Enhanced Residuals Treatment Helps Tampa Bay Water Regional Surface Water Treatment Plant Achieve Total Recycling

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Tampa Bay Water (TBW) is a regional water supply authority that supplies drinking water to its six member governments in the Tampa Bay region. The members include Hillsborough, Pinellas, and Pasco counties, and the cities of Tampa, St. Petersburg, and New Port Richey. Through its member governments, potable water is supplied to more than 2.5 million people, at an average rate of about 180 million gallons per day (mgd), from sources that include groundwater, surface water, and seawater desalination. The TBW's Regional Surface Water Treatment Plant is a critical component of the regional system, and was recently expanded from a treatment capacity of 66 to 120 mgd. The project delivery method chosen for the expansion project was design/build/operate. The TBW selected the team of Veolia Water North America (VWNA) as the designer/builder/operator, and VWNA contracted with CDM Smith as the design engineer. The treatment plant treats raw source water from the Alafia River, Hillsborough River, Tampa Bypass Canal, and Bill Young Regional Reservoir, or a combination of these sources.

Liquid Process and Solids Production

The liquid treatment scheme at the plant consists of high-rate ballasted flocculation/sedimentation, ozonation, biologically active granulated activated carbon and sand filtration, and final disinfection. Residuals are produced primarily from two sources: the high-rate ballasted flocculation/sedimentation basins and the spent filter backwash water. Residuals from the sedimentation basin are first pumped to hydrocyclones, which are used to separate the lighter flocculated solids from the heavier microsand used as a ballast material. After separation, the solids concentration in the hydrocyclone overflow averages approximately 2,500 mg/L, which creates approximately 108,000 dry pounds per day (dppd) of solids at 120 mgd. The residuals concentration from the filter backwash overflow averages approximately 200 mg/L, creating approximately 10,000 dppd of residuals at 120 mgd.

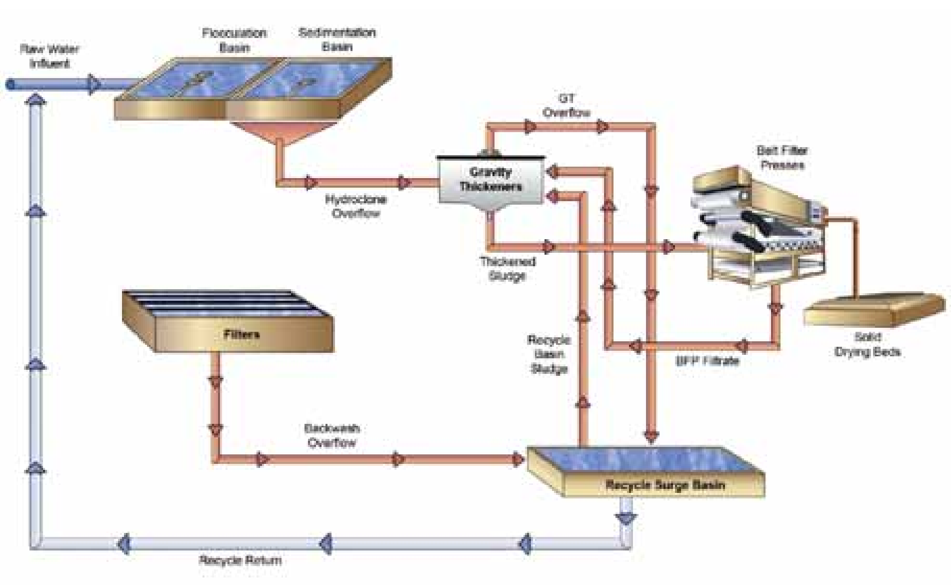

Figure 1. Old solids process flow diagram of the Tampa Bay Water Surface Water Treatment Plant

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Previous Solids Process

Overflow from the high-rate flocculation/sedimentation basins was previously routed directly to gravity thickeners. The gravity thickeners also received flow from two other side streams: the belt filter press (BFP) filtrate pump station and the recycle basin pump barge. The solids residuals were thickened to approximately 5 percent total solids (TS), dewatered using belt filter presses to approximately 19 percent TS, and then further dewatered on a paved solids drying and storage area. The iron-rich product was then hauled off-site and beneficially used as a soil amendment by the citrus industry.

Overflow from the gravity thickeners was routed to a recycle basin where it combined with the other major source of solids, spent filter backwash water. Solids in the recycle basin were periodically pumped to the gravity thickeners using a floating pump barge. A process flow diagram of the previous solids treatment scheme is shown in Figure 1.

Issues and Objectives

As part of the treatment plant expansion, two residuals handling issues were addressed: reducing solids accumulation in the recycle basin and reducing the impact of recycled solids in the blended raw water/recycle water feed while maintaining total sidestream recycling.

In the past, the spent backwash water from the filters would flow directly to the recycle basin and would ultimately be pumped back to the treatment plant's influent piping. A portion of the settled solids in the basin would be pumped back to the gravity thickeners using the pump barge, but the manual operation of this

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system made it very difficult to keep up with the solids entering the basin. The solids in the basin would eventually accumulate enough that they would reduce the available volume in the basin, which made it critical to constantly manage the water level in the basin to avoid overflows. The recycled water that re-entered the plant (blended with raw water) was high in suspended solids and turbidity, creating additional operational challenges at the head of the treatment plant by creating sudden impacts to the control of pH and ferric sulfate coagulant. At times the recycled solids would cause pretreatment upsets resulting in higher solids carryover from the sedimentation basin, which would ultimately lead to shorter filter run times. Because the recycled water had a significantly higher concentration of solids than the raw water, the recycle flow would be limited to 10 percent of the raw water flow to minimize upsets. When the raw water flow was low, the low recycle flow rate created a bottleneck because volume in the recycle basin was needed for spent backwash water. The solids from backwash account for nearly 10 percent of the treatment plant's total solids production, which made intercepting the solids before entering the recycle basin a top priority. Figure 2 shows a photo of the recycle basin before improvements were made.

Solids carryover from the gravity thickeners was also contributing to solids accumulation in the recycle basin. The gravity thickeners were only capturing approximately 75 percent of the solids loading. In addition to treating solids from the high-rate flocculation/sedimentation basins, the gravity thickeners would receive intermittent solids loading from the belt filter press filtrate pump station and the recycle basin pump barge. These side streams would introduce sudden slugs of residuals-laden water into the gravity thickeners without sufficient polymer addition or mixing, which would cause increased solids carryover in the gravity thickener effluent.

Figure 2. Recycle basin nearly half full with solids before improvements.

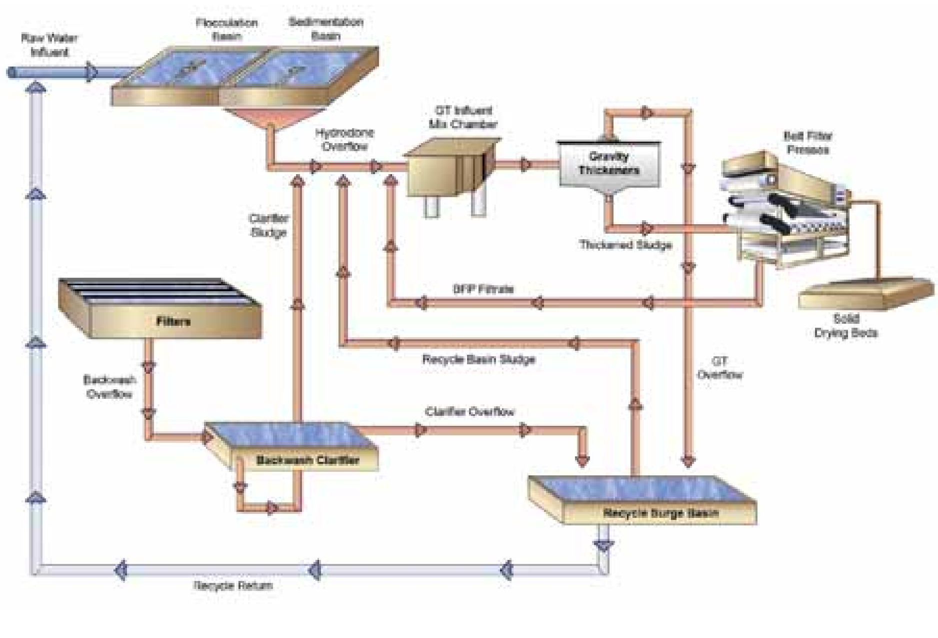

Figure 3. New solids process significantly reduces solids in the recycle stream.

New Solids Process

The three residuals treatment improvements were implemented as part of the treatment plant expansion as follows:

1. New batch clarifiers were added ahead of the recycle basin to capture filter backwash solids and remove them from the liquid treatment scheme.
2. A new gravity thickener influent mix chamber that receives all primary and intermittent flows entering the gravity thickener was added and provides polymer addition and rapid mixing to improve floc formation and increase solids capture and settleability characteristics.
3. Improvements were made to the recycle basin to expand capacity, to provide a more positive means of residuals management and removal via pumping facility, and to allow equipment access.

The new solids process flow diagram of the TBW treatment plant is shown in Figure 3.

Backwash Clarifiers

Three new batch clarifiers were constructed to intercept solids from the spent backwash before being discharged to the recycle basin. Each clarifier is 135 feet long by 40 feet wide and houses a chain and flight sludge scraper system, a screw cross collector, and a floating weir decanter. Polymer is added just upstream of the clarifier and is mixed using an inline static mixer. Since filter backwashing is not a continuous event, the clarifiers were designed and programmed to run in a batch operation. The influent gate, chain and flight collector, screw cross collector, floating weir decanter, and sludge pumps are all controlled either by liquid level or a timer. Settled sludge from the clarifiers is then pumped to the mix chamber. See Figure 4 for a photo of the new backwash clarifiers.

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Figure 4. Three new backwash clarifiers remove solids before discharging to recycle basin.

Figure 5. Gravity thickener influent mix chamber enhances settleability of solids in the gravity thickeners.

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Gravity Thickener Influent Mix Chamber

As discussed, the main issue with the gravity thickeners was that multiple side streams were being pumped directly to the thickeners with inefficient in-pipe mixing and flocculation with polymer. This resulted in solids carryover in the thickener overflow, which contributed to the solids accumulation in the recycle basin. The main function of the mix chamber is to provide a single point for all influent flows to the gravity thickeners to mix with polymer and create good flocculation of solids particles. This provides a homogeneous flow to the gravity thickeners and results in better solids capture and less solids in the effluent, and ultimately, the recycle stream. See Figure 5 for a photo of the mix chamber.

Recycle Basin Improvements

As discussed, the recycle basin was previously equipped with a floating pump barge that was not continuously operated. This made it difficult to remove the sludge entering the basin, which eventually led to a deep blanket of sludge. Besides affecting the treatment at the head of the plant when recycled, the amount of sludge accumulated in the basin greatly reduced the overall volumetric capacity, making it critical to manage water levels in the basin to prevent overflowing.

The major improvement to the recycle basin was to provide a means of sludge removal that was more operator-friendly and could be run either periodically or continuously. A small sump was installed in the middle of the basin where a new recycle sludge pump station would remove sludge and discharge to the mix chamber. Around the basin's perimeter, high pressure water cannons were installed to aid in the periodic washdown of accumulated solids in the basin towards the sump for removal by sludge pumps. Additionally, the original high-density polyethylene liner was removed and replaced with a concrete liner and access ramp, which would allow small equipment (e.g., Bobcat) to periodically enter the basin to remove any accumulated solids that the pumps could

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Figure 6. Improvements to recycle basin provide better solids removal and minimize accumulation.

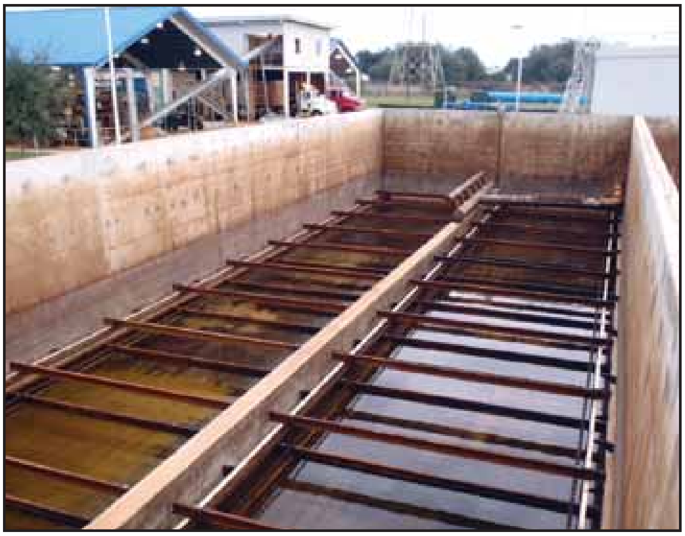

Figure 7. Chain and flight solids scrapers help remove 88 percent of all solids entering the clarifiers.

Figure 8. Intermittent side stream flows and poor polymer dosing/mixing led to high solids carryover in the gravity thickeners.

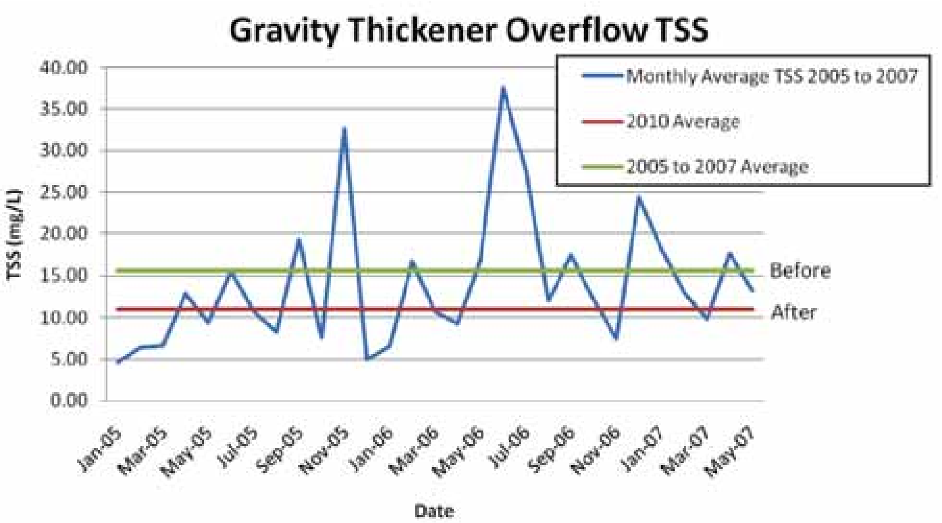

Figure 9. The GTIMC reduced solids carryover in the gravity thickeners by 30 percent.

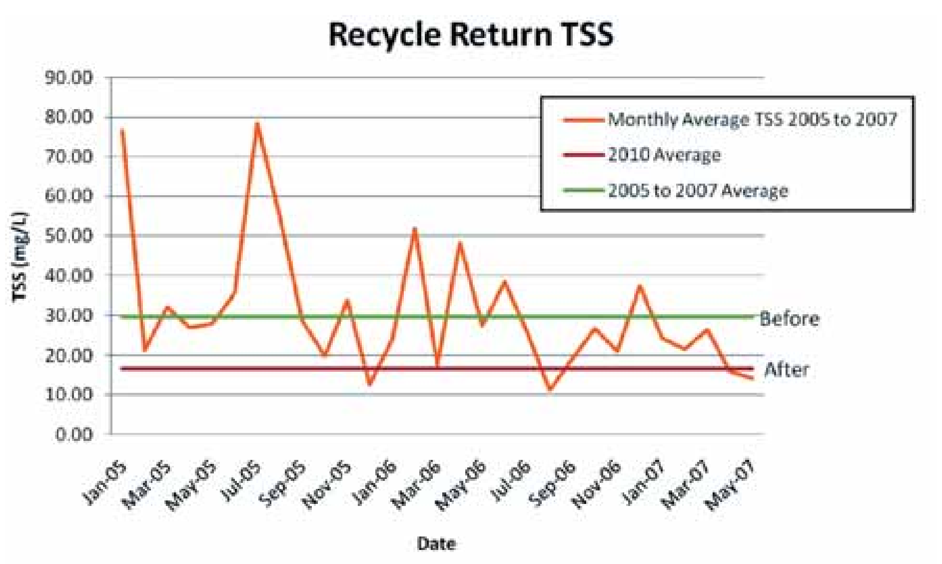

Figure 10. More than 43 percent less solids re-enter the plant after improvements

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not remove. Figure 6 shows photos of the improvements at the recycle basin.

Results

Backwash TSS/Clarifier Overflow TSS

Historical data shows that the composite solids concentration of the spent filter backwash water is approximately 200 mg/L. Each backwash event sends approximately 400,000 gallons to the recycle basin, which results in approximately 670 lbs of solids per backwash. When operating at maximum plant capacity, this could result in over 10,000 lbs/day being discharged to the recycle basin. Data from clarifier overflow grab samples shows that the effluent averages approximately 24 mg/L, indicating that over 88 percent of spent backwash solids are being removed by the clarifiers. Figure 7 shows the chain and flight mechanism and the floating decanter in one of the backwash clarifier.

Gravity Thickener Overflow TSS Before/After

The gravity thickener overflow before improvements was plagued by solids carryover mainly from intermittent flows from the BFP filtrate pump station, recycled sludge from the recycle basin, and from insufficient polymer dosing and mixing. Figure 8 is a photo of the high solids carryover in the gravity thickener effluent.

Combining all continuous (sedimentation basin sludge) and intermittent (BFP filtrate, recycle basin sludge, and backwash clarifier sludge) flows at the mix chamber, and creating a homogeneous mixture with good polymer mixing, creates uniform flocculation and helps the solids entering the gravity thickeners to settle. The improvement in settling characteristics has resulted in a reduction in the average effluent TSS concentration from

15.6 mg/L to 10.9 mg/L, or a 30 percent reduction in solids loading entering the recycle basin, as shown in Figure 9.

Recycle Return TSS Before/After

Due to the reduction in solids entering the recycle basin from the gravity thickeners and backwash clarifiers, the average solids concentration of the recycled flow was reduced from 30 mg/L to 17 mg/L, as shown in Figure 10. At 120 mgd, this reduction results in approximately 1,205 lbs/day less solids from re-entering the plant (as blended raw water/recycle water). The reduction in solids entering the recycle basin, coupled with a means of removing accumulated solids, has also freed up more volume in the recycle basin, making liquid level management less complex.

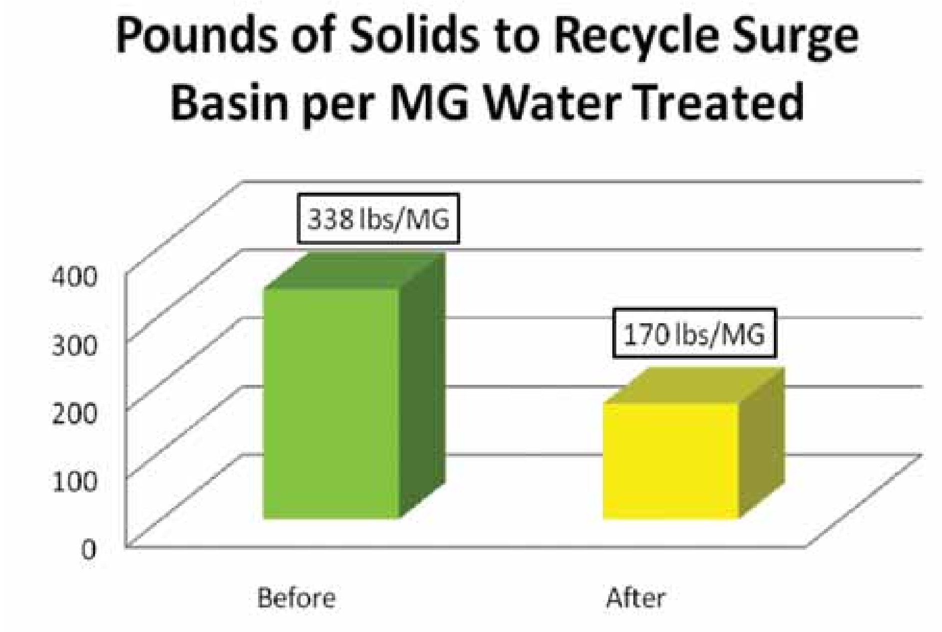

Figure 11. The rate at which solids enter the recycle stream has been reduced by 50 percent.

Conclusions

Removing the solids from spent filter backwash and optimizing gravity thickener performance has reduced the solids entering the recycle basin by 50 percent, as shown in Figure 11. The combination of fewer solids entering the recycle basin and a better system for managing the solids in the basin has significantly reduced solids in the blended raw water/recycle water entering the plant. These improvements have a positive impact by reducing upsets in the pretreatment process, reducing polymer consumption during these upsets, and increasing filter run times. The new solids handling system at the TBW treatment plant reduces solids accumulation in the recycle basin and reduces the impact of recycled solids in the raw water feed, while maintaining total sidestream recycling.