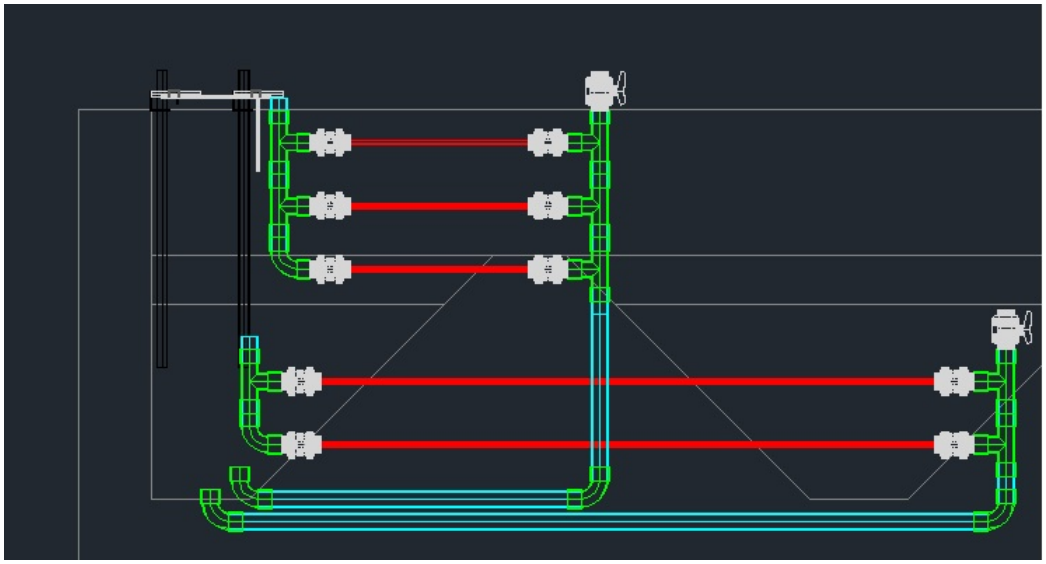

Figure 2: Manifold at 6 Lps

flow rates which result in many dosing tubes, the tops of the air release tubes still stick out above the entrance tank wall, all of the dosing tubes are supported by the entrance tank wall. The results for Flow Rates of 6 Lps, 10 Lps, and 30 Lps are shown below in Figures 2, , and . This version of the code it used in the ChemicalDoseControllerAC file referenced in EtFlocSedFi.

The possible errors with this design are the clearance heights between the dosing tubes and delivery pipes, which can be added to Expert Inputs following discussion with the field engineers or testing in the lab. Currently, the clearance is just estimated and defined as elbow height. Additionally, for very large flow rates with large dosing tube lengths, the plant wall on the front of the entrance tank may become another limiting factor. Lastly, depending on the flow rate and the resulting lengths of the delivery pipes for the chlorine and coagulant, it may reduce construction complication to switch the vertical order of the chlorine and coagulant dosing systems.

Stacked Rapid Sand Filter Influent Weir Control

During the Spring 2014 semester, Runpeng Yu and Paul Larios developed code for a weir control system in the inlet channel of Stacked Rapid Sand Filter. The reason for this change can be found in their report. The motivation of this modification is to allow backwash of an individual filter in a multi-filter system when the flow rate is less than the maximum value. The general changes are the inclusion of a weir control box before the inlet channel, the separation of the inlet channel between filters, and a system of removable weirs to control flow

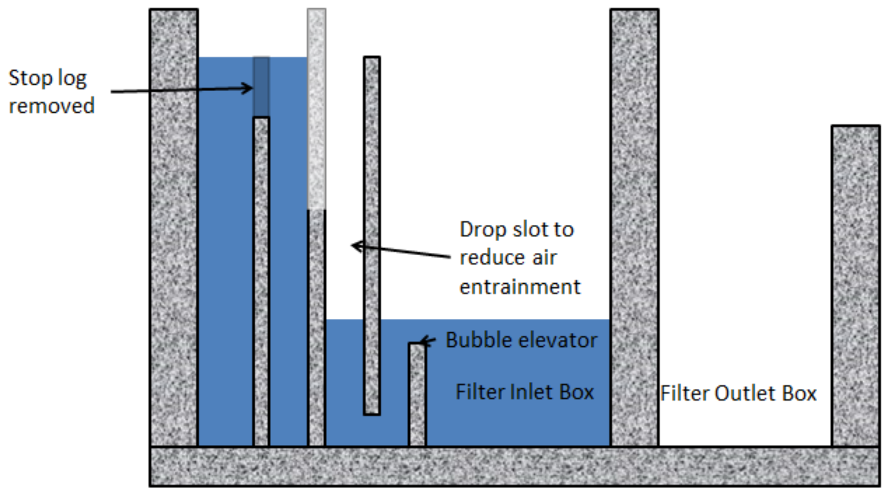

Figure 3: Filter Inlet Weirs During Backwash

between filters.

Inlet Elbow

The purpose of the elbow was to raise the bottom of the weir control box or the filter inlet channel, to make fabrication easier. However, the addition of the elbow to the existing design resulted in a 5 cm increase in the depth of the filter and without making the inlet channel unreasonably wide and shallow, will not ease fabrication. For the above reasons, this method has been discarded.

Removable Weirs

Instead of using an elbow and constructing shallow and potentially wide channels, the inlet channel and weir control box for the filter will be constructed as one deep channel separated by four removable weirs. The last two weirs in this system are already in place as removable baffles spaced close together to prevent spilling, while the second weir will now be adjustable and sink to the depth of the channel and the first weir will be added in a similar manner.

The method of using removable weirs relies upon the assumption that leaking will not inhibit plant performance and that the materials used to construct the weirs are both sustainable and safe to use.

The headloss caused by removing the stop log must be kept to a minimum (chosen value: 5% of the height of the drop slot) so that the water will continue to flow through the filter in normal filtration mode.

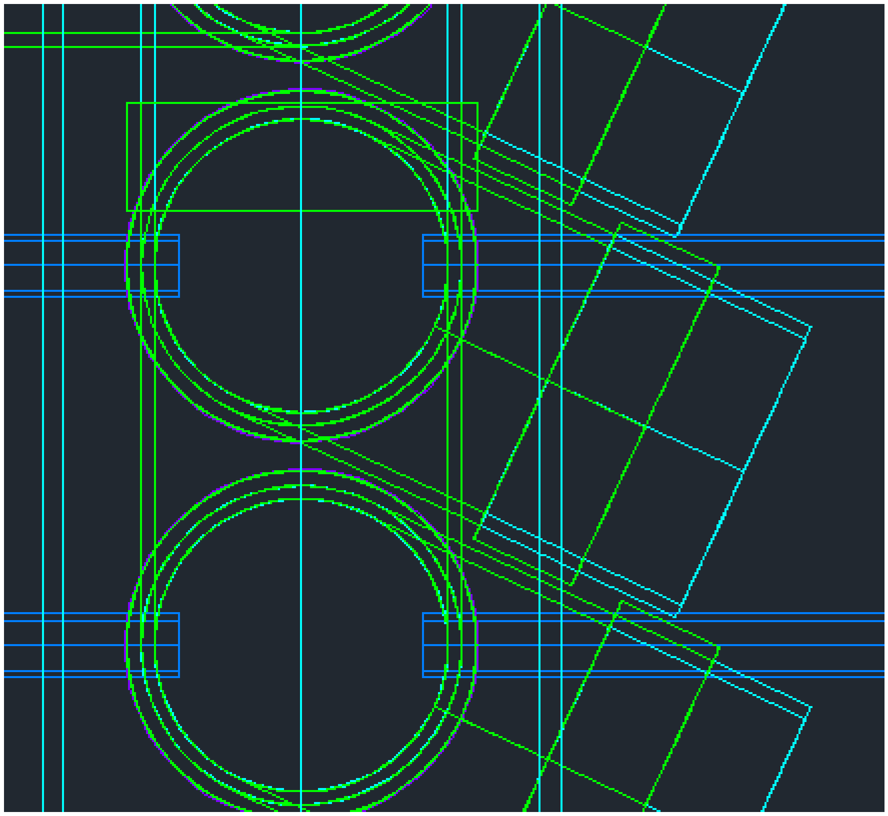

Figure 4: Tight Fit of Entrance and Exit Valves

Entrance and Exit Valves

As in the San Nicholas Plant, the entrance and exit pipes to the filter have valves used for drains which are connected to the manifold using Tee valves at angles of approximately 25 degrees. The valves used must be rotated also and reduced in size to fit. This tight spacing is shown in Figure 4.

Siphon Air Release

The air release valve for the backwash siphon, which is opened prior to backwashing, needed to be brought up to the level of the walkway for easy access. this has been accomplished using a series of PVC reducer plates and elbows to first secure the plumbing close to the outside of the filter box and next to raise it to the level of the walkway.

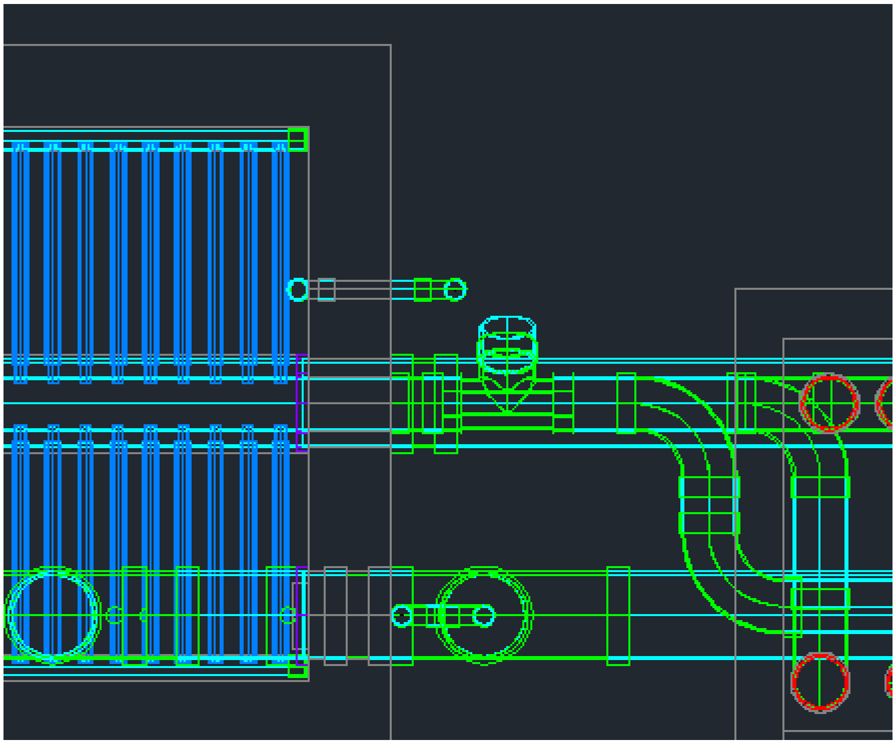

Figure 5: Filter Sand Drain

Sand Drain

The sand drain has been relocated to face into the pipe gallery, exiting the filter box at a 90 degree angle between the 6th and 7th sand layers. The distance from the manifold has yet to be determined.

Future Work

Future work on this modification will stem from increased understanding of fabrication techniques and the accommodation of high flow rate plants.

Fabrication

The weir control box, which is only needed in the case of two or more filters, may be useful on all filters built to allow for the easier addition of filters in the future. Also, the material of the removable weirs must be considered. It is best to have a thin, removable sheet that spans the entire channel width or a more narrow weir? These questions may be answered after consulting with field engineers.

High Flow Rate Plants

In the high flow rate plants with multiple treatment trains, the entire plant layout changes so that the orientation of the filters spins 90 degrees. The drawing files for the weir control system must be conditioned to allow for flexibility in the plant layout.

Sedimentation Tank

Sed Tank Bottom

The concrete slab laid on top of the foundation has been eliminated so that the sludge drain channel begins at the elevation of the foundation. The extra 15 cm of space in the sed tank increases the height of the floc weir, so there is a greater total settling depth. The origin points of the concrete components, the sludge drain, and the hopper drain have been decreased using the addition of a variable called DropSedTank which is calculated in the design code so that the bottom of the sludge drain is the bottom of the sed tank. The reason that this solution is more complicated than simply increasing the height of the sed tank walls while the sed tank origin is decreased is that the sed tank origin is the plant origin, or (0,0,0). The solution used allows the plant origin to be conserved.

Lamella Support

In San Nicholas, Tee fittings have been modified to support the manifold which holds the plate settlers. Instead of cutting the Tee fittings, however, the new design for manifold support in the concrete of the sed tank is to cut holes into the concrete support ledge for the manifold to rest in. This also involves lengthening the manifold pipes which extend in the y direction. The holes are shown in Figure 6.

Floc Weir Width

The width of the floc weir (or T.SedWeir) located in the materials database file was set to 5 cm instead of 4 cm after consulting with engineers in Honduras.

Bay Division Width

While the option for a double bay sed tank has been eliminated, in order to conserve concrete, the thickness of the wall dividing the sed tanks is only 15 cm. There is a ledge that sticks out of the wall to support the lamella. The extra width of the sed tank increases the height of the side slopes and reduces concrete use.

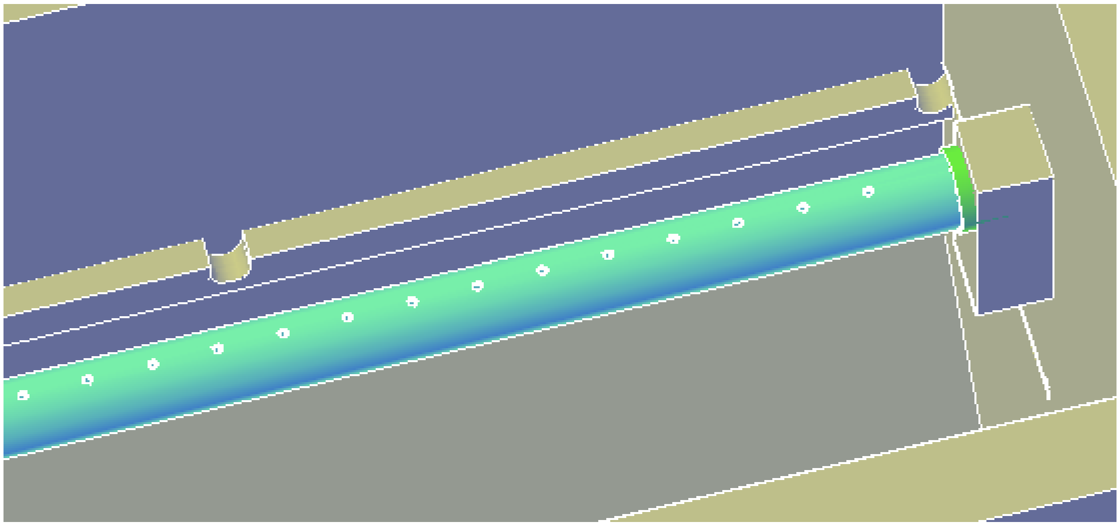

Figure 6: Lamella Support Cutouts

Future Work

The most significant area of future work is the addition of Serena Takada's code for the sloping of the inlet channel into the EtFlocSedFi file. Currently, a drawing error prevents the server from producing drawings of this modification.

Server Preparation for Low Flow Rates

The following changes were made to the EtFlocSedFi file to allow for updated server drawings of the plant.

- Removal of the bottom slab in the Sedimentation Tank
- Moving the filters away from the chemical stock tank platform if there is more than one filter
- Reverting back to LFOM pipes instead of channels for higher flow rates
- Implementation of the filter weir control system discussed above
- LFSRSF for flow rates below 10 Lps

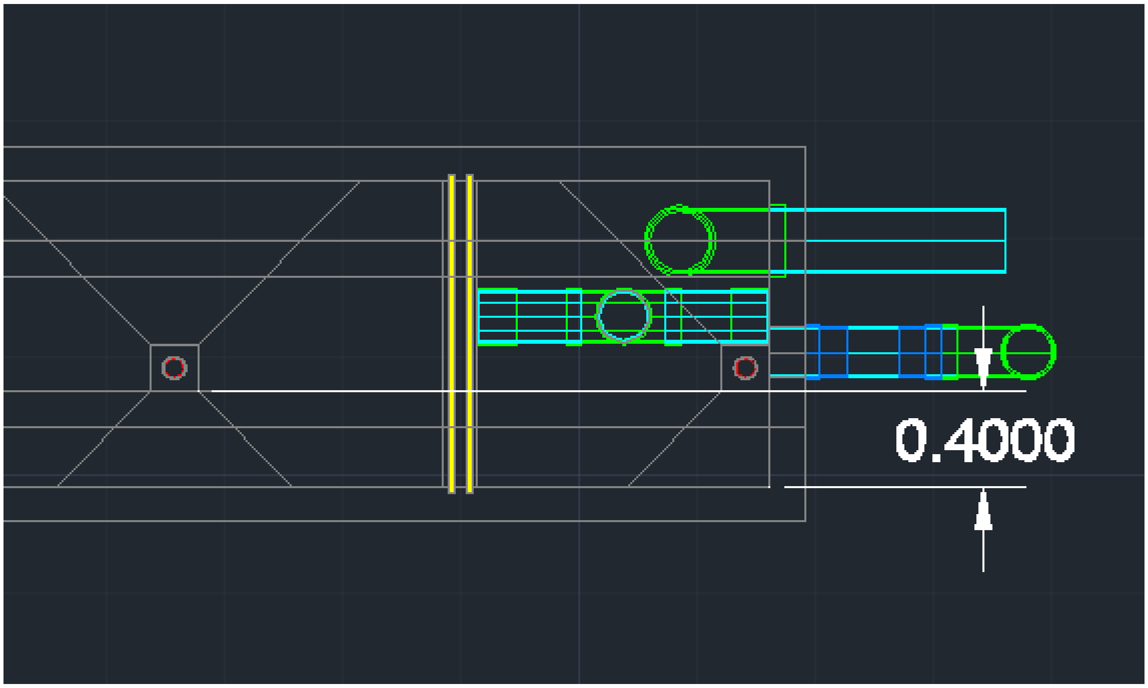

Figure 7: Entrance Tank Hopper Spacing and Support

Small Changes

Entrance Tank

The LFOM channel design is not yet in a place where it can be drawn in sync with the flocculator or hoppers, and the channel itself is still very difficult to construct and to waterproof effectively. Therefore, the LFOM pipe is still used at flow rates as high as 70 Lps. Minor corrections of the hopper and plumbing origin points were also made. The length of the front and back hoppers was set so that the front hopper is exactly 40 cm long to provide adequate support of the entrance tank above the drain channel and as a maximum distance for an operator to reach to remove the pipe stub from the hopper drain. To accommodate this set value, the drain channel was moved so that it starts at the edge of the front hopper.

These minor changes are shown below at 50 Lps in Figure 7.

Future work for the Entrance Tank will include the drawing of the LFOM channels and parallel entrance tanks at high flow rates.

Large Changes: LFSRSF

Fabrication of stacked rapid sand filters below approximately 10 Lps is impractical, meaning that low flow stacked rapid sand filters should be used for all flow rates below 10 Lps. No progress was made this summer towards implementing the LFSRSF into high flow plants.