

CASE STUDY

Utilizing ScaleBlaster to Reduce Lime Scale Build-up in an Industrial Wastewater Treatment Plant



Documented by
The Village of Sauget Physical/Chemical Plant
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Case Study: Utilizing ScaleBlaster to Reduce Lime Scale Build-Up in an Industrial Wastewater Treatment Plant

Purpose

The purpose of this case study is to determine the effectiveness of the **ScaleBlaster** system to reduce lime scale buildup on equipment in an industrial wastewater treatment plant which uses quicklime as the primary means of wastewater neutralization. The case study will also investigate the reduction in process polymer use.



An SB-2800, SB-3600 and SB-4000 was installed on the main waterline at the Village of Sauget water treatment plant.



Background

The Village of Sauget Physical/Chemical Plant, also known as PChem, is an industrial wastewater treatment plant located in Sauget, Illinois. The plant receives wastewater from the local industries. Due to the acidic nature of the industrial wastewater flowing into the plant, a significant amount of lime is added to the stream for neutralization. Historically, PChem added an average of 250 tons of quicklime per month to the incoming wastewater. During the case study, these averages increased to 318 and 417 per month in the last two years (2013 and 2014). The addition of the lime slurry causes significant buildup of lime scale on much of the treatment equipment and structures throughout the plant. The scale buildup reduces equipment life and decreases the plant's treatment capacity. In order to maintain the integrity of the treatment plant, large scale cleanups and equipment replacement are done on a regular basis.

In May of 2011, PChem performed a neutralization evaluation to determine a more cost effective method of neutralizing the acidic wastewater. The evaluation compared several alternative neutralization chemicals and explored the possibility of installing a chemical free water softener system called **ScaleBlaster**. Based on the cost analysis of these alternatives, the most cost effective method of neutralization consisted of the use of quicklime in conjunction with the **ScaleBlaster** units installed to minimize the effects of lime scale buildup.

ScaleBlaster is a chemical free water conditioner frequently used in residential homes, businesses, and cooling towers to break down existing lime scale and prevent future buildup in pipes. It induces electric fields, oriented with the pipe cross section, through coiled wire around a length of pipe. The **ScaleBlaster** system then alternates the current flowing through the coils at a specific frequency to create a resonating effect which causes movement among the ions in the water. Rapidly altering the current causes the ions to continuously change direction and increases the chance of collisions between the positively charged calcium ions and the negatively charged carbonate ions. This prolonged resonance continues downstream of the units and is able to break down existing scale buildup through the continued rapid movement of the charged particles in the wastewater stream.

While the **ScaleBlaster** technology has been proven to work in a variety of situations, it has never been tested in an industrial wastewater treatment plant where lime is intentionally added to the wastewater stream. PChem and **ScaleBlaster** determined an outline for a case study that would test the effectiveness of the **ScaleBlaster** units installed at the PChem plant.



Case Study

The case study covers a period of three years: February 2012 to February 2015. On February 23, 2012, **ScaleBlaster** installed three units on the 20" and 30" influent fiberglass force mains which convey wastewater from the influent wet well to the neutralization system. At the beginning of the study, two of the units were installed on the 30" influent pipe and one was installed on the 20" influent pipe used only during rain events. After a short period of time, it was decided that the unit installed on the 20" rain event pipe needed to be moved to the 30" main pipe. Additionally, a fourth unit was installed on a lime recirculation pipe in an attempt to treat the lime slurry.

Prior to installing the **ScaleBlaster** system, PChem determined a baseline rate of lime scale buildup on plant equipment. After the units were installed, measurements were taken and compared to the baseline to determine if the units were operating effectively. After making adjustments to the equipment, PChem continued to monitor the lime scale buildup throughout the PChem plant to ensure the existing scale buildup was being reduced and no additional scale was forming. PChem also monitored for any lime scale buildup and any adverse effects to the biological system downstream at the municipal biological nutrient removal (BNR) plant, American Bottoms Wastewater Treatment Facility, which receives the PChem effluent flow.

Immediately after the installation of the **ScaleBlaster** system, an unexpected observation was made: the plant now required little-to-no process polymer to settle clarifier solids. According to testing, only a sixth of the average amount of process polymer was needed. Potential to reduce process polymer was then added to the case study.

Monitoring Methods

Pchem fabricated measuring devices and determined 21 primary monitoring locations and seven alternate locations dependent upon process configuration. The path of the water flow can change depending upon which clarifier is in service. In order to capture each situation, monitoring locations were put along both paths and checked according to which path the flow was taking. These devices consisted of metal pipes and wires continuously submerged in the water along with fabricated measuring sticks to measure scale thickness on the walls of the equipment. The scale buildup on the continuously submerged devices was measured on a regular basis. Several visual observation areas were also included with these monitoring locations where PChem personnel would photograph and note any visible changes in scale thickness. The goal was to monitor existing lime scale breakdown and to verify that no additional buildup was forming. It was noticed that the **ScaleBlaster** system caused the top layer of lime scale to become soft, allowing the measuring devices to push through the scale, affecting the measurement accuracy. Many of the devices were used under water where the only way of determining where the scale buildup ended was by feel. Prior to **ScaleBlaster**, the measuring devices would touch the scale buildup and stop. After the installation of the units, the devices easily pushed through the layer of scale. Buildup depth throughout the main channels was also inconsistent; the scale is built up in waves. Based on these two measurement challenges, PChem developed a new monitoring method.

The new method relied heavily on documented visual observations. Historically problematic areas such as flocculation chamber chains, clarifier weirs, and the effluent flume were monitored continuously throughout the case study, with each location being cleaned prior to monitoring. PChem also monitored the frequency of and hours required for cleaning these areas throughout the case study period. As the process permitted, PChem

cleaned out large sections of the treatment process and visually monitored any buildup that occurred after cleaning. Additional methods of determining **ScaleBlaster** effectiveness consisted of compiling historical data pertaining to cleaning projects and comparing to similar data collected during the case study. To determine the effect **ScaleBlaster** had on process polymer usage, PChem monitored the effluent suspended solids along with the amount of process polymer used during the case study period and compared this to historical data. PChem has never historically operated without the use of process polymer; therefore, historical data only consists of effluent suspended solids with the use of process polymer. There is no historical data that shows what the effluent suspended solids would have been without process polymer prior to the installation of the **ScaleBlaster** units.

Results & Findings

Visual Observations

Visual observations made throughout the case study period while the PChem plant equipment was in service were not always conclusive. Due to the murkiness of the water and the flow characteristics, it was difficult to determine an accurate measure of lime scale buildup. This is apparent in [Photos 1 and 2 as seen below](#). These are photographs of the effluent flume. [Photo 1](#) was taken just prior to the installation of the **ScaleBlaster** units. [Photo 2](#) was taken more than three years after the installation. The scale appears to be thicker in [Photo 1](#), but it is difficult to judge. [Photos 3 and 4 \(on the next page\)](#) were taken before and after the case study period of a pile of sand/scale just after the final neutralizer chamber. As can be seen from the photographs, the pile of scale and sand is no longer above the surface of the water.



Photo 1: Effluent Flume taken January 31, 2012



Photo 2: Effluent Flume taken April 28, 2015



Photo 3: Neutralizer 3 Sand Pile taken January 31, 2012



Photo 4: Neutralizer 3 Sand Pile taken April 28, 2015

The main areas of continuous observation that provided conclusive results were the clarifier weirs. Prior to installing the **ScaleBlaster** units, PChem cleaned the clarifier weirs and made weekly observations of the scale buildup for a month before they were cleaned again. These results can be seen in [Photos 5 through 7](#), *below and on the next page*. [Photo 8 \(next page\)](#) is a photograph taken after the case study period. The weirs in this photo have not been cleaned in more than five and a half months. There is a thin layer of lime scale buildup, but there are no chunks of buildup as in the photos taken prior to the **ScaleBlaster** install. Currently, the clarifier weirs are cleaned one to two times per year. Prior to the installation of the **ScaleBlaster** units, these weirs were cleaned biweekly. As can be seen in [Photos 9 and 10, \(on page 9\)](#) the flocculation chamber chains continue to build up some scale. Based on observations, the buildup appears to occur more slowly and is not as thick as it was prior to the **ScaleBlaster** install.

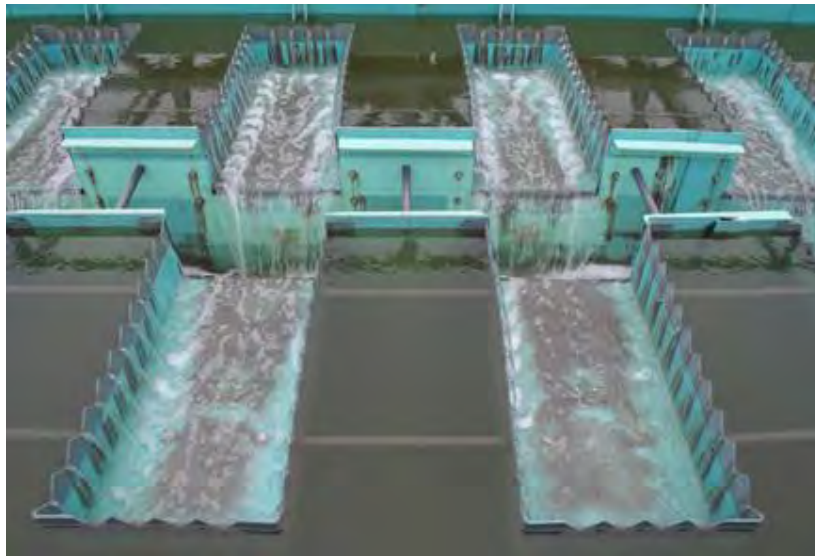


Photo 5: Clarifier Weirs taken November 23, 2011



**Photo 6: Clarifier Weirs taken December 22, 2011
(1 month of no cleaning prior to ScaleBlaster)**



Photo 7: Clarifier Weirs taken December 22, 2011 (close up)



Photo 8: Clarifier Weirs taken April 28, 2015 (Clarifier taken out of service April 22, 2015. No cleaning since November 5, 2014 when clarifier was put in service)



Photo 9: Flocculation Chamber Chains taken January 30, 2012



Photo 10: Flocculation Chamber Chains taken April 28, 2015

Pchem has been able to drain several areas of the plant to observe the scale buildup and clean where necessary. Both clarifiers have been taken out of service during the case study, the main channel has been taken out of service several times, and the final neutralizer chamber was taken out of service for inspection on March 27, 2015. The clarifiers are generally taken out of service for maintenance at least once a year. Most recently, in April of 2015, the South clarifier was taken out of service to inspect the sludge pits after having been in service for approximately six months. As can be seen in [Photo 13, \(next page\)](#) there was only a thin film of scale buildup on the walls of the clarifier. This is compared to the thick buildup that can be seen in the [Photo 11 \(below\)](#) from the clarifier cleanout in 2007. This clarifier had been in service for approximately six months also. As can be seen in the photograph, the scale buildup is much thicker. Part of the clarifier wall had already been scraped when this photograph was taken in 2007. [Photo 12 \(next page\)](#) was taken in 2012 of the North clarifier after it had been in service for more than a year. The clarifier was taken out of service after the installation of **ScaleBlaster**. As can be seen in the photograph, some of the thick scale layer had fallen off of the wall. There was also a big difference in the amount of buildup in the flocculation chambers in the clarifiers. While there is some buildup on the wall, there is little to no buildup on the flocculation paddles. [Photos 14 and 15 \(page 12\)](#) show the scale buildup in the flocculation chambers prior to the **ScaleBlaster** installation, as compared to [Photos 16 and 17 \(page 13\)](#) which were taken at the end of the case study period.



**Photo 11: Clarifier Wall taken April 2, 2007
(Clarifier in service for 6 months. Part of wall already scraped)**



Photo 12: Clarifier Wall taken May 2, 2012 (Clarifier in service for 16 months)



Photo 13: Clarifier Wall taken April 28, 2015 (Clarifier in service for 6 months)



Photo 14: Flocculation Chamber taken May 2, 2012



Photo 15: Flocculation Chamber taken May 2, 2012 (close up)



Photo 16: Flocculation Chamber taken April 28, 2015

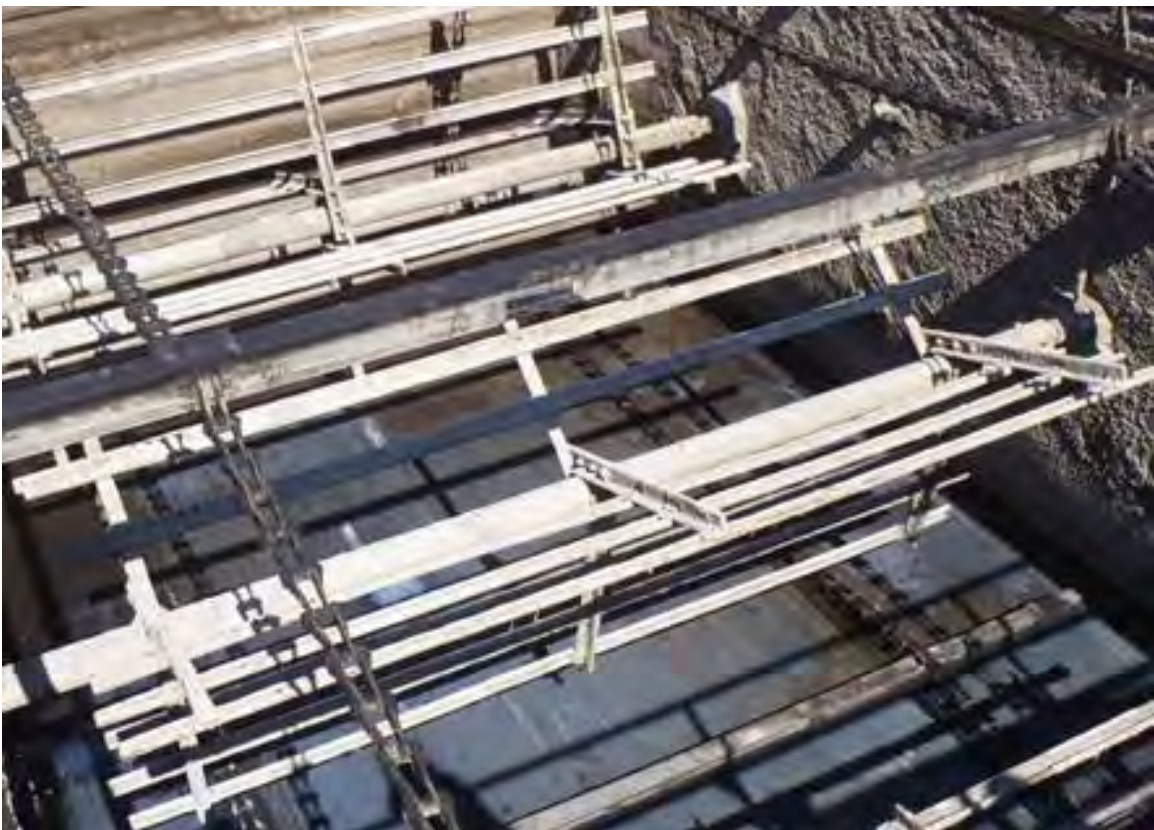


Photo 17: Flocculation Chamber taken April 28, 2015 (close up)

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The main channel between the neutralizer chambers and the clarifiers continues to collect scale. There are few photos of the main channel prior to the **ScaleBlaster** installation. [Photo 18 \(below\)](#) was taken in 2010. It is difficult to see the level of scale buildup in this photograph. The channel was cleaned in 2012, 2013, and partially in 2014 for a gate installation. The buildup between each of these cleanouts was consistent with what PChem had seen in the past, although it could be slightly less. It is difficult to get a good measurement of the amount of scale due to the pattern in which the scale forms. [Photos 19, 20 and 21 \(pages 15 and 16\)](#) are photographs taken during each of these cleanings. PChem and **ScaleBlaster** have discussed possible solutions to this problem area. In response to suggestions from **ScaleBlaster** and for overall process improvement, PChem installed gates at the beginning of the main channels in order to increase flow velocity through the channels by using only a single channel when flows permit. This will in turn improve the effectiveness of the **ScaleBlaster** units in this area.



Photo 18: Main Channel taken October 13, 2010





Photo 19: Main Channel taken November 6, 2012



Photo 20: Main Channel taken October 17, 2013



Photo 21: Main Channel taken March 18, 2015



An SB-2000 was installed on the lime slurry (injection) line

The final large piece of equipment that PChem was able to take out of service for inspection was the final neutralizer. Historically, this has been an area that gathers a significant amount of lime scale. PChem had removed the agitator from this neutralizer just prior to the **ScaleBlaster** installation for cleaning. There was a significant amount of buildup on the agitator. [Photo 22 \(below\)](#) shows the scale buildup on the agitator when it was removed in 2012. When the neutralizer chamber was emptied in 2015, the agitator was inspected. It was determined that the agitator did not require cleaning at that time. The buildup was significantly less, and the agitator had not failed due to high amp draw as it had in the past. [Photo 23 \(next page\)](#) shows the buildup on the agitator when it was taken down in 2015. The buildup on the neutralization chamber walls was also drastically reduced. PChem had taken this chamber out of service in 2008 for cleaning and concrete repair. Comparison photos can be found in the appendix. [Photos 24 and 25 \(Page 19\)](#) were taken during the cleaning in 2008, while [Photos 26 and 27 \(page 20\)](#) were taken in 2015 when the chamber was drained for inspection. As can be seen in the photos, there is a drastic difference in the scale buildup on the boards and on the walls. PChem decided not to clean out the neutralization chamber at this time based on the observed buildup. The chamber was immediately put back into service with no cleaning at all.



Photo 22: Neutralizer Agitator taken February 22, 2012



Photo 23: Neutralizer Agitator taken March 27, 2015



Part of the ScaleBlaster installation at The Village of Saugnet Wastewater Treatment Plant



Photo 24: Final Neutralizer taken February 14, 2008



Photo 25: Final Neutralizer taken February 14, 2008



Photo 26: Final Neutralizer taken March 27, 2015



Photo 27: Final Neutralizer taken March 27, 2015

Cleaning & Disposal

In order to account for all cleanout savings, PChem evaluated a historical period of four years: 2008 through 2011. During this time period, the transfer sewer was cleaned three times, the last neutralizer chamber was cleaned, the flocculation chambers were cleaned, and various pipes and channels connecting to the clarifiers were cleaned. The primary purpose for the four year time span was to capture various levels of cleaning prior to the installation of the **ScaleBlaster** units. As can be seen in [Exhibit 1 \(below\)](#), PChem invested an average of \$79,104 per year in scale related cleaning projects. There were two large cleanout projects in 2008 accounting for a majority of the costs: cleaning the transfer sewer and cleaning the neutralizer.

The average cleaning costs after the installation of the **ScaleBlaster** units are significantly lower. During the case study, PChem spent an average of \$40,532 per year as shown in [Exhibit 1 \(below\)](#). During the initial two years after the units were installed, PChem invested little in scale-related cleaning. The main projects for these years included cleaning the main channels between the neutralizers and the clarifiers along with other minor cleaning in pipes and channels connected to the clarifiers. In 2014, PChem had the transfer sewer cleaned. This accounted for the majority of the cleaning budget. Also included in the cleaning costs is regular cleaning of the clarifier weirs. Prior to the installation of the **ScaleBlaster** units, these required pressure washing every two weeks and took about 12 man-hours to complete. After the installation of the **ScaleBlaster** units, these weirs were pressure washed two times per year and take about four hours to complete. This alone is an annual savings of more than \$4,000. The total estimated savings in cleaning and disposal costs for the PChem plant came to an average of \$38,572 per year.

Exhibit 1 - Cleaning & Disposal Costs

| Total Lime Cleaning & Disposal Costs | |
|---|----------------------|
| Year | Cost Per Year |
| 2008 | \$155,803 |
| 2009 | \$57,264 |
| 2010 | \$67,242 |
| 2011 | \$36,106 |
| Average Cost per Year | \$79,104 |

| Total Lime Cleaning & Disposal Costs | |
|---|----------------------|
| Year | Cost per Year |
| 2012 | \$18,622 |
| 2013 | \$13,871 |
| 2014 | \$89,103 |
| Average Cost per Year | \$40,532 |

Process Polymer Usage

In order to evaluate the **ScaleBlaster** units as an alternative to process polymer, PChem tracked the total suspended solids (TSS) leaving the neutralizer and at the effluent of the plant. A percent removal was then calculated to determine how much of the TSS was removed. As can be seen in [Exhibit 2 \(below\)](#), PChem historically added an average of between 68 and 98 pounds of process polymer per day. As stated previously, there is no historical data available to show percent removal without polymer addition prior to the installation of the **ScaleBlaster** units, as PChem has always added process polymer. Based on the results of the monitoring as shown in [Exhibit 2 \(below\)](#), the percent removal is only about ten percent lower when not adding polymer after the **ScaleBlaster** units were installed. With the exception of 2013, the percent removals are similar when adding and not adding polymer after the **ScaleBlaster** units were installed. Even when adding polymer during this time period, the percent removals are still lower than in the years prior to the installation of the **ScaleBlaster** units. However, it can't be stated with total certainty that the **ScaleBlaster** units were the sole cause of this change. Many process parameters have also changed. There is no guarantee that **ScaleBlaster** would reduce polymer at other facilities. With the change in polymer usage, PChem saved an estimated \$29,513 per year in polymer costs.

Exhibit 2 - Process Polymer Evaluation

| | 2008 | 2009 | 2010 | 2011 |
|---------------------------|-----------------|-----------------|-----------------|-----------------|
| Neutralizer 3 TSS | 601 | 629 | 612 | 523 |
| Pchem Effluent TSS | 35 | 28 | 32 | 40 |
| Average Polymer | 98 | 68 | 77 | 66 |
| Polymer Cost | \$37,531 | \$25,973 | \$29,374 | \$25,174 |
| % Removal | 90.9% | 92.8% | 92.6% | 92.1% |

| | 2012 | 2013 | 2014 |
|---------------------------|----------------|----------------|----------------|
| Neutralizer 3 TSS | 361 | 374 | 720 |
| PChem Effluent TSS | 40 | 48 | 74 |
| Average Polymer | 16 | 8 | 6 |
| Polymer Cost | \$6,166 | \$2,915 | \$2,197 |
| % Removal | 82.7% | 75.9% | 84.4% |

| | 2012 | | 2013 | | 2014 | |
|---------------------------|--------------|--------------|--------------|--------------|--------------|--------------|
| | polymer | no polymer | polymer | no polymer | polymer | no polymer |
| Neutralizer 3 TSS | 361.7 | 359.9 | 385.5 | 372.0 | 1060.8 | 645.8 |
| PChem Effluent TSS | 45.1 | 37.1 | 34.9 | 50.3 | 86.8 | 71.1 |
| % Removal | 82.7% | 82.6% | 86.5% | 74.1% | 88.6% | 83.5% |

Conclusions

Overall, the **ScaleBlaster** units have reduced the scale buildup in the PChem Plant, resulting in an annual savings of \$38,572 per year in cleaning and disposal costs. The need for regular cleaning of historically problematic areas has been reduced along with the difficulty level of the cleaning. Large cleaning projects were not required as frequently; however, the **ScaleBlaster** units have not completely eliminated the lime scale buildup. PChem does continue to have some problem areas, such as the main channels. It appears as though polymer used for settling in the clarifiers was also reduced from the use of the **ScaleBlaster** technology. There were no observed adverse effects on the BNR plant downstream.

Total Savings Per Year Average

Lime Cleaning, disposal cost and polymer savings

\$68,085 per year average



Sauget is located in the American Bottom, the floodplain of the Mississippi River opposite St. Louis, Missouri.

About The Village of Sauget Physical / Chemical Treatment Plant



The Village of Sauget Physical/Chemical Treatment Plant operates the American Bottoms Treatment Plant and the PChem Plant. They are owned, operated, and maintained by a non-profit corporation, the Sauget Sanitary Development and Research Association. Sauget is on the eastern border of Illinois and is a heavy industrial village located just outside of St. Louis, Missouri. This has been cited as one of only three municipal treatment plants of this type in the United States.

The PChem plant is a physical-chemical plant which provides preliminary and primary treatment for industries located in the Village of Sauget and operates 24 hours per day, 365 days per year. The plant was originally constructed in 1942 and has had many additions of treatment equipment and processes to the plant over the years. When the American Bottoms plant opened in 1986, the PChem plant began conveying its treated water to American Bottoms for secondary biological activated sludge treatment. The primary goals of the treatment process at PChem are to neutralize the pH, to remove metals, to remove oil, and to prepare the wastewater for secondary treatment at American Bottoms. The PChem plant also contains a hauled wastewater discharge facility where approved hauled wastewater streams can be discharged for treatment.

The PChem plants can process flow rates of 26 million gallons per day through the plant.

The American Bottoms Treatment Plant, is a very large sewage plant that serves much of the Illinois side of the St. Louis metropolitan area. They provide preliminary, primary, and secondary treatment. The American Bottoms facility can treat an average of 27 million to a maximum of 52 million gallons of wastewater each day. Wastewater flows from homes, businesses, and storm drains through a system of pipes to two pump stations located outside of American Bottoms. They remove large trash and debris. Once removed, the wastewater is pumped from these pump stations through underground pipes. After the preliminary treatment is complete, the wastewater is ready for Primary Treatment involving clarifiers. They are big, round, deep cement tanks. The main purpose of the primary treatment is to settle out heavy solids. The secondary treatment is to remove dissolved organics from the wastewater.

The Village of Sauget Physical/Chemical Treatment Plant also has a large onsite laboratory. Throughout the entire treatment process, samples of wastewater and sludge are taken there for testing. The facility has been accredited by the EPA since 2002. On average, the lab will analyze nearly 10,000 samples of wastewater and solids every year. Laboratory testing is vital to the entire Village of Sauget Physical/Chemical Treatment Plant operations and for compliance.