**FINAL**

# TECHNICAL MEMORANDUM 4.2 - THICKENING MANAGEMENT

NEW Water Facility Plan

**B&V PROJECT NO. 402658**



**PREPARED FOR**

NEW Water
The brand of the Green Bay Metropolitan Sewerage District

1 JULY 2021

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# 1.0 Introduction

The Green Bay Metropolitan Sewerage District, operated under the brand name of NEW Water, collects and treats wastewater from 15 communities in a service area encompassing over 285 square miles with an estimated population of approximately 237,000 in 2019. The NEW Water facility is comprised of the Green Bay Facility (GBF) and the De Pere Facility (DPF). The NEW Water treatment facilities receive domestic, commercial, and industrial wastewater as well as hauled-in waste (HW)/high strength waste (HSW). NEW Water administers an industrial pretreatment program that regulates industrial contributors.

The GBF treated an average of 36.6 mgd of total wastewater in 2019 with a liquid treatment train consisting of influent pumping, screening, primary clarification, primary sludge grit removal, activated sludge configured for enhanced biological phosphorus removal (EBPR), secondary clarification, and disinfection with sodium hypochlorite and dechlorinated with sodium bisulfate. The solids handling treatment train includes sludge thickening with gravity belt thickeners and a thickening centrifuge followed by anaerobic digestion with co-digestion of high strength waste (HSW), centrifuge dewatering, and ending with solids drying and incineration. The GBF receives hauled waste (HW), which is screened and discharged to the plant influent and HSW, which is fed to the digesters. Industrial wastewater flows are pumped to the plant from Proctor & Gamble and Fox River Fiber.

The DPF treated an average of 8.8 mgd in 2019 of wastewater with a treatment train consisting of screening, influent pumping, grit removal, activated sludge configured for enhanced biological phosphorus removal (EBPR), intermediate clarification, final clarification, tertiary sand filters and UV. An industrial forcemain pumps waste from the Fox River Fiber industrial customer downstream of grit removal. Waste activated sludge (WAS) is pumped to the GBF for biosolids processing via a forcemain. In addition, there is an interplant transfer forcemain to the GBF, which provides some flexibility to send DPF influent to the GBF interceptor system for treatment at the GBF.

As part of a full-plant facility plan, determining how to manage solids is critical to ensuring the adequate treatment of wastewater. The purpose of Technical Memorandum 4.2 (TM 4.2) is to summarize the projected solids production rates as well as present the most feasible alternatives for the Green Bay Metropolitan Sewerage District (NEW Water) Facility Plan. The specific objectives of TM 4.2 are:

1. Simulate ten years of historical data using a previously calibrated and validated model at each of the four future loading conditions.
2. Assess three potential alternatives for sludge thickening of waste activated sludge (WAS) thickening and primary sludge (PS) thickening.
3. Provide projected capital and operational costs for each alternative.
4. Recommend which alternative should be implemented going forward.

## 1.1 Drivers for Thickening Improvements

The GBF primary sludge, GBF WAS, and DPF WAS are all thickened prior to digestion. During the planning horizon of the facility plan, there are several major drivers for pre-digestion solids thickening improvements:

- Industrial user growth at the GBF: expansion of Green Bay Packaging is currently under construction, and will increase influent flows and solids production by 2025.
- Aging equipment: the existing gravity belt thickeners used for WAS thickening and the primary sludge gravity thickeners are over 20 years old and lack adequate odor mitigation components.
- Operational limitations: the centrifuge installed as part of the recent solids expansion for primary sludge thickening has proved to be operationally challenging with long repair part lead times.
- Growth in the DPF service area: residential growth will be occurring in the DFP service area over the next 10 to 20 years, increasing solids production rates.
- Resource Recovery and Energy Efficiency (R2E2) operation: to achieve the energy targets for the R2E2 facilities, a net thickened solids concentration of 6 percent is required.
- Nutrient harvesting: current coagulant loadings from industrial users to the GBF and DPF have limited EBPR performance, and thus limit the extractability of phosphorus from biosolids; simplifying operations to avoid thickening prior to P-release in the future would be beneficial.

## 1.2 Improvement Assessment

Assessment of improvements to these drivers were developed to provide NEW Water with increased flexibility, as well as required capacity, for the next 20 years. Several process configurations were developed, along with required thickening components for each infrastructure package. To assess improvements, the following steps are recommended:

- Identify process configurations for thickening operation.
- Project future solids production for each configuration.
- Evaluate equipment solutions to provide required capacity and flexibility.
- Develop capital costs for full infrastructure packages.
- Recommend thickening package for implementation.

## 1.3 Relationship to overall Facility Plan

This TM has been developed as part of Task 4 of the Facility Plan. Task 1 of the Facility Plan is related to project management at execution. Task 2 of the Facility Plan focused on developing the existing conditions for the NEW Water facilities. In Task 2, the following componenents are tied to the overall thickening management evaluation:

- TM 2.1: Flows and Loads – the future conditions for both the DPF and GBF are used for solids projections
- TM 2.3: Process Model – the process model was used to develop projections for solids production at both facilities in the future
- TM 2.4: Gap Analysis – infrastructure gaps identified in the solids thickening area will be addressed as part of the thickening improvements

Task 3 of the Facility Plan is currently being completed to identify future drivers for NEW Water. Within Task 4, solutions are being developed to address the gaps identified in Task 2 along with the vision developed in Task 3. There will be several evaluations in Task 4 that are impacted by decisions presented for thickening. As the Facility Plan progresses, these additional evaluations will be completed to develop a comprehensive Facility Plan. Key related infrastructure evaluations that are impacted by thickening decisions are:

- Influent screening and grit management
- Aeration system and nutrient removal improvements
- Whole plant odor control
- Whole plant nutrient and energy balance
- De Pere long term vision

The recommendations developed as part of the TM, and other Task 4 efforts, will be combined as part of Task 5 to develop a comprehensive capital improvements plan and infrastructure roadmap for NEW Water.

# 2.0 Process Configurations for Solids Thickening

Process configurations were developed to manage the three unthickened sludge streams for NEW Water:

- GBF primary sludge (PS)
- GBF WAS
- DPF WAS

The three main process configurations are:

- Current operation: primary sludge thickened separately, GBF, and DPF WAS combined.
- Separate sludge streams: all three sludge streams management separately.
- Co-thickening: all sludge streams combined prior to mechanical thickening.

For the DPF, there are two key aspects related to solids production. The first is related to WAS flows. WAS from the DPF is pumped in one of two ways: wasting through return activated sludge (RAS) diversion or by wasting from the mixed liquor (ML). RAS wasting occurs unless wasting flows drop below 250 gallons/minute (gpm). This flow rate results in too low of a flow to maintain adequate velocity in the sludge transfer line to the GBF. When flows are less than 250 gpm, which occurs approximately 10 to 15 percent of the year, ML wasting is operated until flow rates increase high enough. This operational strategy is addressed through process modeling and does not impact the overall process configurations.

The second unique aspect of the DPF is the management of sludge generated by the preliminary treatment units (PTUs). The PTUs are designed for grit removal; however, it was noted that when influent flows are below 15 mgd, the PTUs achieve 30 percent total suspended solids removal. Flows are less than 15 mgd at the DPF a majority of time, and therefore these solids are generated for the majority of the year. Currently, this removed TSS is recycled back to the aeration basins, where it is incorporated into the activated sludge process and eventually the WAS. As an alternative to this operation, solids production will be evaluated assuming the TSS stream from the PTUs is being added to the WAS stream, and not to the activated sludge process. Under this scenario, it was assumed that the PTUs remove 30 percent of influent TSS when flows were below 15 mgd, and this “primary” sludge would have a concentration between 0.25 and 0.50 percent to facilitate sludge degritting. This “primary” sludge has a high flow rate, limiting the need to operate in the ML wasting strategy.

When the two different PTU strategies at DPF are combined with each of the main process configurations, a total of six configurations are possible in the future for NEW Water. The main process configurations identified for evaluation are summarized in Table 2-1. These process configurations will be combined with solids projections at the GBF and the DPF to develop infrastructure packages to meeting NEW Water’s current and future needs. Primary sludge management, process configurations, and additional solids improvements all need to be identified to develop solids production projections. In addition to the thickening evaluation and recommendations, a long-term evaluation of scum management and movement at both facilities will be recommended as part of the overall Facility Plan.

**Table 2-1 Summary of Proposed Alternatives**

| Process | GBF PS Approach | GBF WAS Approach | DPF PTU Sludge Approach | DPF WAS Approach |
|---|---|---|---|---|
| Configuration 1a<br>Combined WAS, separate PS | Separate Mechanical Thickening | Mixed with DPF WAS prior to Mechanical Thickening | Added back to DPF aeration basins | Mixed with GBF WAS prior to Mechanical Thickening |
| Configuration 1b<br>Combined WAS, separate PS, DPF PTU modification | Separate Mechanical Thickening | Mixed with DPF WAS prior to Mechanical Thickening | Combined with DPF WAS prior to pipeline | Mixed with GBF WAS prior to Mechanical Thickening |
| Configuration 2a<br>All sludge thickened separately | Separate Mechanical Thickening | Separate Mechanical Thickening | Added back to DPF aeration basins | Separate Mechanical Thickening |
| Configuration 2b<br>All sludge thickened separately, DPF PTU modification | Separate Mechanical Thickening | Separate Mechanical Thickening | Combined with DPF WAS prior to pipeline | Separate Mechanical Thickening |
| Configuration 3a<br>Co-thickening of all sludge | Co-thickening | Co-thickening | Added back to DPF aeration basins | Co-thickening |
| Configuration 3b<br>Co-thickening of all sludge, DPF PTU modification | Co-thickening | Co-thickening | Combined with DPF WAS prior to pipeline | Co-thickening |

## 2.1 Primary Sludge Management

For the process configurations presented in Table 2-1, GBF primary sludge is assumed to have a solids concentration of at least 2 percent and up to 3 percent TS. This can be achieved with the primary clarifiers, but this option would require the construction of new headworks. Alternatively, existing gravity thickeners (GTs) can be utilized to pre-thicken the primary sludge from 0.25 percent TS to 2 percent TS. This would have the additional benefit of grease capture in the GTs, reducing the grease load to the mechanical thickening.

To assess the number of GTs for this operational strategy, surface overflow rates (SORs) were calculated at each simulated year assuming PS had 0.25 percent solids and a GT diameter of 45 feet, with either two or four GTs in operation. As shown in Figure 2-1, with two GTs in operation, the SOR would be near the top end of typical design ranges through 2040. Results are shown in box-and-whisker plots, where the bottom of the box is the 25th percentile, the middle line is the median (50th percentile) and the top of the box is the 75th percentile. Whiskers extend to the largest and smallest values that are not considered outliers. Outliers are values which are more extreme than the inner fences; inner fences are calculated by determining the range between the 25th and 75th percentiles (i.e., the interquartile range, IQR) and multiplying that by 1.5. The inner fences extend beyond the 25th and 75th percentiles by this calculated value. Boxes are colored according to the projected year being simulated. White dots are means of each data set. These design ranges are typical with targets of 6 percent thickened solids (TS), and not 2 percent TS.

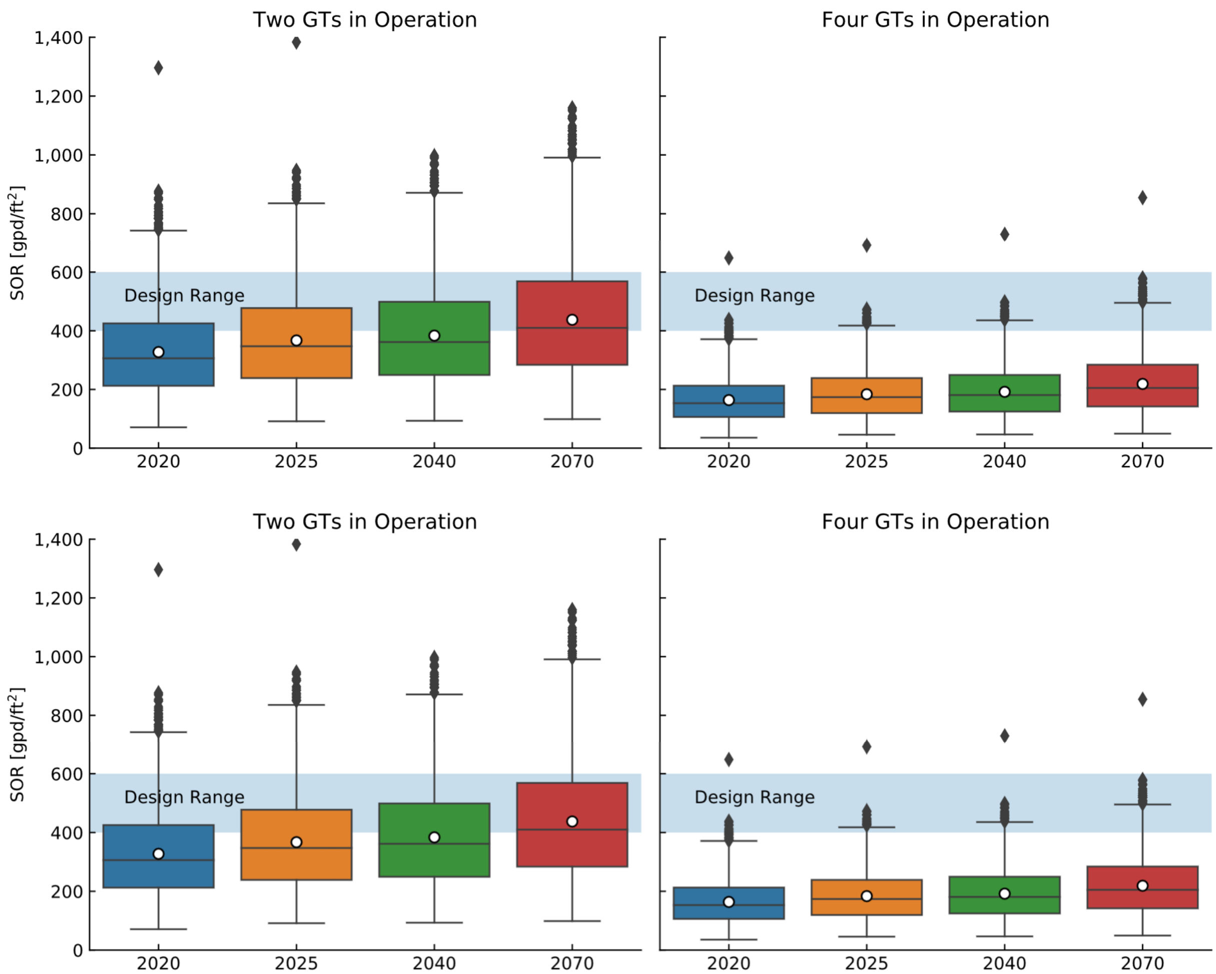



**Figure 2-1 Surface Overflow Rates for Gravity Thickeners with Primary Sludge at 0.25% Solids**

Based on process capacity, two GTs are sufficient to provide thickening to a 2 percent to 3 percent solids concentration. As part of the Facility Plan, it can then be decided if this 2 percent TS is achieved via primary clarifiers with a new headworks at NEW Water or via rehabilitated gravity thickeners.

## 2.2 Process Configurations

Based on the assumption that primary sludge would be at least 2 percent TS prior to mechanical thickening, process flow diagrams were developed for all six process configurations shown in Table 2-1.

### 2.2.1 Process Configuration 1a – Current Operation

This configuration assumes all WAS from GBF and DPF is combined prior to thickening (Figure 2-2). GBF PS is mechanically thickened separately prior to digestion. Thickened WAS and PS are combined prior to digestion and pumped via thickened sludge pumps to the digesters. Under the base scenario, the phosphorus release tank is not in operation for WAS flows.

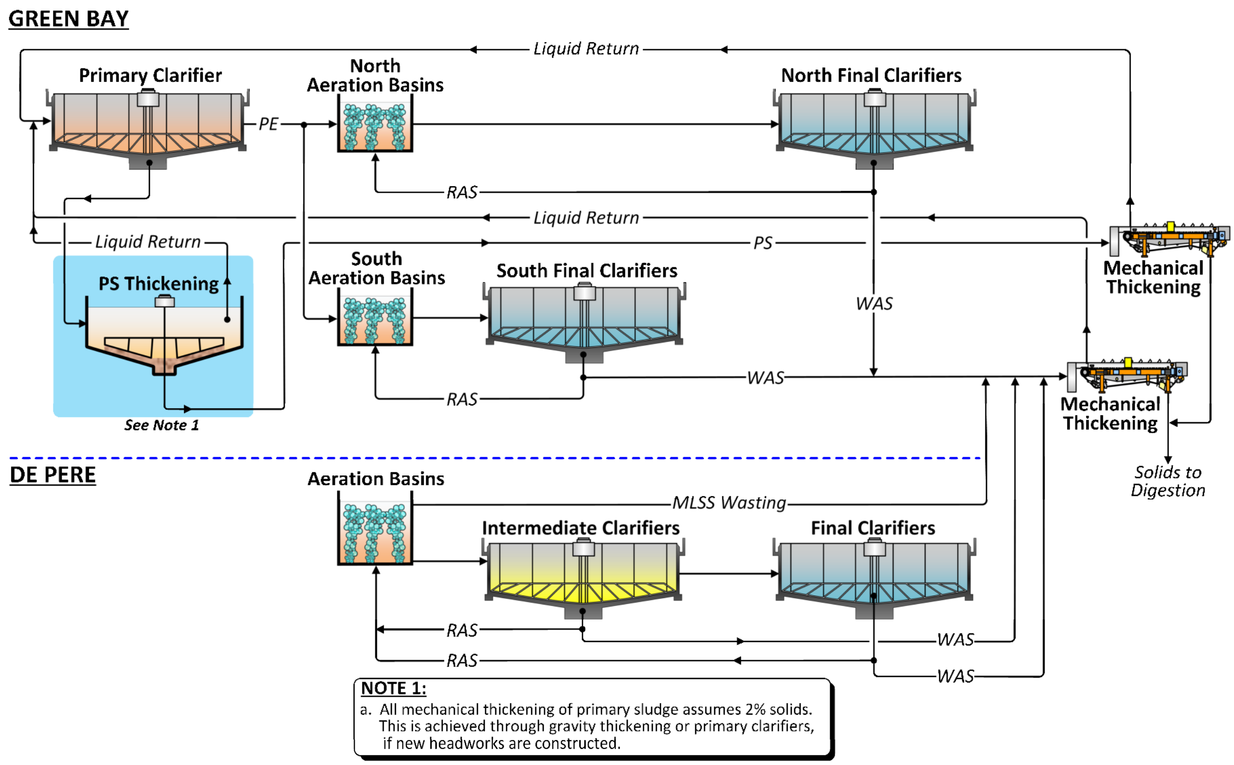



**Figure 2-2 Process Flow Diagram for Configuration 1a**

### 2.2.2 Configuration 1b – Current Operation, modified DPF PTU operation

This configuration assumes WAS from both GBF and DPF is combined with DPF primary solids (0.25-0.5 percent consistency; comprising 39 percent of total solids flow on average) prior to thickening (Figure 2-3). The DPF primary solids are captured from the PTUs when influent flows are below 15 mgd. GBF PS is thickened separately prior to digestion. Thickened WAS and PS are combined prior to digestion and pumped via thickened sludge pumps to the digesters. Under the base scenario, the phosphorus release tank is not in operation for WAS flows.

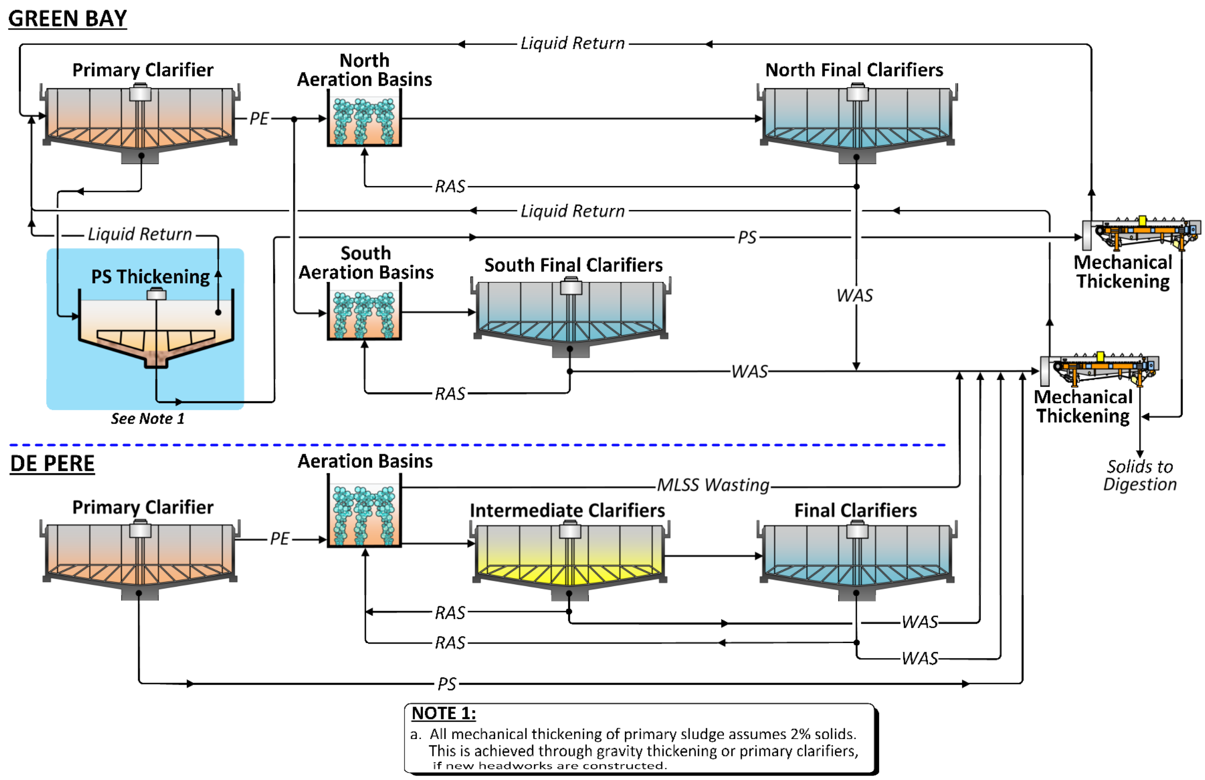



**Figure 2-3 Process Flow Diagram for Configuration 1b (PTUs Represented by Primary Clarifiers)**

## 2.2.3 Configuration 2a – Separate thickening for all streams

This configuration assumes WAS from GBF and DPF are thickened separately (Figure 2-4). GBF PS is thickened separately prior to digestion. This configuration was developed to provided potential flexibility for the design and layout of sludge screening alternatives, allowing one, two, or three streams to be easily managed and screened separately. This configuration would require modifications to the thickening influent wet well to keep the two WAS stream separate. Thickened WAS and PS are combined prior to digestion and pumped via thickened sludge pumps to the digesters. Under the base scenario, the phosphorus release tank is not in operation for WAS flows.

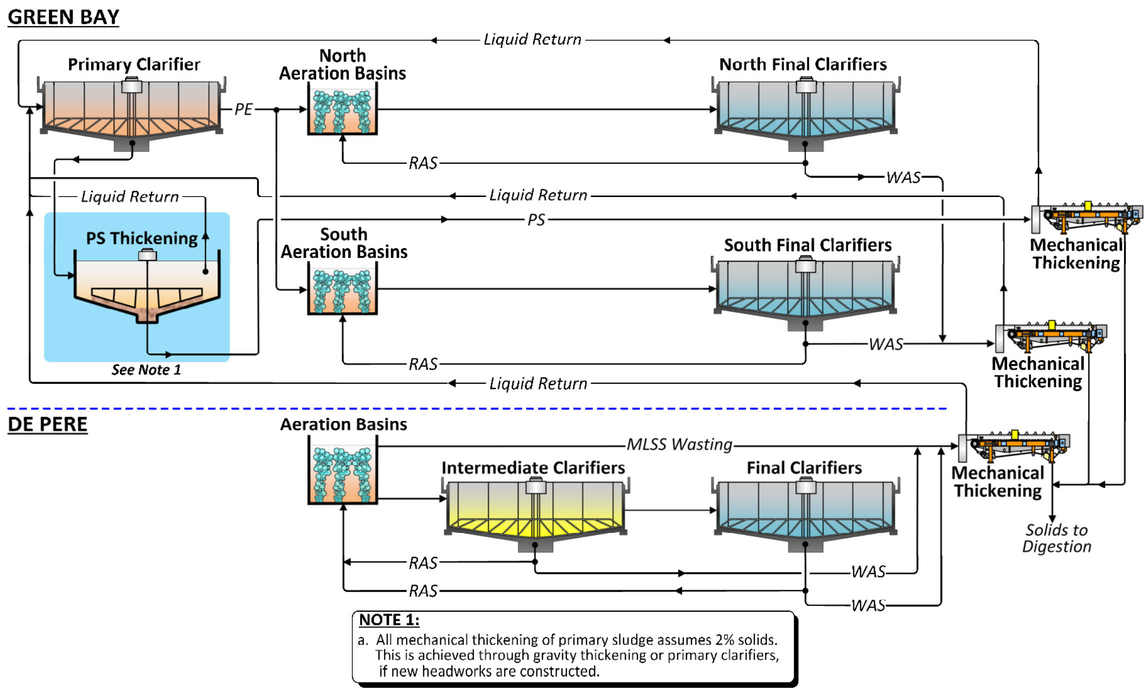



**Figure 2-4 Process Flow Diagram for Configuration 2a**

### 2.2.4 Configuration 2b – Separate thickening for all streams, modified DPF PTU operation

This configuration assumes WAS from GBF and DPF are thickened separately (Figure 2-5), with the modified PTU operation at the DPF. This configuration was developed to provided potential flexibility for the design and layout of sludge screening alternatives, allowing one, two, or three streams to be easily managed and screened separately. This configuration would require modifications to the thickening influent wet well to keep the two WAS stream separate. Thickened WAS and PS are combined prior to digestion and pumped via thickened sludge pumps to the digesters. Under the base scenario, the phosphorus release tank is not in operation for WAS flows.

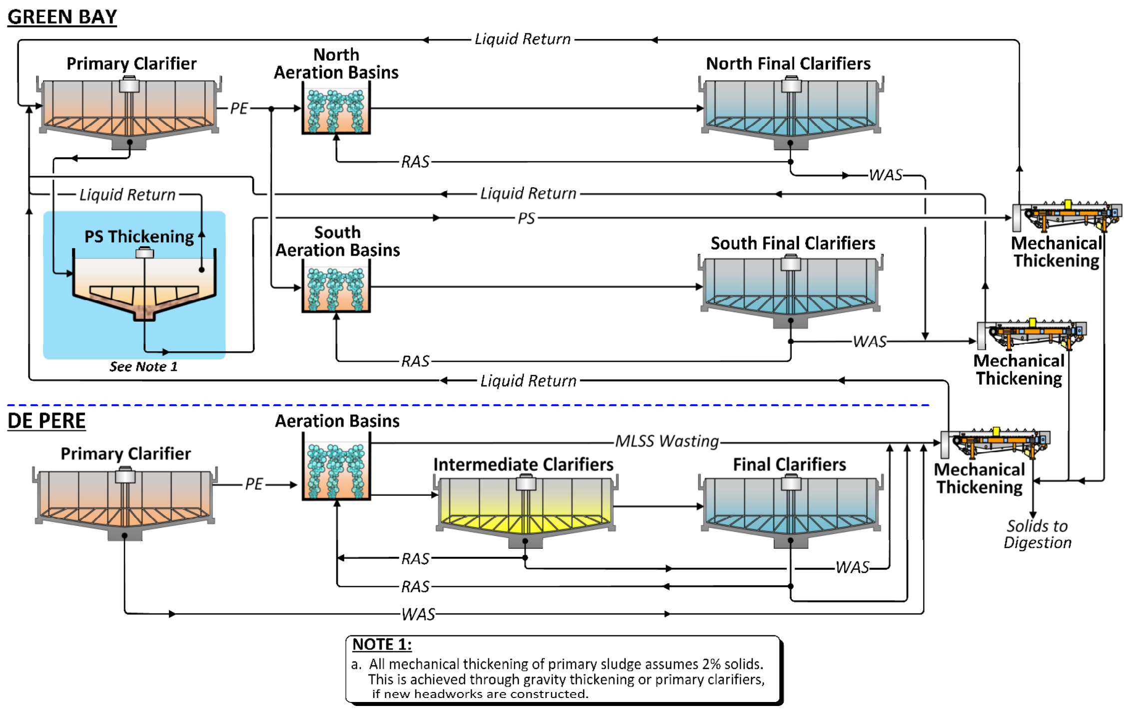



**Figure 2-5 Process Flow Diagram for Configuration 2b (PTUs Represented by Primary Clarifiers)**

## 2.2.5 Configuration 3a - Cothickening

This configuration assumes all WAS from GBF and DPF is combined prior to thickening along with GBF PS (2 percent solids) in the existing thickening wet well (Figure 2-6). Mixing would occur in the existing sludge thickening/equalization tank. This mixed sludge would be evenly split between mechanical thickening units. Thickened sludge would be pumped to the digestion process. Under the base scenario, the phosphorus release tank is not in operation for WAS flows.

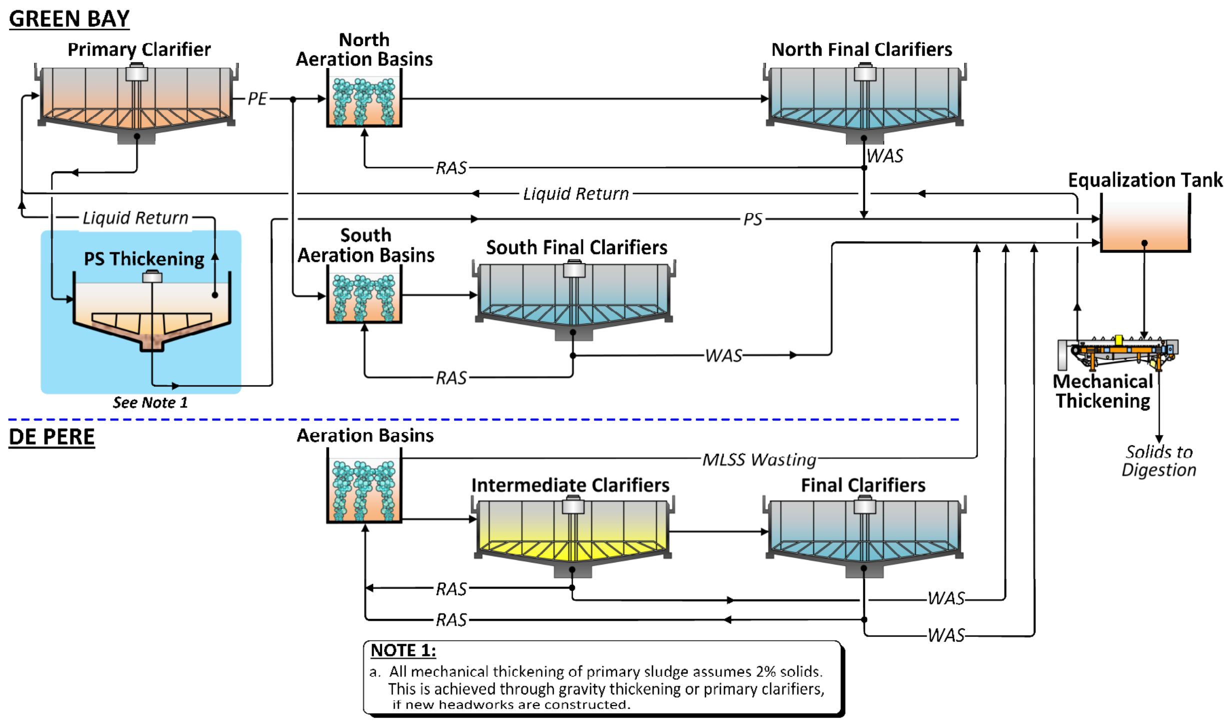



**Figure 2-6 Process Flow Diagram for Configuration 3a**

## 2.2.6 Configuration 3B – Cothickening, modified DPF PTU operation

This configuration assumes all WAS from GBF and DPF is combined is combined with DPF primary solids along with GBF PS prior to thickening (Figure 2-7). Mixing would occur in the existing sludge thickening/equalization tank. This mixed sludge would be evenly split between mechanical thickening units. Thickened sludge would be pumped to the digestion process. Under the base scenario, the phosphorus release tank is not in operation for WAS flows.

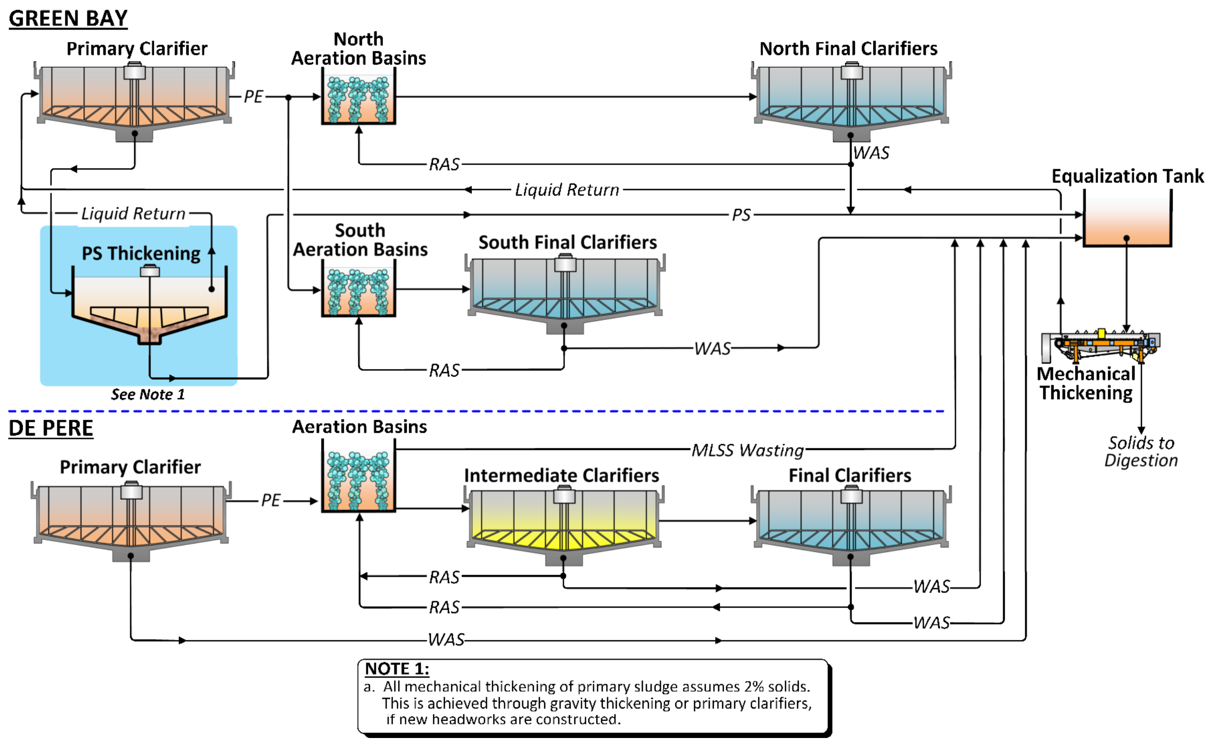



**Figure 2-7 Process Flow Diagram for Configuration 3b (PTUs Represented by Primary Clarifiers)**

## 2.3 Additional Improvements

The process flow diagrams represent the overall process configurations for future PS and WAS thickening. There are two key additional improvements that could be applied to all these configurations to increase reliability and operability of the overall thickening operation. The first, as discussed previously, is improvements to two or four gravity thickeners. The second improvement is related to thickened sludge pumping. The current thickened sludge wet wells and thickened sludge pumps have shown rotor stator wear issues because of grit load.. There are several bends between the wet well and the pump, which can create clogging and restriction conditions from grease and scum, especially on the suction side of the pumps. An additional improvement would be related to improving the configuration of the wet well and layout of the thickened sludge pumps. The details of gravity thickener and thickened sludge transfer improvements will be discussed as part of the overall improvements evaluation, but should be noted as additional improvements with the configurations previously discussed.

## 2.4 Process Configuration Conclusions

Identification of the potential process configurations provides the basis for developing solids projections. Through the identification of six feasible process configurations, a full bracket of potential solids flow can be estimated. These solids production ranges can then be used to develop infrastructure packages to provide the required thickening capacity for each process configuration.

# 3.0 Solids Production Projections

For evaluation of infrastructure packages, a design range for solids mass and hydraulic flows for each process configuration is required. It is important that these projects account for the potential of combining solids flows and future growth scenarios. A process modeling based approach was used for projecting future solids production rates, which can then be used to identify the capacity requirements for thickening infrastructure packages for the six potential process configurations.

## 3.1 Approach for Solids Projections

The previously calibrated and validated process model (see TM 2.3) was used to determine projected solids production rates for the three undigested sludge streams. The model was converted to a liquids-only layout by replacing digestion and sludge thickening units with a simulated thickened digestate supernatant recycle stream.

To generate ranges of solids production rates, a 10-year dynamic simulation was completed based on historic daily concentration data for GBF and DPF for each significant growth year identified in TM 2.1 (i.e., 2020, 2025, 2040, and 2070), but with increased influent flow rates based on the year being simulated (e.g., the 2070 dynamic simulation had higher flows than the 2020 dynamic simulation). Missing data were statistically imputed by calculating pairwise and higher order correlations between inputs (e.g., flow, COD, TKN, etc.). The potential added load from Green Bay Packaging (GBP) was also assessed and SRT control was implemented more strictly (i.e., SRT was set to 18 days between November-March and was set to 10 days between April-October to achieve a nitrification safety factor of 2.5). Table 3-1 below details operational details regarding the 10-year simulations. Completing two scenarios at each design year for the number of GBF aeration basins in operation helps to provide a bracket on the WAS concentrations for the GBF.

**Table 3-1 Dynamic, 10-Year Scenario Operational Data Showing Year Simulated, Inclusion/Exclusion of GBP and How Many Aeration Basin Trains were Assumed to be Online for Each Facility**

| Scenario | Year | GBP added | GBF North ABs online | GBF South ABs online | DPF ABs online |
|---|---|---|---|---|---|
| 1 | 2020 | No | 2 | 1 | 2 |
| 2 | 2020 | No | 3 | 2 | 2 |
| 3 | 2025 | Yes | 2 | 1 | 2 |
| 4 | 2025 | Yes | 3 | 2 | 2 |
| 5 | 2040 | Yes | 3 | 1 | 2 |
| 6 | 2040 | Yes | 4 | 2 | 2 |
| 7 | 2070 | Yes | 4 | 2 | 2 |
| 8 | 2070 | Yes | 3 | 1 | 2 |
| GBP – Green Bay Packaging; GBN – Green Bay North; GBS – Green Bay South; DP – De Pere; AB – aeration basin | | | | | |

For each scenario, the primary sludge, GBF WAS, and DPF WAS production for each of the six process configurations was developed. To ensure that each package assessed as part of this TM will be able to handle future loading for decades to come, four model outputs were utilized to size each alternative: 2025 25$^{th}$ percentile, 2025 50$^{th}$ percentile, 2040 50$^{th}$ percentile, and 2040 90$^{th}$

percentile. The solids production projections for primary sludge, GBF WAS, and DPF WAS will be combined in different manners to size mechanical thickening equipment.

## 3.2 Primary Sludge Production

Table 3-2 provides a summary of the PS design characteristics for the GBF. The PS flow design considers a bracketed range of potential concentrations (i.e., 2 percent or 3 percent solids) and flows. For design purposes, flow rates varied between 150-220 gpm at 2 percent solids, 100-140 gpm at 3 percent solids, and corresponding mass loads varied between 35,000-52,000 ppd (ranges of solids production provided as box-and-whisker plots in **Appendix A**) were identified for average day conditions. The flow rate at 2 percent solids will be the controlling flow for hydraulic considerations. The 2040 90$^{th}$ percentile value will be used for peak loading sizing, and the 2025 50$^{th}$ percentile will be used for average loading sizing.

**Table 3-2 Primary Sludge Flow Rates and Mass Loads for Two Loading Scenarios at Four Different Percentiles for All Process Configurations Simulated**

| | Flow at 2% solids [gpm] | Flow at 3% solids [gpm] | Mass Load [ppd] |
|---|---|---|---|
| 2025 25th | 150 | 100 | 35,000 |
| 2025 50th | 160 | 110 | 39,000 |
| 2040 50th | 170 | 110 | 41,000 |
| 2040 90th | 220 | 140 | 52,000 |

## 3.3 GBF WAS Production

Table 3-3 provides a summary of the combined WAS design characteristics for the two GBF activated sludge systems (i.e., North and South). For evaluation purposes, flow rates varied between 280-700 gpm, and corresponding mass loads varied between 28,000-39,000 ppd (box-and-whisker plots provided in Appendix A). The 90$^{th}$ percentile values are equivalent to maximum month loading conditions. The 2040 90$^{th}$ percentile value will be used for peak loading sizing, and the 2025 50$^{th}$ percentile will be used for average loading sizing.

**Table 3-3 Green Bay WAS Flow Rates and Mass Loads Four Different Percentiles for all Configurations Simulated.**

| | Flow rate [gpm] | Mass Load [ppd] |
|---|---|---|
| 2025 25th | 280 | 28,000 |
| 2025 50th | 430 | 31,000 |
| 2040 50th | 590 | 33,000 |
| 2040 90th | 700 | 39,000 |

## 3.4 DPF WAS Production

Table 3-4 provides a summary of the combined WAS design characteristics for the De Pere facility assuming no sludge diversion of PTU solids; Table 3-5 assumes that solids are diverted from the PTUs when influent flow is less than 15 mgd and combined with the reduced WAS flow rate. For evaluation, flow rates varied between 280-540 gpm for scenarios with no primary solids and 830-1,640 for scenarios with thickening. Corresponding mass loads varied between 21,000-37,000 and 27,000-45,000 ppd, respectively (see Appendix A for box and whisker plots). The large increase with the primary solids from the PTUs is due to the low solids concentration assumed for the primary sludge flow (0.25 percent solids assumed). These solids would be combined with the WAS solids and be pumped to the GBF for processing. The 90th percentile values are equivalent to maximum month loading conditions. The 2040 90th percentile value will be used for peak loading sizing, and the 2025 50th percentile will be used for average loading sizing.

**Table 3-4 De Pere WAS Flow Rates and Mass Loads Four Different Percentiles Assuming No Primary Sludge (Configurations 1a,2a, and 3a)**

| | Flow rate [gpm] | Mass Load [ppd] |
|---|---|---|
| 2025 25th | 280 | 21,000 |
| 2025 50th | 300 | 24,000 |
| 2040 50th | 300 | 27,000 |
| 2040 90th | 540 | 37,000 |

**Table 3-5 De Pere WAS Flow Rates and Mass Loads Four Different Percentiles Assuming Primary Sludge is Added (Configurations 1b, 2b, and 3b)**

| | Flow rate [gpm] | Mass Load [ppd] |
|---|---|---|
| 2025 25th | 830 | 27,000 |
| 2025 50th | 1,050 | 31,000 |
| 2040 50th | 1,120 | 33,000 |
| 2040 90th | 1,640 | 45,000 |

## 3.5 Co-Thickening

While gravity co-thickening is not typically recommended for primary solids and WAS, mechanical co-thickening can be used to thicken the combined solids in a single step. Thickener enclosures limited hydraulic contact time, and polymer optimization can make mechanical co-thickening a beneficial process. Enclosed thickening processes may be more attractive than open processes, due to the odor potential of the combined solids. Advantages and disadvantages are listed in

Table 3-6.

**Table 3-6 Mechanical Co-thickening Advantages and Disadvantages**

| Advantages | Disadvantages |
|---|---|
| Single process for primary and secondary solids | Greater odor potential than separate thickening; enclosed process recommended |
| High solids concentrations for downstream processing | Pumping equipment must be suitable for high solids concentrations |
| Retains energy in solids | Capacity requirements may limit choice of mechanical thickening technology |
| | Additional challenges for grease management and subsequent plugging and wear on equipment. |

Solids production rates for both cothickening configurations are summarized in Table 3-7 and Table 3-8, with box-and-whisker plots provided in Appendix A. The 90th percentile values are equivalent to maximum month loading conditions. The 2040 90th percentile value will be used for peak loading sizing, and the 2025 50th percentile will be used for average loading sizing.

**Table 3-7 Total Solid Production for Configuration 3a Cothickening**

| | Flow rate [gpm] | Mass Load [ppd] |
|---|---|---|
| **2025 25th** | 660 | 84,000 |
| **2025 50th** | 890 | 94,000 |
| **2040 50th** | 1,060 | 101,000 |
| **2040 90th** | 1,460 | 128,000 |

**Table 3-8 Total Solid Production for Configuration 3b Cothickening**

| | Flow rate [gpm] | Mass Load [ppd] |
|---|---|---|
| **2025 25th** | 1,210 | 90,000 |
| **2025 50th** | 1,640 | 101,000 |
| **2040 50th** | 1,880 | 107,000 |
| **2040 90th** | 2,560 | 136,000 |

## 3.6 Solids Production for Process Sizing

Table 3-9 provides the range of the mass loads and flow rates for the six alternative process configurations. These data will be used for prelimnary sizing and evaluation of thickening equipment. The design basis for each applicable flow stream for each configuration is summarized in Table 3-10. The different flow streams for each configuration will be sized for thickening equipment in Section 6.

**Table 3-9 Flow Rates and Mass Loads for Each Configuration and at Four Different Percentiles**

| Process Configuration | Scenario | GBF PS | | GBF WAS | | DPF WAS | | combined WAS | | CoThickened | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mass | Flow[1] | Mass | Flow | Mass | Flow | Mass | Flow | Mass | Flow |
| Configuration 1a | 2025, 25th | 35,000 | 100 | 28,000 | 280 | 21,000 | 280 | 49,000 | 560 | N/A | |
| | 2025, 50th | 39,000 | 160 | 31,000 | 430 | 24,000 | 300 | 55,000 | 730 | | |
| | 2040, 50th | 41,000 | 170 | 33,000 | 590 | 27,000 | 300 | 60,000 | 890 | | |
| | 2040, 90th | 52,000 | 220 | 39,000 | 700 | 37,000 | 540 | 76,000 | 1,240 | | |
| Configuration 1b | 2025, 25th | 35,000 | 100 | 28,000 | 280 | 27,000 | 830 | 55,000 | 1,110 | N/A | |
| | 2025, 50th | 39,000 | 160 | 31,000 | 430 | 31,000 | 1,050 | 62,000 | 1,480 | | |
| | 2040, 50th | 41,000 | 170 | 33,000 | 590 | 33,000 | 1,120 | 66,000 | 1,710 | | |
| | 2040, 90th | 52,000 | 220 | 39,000 | 700 | 45,000 | 1,640 | 84,000 | 2,340 | | |
| Configuration 2a | 2025, 25th | 35,000 | 100 | 28,000 | 280 | 21,000 | 280 | N/A | | N/A | |
| | 2025, 50th | 39,000 | 160 | 31,000 | 430 | 24,000 | 300 | | | | |
| | 2040, 50th | 41,000 | 170 | 33,000 | 590 | 27,000 | 300 | | | | |
| | 2040, 90th | 52,000 | 220 | 39,000 | 700 | 37,000 | 540 | | | | |
| Configuration 2b | 2025, 25th | 35,000 | 100 | 28,000 | 280 | 27,000 | 830 | N/A | | N/A | |
| | 2025, 50th | 39,000 | 160 | 31,000 | 430 | 31,000 | 1,050 | | | | |
| | 2040, 50th | 41,000 | 170 | 33,000 | 590 | 33,000 | 1,120 | | | | |
| | 2040, 90th | 52,000 | 220 | 39,000 | 700 | 45,000 | 1,640 | | | | |
| Configuration 3a | 2025, 25th | 35,000 | 100 | 28,000 | 280 | 21,000 | 280 | N/A | | 84,000 | 660 |
| | 2025, 50th | 39,000 | 160 | 31,000 | 430 | 24,000 | 300 | | | 94,000 | 890 |
| | 2040, 50th | 41,000 | 170 | 33,000 | 590 | 27,000 | 300 | | | 101,000 | 1,060 |
| | 2040, 90th | 52,000 | 220 | 39,000 | 700 | 37,000 | 540 | | | 128,000 | 1,460 |
| Configuration 3b | 2025, 25th | 35,000 | 100 | 28,000 | 280 | 27,000 | 830 | N/A | | 90,000 | 1,210 |
| | 2025, 50th | 39,000 | 160 | 31,000 | 430 | 31,000 | 1,050 | | | 101,000 | 1,640 |
| | 2040, 50th | 41,000 | 170 | 33,000 | 590 | 33,000 | 1,120 | | | 107,000 | 1,880 |
| | 2040, 90th | 52,000 | 220 | 39,000 | 700 | 45,000 | 1,640 | | | 136,000 | 2,560 |

[1]2025 25th percentile based on 3 percent solids concentration.

## Table 3-10 Design Basis for Required Flow Streams for Each Configuration

| Process Configuration | Scenario | GBF PS | | GBF WAS | | DPF WAS | | combined WAS | | CoThickened | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mass | Flow[1] | Mass | Flow | Mass | Flow | Mass | Flow | Mass | Flow |
| Configuration 1a | Average Design | 39,000 | 160 | N/A | | | | 55,000 | 730 | N/A | |
| | Maximum Design | 52,000 | 220 | | | | | 76,000 | 1,240 | | |
| Configuration 1b | Average Design | 39,000 | 160 | N/A | | | | 62,000 | 1,480 | N/A | |
| | Maximum Design | 52,000 | 220 | | | | | 84,000 | 2,340 | | |
| Configuration 2a | Average Design | 39,000 | 160 | 31,000 | 430 | 24,000 | 300 | N/A | | N/A | |
| | Maximum Design | 52,000 | 220 | 39,000 | 700 | 37,000 | 540 | | | | |
| Configuration 2b | Average Design | 39,000 | 160 | 31,000 | 430 | 31,000 | 1,050 | N/A | | N/A | |
| | Maximum Design | 52,000 | 220 | 39,000 | 700 | 45,000 | 1,640 | | | | |
| Configuration 3a | Average Design | N/A | | | | | | | | 94,000 | 890 |
| | Maximum Design | | | | | | | | | 128,000 | 1,460 |
| Configuration 3b | Average Design | N/A | | | | | | | | 101,000 | 1,640 |
| | Maximum Design | | | | | | | | | 136,000 | 2,560 |

[1]2025 25th percentile based on 3 percent solids concentration.

# 4.0 Nutrient Harvesting Considerations

The current operation strategy specified for the nutrient harvesting process consists of sending a blend of thickened PS and WAS to the P-release tank, achieving a net 2 percent solids concentration in the feed to the P-release tank. The 2 percent P-release sludge is then thickened to 6 percent solids. Feeding 2 percent solids into the P-release tank increases the phosphorus concentration in the P-release filtrate water. This concentration is a major driving force in the amount of recoverable phosphorus. Within the nutrient harvesting reactor, the ending soluble phosphorus concentration after the reaction is the driver for recoverable phosphorus. Historically, this ending soluble phosphorus concentration was 40 to 60 mg/L using magnesium chloride. Recent research by Ostara has investigated the use of magnesium oxide to drive precipitation. This chemical can reportedly achieve an ending soluble phosphorus concentration in the harvester of 10 to 30 mg/L. If this lower ending soluble phosphorus concentration is achievable, it may be feasible to send raw WAS to the P-release tank and avoid the intermediate thickening step.

A mass balance was completed to understand the impact of the ending soluble phosphorus concentration on phosphorus harvested. The following assumptions were made for the mass balance, which all assumed full EBPR functionality:

- WAS thickened before P-release
  - Phosphorus mass in WAS: 1,100 ppd (average design condition)
  - Phosphorus released in P-release tank: 35 percent of total solids phosphorus load
  - Phosphorus released in digestion: 30 percent of total solids phosphorus load
  - Solids concentration into P-release tank: 2 percent
  - Thickened solids to digestion: 6 percent
  - Pre-digestion thickening filtrate flow: 0.24 mgd
  - Dewatered cake concentration: 19 percent
  - Post digestion filtrate flow: 0.1 mgd
- Unthickened WAS to P-release
  - Phosphorus mass in WAS: 1,100 ppd (average design condition)
  - Phosphorus released in P-release tank: 35 percent of total solids phosphorus load
  - Phosphorus released in digestion: 30 percent of total solids phosphorus load
  - Solids concentration into P-release tank: 2 percent
  - Thickened solids to digestion: 6 percent
  - Pre-digestion thickening filtrate flow: 0.91 mgd
  - Dewatered cake concentration: 18 percent
  - Post digestion filtrate flow: 0.1 mgd

The difference between the thickened P-release and the WAS P-release is the pre-digestion filtrate flow. This increased flow reduces the combined soluble phosphorus concentration to 90 mg/L when raw WAS is fed to the P-release tank (combination of pre-digestion filtrate and post-digestion filtrate). For the thickened WAS operation in the P-release tank, this phosphorus concentration is 250 mg/L. The impact of the ending soluble phosphorus concentration in the harvester on the phosphorus harvested in each scenario is shown in Figure 4-1. If the ending phosphorus concentration is 50 mg/L, the WAS thickening before P-release doubles the phosphorus harvested. If the ending concentration is 20 mg/L, there is a 20 percent reduction in the phosphorus harvested.

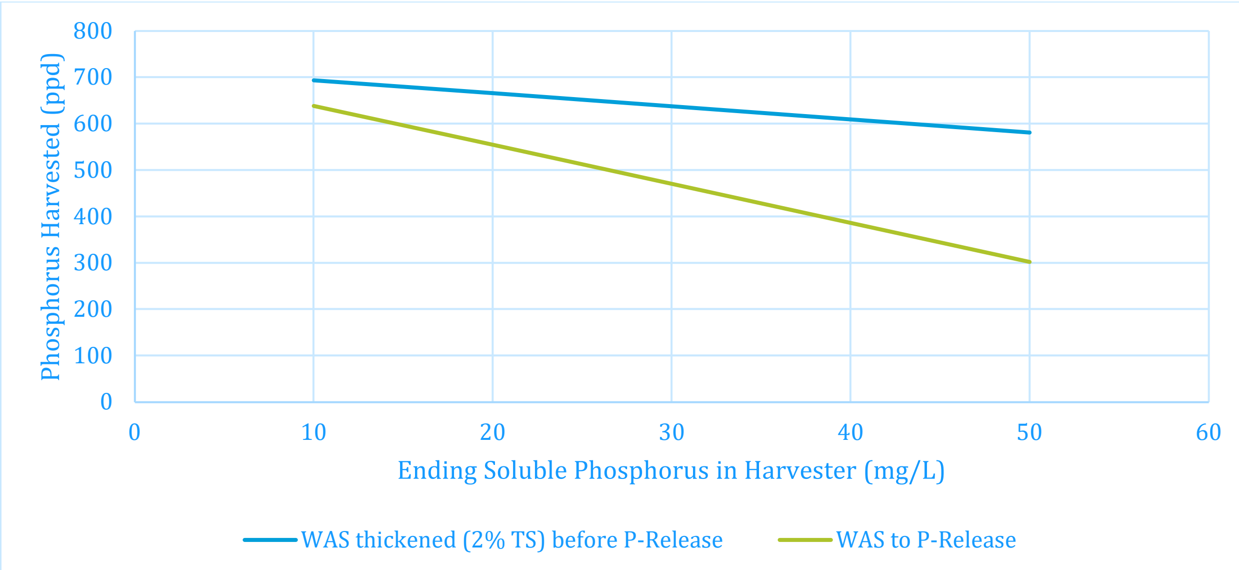



**Figure 4-1 Impact of Ending Soluble Phosphorus Concentration in the Harvester on Phosphorus Harvested**

Given the uncertainty surrounding long-term nutrient harvesting at NEW Water, it is likely not prudent to invest in thickening equipment specifically for nutrient harvesting. Based on developments related to the form of magnesium used for harvesting, it may be possible to operate without the WAS thickening prior to P-release while still harvesting a significant mass of phosphorus. For nutrient harvesting considerations, it is recommended that space be reserved for additional thickening operation; however, applied research to determine the ability to operate at a lower ending soluble phosphorus concentration and simplify the solids thickening process flow schematic should be completed.

# 5.0 Selective Wasting Considerations

The thickening capacity projections developed consider historical performance of both the GBF and the DPF. While the DPF thickening projections consider alternate approaches (PTU TSS stream diversion from activated sludge process), the GBF facility considers only growth projections. One challenge of the GBF secondary process is the high variability of the sludge settling characteristics, poor settleability with sludge volume indices (SVIs) greather than 200 g/mL are frequently observed. One consideration of the NEW Water Facility Plan will include an evaluation of potential alternatives to improve settling characteristics. Improved settling characteristics will provide several benefits to the GBF:

- Increased wet weather capacity of individual secondary treatment unit processes – increased clarifier solids loading rates
- Increased dry weather reliability of individual secondary treatment unit processes – increased solids loading rates allow operation at higher SRTs, increasing nitrification reliability without requiring more treatment units online
- Dry and wet weather clarifier performance – well-flocculating sludge increases the capture rate of discrete particles, decreasing effluent TSS
- Pumping energy reduction – higher settling rates and well-flucculating sludge decrease the required underflow (RAS) rates, reduced RAS rates in-turn can increase compression settling and resulting sludge blanket concentrations

One specific technology that has shown to increase sludge settling rates is the use of hydrocyclones to implement selective wasting of the activated slude system. The use of hydrocyclones requires reconfiguration of the WAS pumps and piping. Flow in excess of the required WAS rates are sent to the hydrocyclone units where higher density particles are separated and returned to the process. Less dense particles are then wasted to the thickening process. Under typical hydrocyclone operation 80 percent of the influent leaves through the overflow (less dense particles that are wasted) with the remaining 20 percent returning to the process. Modifications to the WAS pumping and piping may be required to meet the increased flow and backpressure requirements of the hydrocyclones.

The specific impact to the thickening processes receiving pumped WAS flows with the implementation of selective wasting is anticipated to be minimal. The sludge blanket concentrations would increase as the result of improved settling characteristics, however, the overflow of the hydrocyclones (WAS stream) is not anticipated to have an increased concentration. The combination of selective wasting and a potentially longer SRT with improved settleability could reduce the hydraulic capacity required of the thickening equipment. The equipment evaluated for the NEW Water thickening improvements was limited by hydraulic capacity rather than solids loading capacity. As part of the selective wasting, NEW Water would consider a pilot program; results of this program can be fed into any potential impacts to thickening equipment.

# 6.0 Equipment Feasibility Evaluation

Based on the results presented above, equipment alternatives were determined that would be able to effectively manage the projected flows and solids loads. Three technologies were examined for their feasibility to handle these loads: gravity belt thickeners (GBTs, 2-meter and 3-meter), rotary drum thickeners (RDTs), and centrifuges. These three technologies were identified during the preliminary workshop with NEW Water in February 2020. The initial alternative comparison is based on equipment only, comparing the three technologies in term of capital and life cycle costs as well as non-cost benefits. Full infrastructure configuration costs will be completed in the following section.

## 6.1 Equipment Technologies for Evaluation

The three equipment technologies considered each have benefits and drawbacks for the three sludge streams considered. The following summarizes each technology with the respect to the sludge streams considered.

- Gravity Belt Thickeners (GBTs)
  - Technology requires the most footprint per unit of capacity of the three technologies considered.
  - Ability to thicken all flow streams (WAS, PS, Co-Thickening), one unit could act as a swing unit for both WAS and PS redundancy, although this is not common for GBTs
  - Equipment is familiar to both operations and maintenance staff
  - Least adaptable to odor control required for primary sludge and/or co-thickening
    - Units can be covered with a plexiglass cover (assumption used for cost estimates) but this limits visibility of sludge consistency
    - For NEW Water, enclosed GBTs were evaluated, which can provide accessibility for odor control
  - Equal to or the highest polymer requirements for equivalent thickening of the three technologies considered
- Rotary Drum Thickeners (RDT)
  - Relatively small footprint requirement per unit capacity of the three
  - Ability to thicken all flow streams (WAS, PS, Co-Thickening), one unit could act as a swing unit for both WAS and PS redundancy
  - Equipment is odor control ready as a base package and fully enclosed, reducing odor emissions
  - Equal to or the highest polymer requirements for equivalent thickening of the three technologies considered
- Centrifuge
  - Technology is equal to or the lowest footprint requirement per unit capacity of the three

- Technology not capable of handling all three flow streams (current unit not capable of handling primary sludge), additional redundancy would need to be considered for primary sludge thickening technology selected
- Lowest polymer use of three technologies considered
- Equipment is odor control ready as a base package and fully enclosed, reducing odor emissions

## 6.2 Equipment sizing

Preliminary manufacturer proposals for each technology are included in **Appendix B**. The number of units required for each technology (and therefore, the equipment cost) was determined by comparing the unit's capacity to the established design flows and load for each process configuration. From Section 3, the peak design flow and load was the 90$^{th}$ percentile loading in 2040; average design loading was the 50$^{th}$ percentile loading in 2025. Each technology for each process configuration assumed one additional shared unit for redundancy. This assumption can be further explored with NEW Water. For alternatives that considered WAS and PS thickening separately, the unit would be a swing unit accommodating redundancy for both processes. Therefore, equipment estimates were for the total firm units, plus one total redundancy. Piping would be included for swing redundancy. The total number of units with this redundancy is presented in Table 6-1 for each sludge stream, with a summary presentation in Figure 6-1.

**Table 6-1 Total Number of Units Required for Each Sludge Stream for Each Configuration**

| | Design Range | | 2 M GBTs | | | 3 M GBTs | | | RDTs | | | Centrifuges | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average (gpm) | Max (gpm) | Unit | Avg Cap. (gpm) | Max Cap. (gpm) | Unit | Avg Cap. (gpm) | Max Cap. (gpm) | Unit | Avg Cap. (gpm) | Max Cap. (gpm) | Unit | Avg Cap. (gpm) | Max Cap. (gpm) |
| **Primary Sludge** | | | | | | | | | | | | | | |
| Configuration 1a | 160 | 220 | 1 | 400 | 660 | 1 | 600 | 900 | 1 | 420 | 600 | 1 | 500 | 920 |
| Configuration 1b | 160 | 220 | 1 | 400 | 660 | 1 | 600 | 900 | 1 | 420 | 600 | 1 | 500 | 920 |
| Configuration 2a | 160 | 220 | 1 | 400 | 660 | 1 | 600 | 900 | 1 | 420 | 600 | 1 | 500 | 920 |
| Configuration 2b | 160 | 220 | 1 | 400 | 660 | 1 | 600 | 900 | 1 | 420 | 600 | 1 | 500 | 920 |
| Configuration 3a | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Configuration 3b | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **GBF WAS** | | | | | | | | | | | | | | |
| Configuration 1a | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Configuration 1b | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Configuration 2a | 430 | 700 | 2 | 800 | 1,320 | 1 | 600 | 900 | 2 | 840 | 1,200 | 1 | 500 | 920 |
| Configuration 2b | 430 | 770 | 2 | 800 | 1,320 | 1 | 600 | 900 | 2 | 840 | 1,200 | 1 | 500 | 920 |
| Configuration 3a | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Configuration 3b | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **DPF WAS** | | | | | | | | | | | | | | |
| Configuration 1a | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Configuration 1b | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Configuration 2a | 300 | 540 | 1 | 400 | 660 | 1 | 600 | 900 | 1 | 420 | 600 | 1 | 500 | 920 |
| Configuration 2b | 1,050 | 1,640 | 2 | 800 | 1,320 | 2 | 1,200 | 1,800 | 2 | 840 | 1,200 | 2 | 1,000 | 1,840 |
| Configuration 3a | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Configuration 3b | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| | Design Range | | 2 M GBTs | | | 3 M GBTs | | | RDTs | | | Centrifuges | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average (gpm) | Max (gpm) | Unit | Avg Cap. (gpm) | Max Cap. (gpm) | Unit | Avg Cap. (gpm) | Max Cap. (gpm) | Unit | Avg Cap. (gpm) | Max Cap. (gpm) | Unit | Avg Cap. (gpm) | Max Cap. (gpm) |
| **Combined WAS** | | | | | | | | | | | | | | |
| Configuration 1a | 730 | 1,240 | 3 | 1,200 | 1,980 | 2 | 1,200 | 1,800 | 3 | 1,260 | 1,800 | 2 | 1,000 | 1,840 |
| Configuration 1b | 1,480 | 2,340 | 4 | 1,600 | 2,640 | 3 | 1,800 | 2,700 | 4 | 1,680 | 2,400 | 3 | 1,500 | 2,760 |
| Configuration 2a | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Configuration 2b | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Configuration 3a | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Configuration 3b | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Co-thickened Solids** | | | | | | | | | | | | | | |
| Configuration 1a | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Configuration 1b | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Configuration 2a | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Configuration 2b | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Configuration 3a | 890 | 1,460 | 3 | 1,200 | 1,980 | 2 | 1,200 | 1,800 | 3 | 1,260 | 1,800 | 2 | 1,000 | 1,840 |
| Configuration 3b | 1,640 | 2,560 | 4 | 1,600 | 2,640 | 3 | 1,800 | 2,700 | 4 | 1,680 | 2,400 | 3 | 1,500 | 2,760 |
| **Total Thickening Units (Required for Capacity + 1)** | | | | | | | | | | | | | | |
| Configuration 1a | 890 | 1,460 | 5 | 1,600 | 2,640 | 4 | 1,800 | 2,700 | 4 | 1,680 | 2,400 | 3 | 1,500 | 2,760 |
| Configuration 1b | 1,640 | 2,560 | 6 | 2,000 | 3,300 | 5 | 2,400 | 3,600 | 6 | 2,100 | 3,000 | 5 | 2,000 | 3,680 |
| Configuration 2a | 890 | 1,460 | 5 | 1,600 | 2,640 | 4 | 1,800 | 2,700 | 4 | 1,680 | 2,400 | 3 | 1,500 | 2,760 |
| Configuration 2b | 1,640 | 2,560 | 6 | 2,000 | 3,300 | 5 | 2,400 | 3,600 | 6 | 2,100 | 3,000 | 5 | 2,000 | 3,680 |
| Configuration 3a | 890 | 1,460 | 4 | 1,200 | 1,980 | 3 | 1,200 | 1,800 | 4 | 1,260 | 1,800 | 3 | 1,000 | 1,840 |
| Configuration 3b | 1,640 | 2,560 | 5 | 1,600 | 2,640 | 4 | 1,800 | 2,700 | 5 | 1,680 | 2,400 | 4 | 1,500 | 2,760 |

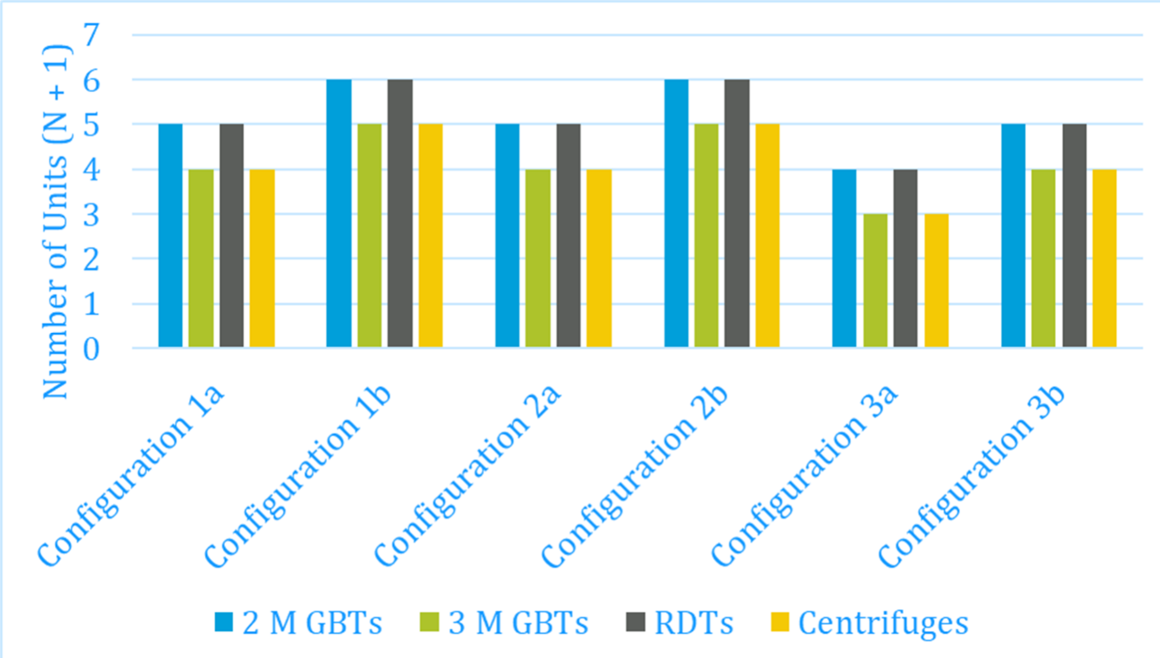



**Figure 6-1 Summary of Total Units Required for each Process Configuration**

For Process Configurations 1b and 2b, where the modified PTU operation is included with separate thickening options, the sizing for the mechanical primary sludge thickener is the main cause for an increased number of thickening units as compared to Process Configuration 3b. It was assumed that all thickening units should be the same model for maintenance simplicity. However, this results in excess capacity in the primary sludge thickening unit. In Configuration 3b, where WAS is blended with PS prior, this excess capacity is captured, and thus fewer overall thickeners are required.

## 6.3 Equipment cost Comparison

The estimated 20-year operation and maintenance (O&M) was determined using a net present value approach (NPV) at the 2025 50th percentile loading condition assuming: cost of electricity is $0.07/kWh, cost of polymer is $3.00/lb, 2 percent of capital cost for annual maintenance, 2 percent inflation, 20-year life cycle, and 3 perecent discount rate (Table 6-3). The total life cycle costs (LCC) are the sum of the equipment cost and the O&M (Table 6-2 and Figure 6-2).

**Table 6-2 Number of Units Required, Equipment Cost, Estimated 20-Year O&M, and Total LCC for Each Equipment Alternative and Process Configuration**

| Configuration | | Alternative | | | |
|---|---|---|---|---|---|
| | | 2M GBTs | 3M GBTs | RDTs | Cent. |
| Configuration 1a Combined WAS, Separate PS | Units Required | 5 | 4 | 5 | 4 |
| | Equipment Cost | $1,125,000 | $1,600,000 | $1,025,000 | $2,555,600 |
| | 20-year O&M NPV | $6,050,880 | $6,013,971 | $6,886,311 | $7,554,794 |
| | **Total LCC** | $7,175,880 | $7,613,971 | $7,911,311 | $10,110,394 |

| Configuration | | Alternative | | | |
|---|---|---|---|---|---|
| | | 2M GBTs | 3M GBTs | RDTs | Cent. |
| Configuration 1b Combined WAS, Separate PS, DPF PTU modification | Units Required | 6 | 5 | 6 | 5 |
| | Equipment Cost | $1,380,000 | $2,000,000 | $1,230,000 | $3,194,500 |
| | 20-year O&M NPV | $6,463,710 | $6,426,801 | $6,426,801 | $8,969,777 |
| | **Total LCC** | $7,843,710 | $8,426,801 | $7,656,801 | $12,164,277 |
| Configuration 2a All sludge thickened separately | Units Required | 5 | 4 | 5 | 4 |
| | Equipment Cost | $1,125,000 | $1,600,000 | $1,025,000 | $2,555,600 |
| | 20-year O&M NPV | $6,037,504 | $6,000,595 | $5,994,444 | $7,487,084 |
| | **Total LCC** | $7,162,504 | $7,600,595 | $7,019,444 | $10,042,684 |
| Configuration 2b All sludge thickened separately, DPF PTU modification | Units Required | 6 | 5 | 6 | 5 |
| | Equipment Cost | $1,575,000 | $2,000,000 | $1,435,000 | $3,194,500 |
| | 20-year O&M NPV | $6,481,339 | $6,425,976 | $6,425,976 | $8,994,215 |
| | **Total LCC** | $8,056,339 | $8,425,976 | $7,860,976 | $12,188,715 |
| Configuration 3a Co-thickening of all sludge | Units Required | 4 | 3 | 4 | 4 |
| | Equipment Cost | $900,000 | $1,200,000 | $820,000 | $2,555,600 |
| | 20-year O&M NPV | $2,943,306 | $3,224,852 | $2,844,852 | $5,069,092 |
| | **Total LCC** | $3,843,306 | $4,424,852 | $3,664,852 | $7,624,692 |
| Configuration 3b Co-thickening of all sludge, DPF PTU modification | Units Required | 5 | 4 | 5 | 4 |
| | Equipment Cost | $1,150,000 | $1,600,000 | $1,025,000 | $2,555,600 |
| | 20-year O&M NPV | $3,330,747 | $3,762,293 | $3,181,141 | $6,132,311 |
| | **Total LCC** | $4,480,747 | $5,362,293 | $4,206,141 | $8,687,911 |

**Table 6-3 Operation and Maintenance Cost Assumptions**

| Cost Category | All Thickening | | |
|---|---|---|---|
| | GBT | RDT | Centrifuge |
| WAS Polymer Use, lb/ton | 8 | 10 | 3 |
| PS Polymer Use, lb/ton | 8 | 8 | 3 |
| Co-Thickening Polymer Use, lb/ton | 8 | 8 | 3 |
| Cost of Polymer, $/lb | 3 | | |
| Power Use, HP/unit | 3 | 3 | 175[1] |
| Cost of Electricity, $/kWh | 0.07 | | |

| Cost Category | All Thickening | | |
|---|---|---|---|
| | GBT | RDT | Centrifuge |
| Maintenance, % of capital | 2 | 2 | 2 |
| Maintenance, $/year/unit | $4,500 | $4,100 | $12,800 |
| Inflation Rate, % | 2 | | |
| Discount Rate, % | 3 | | |
| [1] Power costs used a 0.2 kW/gpm value for centrifuges to account for turndown | | | |

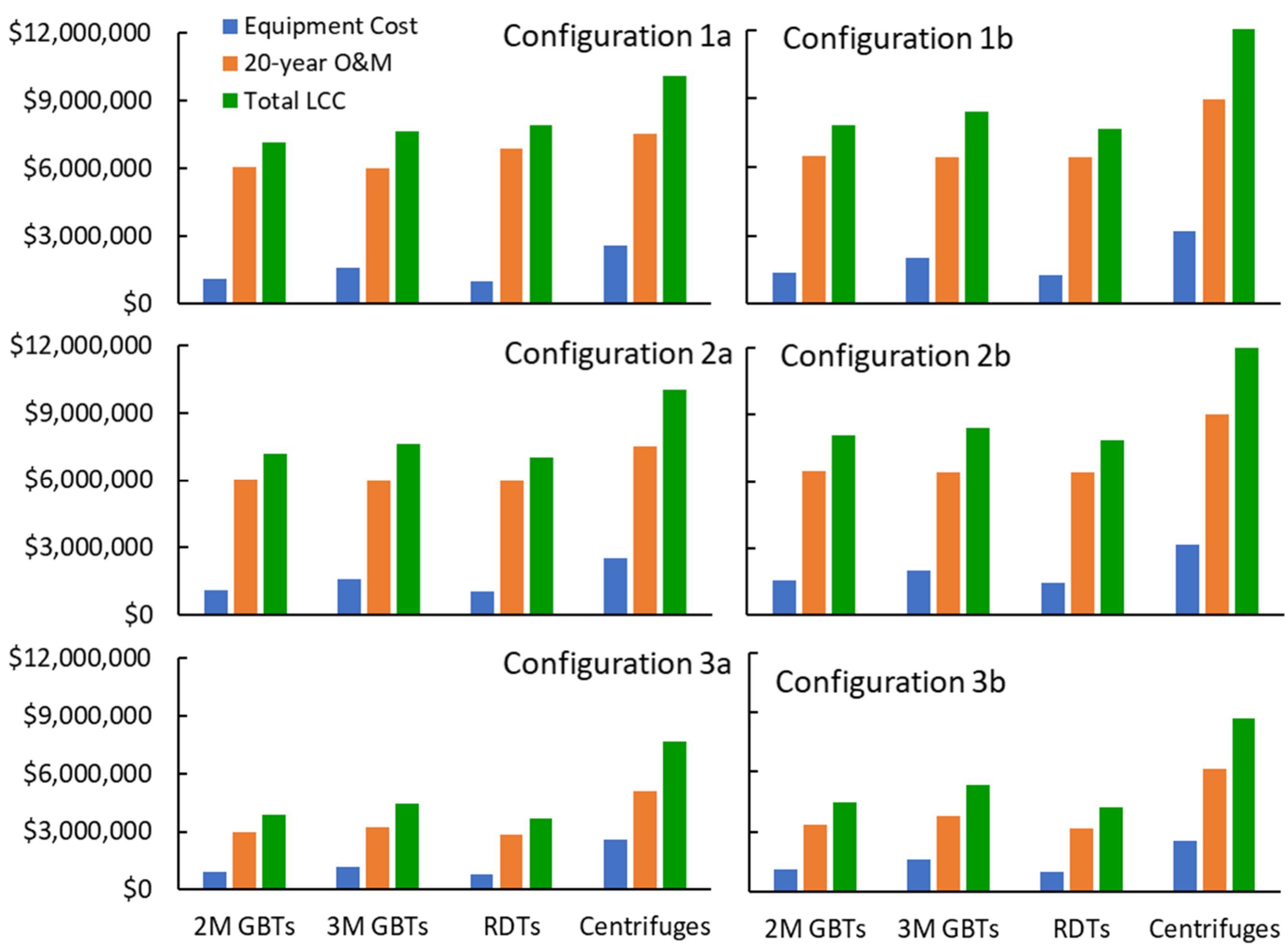



**Figure 6-2 Grouped Bar Chart Showing Equipment, O&M NPV, and Total Costs for Each Alternative and Process Configuration**

## 6.4 Equipment Conclusions

The technologies evaluated have a clear separation between RDTs/GBTs (which were within 5 percent equipment and LCC of each other) and the centrifuge technology. Centrifuges represent the high cost alternative and provide minimal non-cost benefits compared to the other two technologies. Due to the equipment comparisons, centrifuges have been eliminated for further consideration as a thickening technology for infrastructure packages. RDTs and GBTs both represent viable technologies for NEW Water and should be considered further. The RDTs, 2 M GBTs, and 3 M GBTs are near equivalent in terms of life cycle costs. However, RDTs may offer advantages in terms of space requirements and flexibility to treat multiple flow streams with low odor emissions. The following sections will consider full infrastructure packages for both RDTs and 2 M GBTs. These two technologies were the focus of the evaluation given space constraints, future flexibility, and the more common 2 M GBT equipment. A final decision between these three technologies can be made during preliminary design.

# 7.0 Infrastructure Package Capital Cost Estimates

The full cost of an upgrade requires consideration of non-equipment costs (e.g., piping, electrical, and labor). Using the feasible alternatives identified above, full infrastructure package capital costs were estimated.

## 7.1 Basis for Infrastructure Packages

When the number of required thickeners (2 M GBTs or RDTs) is compared for the six process configurations identified, four of the six process configurations are compatible with five total thickeners (which includes one redundant unit), while two configurations require six thickeners. This is summarized in Table 7-1. Piping flexibility would provide the ability to operate in the Process Configurations 1a, 2a, 3a, and 3b. For Process Configurations 1b and 2b, five thickeners would provide the capacity to thicken the solids loads, but there would be no redundancy. If Process Configurations 1b or 2b were implemented, the flexibility to pivot to cothickening when a unit was down for maintenance would be a potential option. Otherwise, six thickeners would be required. Based on the required number of units, two infrastructure packages were developed for solids thickening that address all six process configurations:

- Infrastructure Package 1: Five thickeners
- Infrastructure Package 2: Six thickeners

**Table 7-1 Thickener Requirements for Process Configurations**

| Process Configuration | Number of Thickeners (one redundant Unit) |
|---|---|
| Configuration 1a<br>Combined WAS, separate PS | Infrastructure Package 1<br>Five 2 M GBTs or five RDTS |
| Configuration 1b<br>Combined WAS, separate PS, DPF PTU modification | Infrastructure Package 2<br>Six 2 M GBTs or six RDTS |
| Configuration 2a<br>All sludge thickened separately | Infrastructure Package 1<br>Five 2 M GBTs or five RDTS |
| Configuration 2b<br>All sludge thickened separately, DPF PTU modification | Infrastructure Package 2<br>Six 2 M GBTs or six RDTS |
| Configuration 3a<br>Co-thickening of all sludge | Infrastructure Package 1<br>Five 2 M GBTs or five RDTS |
| Configuration 3b<br>Co-thickening of all sludge, DPF PTU modification | Infrastructure Package 1<br>Five 2 M GBTs or five RDTS |

## 7.2 Thickening Building Configuration

For the infrastructure package capital cost, the equipment cost and LCC for GBTs and RDTs were within 5 percent of each other. When the existing footprint of the facility is examined, conceptual layouts for five GBTs and five RDTs appear to fit in the existing solids thickening building (Figure 7-1 and Figure 7-2, respectively). Therefore, for Infrastructure Package 1, it is recommended that five thickeners be assumed for capital planning, with the final decision between GBTs and RDTs reserved for preliminary design. One important note for the RDTs is that some manufacturers require significant clearance for maintenance of internal components. The Andritz RDT requires a 15-foot clearance on the discharge of the RDT. However, the Parkson RDT only requires a 3-foot clearance. For RDTs, the site-specific constraints will likely be a key factor in the final equipment section if RDTs are ultimately selected for design.

For Infrastructure Package 2, where six total thickening units are required, it would not be possible to accommodate this with GBTs. Six RDTs are feasible, but increase the overall footprint (Figure 7-3). For Infrastructure Package 2, which provides increased flexibility for operational strategies for NEW Water, preliminary design would need to move forward only considering RDTs.

Although not a focus of the evaluation, a layout using four, 3 M GBTs was developed (Figure 7-4). The four 3 M GBTs limited future expandability, and cannot meet all six of the conditions developed for consideration. Given the similar capital and operating costs as compared to the 2 M GBT and RDT options, the 3 M GBT option was not carried to final capital cost estimating.

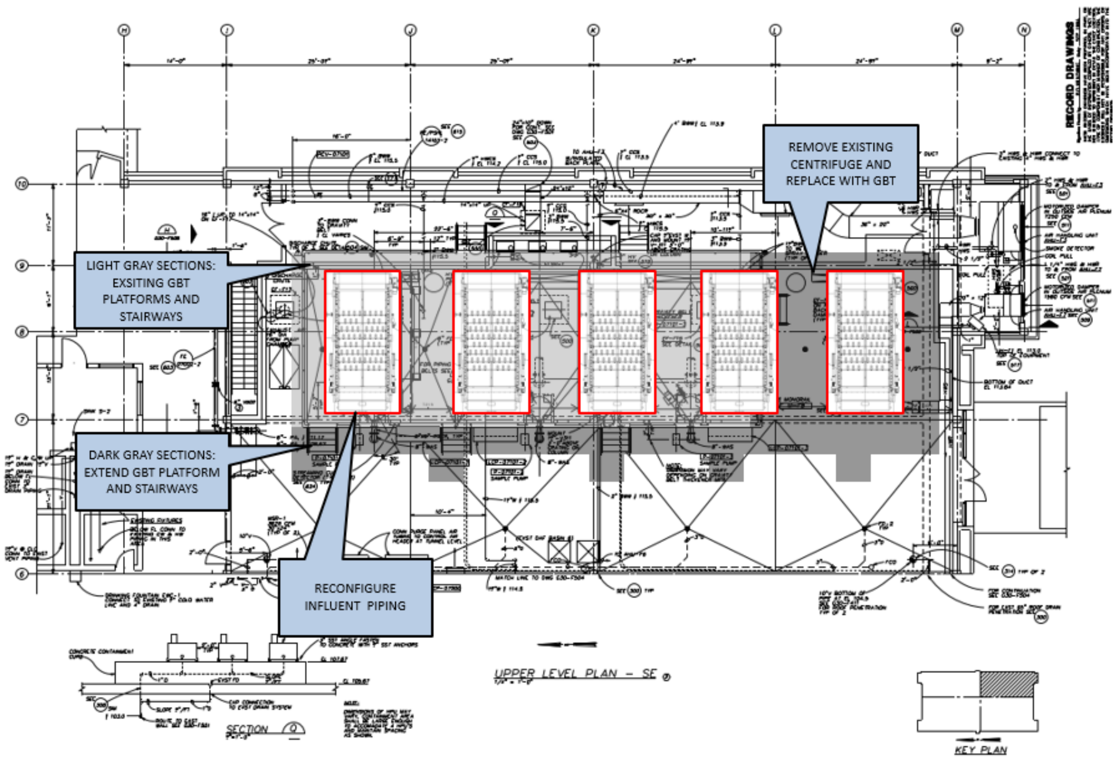



**Figure 7-1 Conceptual Layout for Five 2-m GBTs in the Existing Thickening Building**

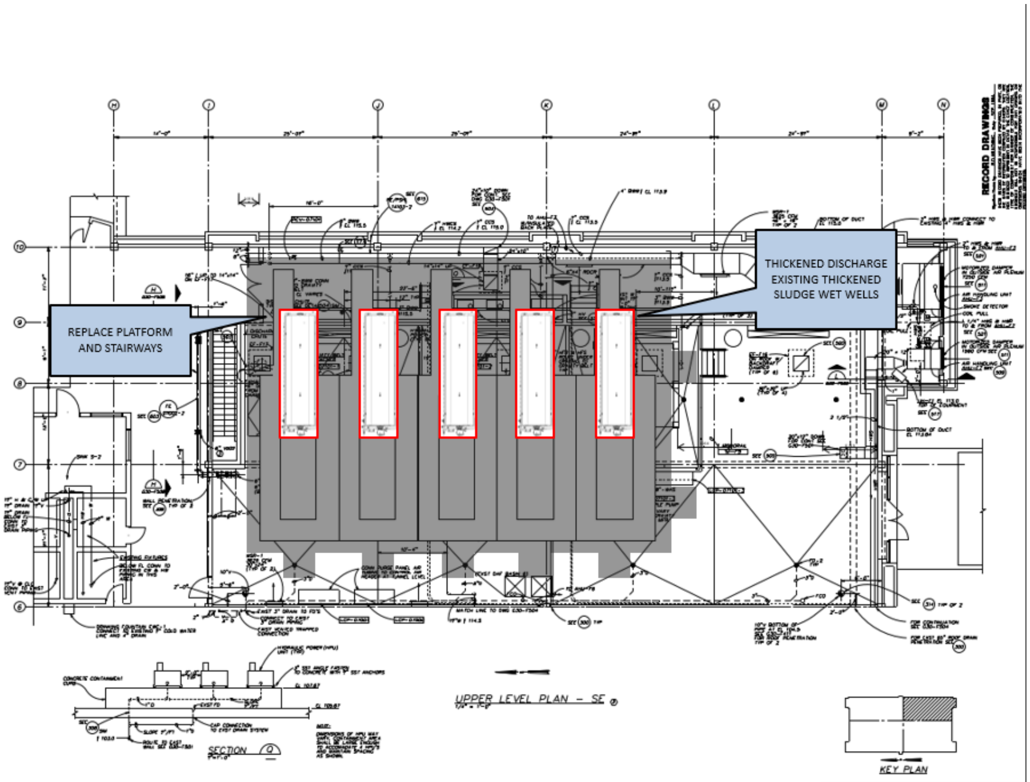



**Figure 7-2 Conceptual Layout for Five RDTs in the Existing Solids Thickening Building**

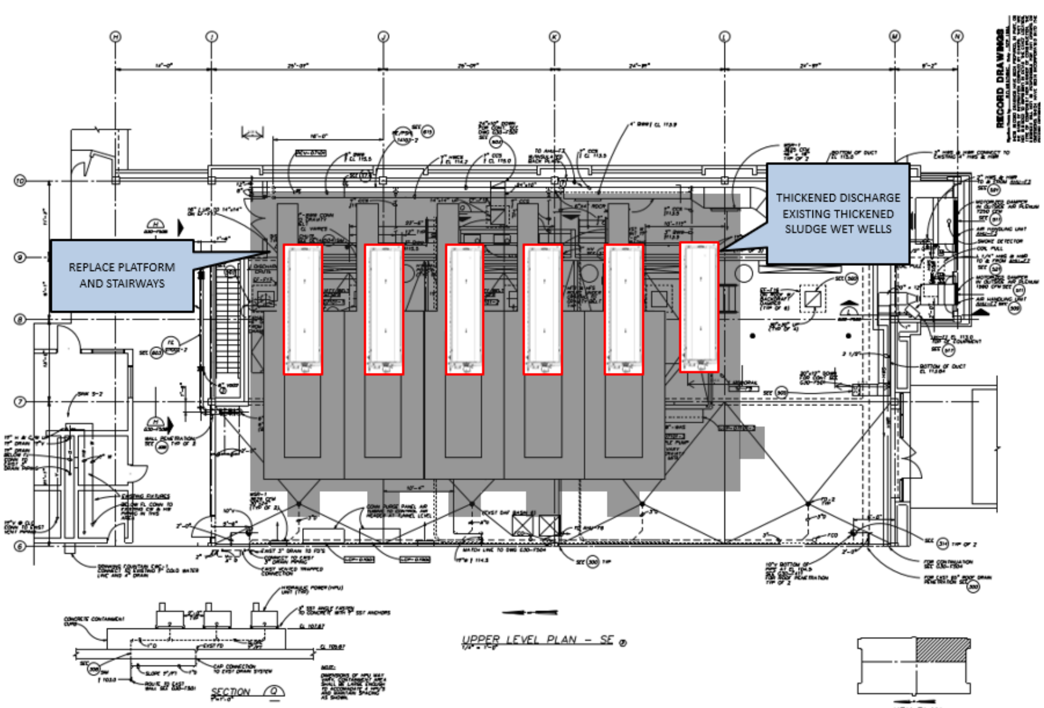



**Figure 7-3 Conceptual Layout for Six RDTs in the Existing Solids Thickening Building**

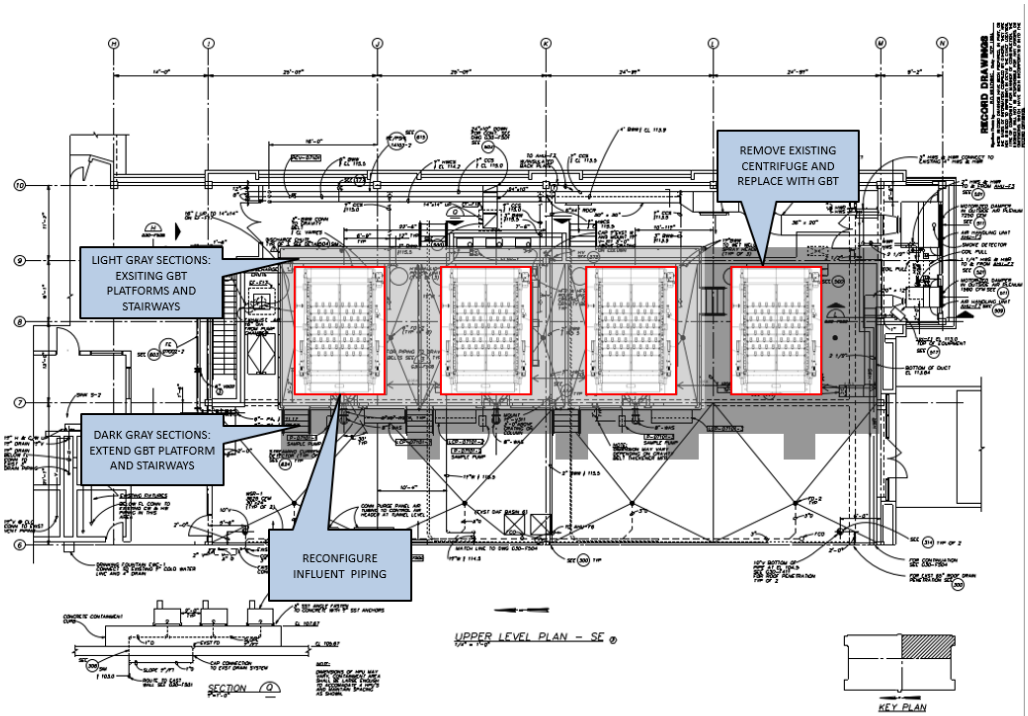



**Figure 7-4 Conceptual layout for 3 M GBTs**

## 7.3 Capital Cost Estimates

Total capital costs were determined using the percentages listed in Table 7-2. Infrastructure package project capital cost estimates are summarized in Table 7-3. These cost estimates include the major infrastructure indicated, with additional multipliers and factors shown in Table 7-2. The potential capital cost range represents the range of project costs as defined for a Class 4 cost estimate (AACE International Recommended Practice No. 18R-97), with the range representing 85 percent to 125 percent of that most probable capital cost. The thickening equipment is being installed in an existing thickening building, and therefore no major building modifications related to code requirements were assumed. Odor mitigation is included in the form of duct work and vent fans to manage odor in the thickening building. See Section 7.3.4.1 for additional odor control discussion. Additional capital cost estimate details are included in **Appendix C**.

**Table 7-2 Multipliers Used to Determine Total Capital Costs**

| Component | Multiplier | Value multiplied against |
|---|---:|---|
| Installation | 30% | Equipment |
| Mechanical | 20% | Equipment + Installation |
| Electrical and I&C | 20% | Equipment + Installation |
| Contractor Overhead and Profit | 25% | Installed equipment cost |
| Contingency | 50% | Installed cost + Overhead |
| Engineering | 25% | Installed cost + Overhead + Contingency |

**Table 7-3 Capital Cost Estimates for the Main Infrastructure Packages**

| Infrastructure Package | Major Infrastructure | Potential Capital Cost Range | Most Probable Capital Cost |
|---|---|---|---|
| Package 1<br><br>Configuration 1a, 2a, 2a, 3b | • Five GBTs or RDTs<br>• Required platforms and piping<br>• Thickened sludge feed pumps<br>• Odor mitigation | $5.7M to $8.3M | $6.7M |
| Package 2<br><br>All six configurations | • Six RDTs<br>• Required platforms and piping<br>• Thickened sludge feed pumps<br>• Odor mitigation | $6.6M to $9.7M | $7.8M |

## 7.3.1 Additional Improvements

### 7.3.1.1 Gravity Thickening

There are two additional improvements that could be added to the capital project for sludge thickening. As discussed, the mechanical thickening of primary sludge is based on a feed concentration of at least 2 percent solids. This requires either thickening in the primary clarifiers (which would require a new headworks facility at the GBF) or pre-thickening with the GTs. To improve the operability of the GTs and modify the flow path to feed the gravity thickened sludge to the mechanical thickening, the following improvements would be recommended:

- New gravity thickener mechanisms
- New aluminum covers for odor mitigation
- Improvements to interior concrete (assumed due to age)
- New piping to convey gravity thickened primary sludge to the unthickened sludge wet well, where piping would go to both wet wells for flexibility; piping would be in the existing tunnel system

Based on the SOR and the target solids concentration of 2 percent solids, rehabilitation of two GTs would provide sufficient process capacity. NEW Water may decide to rehabilitate all four GTs for redundancy purposes. The capital cost estimates for rehabilitation of two or four GTs is shown in Table 7-4.

**Table 7-4 Capital Cost Estimates for Additional Package 1 and 2 Related to GT Rehabilitation**

| Package | Major Infrastructure | Potential Capital Cost Range | Most Probable Capital Cost |
|---|---|---|---|
| Additional Package 1 | Rehabilitate two GTs, with associated pumping and piping | $3.6M to $5.3M | $4.2M |
| Additional Package 2 | Rehabilitate four GTs, with associated pumping and piping | $7.1M to $10.4M | $8.4M |

### 7.3.1.2 Thickened Wet Well and Pumping

An additional area for capital investment is the thickened sludge wet well and pumps. Currently, each thickening unit discharges into one of four wet wells. These wet wells are connected by pipes but are essentially independent. Progressive cavity pumps then pull sludge from the wet wells, but a series of bends exist between the wet well and the pump intake. This has led to stator wear due to grease clogging the inlet piping. Improvements to the wet well and new progressive cavity pumps were developed to improve the flowability and redundancy of the wet well system. Preliminary improvements identified include:

- Removing walls to create two thickened sludge wet wells
- Slopping the floor of the wet wells towards the pump suction
- Reorientation of the progressive cavity pump suction pipes

A preliminary layout of these wet well modification is shown in Figure 7-5. The capital cost estimates for the thickened sludge wet well and pumping improvements is shown in Table 7-5.

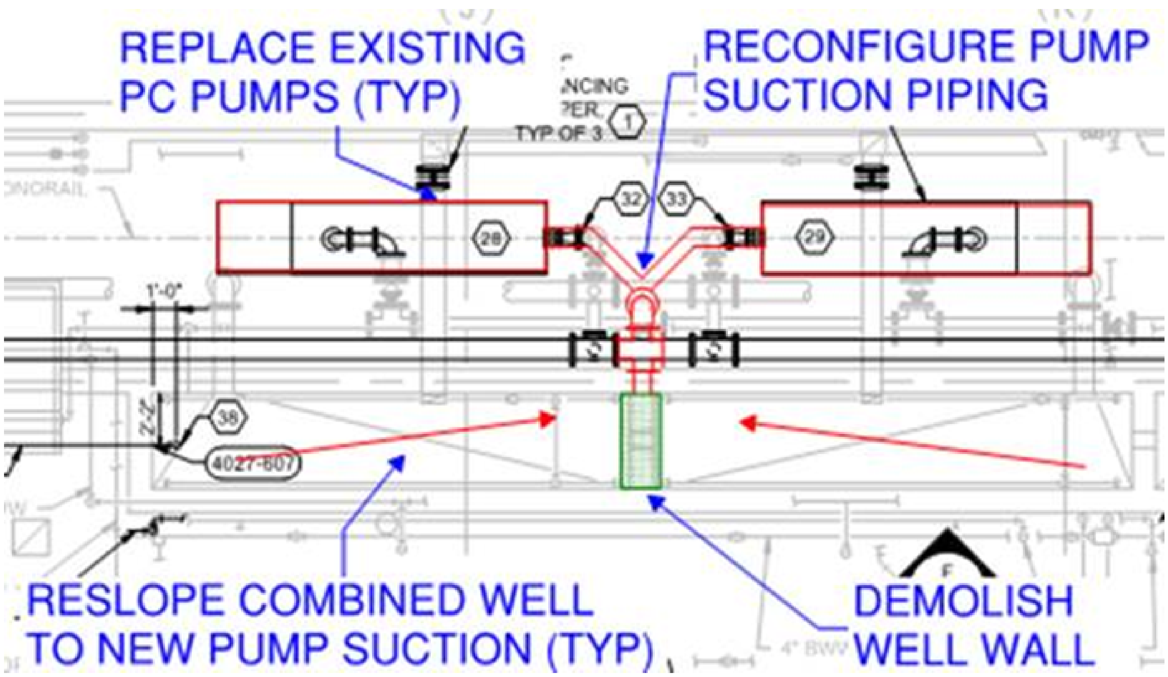



**Figure 7-5 Conceptual Modification for Thickened Sludge Wet Well Modifications (Similar for Two Wells)**

**Table 7-5 Capital Cost Estimates for Thickened Sludge Wet Well and Pumping Improvements**

| Package | Major Infrastructure | Potential Capital Cost Range | Most Probable Capital Cost |
|---|---|---|---|
| Additional Package 3 | Thickened wet well and pumping improvements | $1.2M to $1.8M | $1.4M |

#### 7.3.1.3 Primary Sludge Directly to GBTs or RDTs

An alternative option for treating primary sludge is to send it directly to the GBTs or RDTs and not use gravity thickeners. Table 3-2 presented a summary of the PS design characteristics for the GBF. Based on the flows and loads shown, if the primary sludge was sent directly to the GBTs or RDTs an additional two or three thickeners would be required, in addition to the five to six presented in Section 7.1. Requiring a total of eight thickeners would necessitate an approximate 75 foot by 40 foot solids thickening building expansion to provide sufficient space for the new equipment. The expansion would require the relocation of existing piping, HVAC, and other infrastructure to complete. Installing the additional thickeners and expanding the building would cost at least an estimated $5.0 M including engineering costs. This is greater than the approximate $3.9 M required for Additional Package 1 presented in Table 7-4 for the rehabilitation of two GTs. In addition, there are operating advantages to utilizing the GTs. Due to costs and the operational advantages of continuing to operate the GTs this option was removed from further considersation.

#### 7.3.1.4 Odor Control

If odor treatment was determined to be necessary for either infrastructure package, a total air flow of approximately 1,000 cfm, based on required air exchanges, would need to be treated. A carbon absorber on a 12 foot by 8 foot skid unit could treat flows at this rate, and would cost approximately $200,000, including engineering to install.

## 7.4 Infrastructure Package summary

Five different infrastrucuture packages were developed for solids thickening management. Overall capital costs are summarized in Table 7-6. For the ultimate thickening solutions, NEW Water will need to choose Infrastructure Package 1 or 2, and combine with the desired additional infrastructure packages.

**Table 7-6 Summary of Potential Infrastructure Packages**

| Infrastructure Package | Major Infrastructure | Potential Capital Cost Range | Most Probable Capital Cost |
|---|---|---|---|
| Package 1<br>Configuration 1a, 2a, 2a, 3b | • Five GBTs or RDTs<br>• Required platforms and piping<br>• Thickened sludge feed pumps<br>• Odor mitigation | $5.7M to $8.3M | $6.7M |
| Package 2<br>All six configurations | • Six RDTs<br>• Required platforms and piping<br>• Thickened sludge feed pumps<br>• Odor mitigation | $6.6M to $9.7M | $7.8M |
| Additional Package 1 | • Rehabilitate two GTs, with associated pumping and piping | $3.6M to $5.3M | $4.2M |
| Additional Package 2 | • Rehabilitate four GTs, with associated pumping and piping | $7.1M to $10.4M | $8.4M |
| Additional Package 3 | • Thickened wet well and pumping improvements | $1.2M to $1.8M | $1.4M |

# 8.0 Thickening Recommendations

Within the existing solids handling building, there is sufficient space for a six thickeners, but it would limit the technology solution to RDTs. This future flexibility is beneficial, but NEW Water does not have prior experience with the RDT technology. It would be beneficial to conduct a pilot test of the RDT technology in 2020 to gain operational exposure to the RDT. An applied research project to pilot test the RDTs with the different sludge streams at NEW Water would be valuable investment. Pilot equipment rental is $40,000 to $60,000 depending on the length of piloting (base price is for one month of pilot testing). Additional temporary piping, pumping, engineering support, and data analysis would bring the total pilot effort to a cost of $75,000 to $100,000. Pilot information is included in Appendix D.

The overall recommended package would include five thickeners, rehabilitation of four existing gravity thickeners, and modifications to the thickened sludge well and pumping. As shown in Table 8-1, this Total Thickening Infrastructure Package would have a capital cost range of $14.1M to $20.6M, with a most probable cost of $16.6M.

**Table 8-1 Recommended Thickening Infrastructure Package**

| Package | Major Infrastructure | Potential Capital Cost Range | Most Probable Capital Cost |
|---|---|---|---|
| Infrastructure Package 1 | • Five GBTs or RDTs<br>• Required platforms and piping<br>• Thickened sludge feed pumps<br>• Odor mitigation | $5.7M to $8.3M | $6.7M |
| Additional Package 2 | Rehabilitate four GTs, with associated pumping and piping | $7.1M to $10.4M | $8.4M |
| Additional Package 3 | Thickened wet well and pumping improvements | $1.2M to $1.8M | $1.4M |
| Applied Research: RDT pilot testing | | $75,000 to $100,000 | $0.1M |
| **Total Thickening Infrastructure Package** | | **$14.1M to $20.6M** | **$16.6M** |

As the Facility Plan advances, there are several related components to solids thickening that will need to be examined. Given the operational flexibility available with five thickening units, this would be a reliable initial investment in thickening for NEW Water. It also addresses the key drivers for thickening improvements:

- Industrial user growth at the GBF: increased overall thickening capacity.
- Aging equipment: existing mechanical thickeners will be replaced; the gravity thickeners will be rehabilitated.
- Operational limitations: a high degree of flexibility will be achieved for solids management.
- Growth in the DPF service area: increased overall thickening capacity.
- Resource Recovery and Energy Efficiency (R2E2) operation: reliable thickening of all sludge streams to 6 percent solids, as well as improvements to thickened sludge transfer.

- Nutrient harvesting: flexibility provided for future operation of nutrient harvesting facilities.

Several key areas that should be evaluated in more depth that relate to the thickening operation are:

- DPF operation: modifying the PTUs to have the solids flow mixed with WAS would benefit grit handling at the DPF, but the major impact is the reduced loading to the aeration basins at the DPF. This reduces the mixed liquor suspended solids at the DPF, which will lead to increased peak flow capacity. This impact will be quantified during the De Pere Facility Vision task.
- DPF grit management: the sizing and operation of the PTUs and the grit classifier may operate at a more constant flow rate than simulated; this would decrease the peak flow and load for design and potentially reduce the number of units required by one.
- Whole plant odor control: the current capital costs include odor mitigation inside the thickening building, with duct work and venting of the headspace around enclosed thickening devices. The need to treat this ventilated air will be evaluated as part of the Whole Plant Odor Control task.
- Selective wasting: as discussed, selective wasting does have an impact on the WAS solids concentration. The feasibility of selective wasting and process impacts will be evaluated as part of the Aeration and Nutrient Removal task.
- Nutrient harvesting: if five RDTs are installed as part of the thickening infrastructure package, there would be room for a sixth RDT in the future. This would provide the flexibility to operate in the previously developed configuration. However, if the soluble phosphorus concentration in the struvite harvesting is taken down to 20 mg/L, there is a minor benefit of the additional WAS thickening before P-release.

# Appendix A. Solids Production Projections

Projected sludge flows and mass flow rates are summarized as box-and-whisker plots, where the bottom of the box is the 25th percentile, the middle line is the median (50th percentile) and the top of the box is the 75th percentile. Whiskers extend to the largest and smallest values that are not considered outliers. Outliers are values which are more extreme than the inner fences; inner fences are calculated by determining the range between the 25th and 75th percentiles (i.e., the interquartile range, IQR) and multiplying that by 1.5. The inner fences extend beyond the 25th and 75th percentiles by this calculated value. Boxes are colored according to the projected year being simulated. White dots are means of each data set.

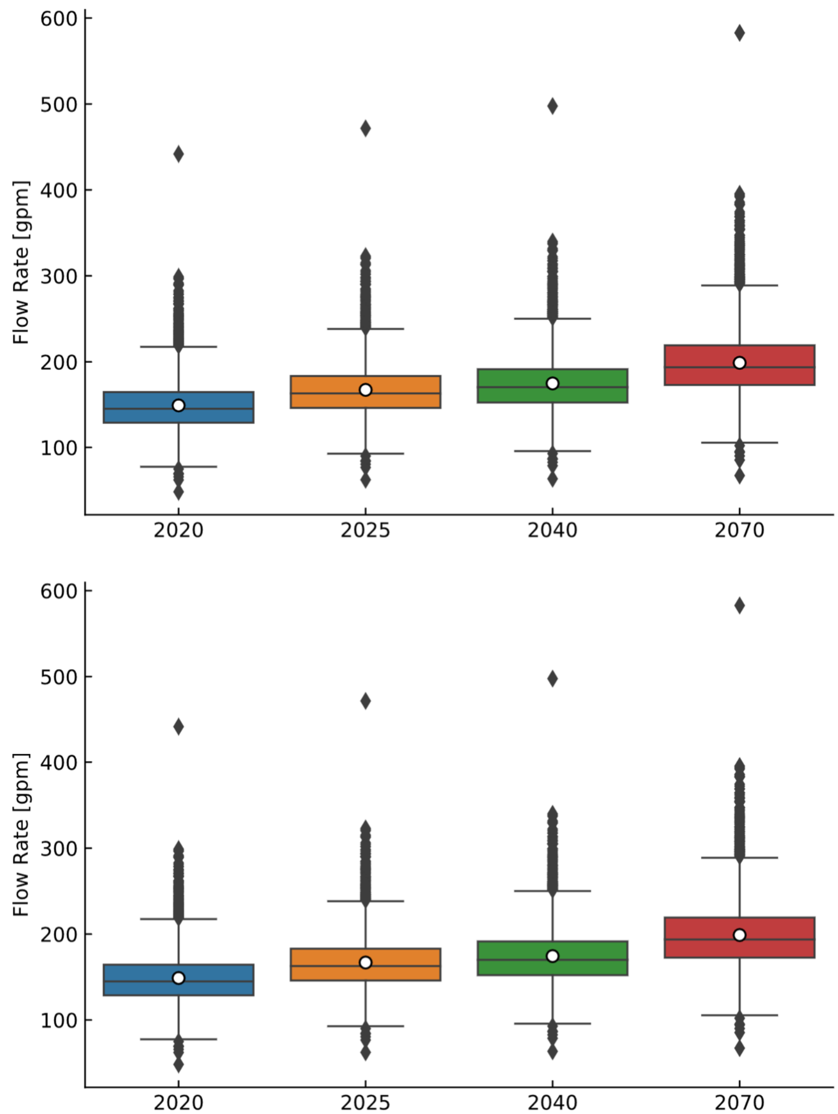



**Figure A-1 Boxplots of PS Flow Rates Assuming 2% Solids for Each Year as a Part of all Configuration Simulated. Boxes are Colored by 10-Year Dynamic Input that was Simulated. White Points are Means.**

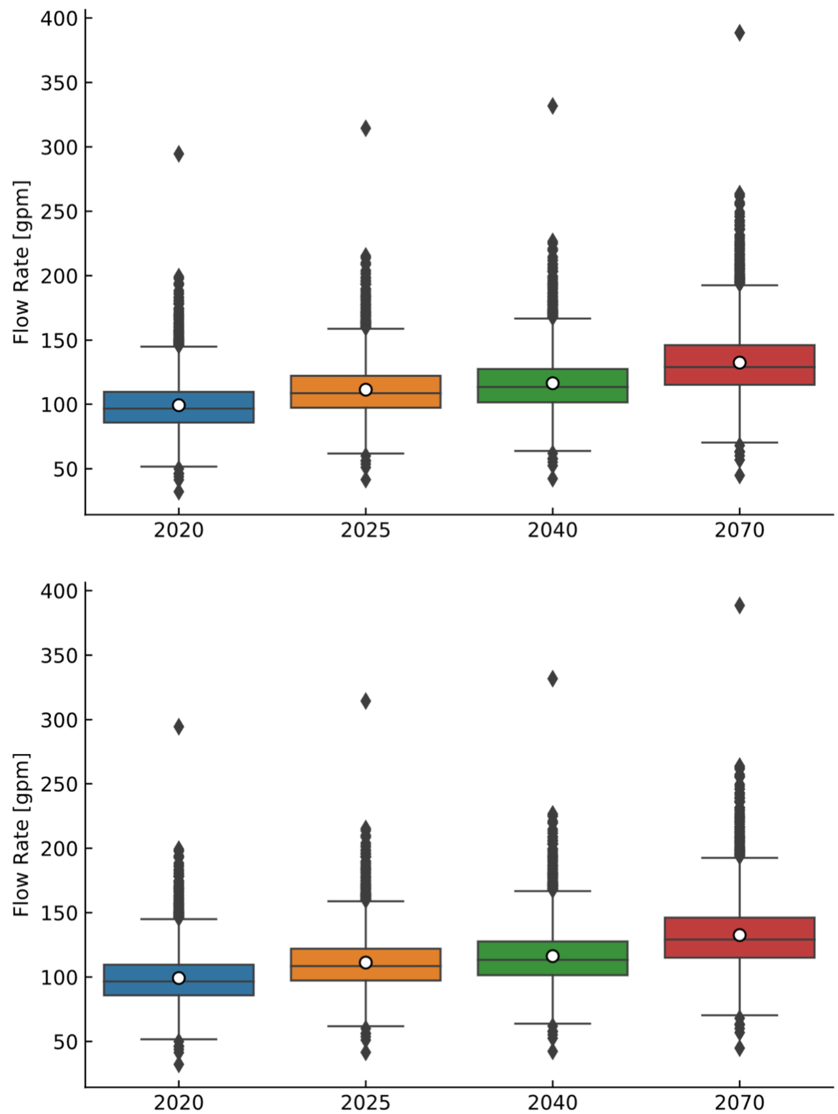
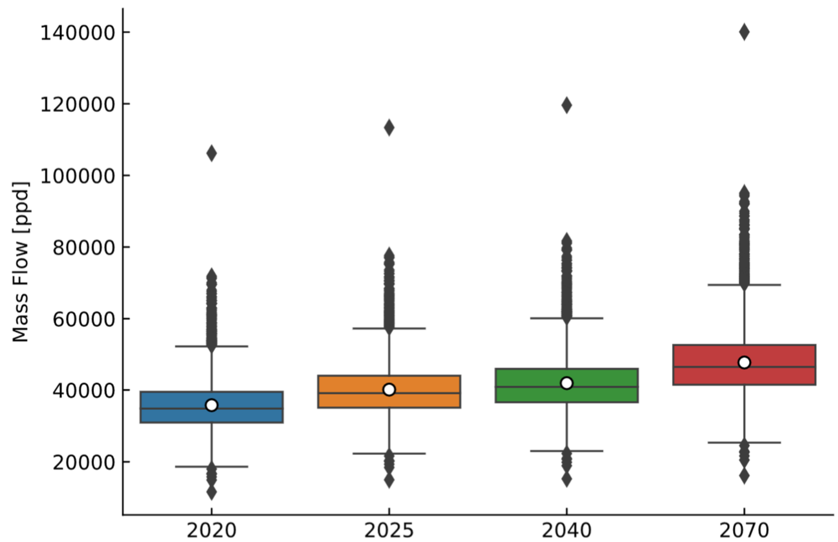



**Figure A-2 Boxplots of PS Flow Rates Assuming 3% Solids for Each Year as a Part of all Configuration Simulated. Boxes are Colored by 10-Year Dynamic Input that was Simulated. White Points are Means.**



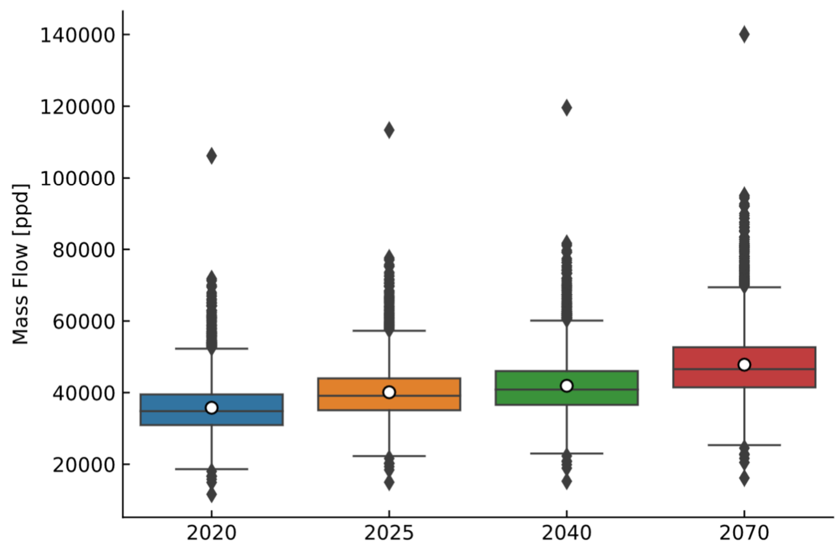
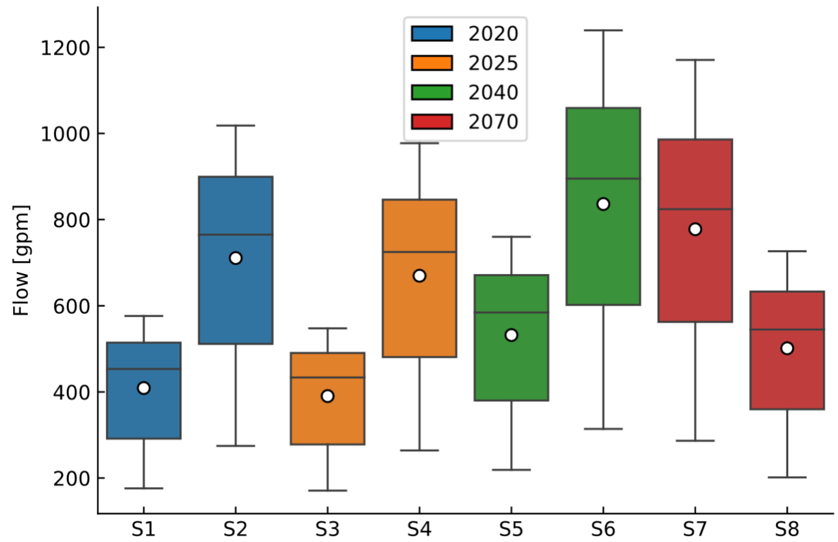




**Figure A-3** **Boxplots of PS Mass Flow Rates for Each Year as a Part of all Configurations Simulated. Boxes are Colored by 10-Year Dynamic Input that was Simulated. White Points are Means.**



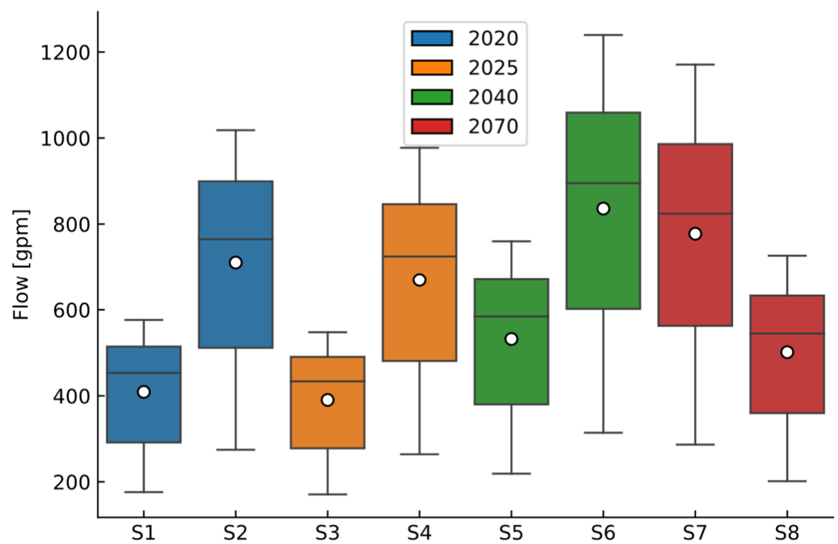
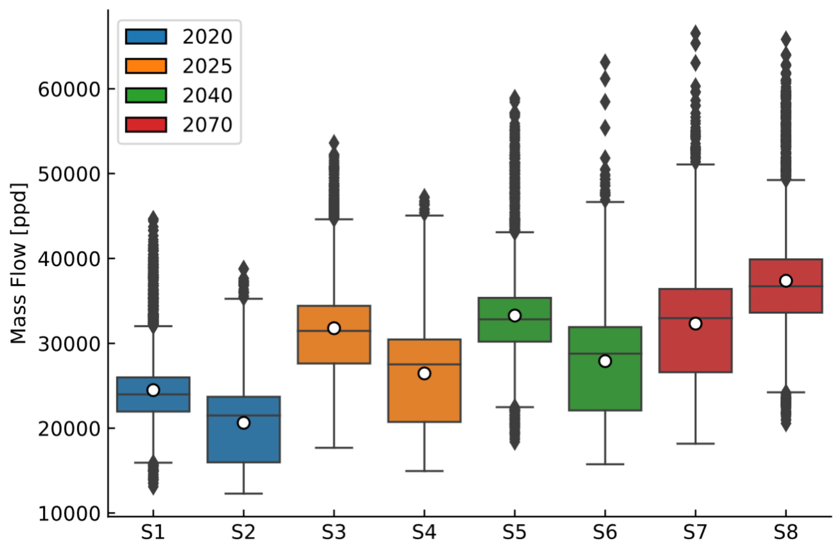




**Figure A-4 Boxplots of Green Bay WAS flow rates for 8 scenarios as a part of all configurations simulated. Boxes are colored by 10-year dynamic input that was simulated. White points are means.**



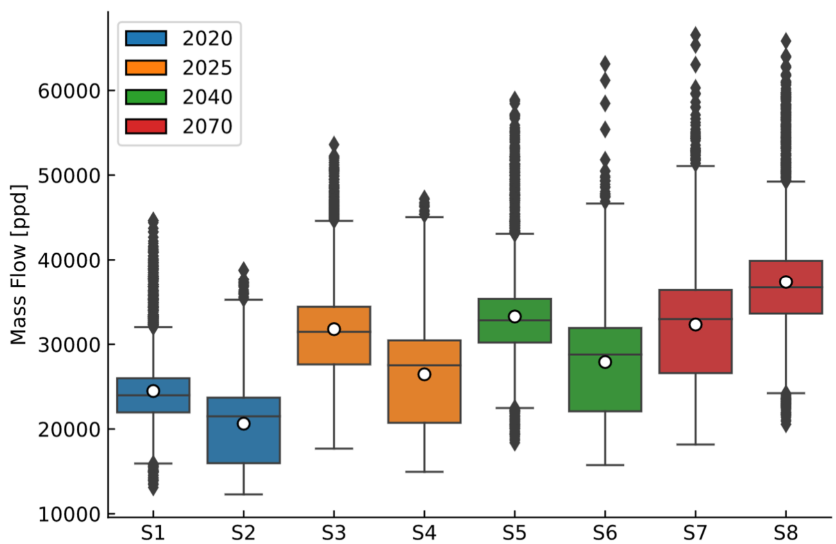
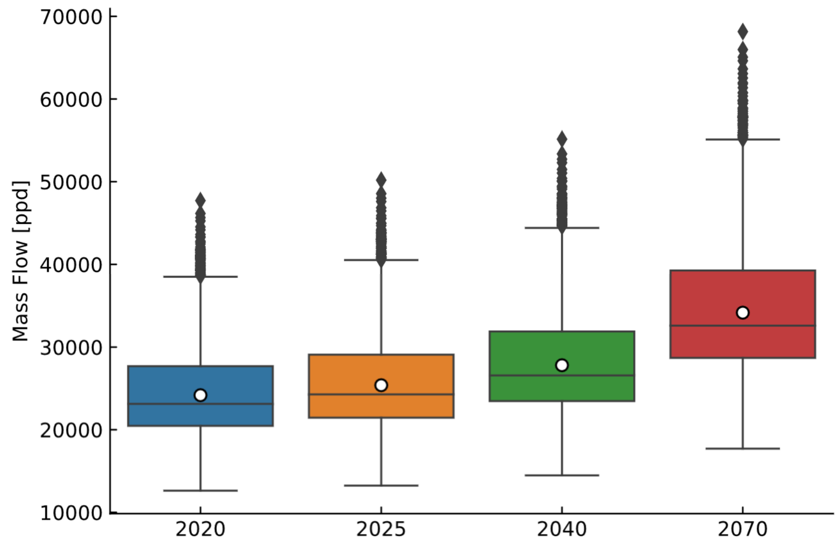




**Figure A-5 Boxplots of Green Bay WAS mass flow rates for 8 scenarios as a part of all configurations simulated. Boxes are colored by 10-year dynamic input that was simulated. White points are means.**



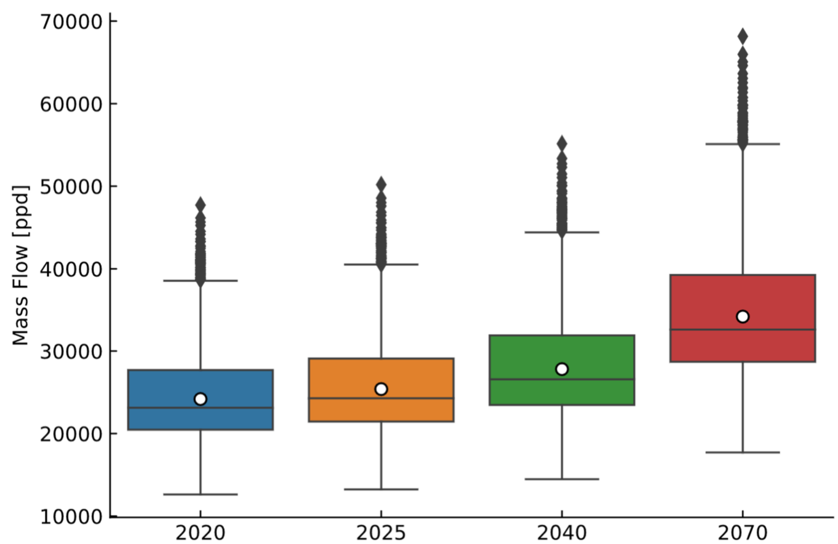




**Figure A-6** **Boxplots of De Pere WAS Mass Flow Rates for 4 Scenarios Simulated as a Part of Configurations 1a, 2a, and 3a. Boxes are Colored by 10-Year Dynamic Input that was Simulated. White Points are Means.**

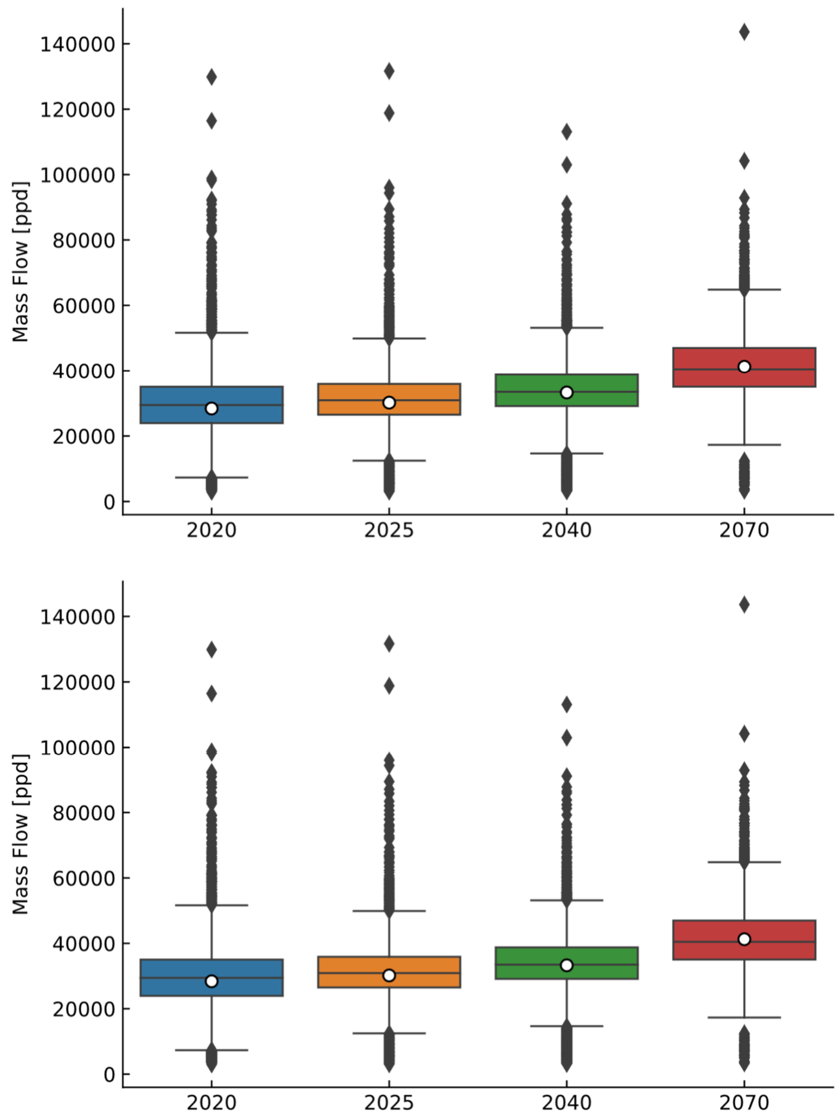



**Figure A-7 Boxplots of WAS Flow Rates for 4 Scenarios Simulated as a Part of Configurations 1b, 2b, and 3b. Boxes are Colored by 10-Year Dynamic Input that was Simulated. White Points are Means.**

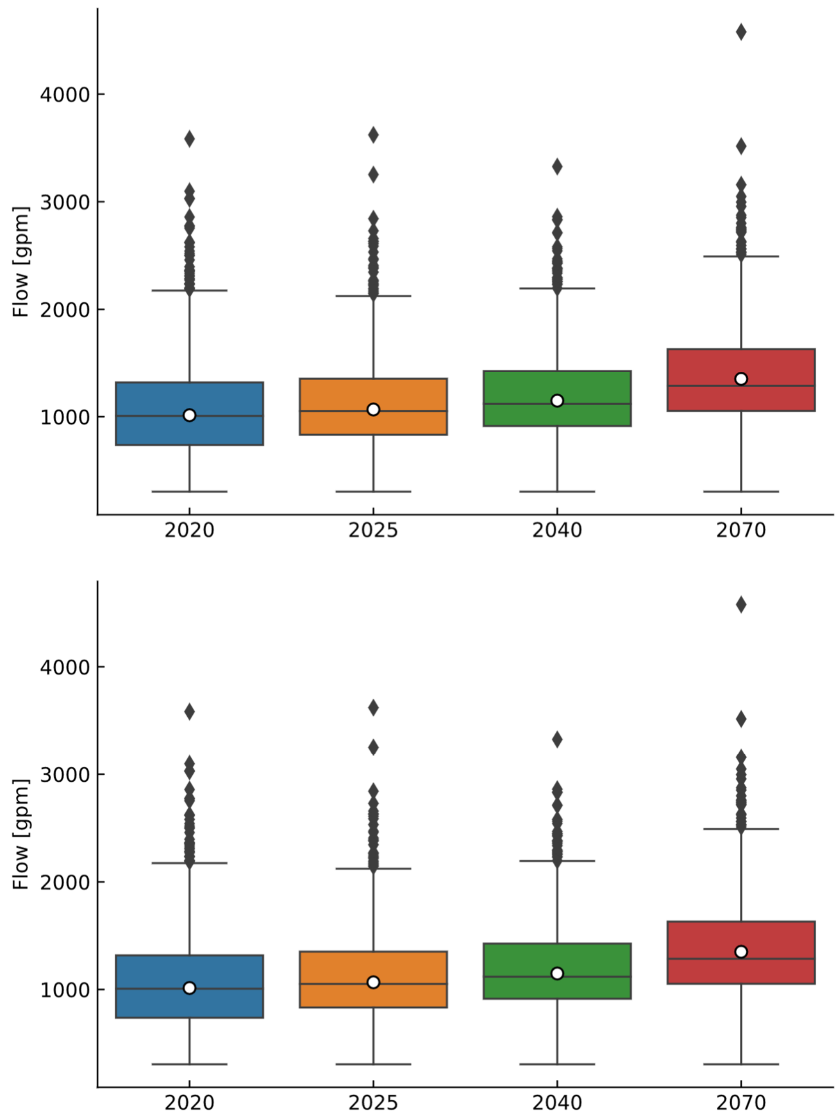
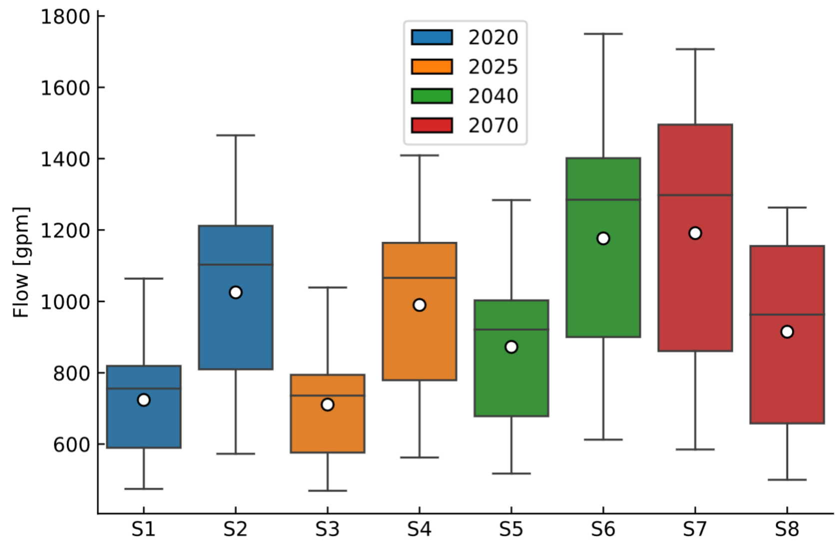



**Figure A-8 Boxplots of WAS Mass Flow Rates for 4 Scenarios Simulated as a Part of Configurations 1b, 2b, and 3b. Boxes are Colored by 10-Year Dynamic Input that was Simulated. White Points are Means.**



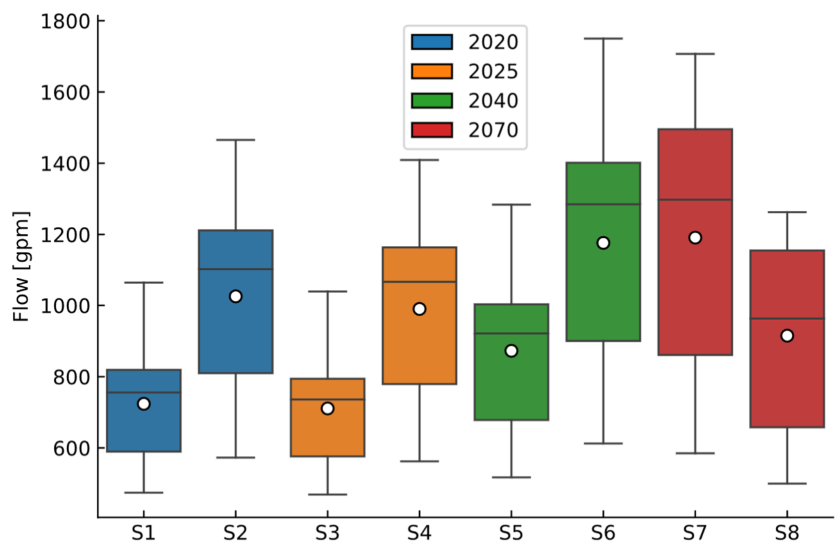




**Figure A-9 Boxplots of Combined WAS and PS Flow Rates for 8 Scenarios Simulated as a Part of Configuration 3a. Boxes are Colored by 10-Year Dynamic Input that was Simulated. White Points are Means**

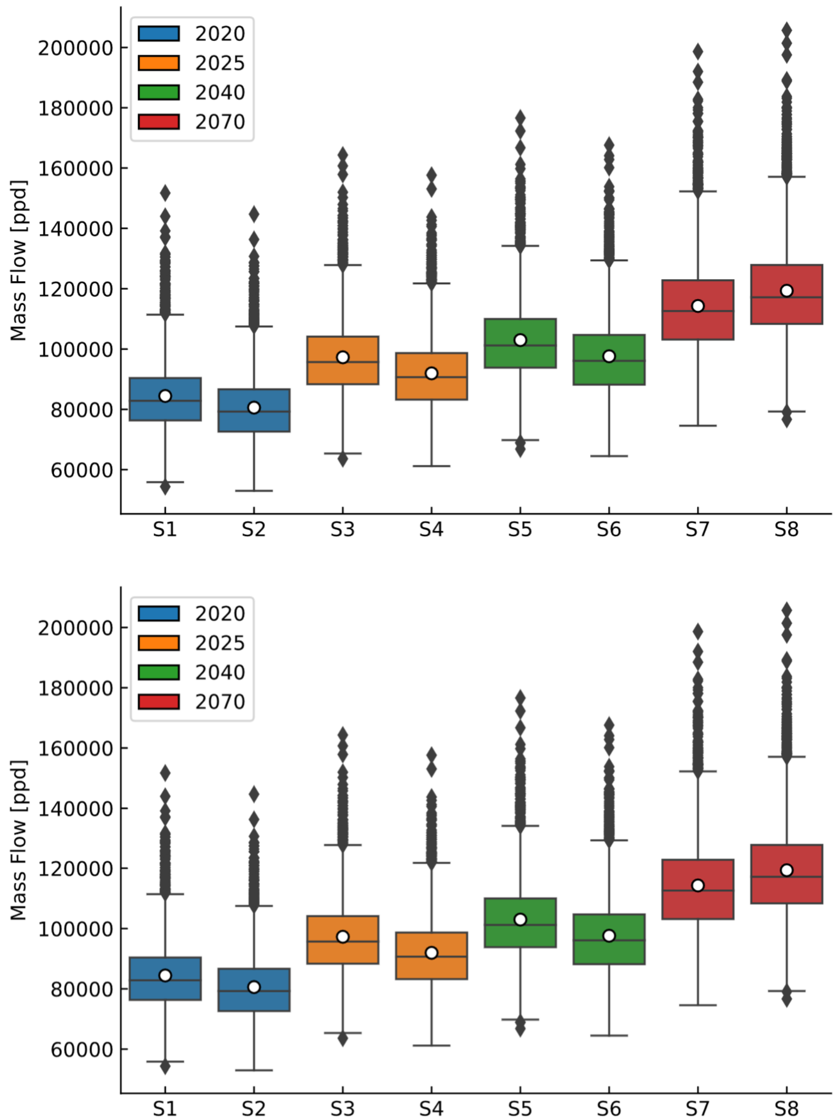



**Figure A-10 Boxplots of Combined WAS and PS Mass Flow Rates for 8 Scenarios Simulated as a Part of Configuration 3a. Boxes are Colored by 10-Year Dynamic Input that was Simulated. White Points are Means**

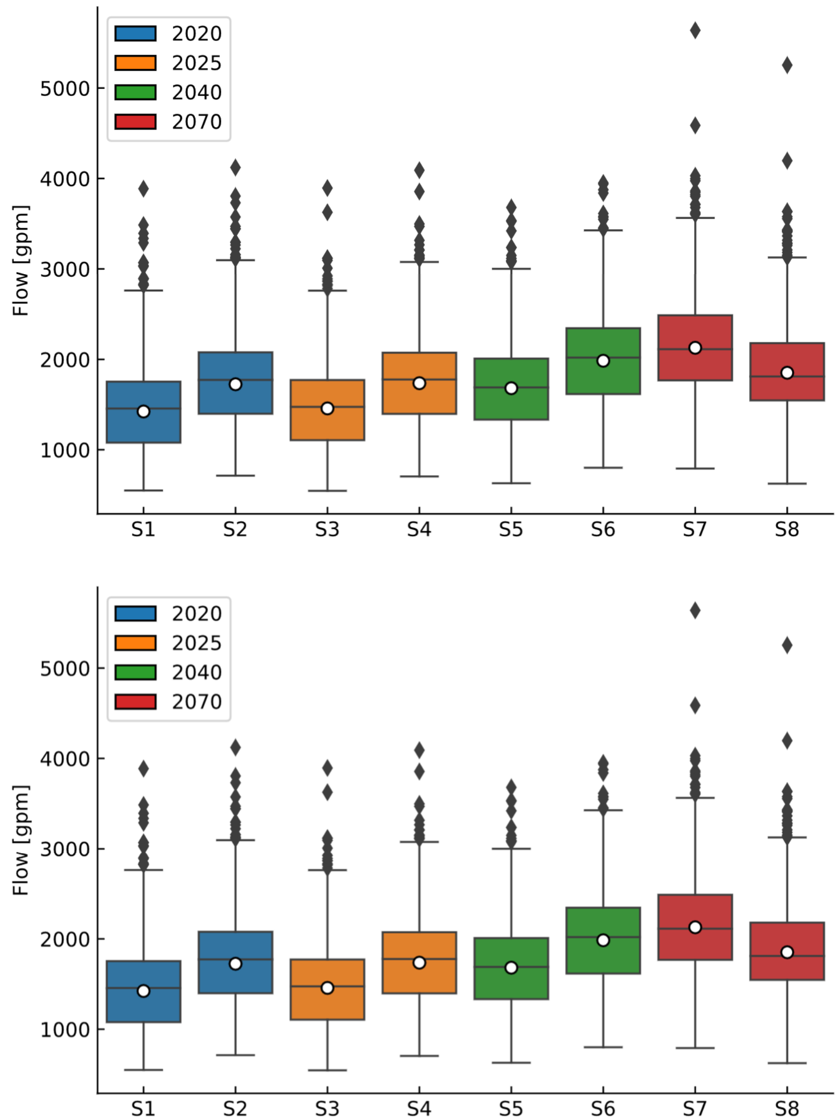



**Figure A-11 Boxplots of Combined WAS and PS Flow Rates for 8 Scenarios Simulated as a Part of Configuration 3b. Boxes are Colored by 10-Year Dynamic Input that was Simulated. White Points are Means**

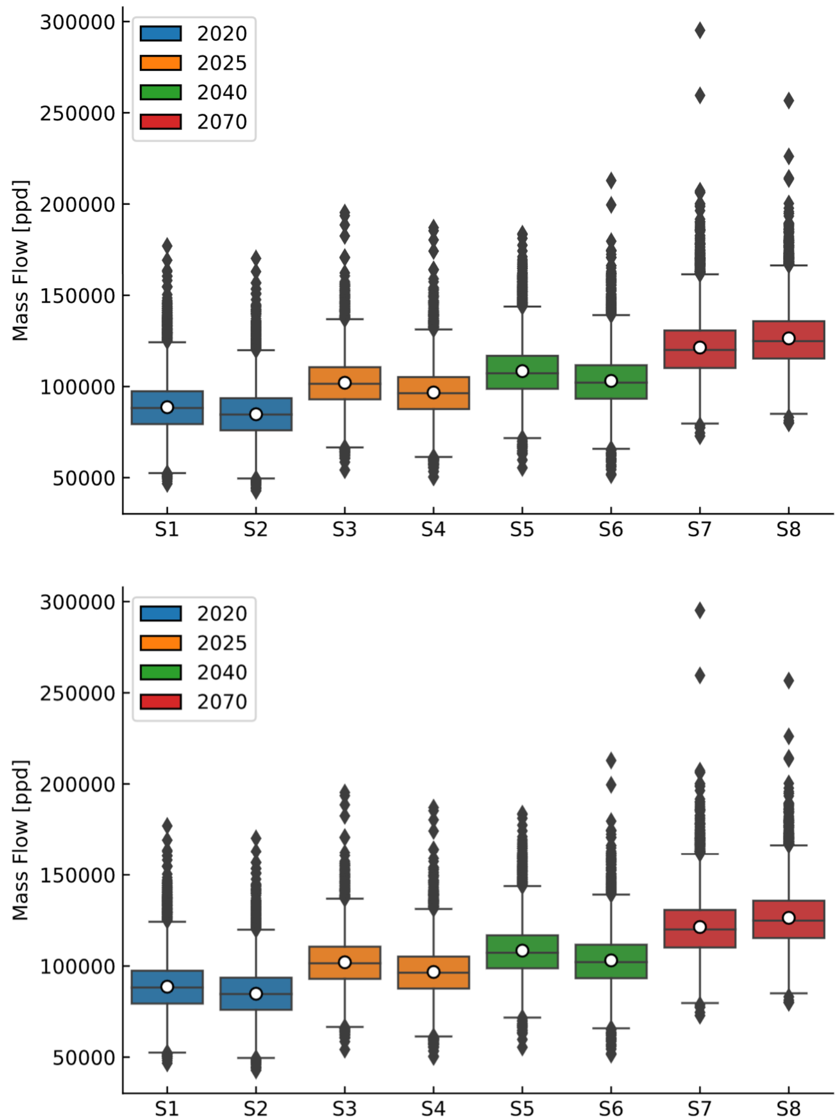
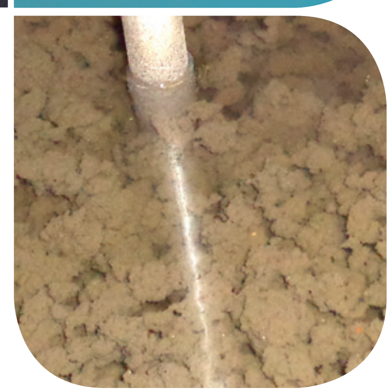



**Figure A-12** **Boxplots of Combined WAS and PS Mass Flow Rates for 8 Scenarios Simulated as a Part of Configuration 3b. Boxes are Colored by 10-Year Dynamic Input that was Simulated. White Points are Mean**

# Appendix B. Manufacuterer's Proposal

Parkson™

Treating Water Right



# ThickTech™

## Rotary Drum Thickener

- Highest performance
- Lowest cost of ownership
- Adjustable to changing sludges
- Designed to build floc
- Sludges: waste activated, primary, blends, recuperative

# Why Thicken Sludge?

– **Increase digester capacity**
– **Reduce hauling costs**
– **Pre-thicken before other dewatering equipment**

Sludge thickening, for example, can reduce 192,000 gallons of sludge per day down to 13,400 gallons by thickening 0.5% feed to 7%. The higher concentration of solids equates to more pounds of solids stored in the same volume area.

The industry leading Parkson ThickTech™ Rotary Drum Thickener (RDT), with over 300 installations, consumes the lowest amount of expensive polymer while offering the highest capture rate of 98% and therefore, the lowest cost of re-treatment. Units are compact, require little operator attention and are pre-engineered for easy installation.

## Why Rotary Drum Thickeners

– Fully enclosed – clean
– Odor control capability
– Smaller footprint
– Indoor/outdoor installation
– Ease of operation
– Low polymer usage
– Replace centrifuges
– Lower power costs
– Replace DAFs

## Why Choose the Parkson ThickTech™

– Industry leading performance
– Quality of design
– Over 300 installations
– Designed to build floc
– Lowest polymer consumed
– Adjustable performance for changing sludges

Mobile on-site pilot testing

## Cost Savings Through Superior Design

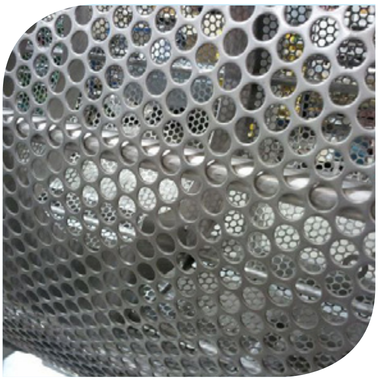
A 400 GPM ThickTech™ RDT can save users ~$860,000 or more in reduced polymer consumption over a 15-year period vs. a leading competitor. Savings are based on a side-by-side pilot test conducted by an independent third party.

**Summary of Comparison Report**
**(ThickTech vs. Leading Competitor)**

| | Parkson | Competitor |
|---|---|---|
| Inlet Sludge | 400 GPM @ 0.95-1.37% Solids | 400 GPM @ 0.95-1.37% Solids |
| Thickened Sludge | 6.6% | 6.6% |
| Polymer Use | 72 lbs/day | 168 lbs/day |
| Polymer Cost (@ $2/lb) | $52,458/year<br>$645,028/15 years* | $122,402/year<br>$1,505,065/15 years* |
| | **$860,037 savings** | |

* 3% net discount rate






# How the ThickTech Outperforms Other RDTs

## Superior Drum Design Controls Sludge Advancement

**Staged Screens:**

– Dewatering occurs in four distinct dewatering stages divided by split augers
– Woven wire mesh size can be changed between stages to maximize dewatering

**Roll Bars:**

– Flip sludge over for additional water removal

**Woven Wire Mesh Filtration Media:**

– Provides significantly more open area than wedge wire or perforated plate
– Easily removable and replaceable to match sludge

**Other Special Features:**

– Perforated stainless steel support media
– Split augers
– Detention rings with ports to adjust sludge detention time
– Self-cleaning spray header with booster pump

## Low Shear Flocculation Tank

Tangential Inlet and Outlet: All polymer mixing occurs prior to the sludge entering the flocculation tank. The tank is where the sludge and polymer grow into a popcorn floc before entering the drum. Tangential feed and outlets promise low shear and maximize floc size.

## General Performance Specifications

| | |
|---|---|
| **Capacity** | 50 GPM – 400 GPM (50, 100, 150, 200, 300 and 400) |
| **Inlet** | 0.5% - 1.5% solids |
| **Outlet** | 5% - 8% solids |
| **Typical Polymer Usage** | 5-10 lbs (100% active) / ton of sludge (dry wt.) |
| **Solids Capture** | 98%+ for low retreatment costs |

## Polymer Cost by Dose

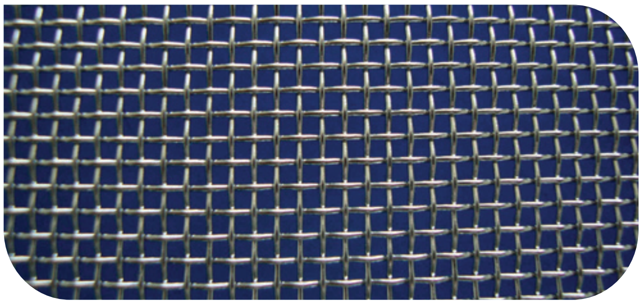
| Polymer Use | Cost Over 10 Years | 10-Year Difference from Base Case | |
|---|---|---|---|
| 5 lbs/Dry-Ton | $520,416 | $0 | **Parkson ThickTech™ Dose Range** |
| 10 lbs/Dry-Ton | $1,040,832 | $520,416 | |
| 15 lbs/Dry-Ton | $1,561,260 | $1,040,844 | |
| 20 lbs/Dry-Ton | $2,081,680 | $1,561,264 | **Polymer Dose of Competitors** |
| 25 lbs/Dry-Ton | $2,602,100 | $2,081,684 | |
| 30 lbs/Dry-Ton | $3,122,520 | $2,602,104 | |
| 35 lbs/Dry-Ton | $3,642,940 | $3,122,524 | |

* This table is based on 1,000 GPM @ 1.0% solids inlet sludge concentration

## Screening Material

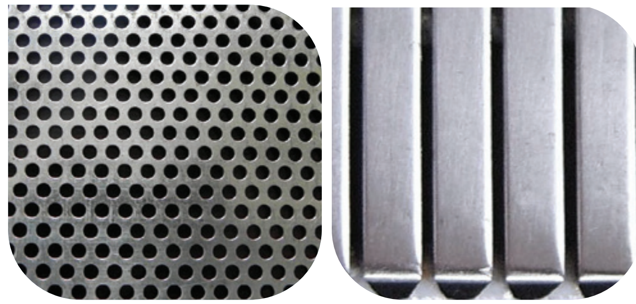
**The ThickTech Way**

Woven wire mesh with perpendicular openings has more open area and better water release for more efficient thickening.



**The Competition**

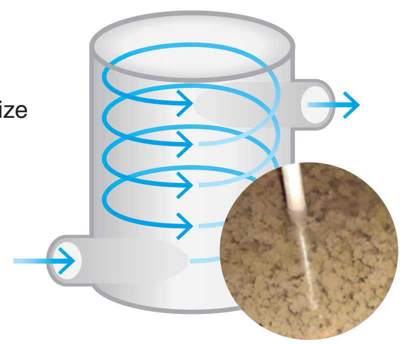
Perforated sheet and wedge wire drums have significantly less open area and lower solids capture. Multi-layered poly cloths can be hard to clean.



## Flocculation Tank Design Builds a Popcorn Floc

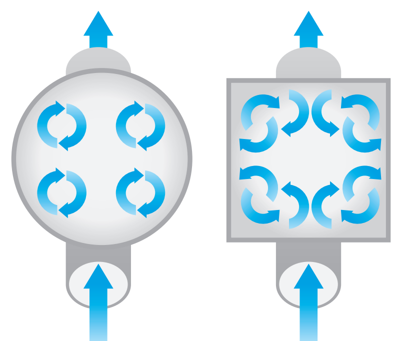
**The ThickTech Way**

Tangential inlet and outlet openings maximize detention time and flocculation, reducing shear from turbulence.



**The Competition**

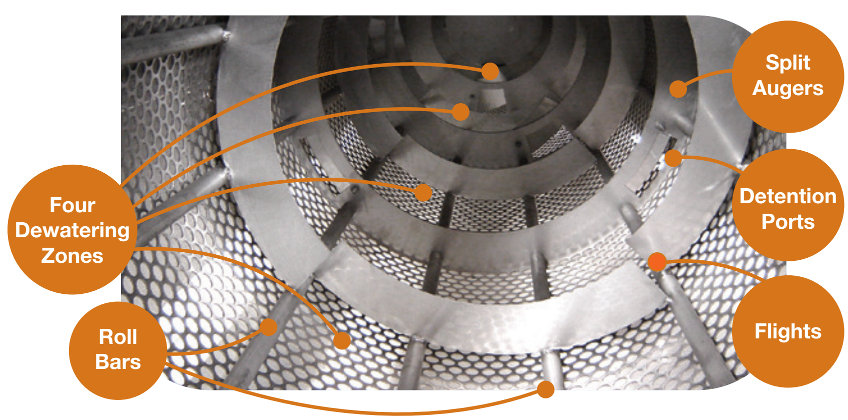
Direct inlet and outlets creates turbulence and fluid shear that break up and reduce floc development.



## Internal Drum Components

**The ThickTech Way**

Internal drum components such as roll bars, split augers, flights and detention ports roll, flip and control sludge movement through the drum and detain sludge for maximum water release.




Parkson™
Treating Water Right

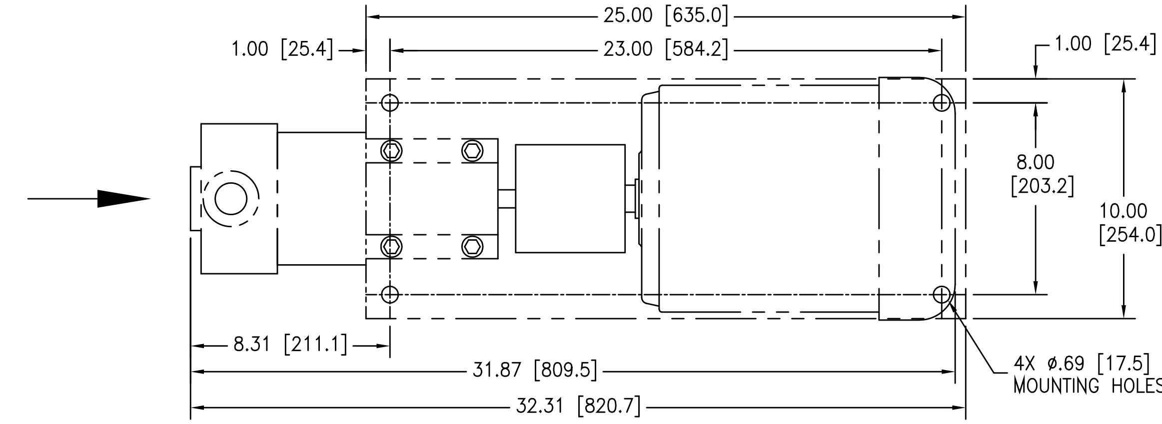
Fort Lauderdale
Chicago
Kansas City
Denver

1.888.PARKSON
technology@parkson.com
www.parkson.com

RDT

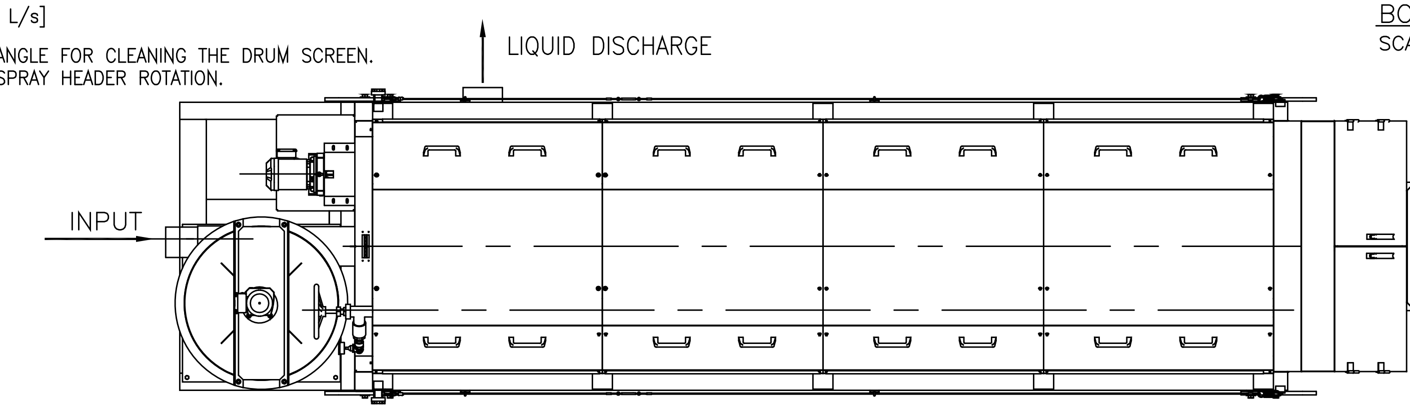
NOTES:

1. ALL 304 STAINLESS STEEL CONSTRUCTION EXCEPT FOR TRUNNION WHEELS, DRIVE MOTORS, DRIVE CHAIN, SPROCKETS, HANDLES, CABLE PULL SAFETY SWITCH, BEARING BLOCK AND MANUAL CLEANING SPRAY BRUSH.
2. DRIVE SPECIFICATIONS:
   DRUM GEARMOTOR: 3 HP [2.3 kW], 1800 RPM, 230/460 V, 3 PH, 60 HZ, TEFC, SEVERE DUTY.
   FLOC GEARMOTOR: 1/2 HP [.37 kW], 1800 RPM, 230/460 V, 3 PH, 60 HZ, TEFC, SEVERE DUTY.
   BOOSTER PUMP MOTOR: 5 HP, [3.7 kW], 3500 RPM, 230/460 V, 3 PH, 60 HZ, TEFC, SEVERE DUTY.
3. DRUM SPEED: 9 RPM MAXIMUM
4. RECOMMENDED MINIMUM CLEARANCE TO BE 36.00 [914.4] AROUND UNIT AND 36.00 [914.4] ABOVE UNIT.
5. ALL EXTERNAL PIPING TO BE SUPPORTED INDEPENDENTLY OF THICKTECH UNIT.
6. EST. DRY WEIGHT: 6501 LB [2955 kg]; OPERATING WEIGHT: 14751 [6705 kg]
7. TOTAL SPRAY USAGE WITH BOOSTER PUMP AT 100 PSI [6.9 BAR]: 19.00 GPM [1.2 L/s]
8. THE SPRAY HEADER ASSEMBLY MAY BE ROTATED SLIGHTLY TO OPTIMIZE THE SPRAY ANGLE FOR CLEANING THE DRUM SCREEN. PROVIDE APPROXIMATELY 2 FEET OF SLACK IN THE HOSE TO ALLOW FOR POSSIBLE SPRAY HEADER ROTATION.
9. DIMENSIONS WRITTEN IN INCHES [mm] UNLESS OTHERWISE SPECIFIED.
10. CONSULT THE HYCOR® PRODUCTS GROUP OR YOUR LOCAL HYCOR PRODUCTS REPRESENTATIVE FOR AVAILABLE OPTIONS.
11. ONE (1) UNIT SUPPLIED

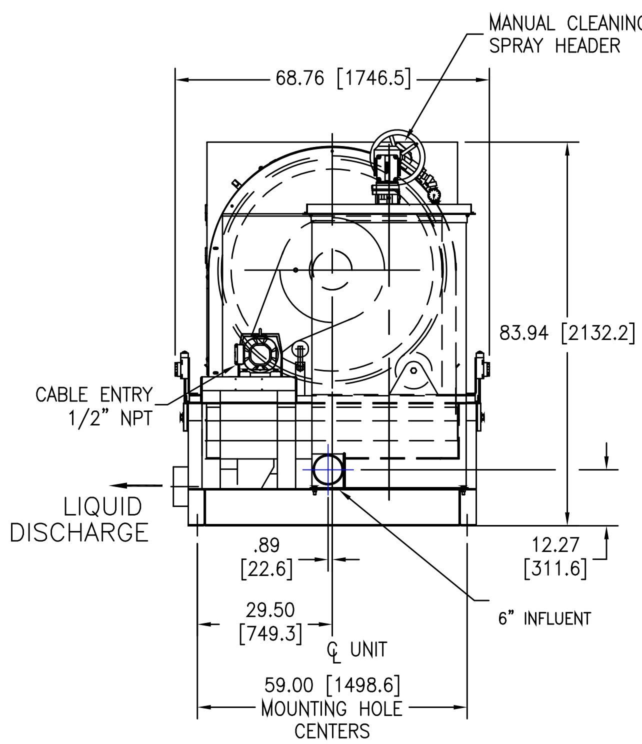


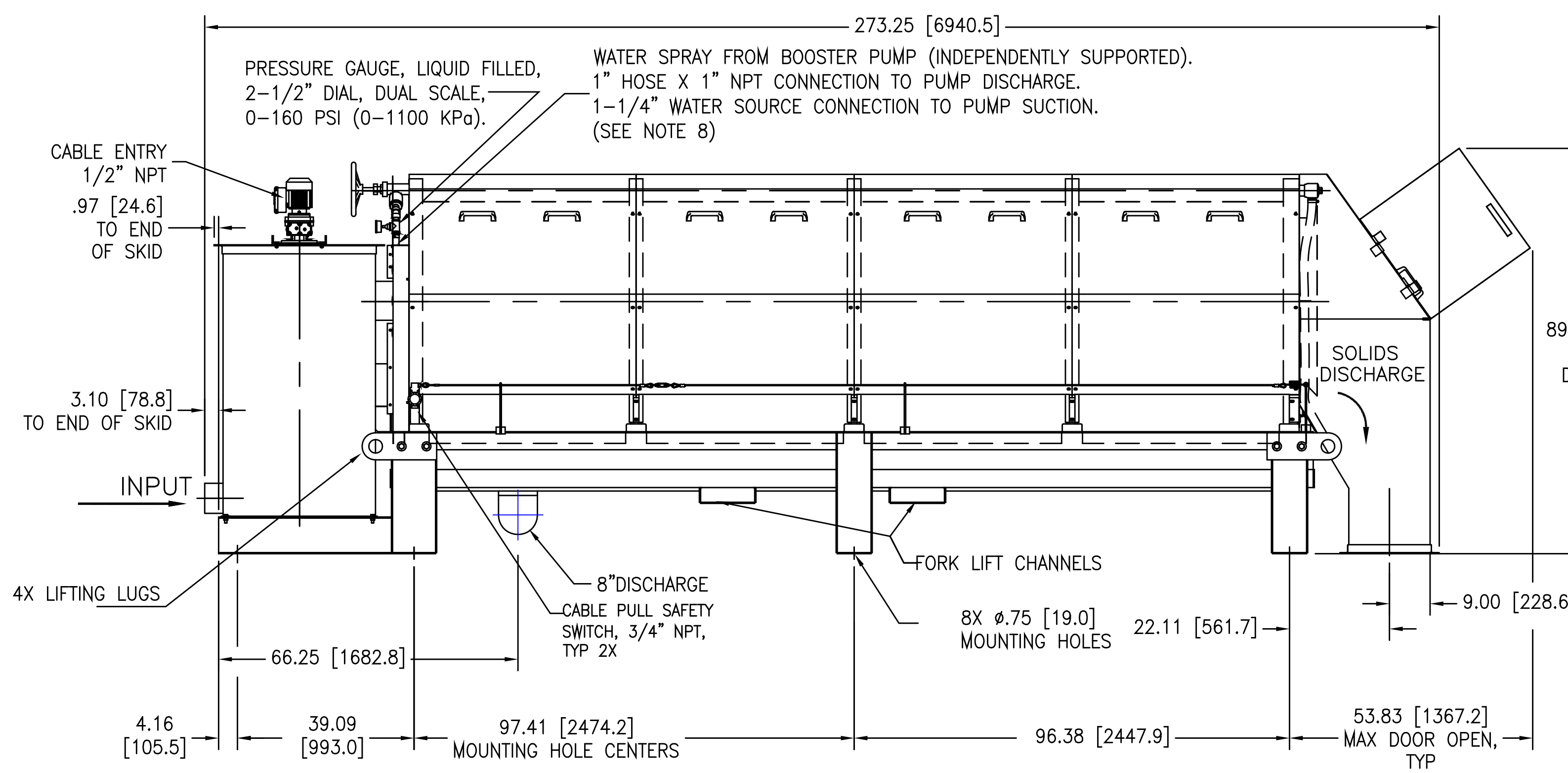

BOOSTER PUMP MOUNTING HOLE LOCATIONS

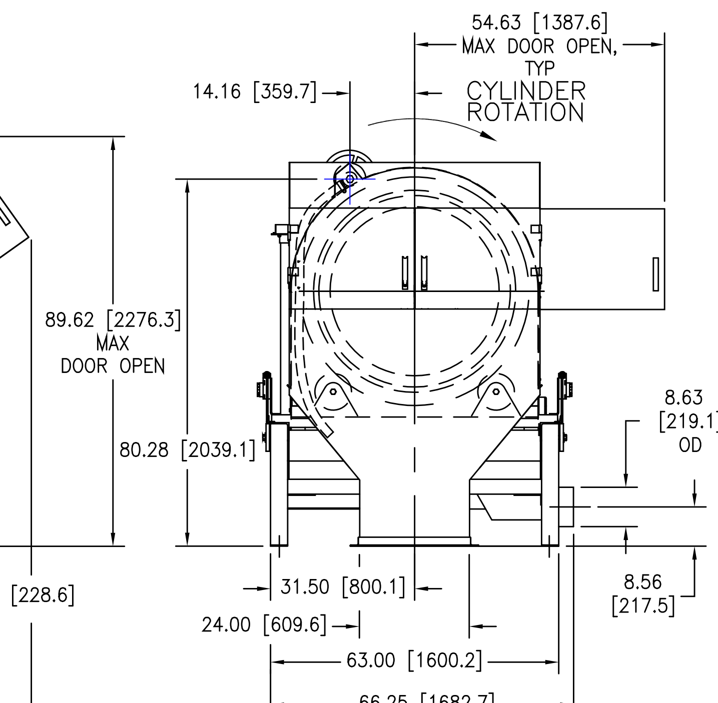
SCALE: 1/8" = 1"




PLAN VIEW






| REV | DESCRIPTION | DATE | BY |
|---|---|---|---|
| | | | |

__PRELIMINARY __APPROVAL

X INFORMATION __CERTIFIED

THIS DRAWING IS LIMITED TO FUNCTIONAL DESIGN, GENERAL ARRANGEMENT AND CLEARANCE. NO RESPONSIBILITY IS ACCEPTED BY PARKSON CORPORATION FOR OTHER DIMENSIONS, QUANTITIES, OR COORDINATION WITH OTHER EQUIPMENT OR DRAWINGS EXCEPT AS STATED IN PURCHASE ORDER.

| DRAWN BY | DATE |
|---|---|
| IMP | MM/DD/YY |
| CHECKED BY | DATE |
| MBK | MM/DD/YY |
| SCALE | SIZE |
| 1/42"=1" | B |

Parkson™

PROJECT NAME
PROJECT NUMBER
PROJECT NAME
PROJECT LOCATION

TITLE
RDT400
HYCOR® THICKTECH™
ROTARY DRUM THICKENER

REFERENCE INFORMATION
SPECIFICATION SECTION
XX

DRAWING NO
RDT400L

REV

SHEET 1 OF 1

1401 West Cypress Creek Road
Suite 100
Fort Lauderdale FL 33309-1969

*Phone* 1.888.PARKSON
*Fax* 954.974.6182

# ThickTech™ Rotary Drum Thickener (RDT) Budget

April 14, 2020

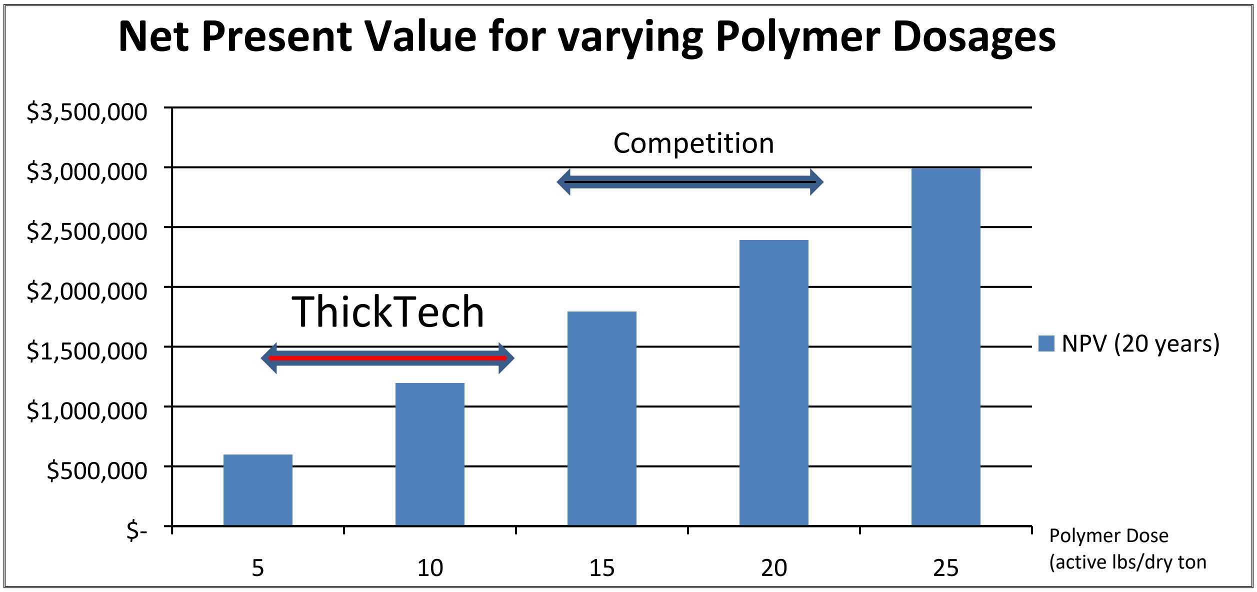
Black & Veatch
Attn: Eric Redmond

Re: NEW Water Sludge Thickening

Parkson Corporation is pleased to provide a budget for our ThickTech™ rotary drum thickener (RDT) for your project. Your requested information is included with this letter, along with other items which detail our offering for this project.

| Basis of Design | |
|---|---|
| **Parameter** | **Values** |
| **Thickening Application** | WAS, primary, or mix |
| **Influent Flow** | 400 GPM maximum |
| **Influent solids (%)** | 0.5%-1.5% |
| **Capture Efficiency (%)** | 98% |
| **Thickened Solids** | 6% |
| **Polymer Usage** | 7 to 10 active lbs/dry ton sludge |

The ThickTech RDT offers many advantages over other thickeners on the market. In addition to having the most installations (over 250 units), the longest history (over 20 years) and robust, high quality manufacturing made in America, the Parkson ThickTech™ uses less polymer than any other RDT on the market. For an RDT, more money is spent on polymer than for anything else in the system. Polymer costs more than electricity, supporting equipment, and can be up to 10 times the cost of the RDT itself! Although this is by far the highest cost item, it is regularly overlooked when selecting an RDT while focus is made on the comparative capital cost, which is a small fraction of the overall lifecycle costs.



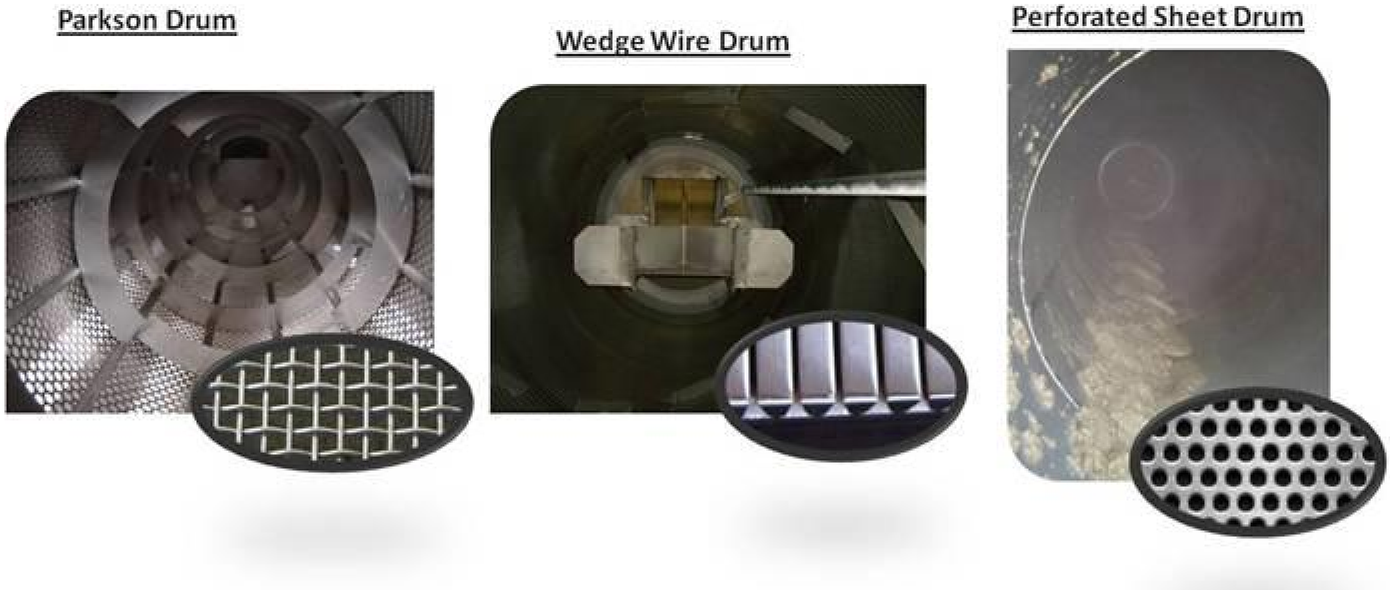

**<u>Calculation Basis</u>:**
**Flow: 400 GPM @ 1.5% solids**
**Polymer cost: $2.5/lb (active)**
**Operation: 5 days/week, 8 hrs/day**
**Discount Rate: 3%**

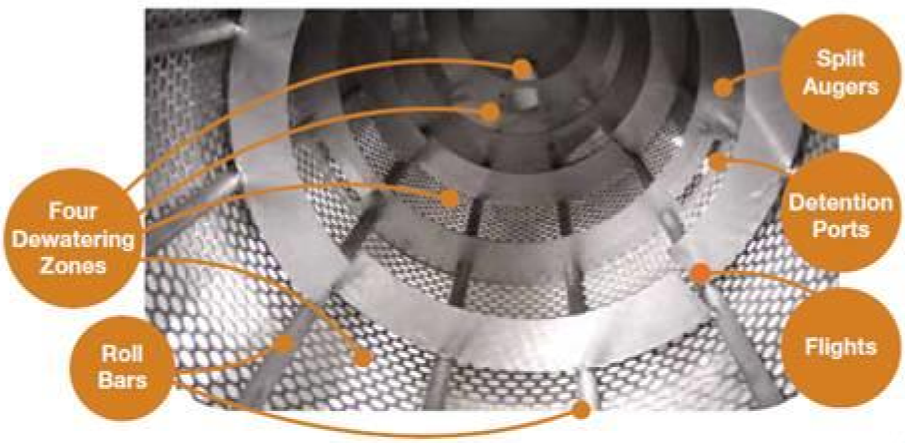
As displayed in the 20 years Net Present Value (NPV) chart, the lifecycle polymer cost for given influent flow and solids could be as high as 2X for the competition. So, it is crucially important to pick the best performing unit for the lowest life cycle cost.

Why the Parkson ThickTech uses so less polymer is pretty elementary. It comes down to three things:

1. Flocculation tank design: The tangential inlet and outlet creates a swirling upward flow pattern with negligible shear promoting enhanced floc development.
2. Screening material: Woven wire mesh has the smallest opening size leading to high capture rates and most open area allowing for most efficient release of water.
3. Internal drum components: The drum is divided into four zones with split augers and detention ports to fine tune the sludge residence time and also prevents breaking down of floc. The roll bars allow for gentle flipping and turning of the sludge for efficient water removal.

So, although woven wire mesh screens can be a little more expensive up front, they save a lot of money down the line. Below is a picture of the Parkson drum showing the internal drum features compared to our two leading competitors (a wedge wire and perforated sheet drum).




Scope:

- 304 SS unit
- Basic Controls
- End Enclosure
- Booster Pump
- Vortex Mixer with polymer injection ring

Based on the design parameters and above scope, the budget price for **one (1) RDT400** including startup service is……………………………………………………………………..**$200,000 USD**

Thank you for considering the comments I have provided above. Should you have any questions at all I would appreciate the opportunity to discuss with you and provide answers.

Sincerely,

Dave Mitchell
RDT Product Manager

| | | | |
|---|---|---|---|
| **NUMBER:** | 09174 | **DATE:** | 03/27/20 |
| **TO:** | Black & Veatch<br>Attn : Leon Downing | **REF.:** | Thickener |

---

# Budget Proposal
# NEW Water
# Green Bay, WI
# THK 600 Thickening Unit



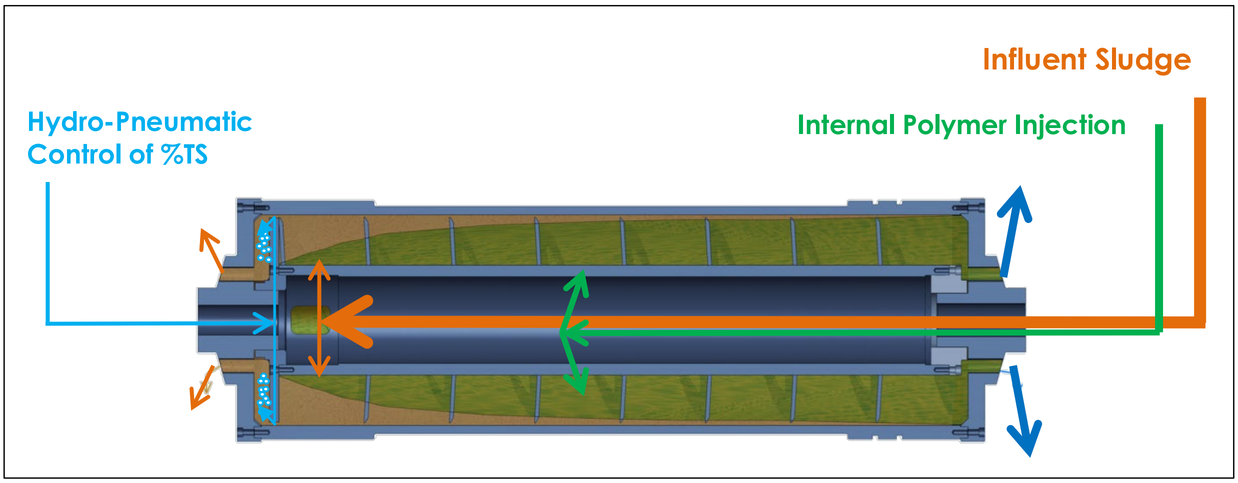
**Centrisys Contact**
Josh Gable
Regional Sales Manager
9586 58th place
Kenosha, WI 53144
Ph: (262) 654-6006
Direct: (262) 705-3064
Email: josh.gable@centrisys.us

**Centrisys Representative**
Rachel M. Lee, P.E.
LAI, Ltd.
2935 S. Fish Hatchery Rd. #116
Madison, WI  53711
Office: (608) 298-7271
Cell: (608) 698-6531
Email: rlee@lai-ltd.com

# Process Description: Centrisys THK Series

**The THK Thickening Centrifuge:**

Sludge thickening using centrifugal force is a common process that can be applied to increase the concentration of sludge for further processing. During operation, sludge is continuously fed into the unit. The moving shaft has a set of helical scrolls, which push the solid waste towards one end, away from the liquid moving in the opposite direction. Centrisys' innovative, patented Hydraulic Assist Technology discharges the thickened sludge more efficiently while reducing costs. Our centrifugal thickening process is the smallest footprint approach to reduce volume while increasing digesting capacity and performance.




The most significant differentiator of the Centrisys THK product is its ability to achieve 2 -6% cake solids **without the use of polymer**. Within this range, the solids content can be reliable controlled at the desired level. We've validated these results in pilots and demonstration installations across the United States for waste active sludge. This is a huge benefit to water & wastewater treatment facilities by substantially reducing their operating costs. Compared to gravity belt thickeners, a comparable Centrisys THK unit thickener has demonstrated a potential payback of 5 years, or less, based on reductions in polymer, water & electricity usage. We've recorded similar results compared to DAF thickening systems, while using a fraction of the required footprint.

## The Centrisys THK Series Design

Centrisys considers all critical design elements including axial flow, pitch design, scroll hub design, cone angles, feed chamber design and disc design, hydra-pneumatic control of the cake solids, Rotor aerodynamics, discharge nozzle geometry, plus our advanced high torque hydraulic Centrisys scroll-drive to achieve the highest performance of any decanter centrifuge. The bowl section is maximized in length (varying from 3.5 to 4.5, depending on the size) for high flow rate and efficient clarification.

### *Feed Flow*

The Centrisys advanced feed chamber design minimizes wear and maximizes performance. This design gently accelerates the continuous incoming feed and distributes it evenly over a larger area as it enters the bowl through multiple field-replaceable tungsten carbide nozzles. This maximizes separation and clarification while minimizing wear, and avoids disturbing already-separated cake solids in the liquid layer.

### *Patented Hydro-Pneumatic Solids Control*

Using injection of air into the thickened solids blanket, coupled with the already present centrifugal force, adjustment of the cake solids consistency can be made on the fly.

- If a plant operator desires to modify the cake solids consistency, the airflow of the THK thickener can be adjusted via the HMI, quickly changing output solids consistency on-demand, without any mechanical adjustments or shutting down the unit.

### *Polymer Feed Injection Option*

The proprietary internal polymer injection design provides the option to inject polymer directly into the fast moving layer of water which flows axially along the hub towards the liquids end of the bowl. Generally, for WAS we do not foresee the necessity for polymer use under normal circumstances. However, use of polymer can be used to substantially increase throughput of the THK (typically by 75 to100%) while maintaining high solids capture efficiencies. Because of the internal polymer injection design, polymer doses are typically 10 to 20% of other mechanical thickening technologies, even at maximum capacities.

### *Low Speed Operation*

The THK series centrifuge is designed to for operation up to 3,000 G – standard for decanting centrifuges. However, because the separation and discharge mechanisms for the THK units are so much different than for conventional centrifuges, the typical bowl speeds required are much lower – typically within the 1,000 to 2,000 G range. This means less power is consumed and the machine's wear is much less than what is typically observed in modern decanter centrifuges.

Centrisys is pleased to provide this quotation for the following:

**ONE (1) THICKENING CENTRIFUGE UNIT, MODEL THK 600 COMPLETE WITH AUTOMATIC HYDRAULIC BACKDRIVE**

## ITEM 1. <u>BASIS OF DESIGN</u>

| | | |
|---|---|---|
| Industry Type: | Municipal | |
| Application: | WAS & Primary/WAS Co-Thickening | |
| Number of units: | 1,2, or 3 | |
| Design Hydraulic Throughput/Unit – | | |
| WAS thickening: | 278 – 921 | gpm |
| Co-thickening: | 576 – 921 | gpm |
| Design Solids Loading Rate/Unit – | | |
| WAS thickening: | 698 – 2485 | lb/hr |
| Co-thickening: | 1764 – 4217 | lb/hr |
| Feed Concentration: | | |
| WAS thickening: | 0.23 – 0.83 | %TS |
| Co-thickening: | 0.47 – 1.3 | %TS |
| Organic/Volatile Content: | TBA | %VS |
| Operation time: | 24 | hrs/day; 7 days/week |
| Temperature: | Ambient | |
| pH: | 6-8 | |

## ITEM 2. <u>ANTICIPATED PERFORMANCE</u>

See spreadsheet

## ITEM 3. <u>CENTRIFUGE SPECIFICATION</u>

| | | |
|---|---|---|
| Model: | THK 600 | |
| Inside bowl diameter: | 26 | in |
| Bowl length: | 118 | in |
| Bowl length to diameter ratio: | 4.5:1 | |
| Maximum Bowl speed: | 2850 | rpm |
| Type of lubrication: | Air/Oil | |
| Main Motor Size: | 150 | HP |
| Back Drive Motor Size: | 25 | HP |
| Max Hydraulic Throughput: | 1100 | gpm |

## ITEM 4. SCOPE OF SUPPLY

Each unit will be provided based on the attached drawing THK 600 GA.pdf

(i) Centrifugally Casted Duplex SS Solid bowl
(ii) Scroll conveyor with Duplex SS Scroll shaft; 316SS flights
(iii) 316 SS lower and upper casing
(iv) Solid and liquid flexible connectors
(v) Dewatered Sludge and Centrate Chutes/Hoppers
(vi) Powder coated carbon steel base/frame
(vii) Vibration isolators
(viii) Spare parts/tools
(ix) Control Panel (water cooled)
  - A. 304SS NEMA 4X Enclosure for each centrifuge
  - B. Main circuit breaker
  - C. VFD for main drive motor
  - D. Allen Bradley PLC (compact logix), valve amplifier and motor starter for automatic hydraulic back drive system
  - E. Ethernet communication and historical trending of key parameters
  - F. 10" Allen-Bradley panel view touch screen
(x) Instrumentation
  - A. One (1) vibration sensor per unit
  - B. One (1) main bearing temperature sensor, type PT100 on each bearing
  - C. One (1) each Bowl/Scroll speed sensor/unit
  - D. One (1) Hydraulic oil level/temp, hydraulic pressure sensor/unit
*(xi)* Automatic Air/Oil Lubrication System
  - A. One (1) low air/oil level sensor per unit
(xii) One (1) trip and 5 days of startup assistance

## ITEM 5. BUDGET PRICE

All of the above for ........................................................................... $**638,900** USD
F.O.B. Job Site, freight included, taxes excluded.

**PAYMENT TERMS:**

30% with order; 60% upon shipment; 10% after startup not to exceed 90 days after shipment.

## ITEM 6. LEAD TIME

18-20 weeks following receipt of the Approval drawings

## ITEM 7. BUYER/OWNER RESPONSIBILITY

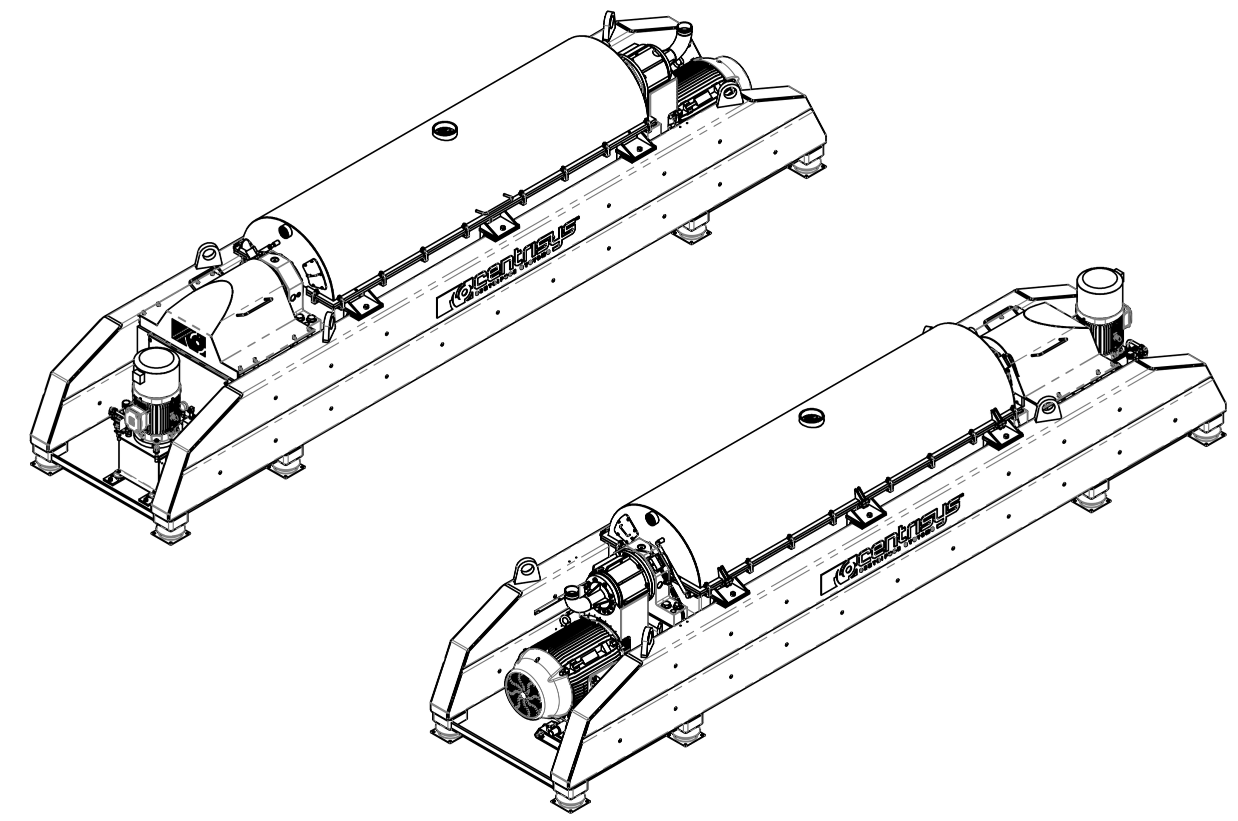
- Stand
- Feed pump
- Polymer system
- Flow meter
- Air compressor
- Cake conveyor
- Anchor bolts.

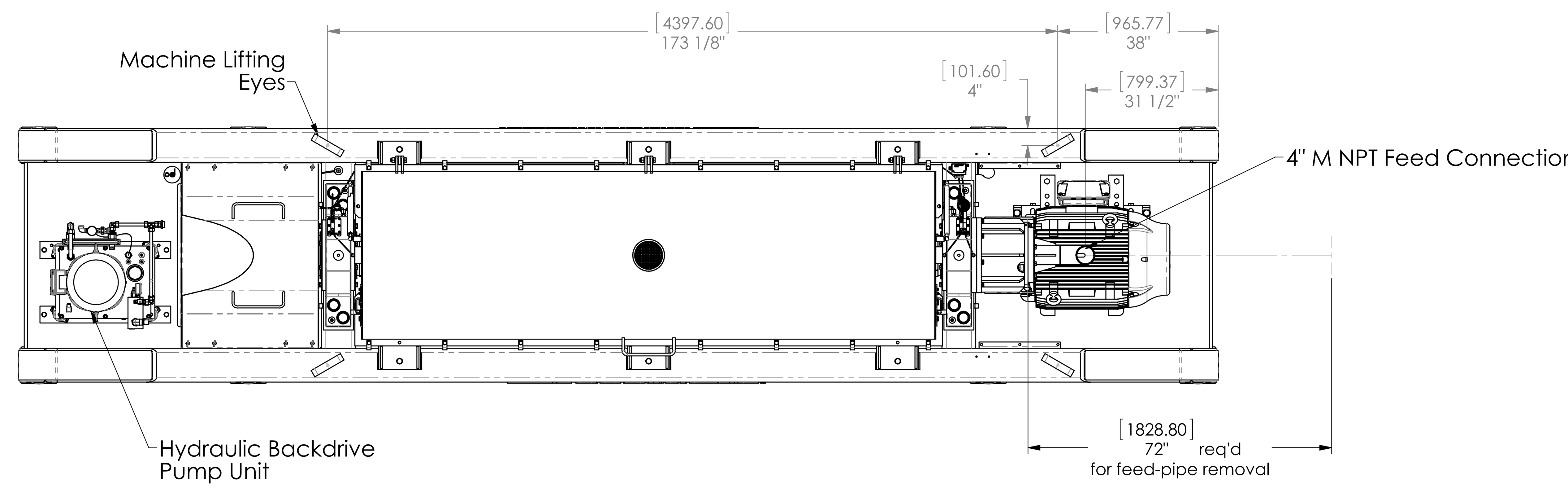
- Building and building plans (Centrisys provides only the layout drawings without any responsibility of updating any plans or building)
- Building modifications
- Structural and Civil engineering labor
- Lubricants
- All utilities that are required for operation
- Unloading, uncrating, installation and installation supervision. Installation will, at minimum, require a forklift and possibly a crane/hoist.
- Readiness of the Equipment before requesting start-up service. Non-readiness may incur additional charges.
- Compatibility of Equipment materials of construction with process environment.
- Piping connections, platforms, gratings and railings unless stated otherwise.
- Any other auxiliary equipment or service not detailed above.

Issued by:

Brett Bevers
Applications Engineer

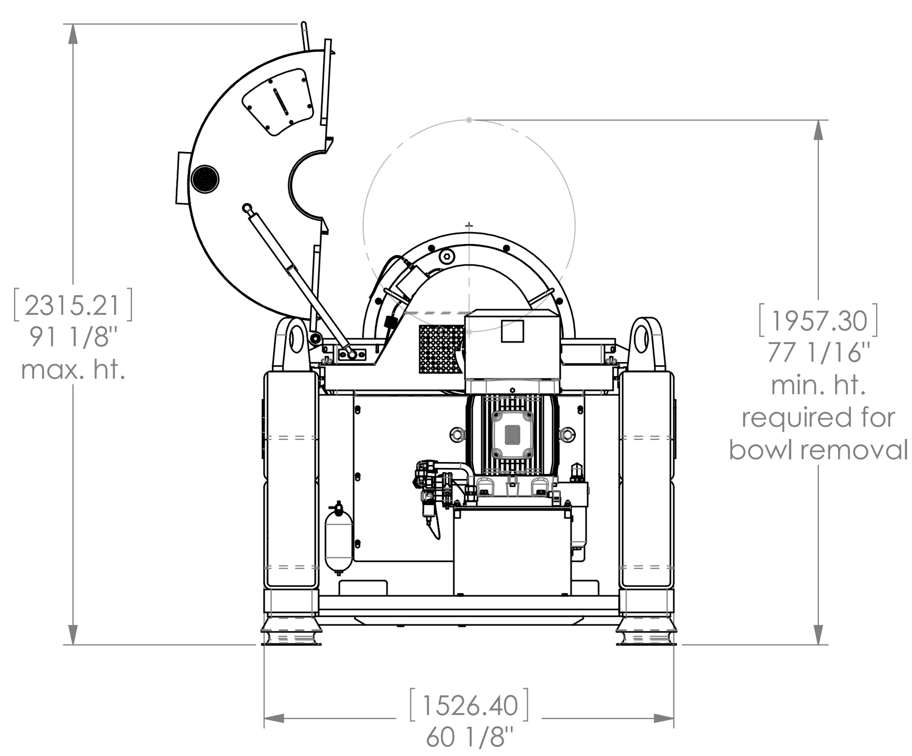
Date:03/27/20

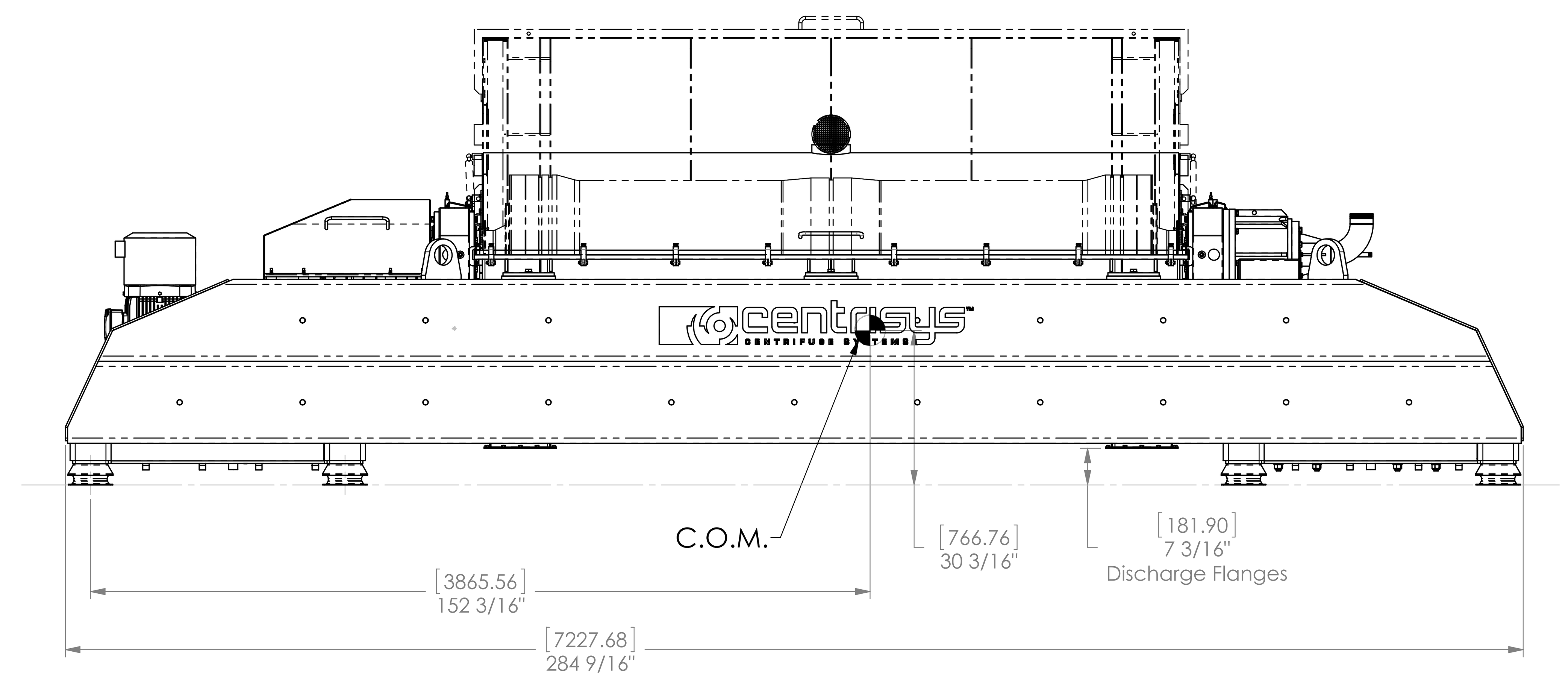


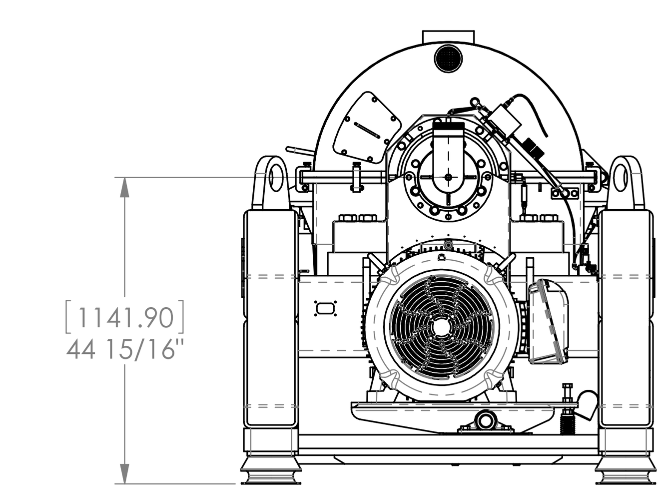


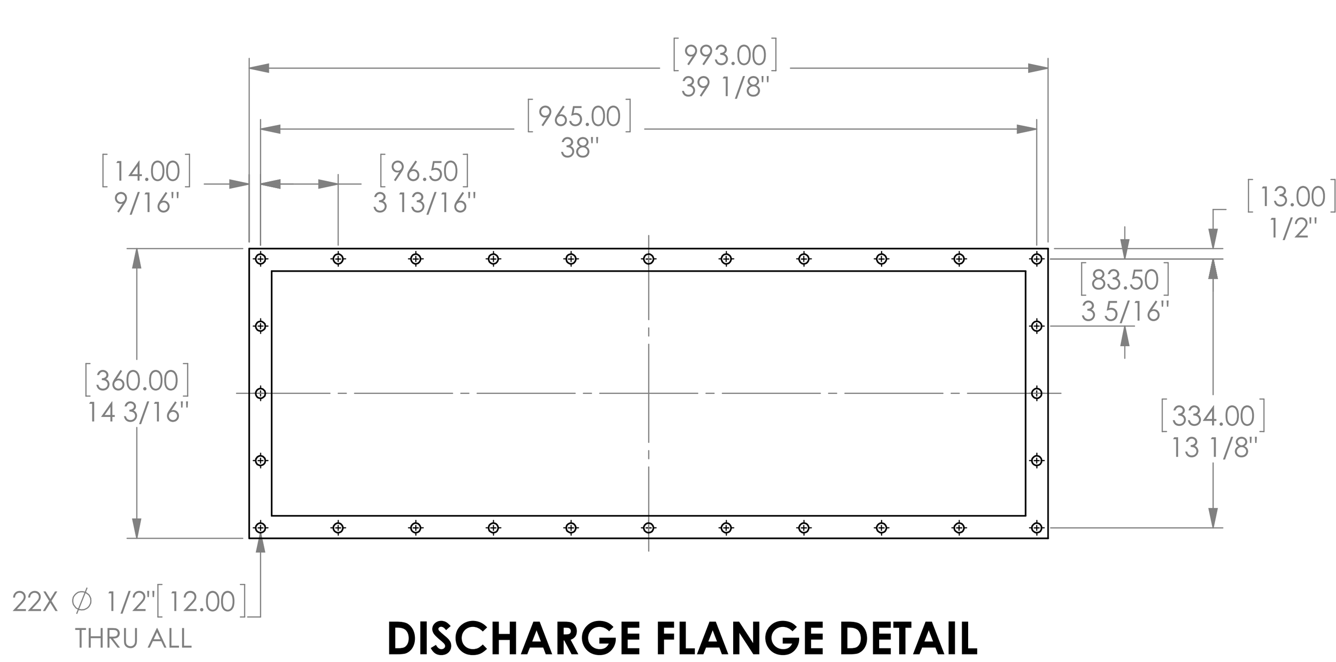

| Est. Centrifuge Loading: | *lbs [kg]* |
|---|---|
| **Rotating Assembly** | 9150 [4150] |
| **Bowl Filling w/SP 1.0** | 2000 [907] |
| **Complete Centrifuge (w/o filling)** | 27000 [12247] |
| **Static loads below foot pads:** | |
| A | 3821 [1733] |
| B | 3821 [1733] |
| C | 3821 [1733] |
| D | 3821 [1733] |
| E | 2929 [1329] |
| F | 2929 [1329] |
| G | 2929 [1329] |
| H | 2929 [1329] |
| **Dynamic loads below each corner of complete centrifuge:** | |
| A | 4203 [1906] |
| B | 4203 [1906] |
| C | 4203 [1906] |
| D | 4203 [1906] |
| E | 3222 [1461] |
| F | 3222 [1461] |
| G | 3222 [1461] |
| H | 3222 [1461] |
| **Dynamic loads below each corner of complete centrifuge with full bowl @ start-up during critical:** | |
| A | 4575 [2075] |
| B | 4575 [2075] |
| C | 4575 [2075] |
| D | 4575 [2075] |
| E | 3400 [1542] |
| F | 3400 [1542] |
| G | 3400 [1542] |
| H | 3400 [1542] |

*Assume horizontal loads approximately 5% of vertical loads

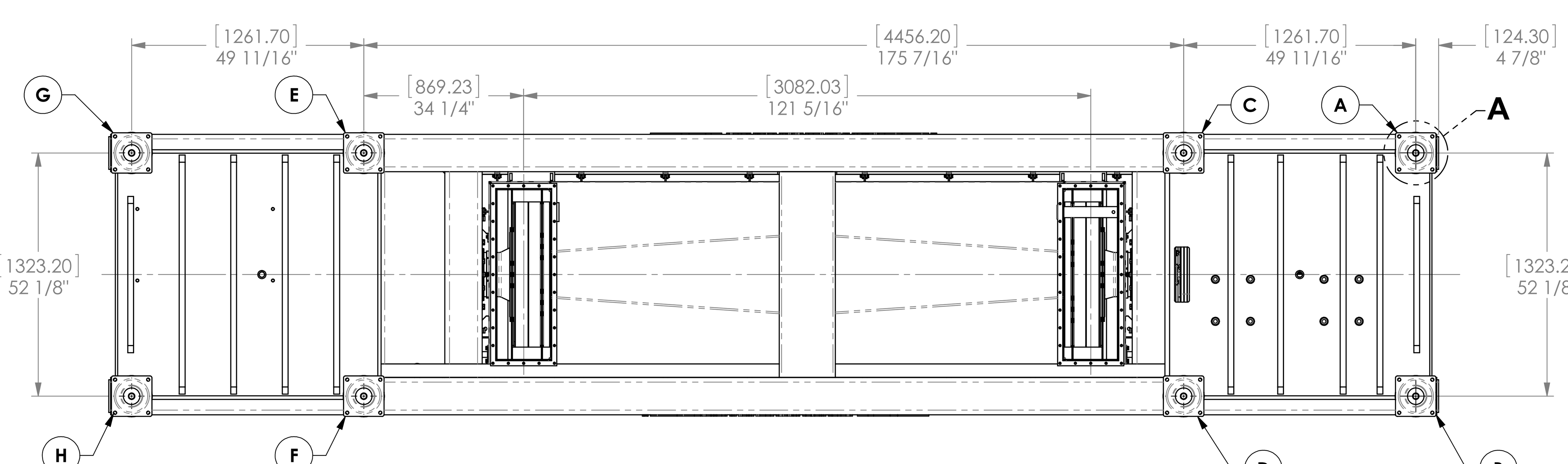


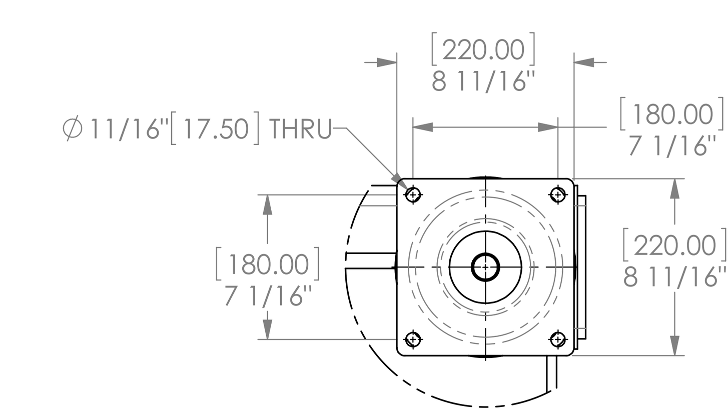




**DISCHARGE FLANGE DETAIL**
Scale 1 : 8




**DETAIL A**
**SCALE 1 : 8**

REVISE ON CAD ONLY

CENTRISYS CENTRIFUGE SYSTEMS
9586 58th Place
Kenosha, WI 53144
Tel: (262) 654-6006
Fax: (262) 764-8705

| Designed by: | Date: |
|---|---|
| A.A. | --- |
| Drawn by: A.A. | Date: 8/26/13 |
| Chk'd by: - | Date: - |
| Approved by: - | Date: - |

GD&T ASME Y14.5M1994+ Tolerancing Std. & Rules apply

3rd Angle Projection

Material(s): See BOM

Estimated weight (lbs): See Note



Title: THK 26-600 General Arrangment

Project:

Sheet Size: D | Drawing #: GA23210

Sht: 1 OF 3 | Scale: 1:24 | REV

# Budgetary Sizing for Black & Veatch New Water, Green Bay, WI Facility Plan

## ANDRITZ Rotary Drum Thickener
## ANDRITZ Gravity Belt Thickener

Bid Scope No: 3314745
Date: 3/30/2020

By: Chris Mahoney
Tel: (817) 271-4826
Email: chris.mahoney@andritz.com

ENGINEERED SUCCESS


ANDRITZ Separation Technologies Inc.
1010 Commercial Blvd. South
Arlington, TX 76001
(817) 465-5611
Separation.us@andritz.com
www.Andritz.com

3/30/2020

**Leon S. Downing, Ph.D., P.E**
Black & Veatch
826 Minakwa Dr
Madison, WI 53711

Reference: **New Water, Green Bay, WI**
**Facility Plan**

Subject: **ANDRITZ Budgetary Proposal 3314745**

Thank you for the opportunity to provide this preliminary equipment sizing and budgetary pricing for use in your study for New Water project.

We understand that the process data is still being developed and may not completely balance out at this point. Where we found potential conflicts we either adjusted it or based our sizing on the hydraulic loadings since they are normally more of a firm estimate at this point in a study.

While a number of models and sizes of equipment can be reviewed at the time of final analysis to provide the best cost and performance, for this review the primary equipment used for this analysis is the following.

Rotary Drum Thickeners –

Thicken WAS and Primary sludges from 0.5%-5% (higher with primary blends)
Model PDR 900XL – Capacities up to 250 GPM
Budgetary Costs - $175,000 USD per machine

Model PDR 1200 - Capacities up to 420 GPM
Budgetary Costs - $205,000 USD per machine

Gravity Belt Thickeners

ANDRITZ 1 Meter GBT – Primary and secondary sludges up to 300 GPM
Budgetary Costs - $200,000 USD per machine

ANDRITZ 2 Meter GBT – Primary and secondary sludges up to 300 GPM
Budgetary Costs - $225,000 USD per machine

ANDRITZ 3 Meter GBT – Primary and secondary sludges up to 300 GPM
Budgetary Costs - $400,000 USD per machine

Data Sheets and typical engineering drawings are included for your use.

ENGINEERED SUCCESS

Case 1:

## WAS THICKENING INFORMATION

- **Requested technologies**:
- Rotary Drum Thickener
- Gravity Belt Thickener

Table 1. WAS flow rates and concentrations for each of five loading scenarios and at four different percentiles

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Equipment sizing | | | | | | | | | | |
| | | | | | | | | | | |
| Process Conditions | | | | | | | | | | |
| | Flow [gpm] | | | | | Mass Load [ppd] | | | | |
| | WT1 | WT2 | WT3 | WT4 | WT5 | WT1 | WT2 | WT3 | WT4 | WT5 |
| 2025 25th | 576 | 1,106 | 278 | 833 | 279 | 50,881 | 55,745 | 27,630 | 26,500 | 21,458 |
| 2025 50th | 736 | 1,474 | 434 | 1,052 | 298 | 56,077 | 62,223 | 31,471 | 30,900 | 24,277 |
| 2040 50th | 921 | 1,689 | 585 | 1,119 | 298 | 59,636 | 66,329 | 32,835 | 33,480 | 26,574 |
| 2040 90th | 1,157 | 2,235 | 700 | 1,638 | 536 | 72,235 | 80,472 | 38,865 | 44,739 | 36,712 |
| | | | | | | | | | | |
| | | | | | | | | | | |
| Rotary Drum Thickeners | | | | | | | | | | |
| | Flow [gpm] | | | | | Mass Load [ppd] | | | | |
| | WT1 | WT2 | WT3 | WT4 | WT5 | WT1 | WT2 | WT3 | WT4 | WT5 |
| 2025 25th | 2x PDR1200 | 3x PDR1200 | 1x PDR900XL | 2x PDR1200 | 1x PDR1200 | 50,881 | 55,745 | 27,630 | 26,500 | 21,458 |
| 2025 50th | 2x PDR1200 | 4x PDR1200 | 2x PDR900XL | 2x PDR1200 | 1x PDR1200 | 56,077 | 62,223 | 31,471 | 30,900 | 24,277 |
| 2040 50th | 3x PDR1200 | 4x PDR1200 | 2x PDR1200 | 2x PDR1200 | 1x PDR1200 | 59,636 | 66,329 | 32,835 | 33,480 | 26,574 |
| 2040 90th | 3x PDR1200 | 4x PDR1200 | 2x PDR1200 | 3x PDR1200 | 2x PDR1200 | 72,235 | 80,472 | 38,865 | 44,739 | 36,712 |
| | | | | | | | | | | |
| | | | | | | | | | | |
| Gravity Belt Thickeners | | | | | | | | | | |
| | Flow [gpm] | | | | | Mass Load [ppd] | | | | |
| | WT1 | WT2 | WT3 | WT4 | WT5 | WT1 | WT2 | WT3 | WT4 | WT5 |
| 2025 25th | 1x 3M GBT | 2x 3M GBT | 1x 2M GBT | 2x 2M GBT | 1x 2M GBT | 50,881 | 55,745 | 27,630 | 26,500 | 21,458 |
| 2025 50th | 1x 3M GBT | 2x 3M GBT | 1x 2M GBT | 2x 3M GBT | 1x 2M GBT | 56,077 | 62,223 | 31,471 | 30,900 | 24,277 |
| 2040 50th | 2x 2M GBT | 3x 3M GBT | 1x 3M GBT | 2x 3M GBT | 1x 2M GBT | 59,636 | 66,329 | 32,835 | 33,480 | 26,574 |
| 2040 90th | 2x 3M GBT | 3x 3M GBT | 1x 3M GBT | 3x 3M GBT | 2x 2M GBT | 72,235 | 80,472 | 38,865 | 44,739 | 36,712 |

Case 2:

## PS THICKENING INFORMATION

- **Requested technologies**:

| Table #2 | GBT Sizing Only | | | |
|---|---|---|---|---|
| | Flow [gpm] | Corrected Flow [gpm] for 2% solids | Mass Load [ppd] | Equipment |
| **2025 25th** | 0.14 | 146 | 35,083 | 1x 1M GBT |
| **2025 50th** | 0.2 | 163 | 39,121 | 1x 1M GBT |
| **2040 50th** | 0.24 | 170 | 40,862 | 1x 1M GBT |
| **2040 90th** | 0.31 | 216 | 51,809 | 1x 1M GBT |
| ANDRITZ 1.0 meter GBT has a capacity of 300 GPM on | | | | |

Case #3

## COMBINED WAS AND PS THICKENING INFORMATION

Table 3. Combined flow rates and concentrations for two loading scenarios at four different percentiles.

- **Requested technologies**:
- Rotary Drum Thickener
- Gravity Belt Thickener

| | Flow [gpm] | | Mass Load [ppd] | |
|---|---|---|---|---|
| | Co-T1 | Co-T2 | Co-T1 | Co-T2 |
| **2025 25th** | 576 | 1,106 | 88,355 | 92,985 |
| **2025 50th** | 736 | 1,475 | 95,701 | 101,503 |
| **2040 50th** | 921 | 1,690 | 101,213 | 107,271 |
| **2040 90th** | 1,157 | 2,235 | 120,005 | 126,995 |

Rotary Drum Thickener

| | Flow [gpm] | | Mass Load [ppd] | |
|---|---|---|---|---|
| | Co-T1 | Co-T2 | Co-T1 | Co-T2 |
| **2025 25th** | 2x PDR1200 | 3x PDR1200 | 88,355 | 92,985 |
| **2025 50th** | 2x PDR1200 | 4x PDR1200 | 95,701 | 101,503 |
| **2040 50th** | 3x PDR1200 | 4x PDR1200 | 101,213 | 107,271 |
| **2040 90th** | 3x PDR1200 | 4x PDR1200 | 120,005 | 126,995 |

Gravity Belt Thickener

| | Flow [gpm] | | Mass Load [ppd] | |
|---|---|---|---|---|
| | Co-T1 | Co-T2 | Co-T1 | Co-T2 |
| **2025 25th** | 1x 3M GBT | 2x 3M GBT | 88,355 | 92,985 |
| **2025 50th** | 1x 3M GBT | 2x 2M GBT | 95,701 | 101,503 |
| **2040 50th** | 2x 2M GBT | 3x 3M GBT | 101,213 | 107,271 |
| **2040 90th** | 2x 3M GBT | 3x 3M GBT | 120,005 | 126,995 |

Please use the sizing tables above in conjunction with the budgetary numbers to generate the preliminary capital costs for the recommended equipment. In addition, we have made some assumptions on the number and size of the units. If you feel that you need redundancy in the case of one machine specified and you want to move down to two machines of a smaller size, the information above should help you make that adjustment.

O&M Costs

All of this equipment uses small motors, 5-10 hp so the major costs associated with operations is polymer usage which is driven by the solids end of the equation. For preliminary estimates you can use 5-10 lbs/ton (active).

I hope this provides you with the information you need and please feel to call or email me directly if you have any questions.

Included in this document is ANDRITZ Proposal for the above referenced equipment specification section. ANDRITZ is bidding as a named Rotary Drum Thickener supplier with our ANDRITZ PDR-900XL Sludge Thickener.

ANDRITZ is a world leader in liquids/solids separation and drying equipment. We have earned a reputation for engineering and manufacturing equipment of the highest quality. We trust that our quality service and value will enable ANDRITZ to be the Rotary Drum Thickener supplier for this project.

Your consideration is appreciated.

Sincerely,

*Chris Mahoney*

**Chris Mahoney**
Regional Sales Manager
ANDRITZ Separation Technologies, Inc.
Cell: (817) 271-4826
Email: chris.mahoney@andritz.com
www.ANDRITZ.com

# DRUM THICKENER

## PDR 900

### General

The PDR Series drum thickeners ensure dynamic thickening by continuous rotation of sludge for large flow (35 to 90 m3/hr)

Dynamic mechanical thickening allows a compact and completely enclosed solution. The specific installation with inline Venturi mixer optimizes compactness of system and decreases polymer consumption.

### Dimensions and Weight

See table1

### Construction Materials

| | |
|---|---|
| Frame tank | 1.4306 (AISI 304L) |
| Drum | 1.4306 (AISI 304L) |
| Belt | Polyester |
| Spray ramp | 1.4306 (AISI 304L) |
| Nozzle | PVDF |
| Cover | 1.4306 (AISI 304L) |
| Frame finishing | Acid pickling |
| Cover finishing | Brushed Stainless Steel |
| Option: | |
| Raw Material | 1.4404 (AISI 316L) |

### Frame

| | |
|---|---|
| Thickness | 3mm |

### Drum

| | |
|---|---|
| Diameter | 900 mm |
| Length | 2370, 3370, 4370 mm |
| Speed | 2.80 to 8.30 RPM |

### Belt

| | |
|---|---|
| Size | 2830 x 1000mm |
| Type | Linear Screen |
| Quantity: | |
| M | 1 |
| L | 1 |
| XL | 2 |
| Type | Spiral dry |
| Quantity: | |
| M | 1 |
| L | 2 |
| XL | 2 |

### Washing spray pipe

| | |
|---|---|
| Flow | See Table 1 |
| Pressure | 8 bar |
| Quality | 500µm (100ppm) |
| | Without Sulfite or/and Chloride |

### Air Connection (suction)

| | |
|---|---|
| Flow : | |
| M | 30 $m^3/h$ |
| L | 45 $m^3/h$ |
| XL | 55 $m^3/h$ |

### Gear-motor & frequency inventer

See table 2

### Lubrication

| | |
|---|---|
| Bearing | with grease/ type: KP2K |
| Gear motor | Oil (CLP220 Mineral) |

### Noise level

| | |
|---|---|
| Noise | < 80 dB(A) |

### Inline Dynamic Venturi Mixer

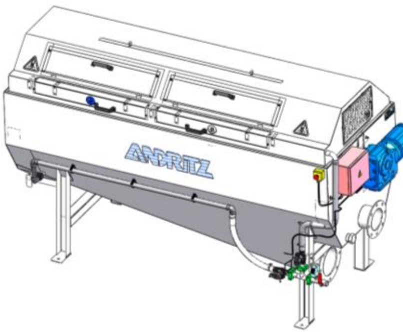
See table 3

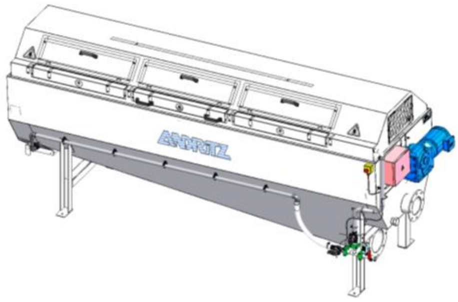
| | |
|---|---|
| Raw Material | 1.4404 (AISI 316L) |

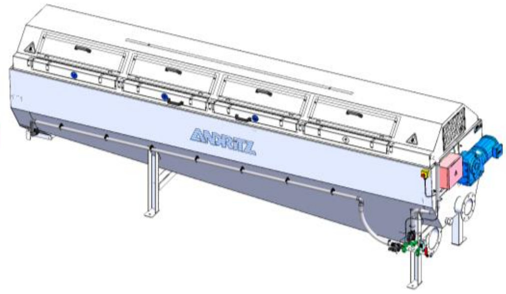
## DRUM THICKENER

## PDR 900

**Dimensional** **Type M** **Type L** **Type XL**




| | | M | L | XL |
|---|---|---|---|---|
| | | | | |
| Length | mm | 2978 | 3948 | 4948 |
| Height | mm | 1733 | | |
| Width | mm | 1179 | | |
| Empty weight | kg | 645 | 779 | 916 |
| Load weight | kg | 761 | 940 | 1122 |
| Maintenance footprint | drawing number | 54047 (M) | 54047 (L) | 54047 (XL) |
| Anchors (option) | Anchor Bolts | x4 - M12 /A4-70 | x4 - M12 /A4-70 | x4 - M12 /A4-70 |
| Flow supply (8 bar) | m3/h | 4 | 6 | 8 |
| Power | Kw | 1,1 | 1,5 | 1,5 |

*Table 1*

**Moto-reducer & frequency inverters**

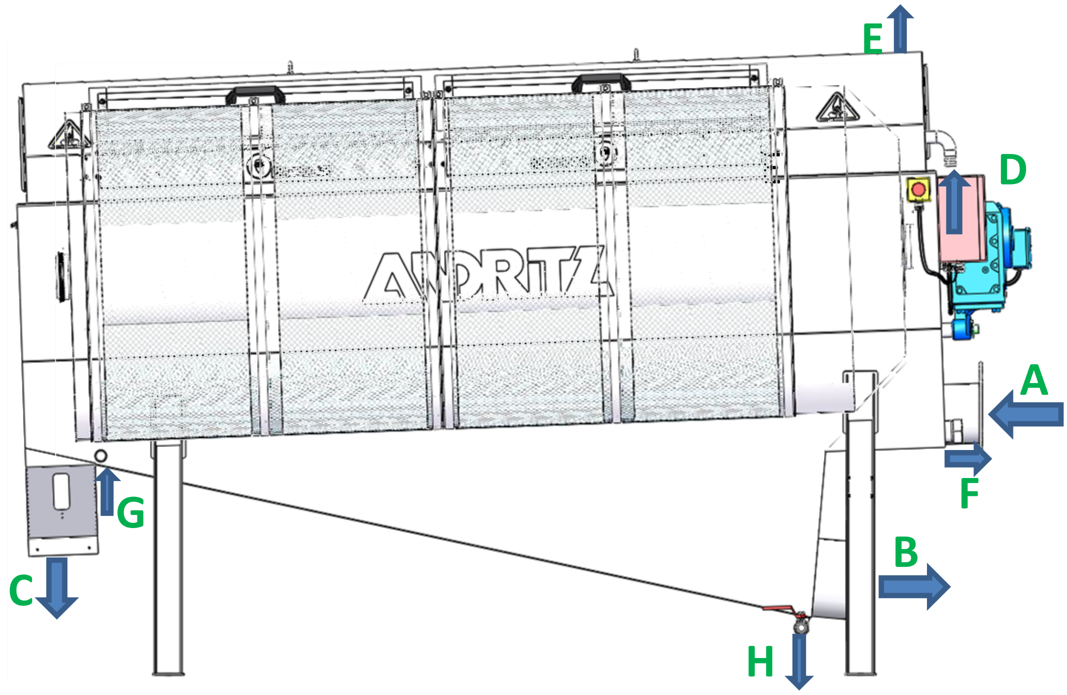
| | | M | L – XL |
|---|---|---|---|
| **Moto-reducer** | | | |
| Type | | **Helical Bevel gear** | |
| Power | kW | 1.1 | 1.5 |
| Voltage | V | 230/400 | 230/400 |
| Rated current | A | 4 / 3,1 | 7 / 4 |
| Frequency | Hz | 50 | |
| Output speed | RPM | 2.80 to 8,30 | |
| Service factor | | 1,2 | 0,9 |
| Hollow shaft | Ø | 50mm | |
| Motor protection type | IP | 54 | 55 |
| Thermal Classification | | B | |
| Efficiency Class | | IE2 | |
| Performance (50 / 75 / 100% Pn) | % | 77,2 / 79,4 / 78,7 | 79,7 / 81,5 / 80,9 |
| Weight | Kg | 76 | 80.538 |
| Option | | Explosion proof | |
| **Frequency inverters** | | | |
| Nominal voltage | V | 380…500 | |
| Power Motor at 400V (low overload) | KW | 1.1 | 1.5 |
| input Frequency | Hz | 50…60 (+/-10%) | |
| Protection | IP | 21 | |

*Table 2*

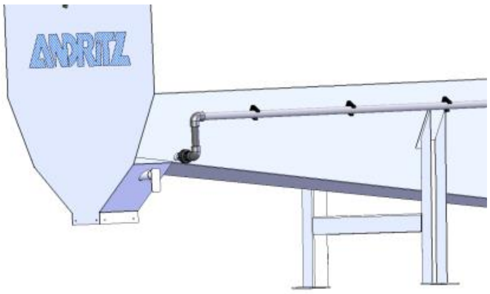
## DRUM THICKENER

## PDR 900

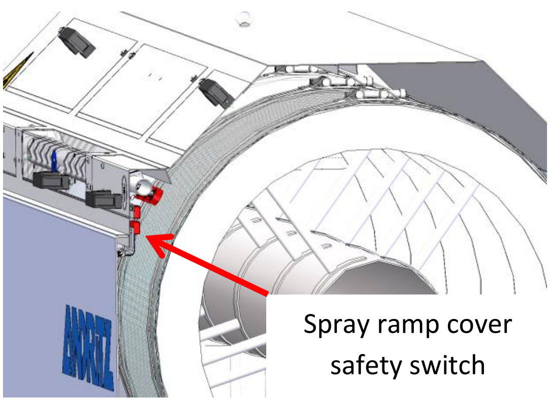
**Connection**




| ITEM | DESCRIPTION | DIMENSIONS | DETAILS |
|---|---|---|---|
| A | Sludge Inlet | DN 150 (ISO) | Flange |
| B | Filtrate outlet | DN 200 (ISO) | Flange |
| C | Sludge outlet | 200mm x 200mm ext. | Square Flange |
| D | Wash water Inlet (Drum) | Ø1''G Male | Flange |
| E | Air connection (suction) | Ø114.3mm Ext | Flange |
| F | Sludge Inlet drain | Ø2''G Male | Threaded + cap |
| G | Wash water Inlet (Tank) | Ø1''G Male | Threaded |
| H | Filtrate sample | Ø1''G female | Manuel valve |



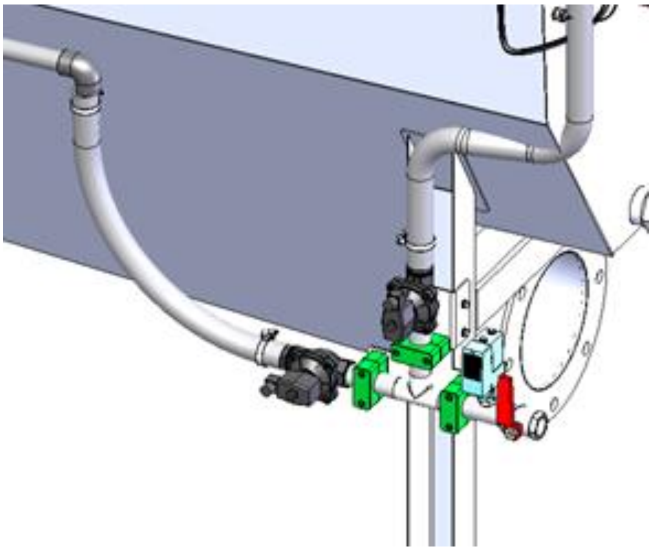

Outlet sludge




Spray ramp cover safety switch

## Options

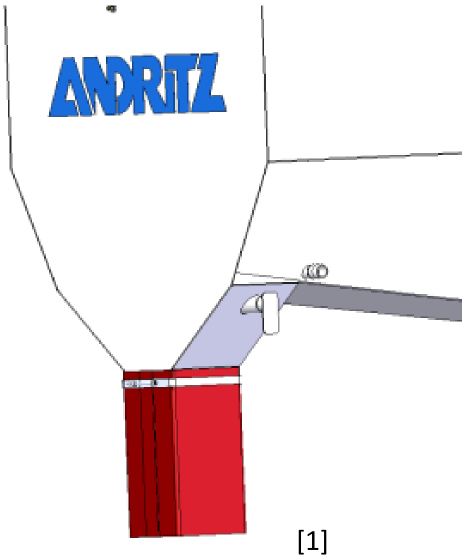
Hydraulic piping preparation:



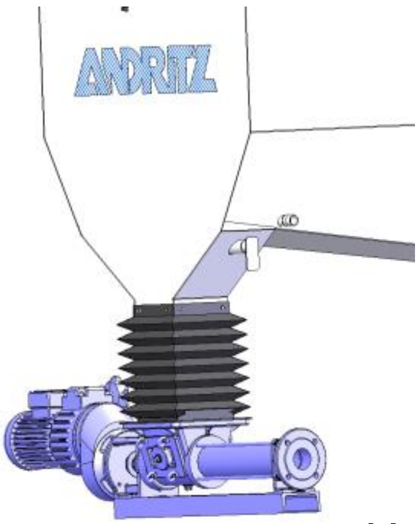
- X2 Solenoid valve
- X1 Pressure switch
- X1 Manual valve

Sludge outlet interface:

- Rubber skirt [1]
- Bellows [2]




[1]

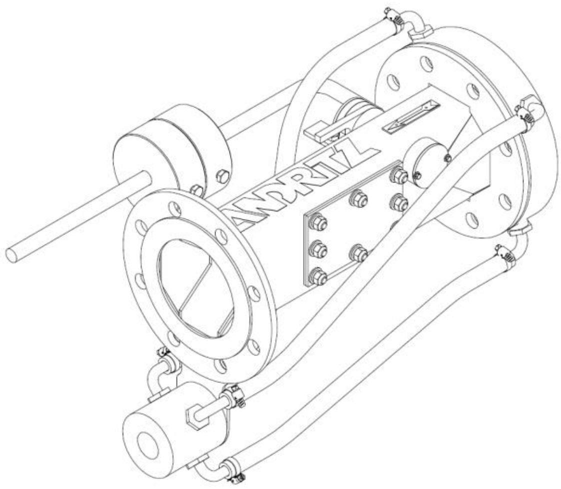



[2]

# DRUM THICKENER

## PDR 900

**Inline Dynamic Venturi Mixer**




| TYPE | Flow Min. m3/h | Flow Max. m3/h | Dimensions (L/w/h) | Connection | Polymer connection | Weight (kg) |
|---|---|---|---|---|---|---|
| 4" VENTURI | 4,5 | 23 | 500x450x500 | ISO DN100 PN10 | G1" Female threaded | 20 |
| 6" VENTURI | 23 | 91 | 560x450x500 | ISO DN150 PN10 | G1" Female threaded | 25 |
| 10" VENTURI | 91 | 275 | 560x450x500 | ISO DN250 PN10 | G1" Female threaded | 40 |

*Table 3*

* Head loss: 0,5 to 1 bar.

** The Venturi Mixer needs to be located 5 meters away from headbox or closer but the efficiency will be lowered. Two locations must be considered on the pipe (5 and 10 meters away) according to sludge and polymer rate.

# DRUM THICKENER

## PDR 1200

### General

The PDR 1200 Series drum thickeners ensure dynamic thickening by continuous rotation of sludge for very large flow (up to 140 m3/hr)

Dynamic mechanical thickening allows a compact and completely enclosed solution. The specific installation with inline Venturi mixer optimizes compactness of system and decreases polymer consumption.

### Dimensions and Weight

| | |
|---|---|
| | See table1 |

### Construction Materials

| | |
|---|---|
| Frame tank | 1.4306 (AISI 304L) |
| Drum | 1.4306 (AISI 304L) |
| Belt | Polyester |
| Spray ramp | 1.4306 (AISI 304L) |
| Nozzle | 1.4404 (AISI 316L) |
| Cover | 1.4306 (AISI 304L) |
| Frame finishing | Acid pickling |
| Cover finishing | Brushed Stainless Steel |
| Option: | |
| Raw Material | 1.4404 (AISI 316L) |

### Frame

| | |
|---|---|
| Thickness main body | 5 mm |
| Thickness tank | 3 mm |

### Drum

| | |
|---|---|
| Diameter | 1200 mm |
| Length | 4430 mm |
| Speed | 1.8 to 8.4 RPM |

### Belt

| | |
|---|---|
| Size | 3800 x 1000 mm |
| Linear screen: | 2 |
| Spiral dry: | 2 |

### Washing spray pipe

| | |
|---|---|
| Flow | 13.2 m3/h |
| Pressure | 8 bar |
| Quality | 500µm (100ppm) |
| | Without Sulfite or/and Chloride |

### Air Connection (suction)

| | |
|---|---|
| Flow : | 110 m3/h |

### Gear-motor & frequency inventer

| | |
|---|---|
| | See table 2 |

### Lubrication

| | |
|---|---|
| Bearing | with grease/ type: KP2K |
| Gear motor | Oil (CLP220 Mineral) |

### Noise level

| | |
|---|---|
| Noise | < 80 dB(A) |

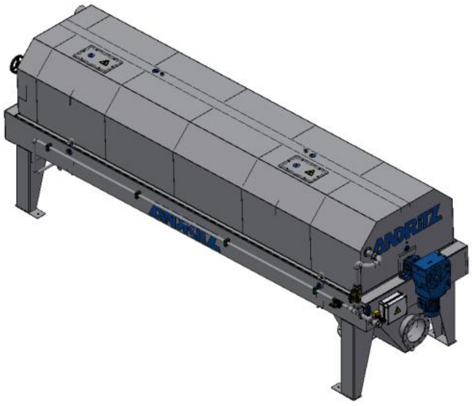
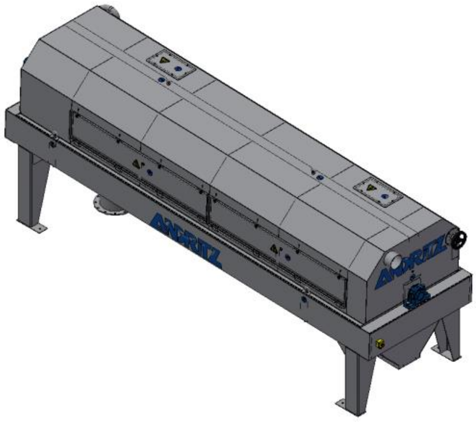
### Inline Dynamic Venturi Mixer

| | |
|---|---|
| | See table 3 |
| Raw Material | 1.4404 (AISI 316L) |

# DRUM THICKENER

# PDR 1200

## Dimensional

| | | PDR 1200 |
|---|---|---|
| | | |
| Length | mm | 5663 |
| Height | mm | 2125 |
| Width | mm | 1650 |
| Empty weight | kg | 2260 |
| Load weight | kg | 2950 |
| Maintenance footprint | drawing number | 702906657 |
| Anchors (option) | Anchor Bolts | x4 – M16 /A4-70 |
| Flow supply (8 bar) | m3/h | 13.2 |
| Power | Kw | 1,5 |

*Table 1*

## Gearmotor & frequency inverters

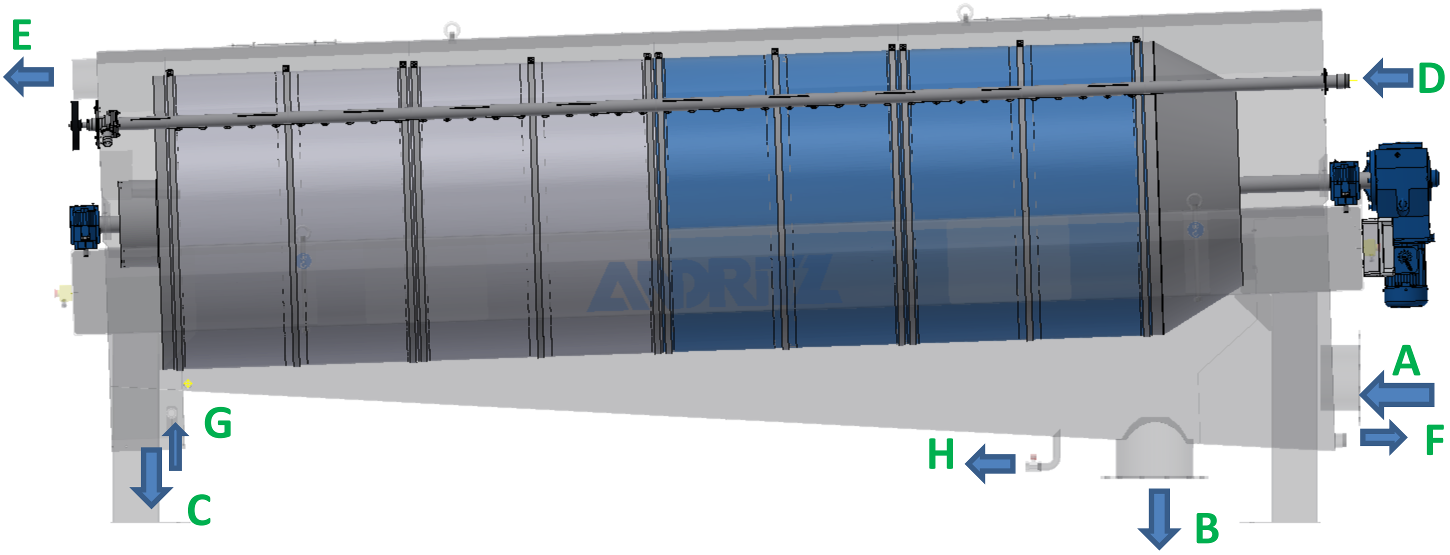
| Gearmotor | | | |
|---|---|---|---|
| Type | | Helical Bevel gear | |
| Power | kW | 1.5 | 1.5 |
| Voltage | V | 230/400 | 230/460 |
| Rated current | A | 3.23 | 2.8 |
| Frequency | Hz | 50 | 60 |
| Output speed | RPM | 2.80 to 8,30 | 2.80 to 8,30 |
| Service factor | | 1,2 | 1.4 |
| Hollow shaft | Ø | 60mm | 60mm |
| Motor protection type | IP | 55 | 55 |
| Thermal Classification | | B | B |
| Efficiency Class | | IE3 | Premium |
| Performance | % | 85.3 | |
| Weight | Kg | 133 | 133 |
| Option | | Explosion proof | Explosion proof |
| **Frequency inverters** | | | |
| Nominal voltage | V | 380…500 | |
| Power Motor at 400V (low overload) | KW | 1.5 | |
| input Frequency | Hz | 50…60 (+/-10%) | |
| Protection | IP | 21 | |

*Table 2*

# DRUM THICKENER

## PDR 1200

### Connection



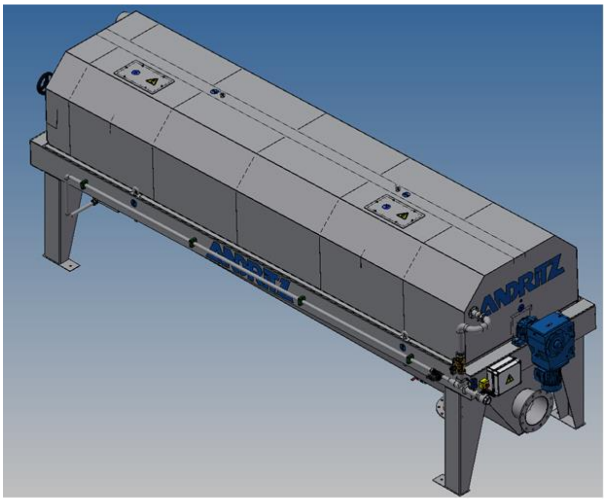

| ITEM | DESCRIPTION | DIMENSIONS | DETAILS |
|---|---|---|---|
| A | Sludge Inlet | DN 250 (ISO)* | Flange |
| B | Filtrate outlet | DN 300 (ISO)* | Flange |
| C | Sludge outlet | 300mm x 310mm ext. | Square Flange |
| D | Wash water Inlet (Drum) | Ø2''G Male | Threaded |
| E | Air connection (suction) | Ø168.3mm Ext | Flange |
| F | Sludge Inlet drain | Ø2''G Male | Threaded + cap |
| G | Wash water Inlet (Tank) | Ø1''G Male | Threaded |
| H | Filtrate sample | Ø1''G female | Manuel valve |

*Option: Flange ANSI

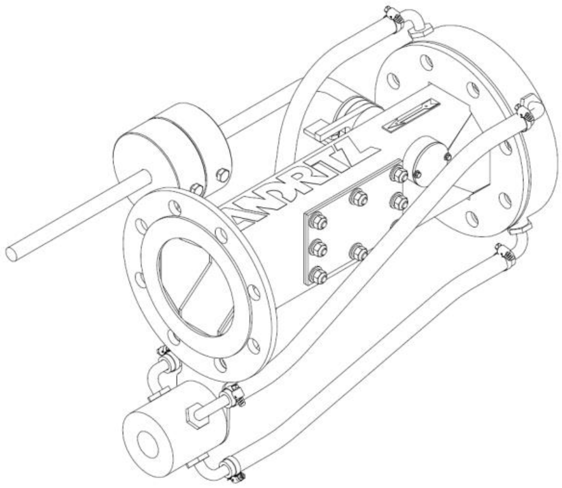
## Options

Hydraulic piping preparation:

- X2 Solenoid valve
- X1 Pressure switch
- X1 Manual valve



## Inline Dynamic Venturi Mixer

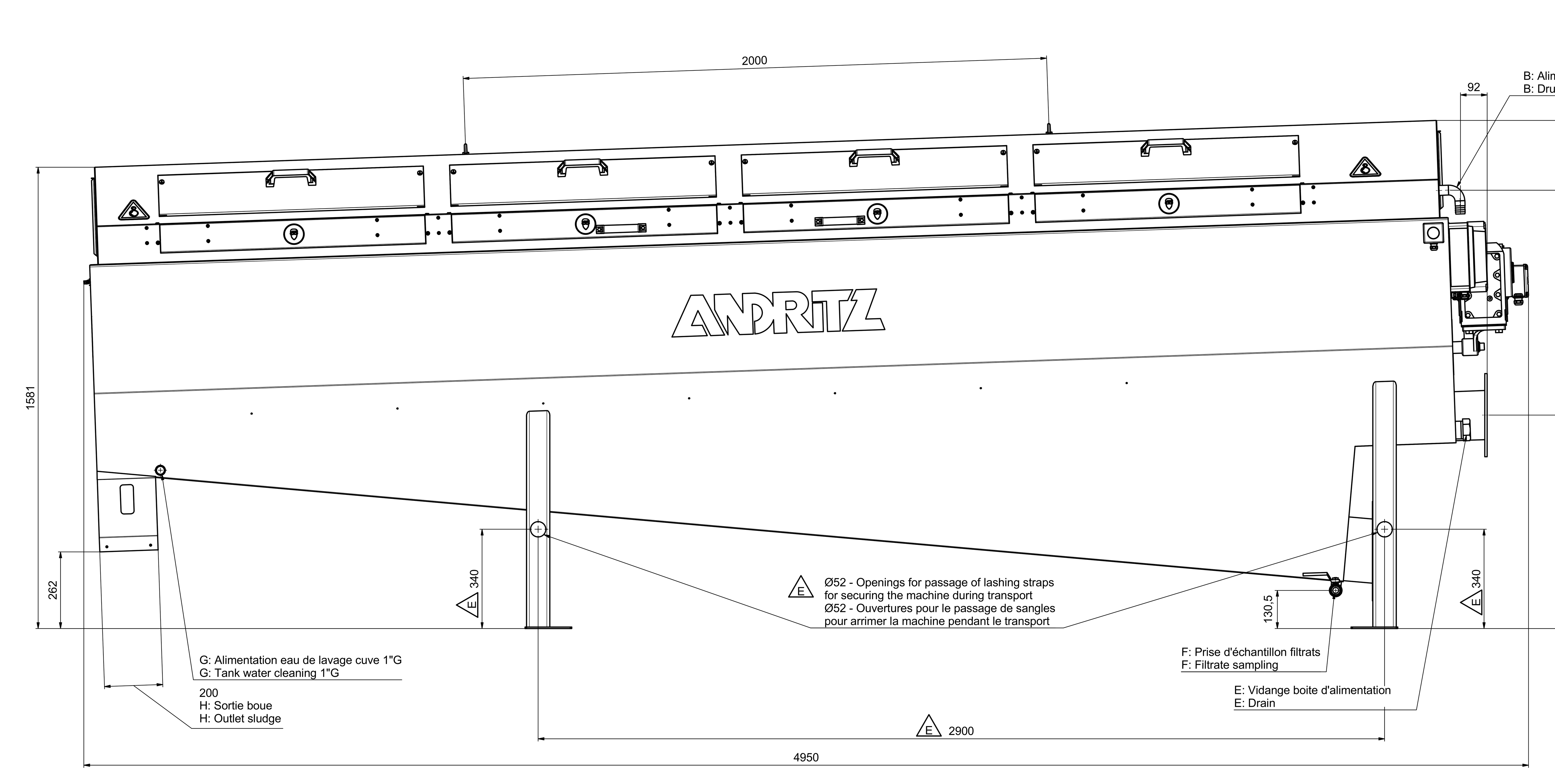


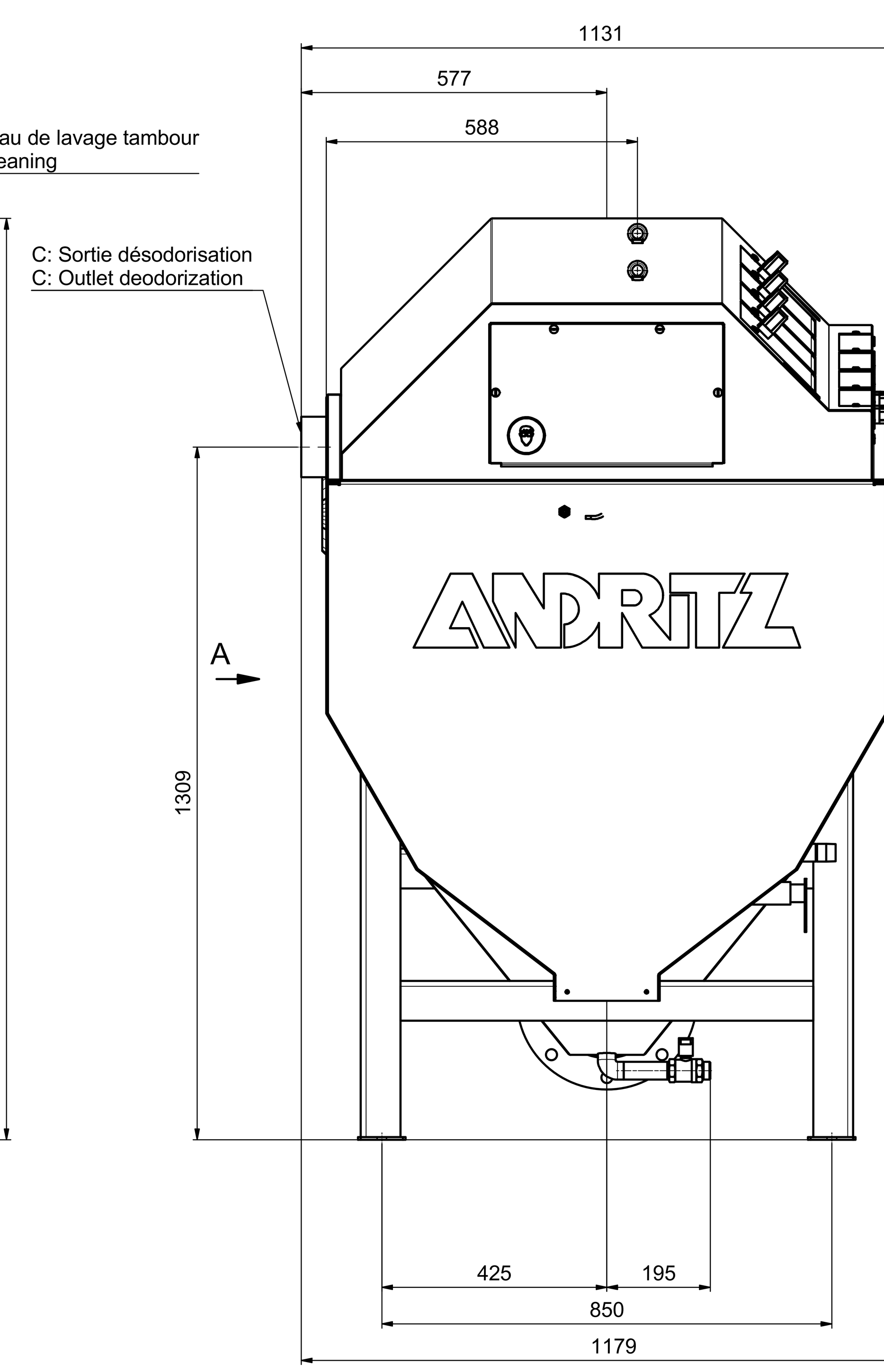

| TYPE | Flow Min. m3/h | Flow Max. m3/h | Dimensions (L/w/h) | Connection | Polymer connection | Weight (kg) |
|---|---|---|---|---|---|---|
| 10" VENTURI | 91 | 275 | 560x450x500 | ISO DN250 PN10 | G1" Female threaded | 40 |

*Table 3*

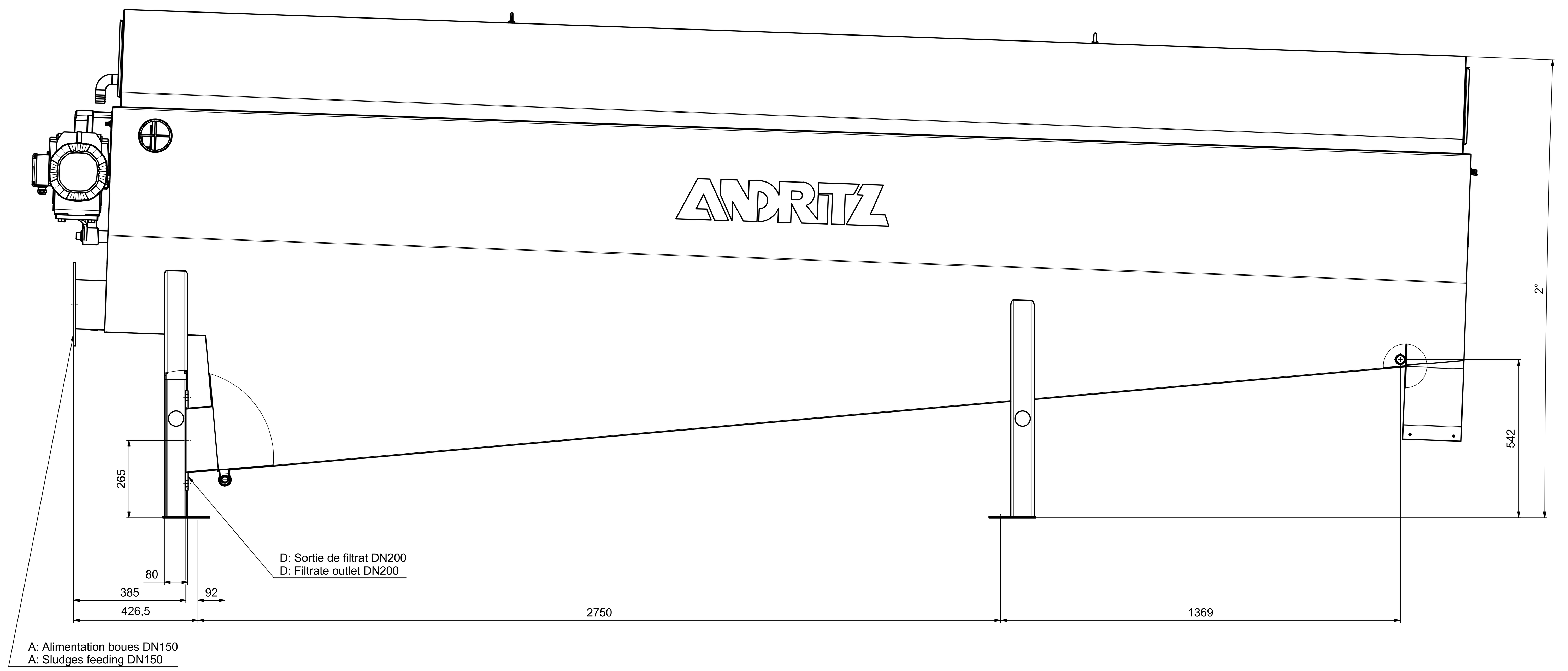
* Head loss: 0,5 to 1 bar.

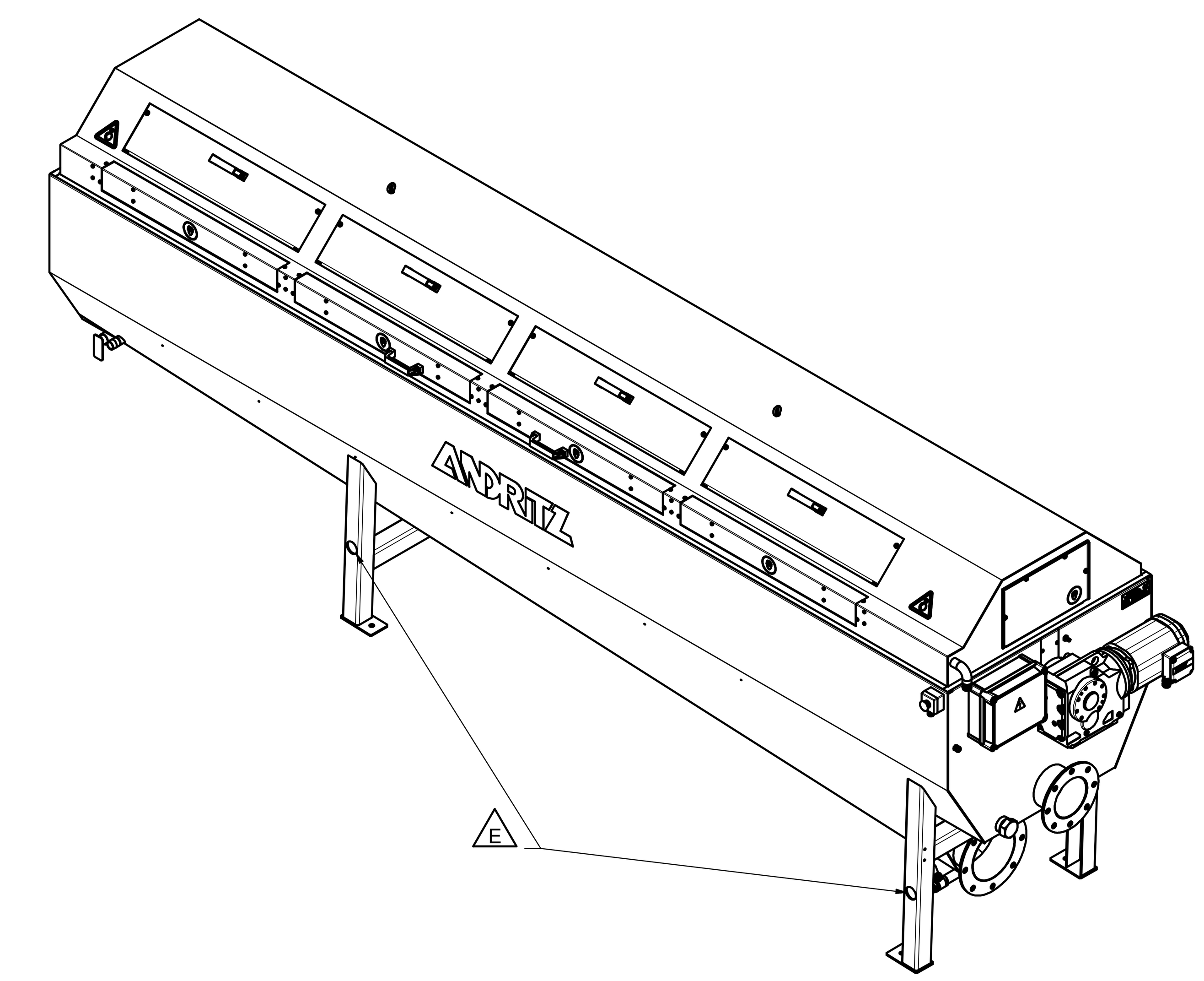
** The Venturi Mixer needs to be located 5 meters away from headbox or closer but the efficiency will be lowered. Two locations must be considered on the pipe (5 and 10 meters away) according to sludge and polymer rate.



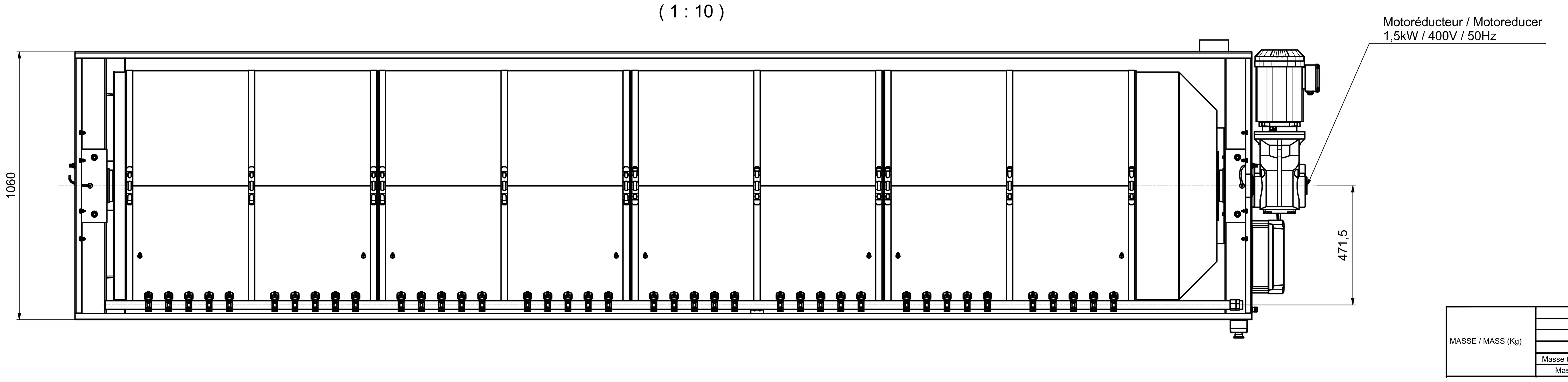




View A
( 1 : 8 )



Without cover / Sans couverture
( 1 : 10 )




| Ø (mm) | Tightening torque / Couple de serrage (N*m) |
|---|---|
| M4 | 2 |
| M6 | 7 |
| M8 | 17 |
| M12 | 57 |
| M16 | 140 |

**TOLERANCES UNLESS OTHERWISE NOTED** — DIMENSIONAL TOLERANCING in Millimeters

| Machined | Raw | Oxyfuel flame cutting | Welding | Casting |
|---|---|---|---|---|
| ISO 2768 mK-E | ISO 2768 cK-E | ISO 9013-341 | ISO 13920 - BAE | ISO 8062-3 - DCTG 8<br>ISO 8062-3 - GCTG 6 |

| GENERAL TOLERANCES LINEAR DIMENSIONS | Nominal measure | >0.5 ≤3 | >3 ≤6 | >6 ≤30 | >30 ≤120 | >120 ≤400 | >400 ≤1000 | >1000 ≤2000 | >2000 ≤4000 | >4000 ≤8000 | >8000 ≤12000 | >12000 ≤16000 | >16000 ≤20000 | >20000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - Welding | ISO13920-BAE | ± 1 | ± 1 | ± 1 | ± 2 | ± 2 | ± 3 | ± 4 | ± 6 | ± 8 | ± 10 | ± 12 | ± 14 | ± 16 |
| - Machining | ISO 2768-m | ± 0.1 | ± 0.1 | ± 0.2 | ± 0.3 | ± 0.5 | ± 0.8 | ± 1.2 | ± 2 | ± 3 | ± 4 | ± 5 | ± 6 | – |
| - Chamfers and radius | ISO 2768-m | ± 0.2 | ± 0.5 | ± 1.0 | | | | | | | | | | |
| - Raw, cutting, bending | ISO 2768-c | ± 0.2 | ± 0.3 | ± 0.5 | ± 0.8 | ± 1.2 | ± 2 | ± 3 | ± 4 | ± 5 | ± 6 | ± 7 | ± 8 | – |

EDGES by ISO 13715 (-0,3 / +0,3); 3.2 Non specified machinings

**ANGULAR DIMENSIONS**
- Welding ISO13920-BAE
- Machining ISO 2768-m
- Cutting / - Raw / - Bending: ISO 2768-c s<4; ISO 2768-v s>4

**SYMBOLS**
- Surface roughness ISO 1302-Ra
- Welding symbols ISO 2553
- Tolerancing ISO 8015

**GEOMETRICALTOLERANCES**
- Symbols ISO 1101
- Welding ISO 13920-BAE
- Machining & Raw ISO 2768-K

**REFERENCE DRAW. NUMBER**

Nota:
- Pour tout appareil installé sur un support supérieur à 600mm, une plateforme avec garde corps devra être installé pour l'exploitation et la maintenance de la machine

Note:
- For all machine installed on a base upper than 600mm, a platform with guardrail has to be installed for operation and machine maintenance

| SAP Material / Item name | AMC | Basic material name | Basic material standard |
|---|---|---|---|
| 202819640 | 1050 00 01 000 | 1.4306 | EN10028-7 |
| 202819539 | 1000 00 01 000 | 1.4404 | EN10028-7 |

| | | | | | |
|---|---|---|---|---|---|
| A | Alimentation boues | Sludges feeding | DN150 | Bride | Flange |
| B | Alimentation eau de lavage tambour | Drum water cleaning | Ø1"G mâle | Fileté mâle | Male thread |
| C | Désodorisation | Deodorization | Ø114.3 ext. | Tube lisse | Pipe |
| D | Sortie filtrats | Filtrate outlet | DN200 | Bride | Flange |
| E | Vidange boite d'alimentation | Drain | 2"G mâle | Fileté mâle | Male thread |
| F | Prise d'échantillon filtrats | Filtrate sampling | Ø1"G femelle | Fileté femelle | Female thread |
| G | Alimentation eau de lavage cuve | Tank water cleaning | Ø1"G mâle | Fileté mâle | Male thread |
| H | Sortie Boue | Outlet sludge | 200 x 200 | Jupe | Skirt |

| MASSE / MASS (Kg) | | |
|---|---|---|
| | Capot + rampe de lavage / Cover + washing ramp | 232 |
| | Tambour + moteur / Drum + motor | 387 |
| | Cuve / Tank | 416 |
| | | |
| | Masse totale version standard / Total mass in standard version | 936 |
| | Masse totale en tout options / Total mass in full options | 946 |

Product Type: PDR900XL
Product Code:

| | Initial Revision | | | Actual Revision | | |
|---|---|---|---|---|---|---|
| Drawn | M.Placko | spimat01 | 24.08.2016 | T.Blanchard | chathi01 | 11.06.2018 |
| Checked | F.Gerome | chaflo01 | 26.08.2016 | F.Danjoux | chafab03 | 13.06.2018 |

Revision: Added passages for lashing straps

Replacement for Drawing No — Rev
Copy from Drawing No — Rev
Old Drawing No: 54047 — Rev: 3

Description:

# DRUM THICKENER

# TAMBOUR EGOUTTEUR

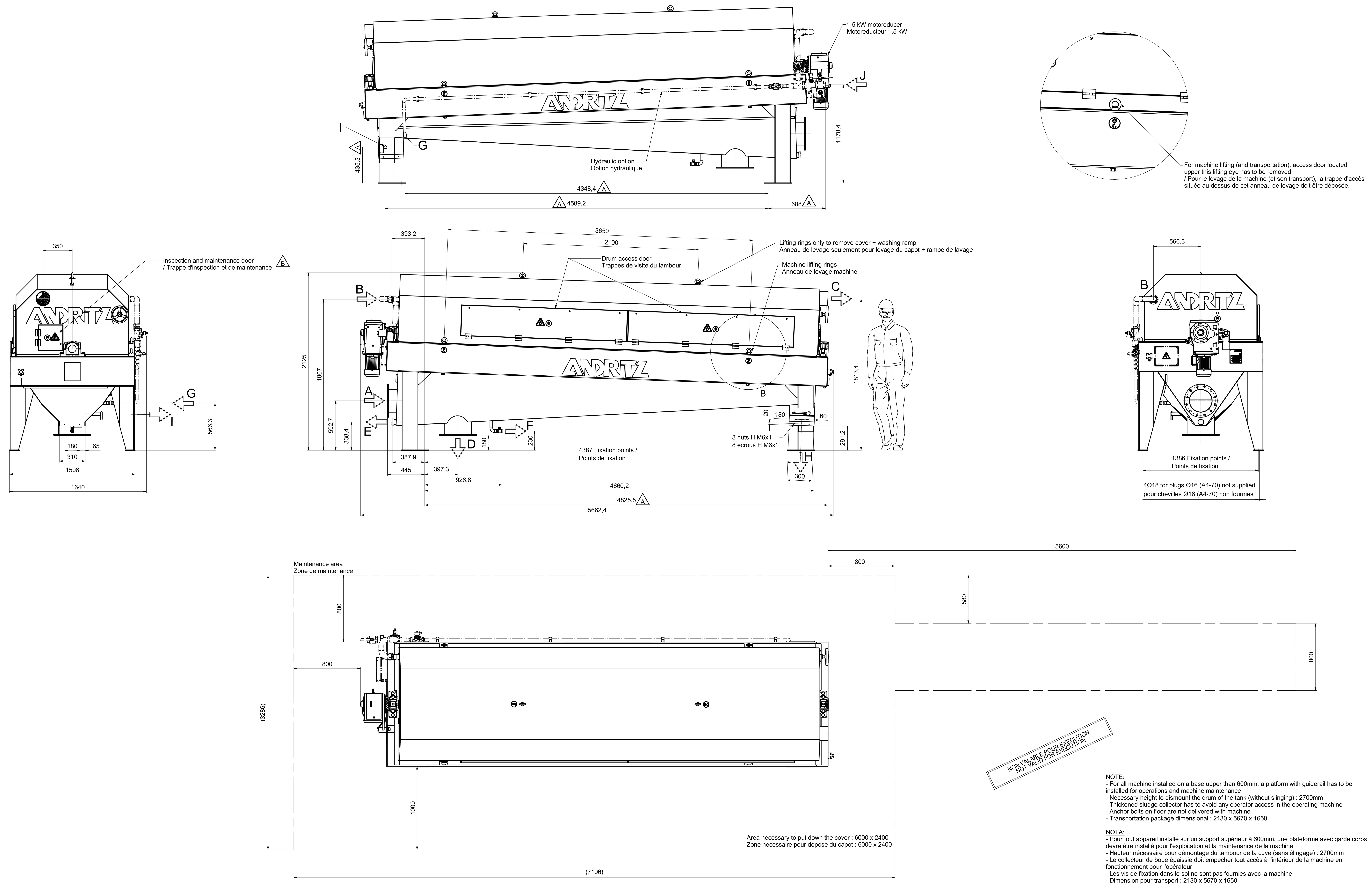
Drawing No: 702712905 — Rev: E

| Size | Sheet/Sheets | Scale |
|---|---|---|
| A0 | 1 / 1 | 1 : 8 |

ANDRITZ

Filename: as-m-machine___-526-000000-2400005000-drum thic_-61971201476.idw
VAULT Database: SE_ITEM_001
Ver.: 2.0

Drawing sheet ISO 5457:1999 - A0




NOTE:
- For all machine installed on a base upper than 600mm, a platform with guiderail has to be installed for operations and machine maintenance
- Necessary height to dismount the drum of the tank (without slinging) : 2700mm
- Thickened sludge collector has to avoid any operator access in the operating machine
- Anchor bolts on floor are not delivered with machine
- Transportation package dimensional : 2130 x 5670 x 1650

NOTA:
- Pour tout appareil installé sur un support supérieur à 600mm, une plateforme avec garde corps devra être installé pour l'exploitation et la maintenance de la machine
- Hauteur nécessaire pour démontage du tambour de la cuve (sans élingage) : 2700mm
- Le collecteur de boue épaissie doit empecher tout accès à l'intérieur de la machine en fonctionnement pour l'opérateur
- Les vis de fixation dans le sol ne sont pas fournies avec la machine
- Dimension pour transport : 2130 x 5670 x 1650

| | | |
|---|---|---|
| Masse / Mass (Kg) | Capot + rampe de lavage / Cover + washing ramp | 510 |
| | Tambour + moteur / Drum + motor | 895 |
| | Cuve / Tank | 930 |
| | Masse totale version standard / Total mass in standard version | 2330 |
| | Masse totale en toutes options / Total mass in full options | 2360 |
| | Masse maxi en charge / Max operating mass | 3050 |

| | | | |
|---|---|---|---|
| A | Alimentation boues | Sludges feeding | DN 250 |
| B | Alimentation eau de lavage tambour | Inlet water for drum cleaning | ISO7 R2" |
| C | Désodorisation | Deodorization | Ø168,3 |
| D | Sortie filtrats | Filtrate outlet | DN 300 |
| E | Vidange boite alimentation | Inlet box drain | ISO7 R2" |
| F | Prise échantillon filtrats | Filtrate sampling | ISO7 R1" |
| G | Alimentation eau lavage cuve | Inlet water for tank cleaning | ISO7 R1" |
| H | Sortie boue | Sludge sampling | 300 x 310 |
| I | Prise échantillon boue | Sludge filtrate | Ø33,7 |
| J | Option hydraulique :<br>Alimentation eau de lavage tambour + cuve | Hydraulic option:<br>Inlet water for drum and tank cleaning | ISO7 R2" |

| | | | | | | |
|---|---|---|---|---|---|---|
| Product Type: PDR 1200 | | | | Product Code | | |
| | Initial Revision | | | Actual Revision | | |
| Drawn | C.Boutet | chachr11 | 10.10.2018 | F.Danjoux | chafab03 | 27.09.2019 |
| Checked | F.Danjoux | chafab03 | 07.11.2018 | C.Boutet | chachr11 | 27.09.2019 |
| Revision | ADD INSPECTION HOLE ON COVER FLANGE | | | | | |

Replacement for Drawing No — Rev
Copy from Drawing No — Rev
Old Drawing No — Rev

Description

# DRUM THICKENER
PDR 1200

# TAMBOUR EGOUTTEUR
PDR 1200

Drawing No: 702906657 Rev: C

| Size | Sheet/Sheets | Scale |
|---|---|---|
| A0 | 1 / 1 | 1 : 10 |

ANDRITZ

Filename: ly-m-machine___-530-000000-5500005000-drum thic_-81790921501.idw

VAULT Database: SE_ITEM_001

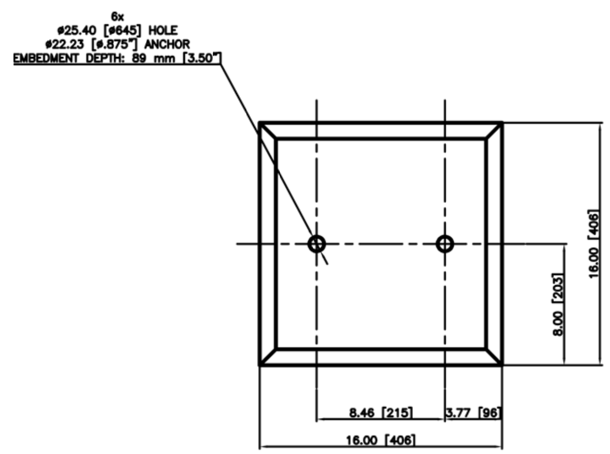
Ver.: 2.0

Drawing sheet ISO 5457:1999 - A0

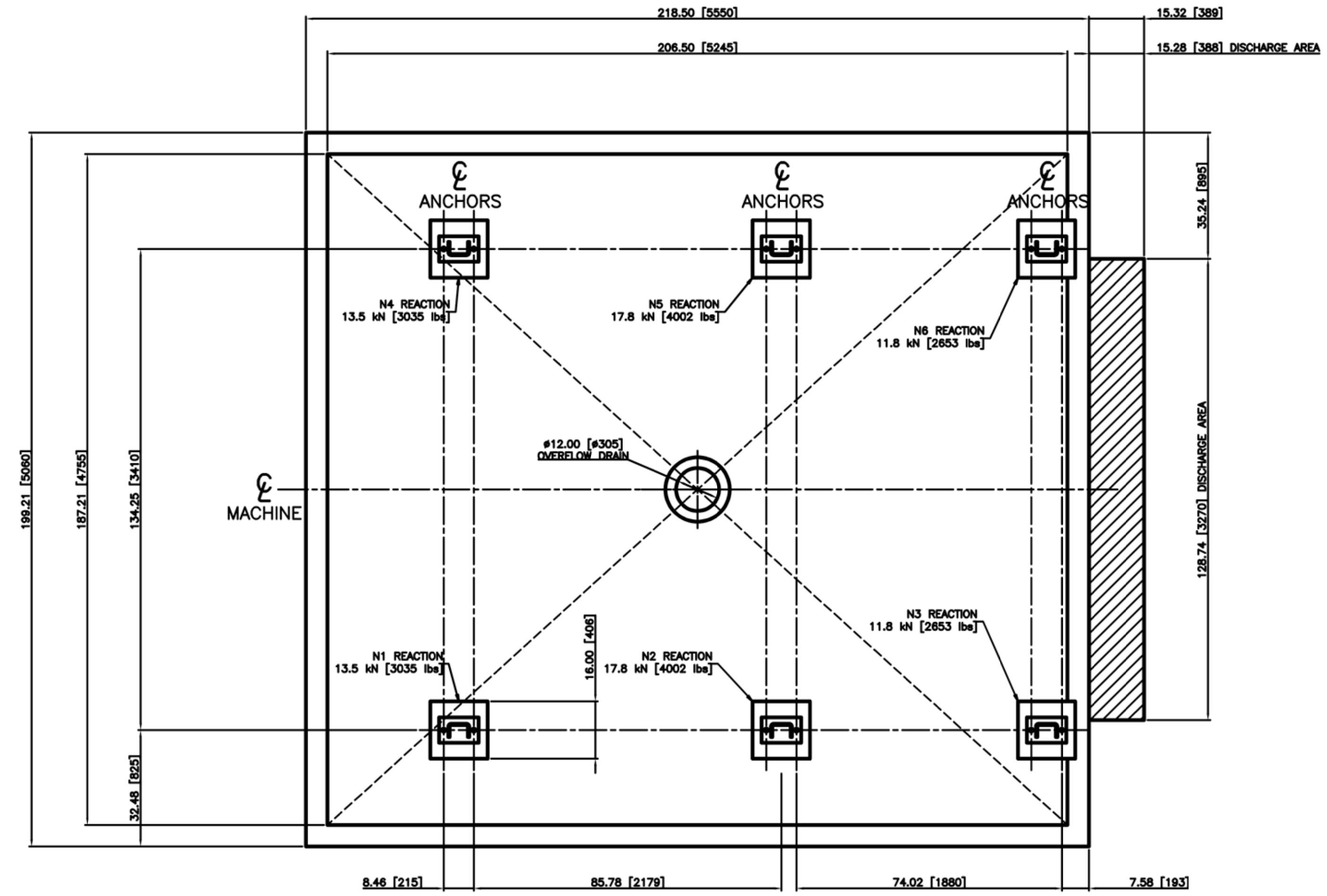
Status: Released

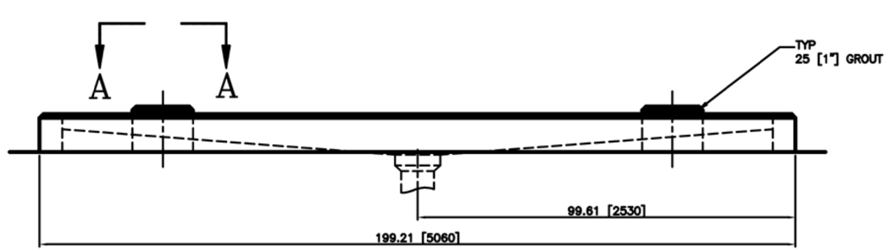
**NOTE:**

1. THE FOUNDATION DESIGN INDICATES MINIMUM REQUIREMENTS FOR CLEARANCE AND DRAINAGE. ACTUAL FOUNDATION DESIGN AND CONSTRUCTION TO BE FURNISHED BY OTHER THAN ANDIRTZ.
2. MACHINE MUST BE LEVEL TO WITHIN 1/16 INCH.
3. ALL PIPING ATTACHED TO THE EQUIPMENT MUST BE SELF SUPPORTED. ALL SUPPORTS BY OTHER THAN ANDRITZ.
4. ALL DIMENSIONS ARE PRELIMINARY.
5. MINIMUM UTILITIES REQUIRED:
   - 5.1. ELECTRICAL:
     - 5.1.1. MAIN MOTOR: 5 HP – 460V/3PH/60HZ
   - 5.2. WASH WATER – 69 GAL/MIN AT AMBIENT TEMPERATURE AND 120 PSIG FILTERED TO 200 MICRONS.
   - 5.3. AIR: 4 CFM AT 100 PSIG
6. DRY WEIGHT OF THE MACHINE: 6,249 kg [13,781 LBS]
7. WET WEIGHT OF THE MACHINE: 6,877 kg [19,100 LBS]

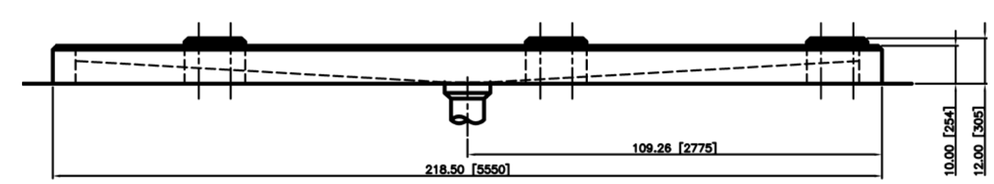



VIEW A–A
SCALE 1:4




END ELEVATION

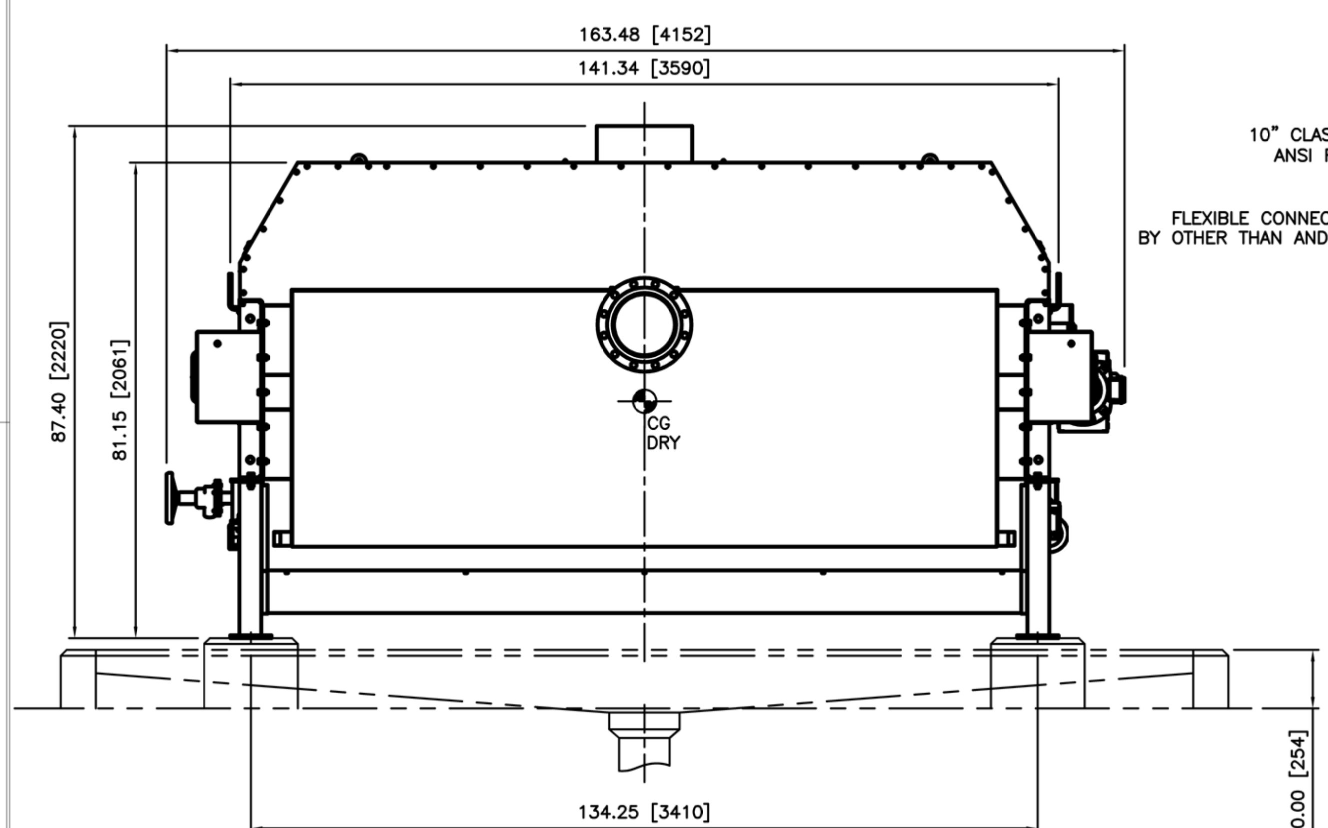



SIDE ELEVATION

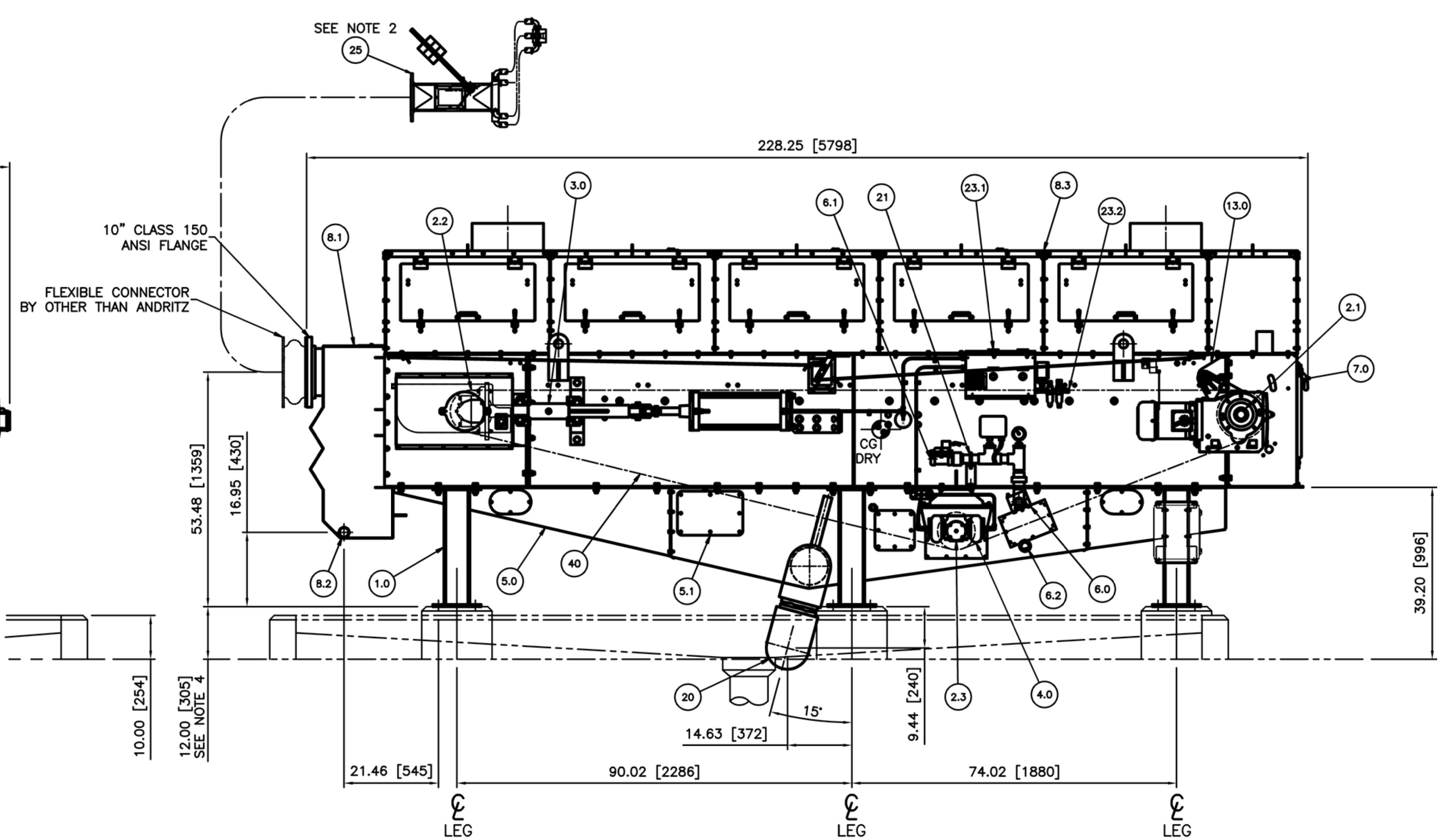


| | | | | |
|---|---|---|---|---|
| ESTIMATED WEIGHT IN LBS: – | DRAWN BY: QG | DATE 12/14/18 | ANDRITZ | TITLE 3.0m GBT GENERAL ARRANGEMENT GBT FOUNDATION DETAILS |
| UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES WITH MILLIMETERS IN [ ] | CHECKED BY: | DATE | ANDRITZ SEPARATION, INC. 1010 COMMERCIAL BLVD. SOUTH ARLINGTON, TEXAS 76001 | SIZE E · DRAWING NUMBER DMF1514 · REV 0 |
| | APPROVED BY: JB | DATE 12/14/18 | PHONE: (817) 465-5611 | SCALE 1/16 · FILE DMF1514 · SHEET 1 OF 1 |
| | THIRD ANGLE PROJECTION | | | |

1.0 FRAME ASSEMBLY
2.0 ROLL ASSEMBLY
  2.1 DRIVE ROLL ASSEMBLY
  2.2 DEFLECTION ROLL ASSEMBLY
  2.3 TRACKING ROLL ASSEMBLY
3.0 BELT TENSION ASSEMBLY
4.0 TRACKING ASSEMBLY
5.0 FILTRATE PAN ASSEMBLY
  5.1 BELT ACCESS PANELS
6.0 SHOWER ASSEMBLY
  6.1 SHOWER WATER INLET, 2" FNPT
  6.2 SHOWER WATER DRAIN CONNECTION, BOTH SIDES, 2" MNPT
7.0 BELT DOCTOR ASSEMBLY
8.0 HEADBOX ASSEMBLY
  8.1 RETENTION TANK
  8.2 RETENTION TANK DRAIN, BOTH SIDES, 2" MNPT
  8.3 ODOR CONTROL HOOD
10.0 GRID ASSEMBLY (NOT SHOWN)
13.0 DRIVE ASSEMBLY
15.0 PLOW ASSEMBLY (NOT SHOWN)
20.0 FILTRATE DRAIN (BOTH SIDES)
21.0 SHOWER INLET PIPING, DRIVE SIDE
23.0 PNEUMATIC COMPONENTS
  23.1 PNEUMATIC CONTROL CONSOLE
  23.2 INLET AIR CONNECTION
25.0 VENTURI MIXER ASSEMBLY
40.0 BELT




INLET END VIEW
DISCHARGE HOPPER NOT SHOWN




NOTES:

1. FINAL ROUTING OF SLUDGE FEED PIPING BY OTHERS. SLUDGE FEED PIPING IS TO BE SUPPORTED BY OTHERS. FLEXIBLE CONNECTION MUST BE INSTALLED TO ISOLATE MACHINE FROM PIPING MOVEMENT. SLUDGE FEED PIPING AND FLEXIBLE CONNECTION TO BE SUPPLIED BY OTHERS.
2. VENTURI MIXER SHOULD BE LOCATED APPROXIMATELY 15 FEET FROM THE INLET FLANGE. PROVISIONS SHOULD BE MADE FOR ALTERNATE DISTANCES OF 30 FEET AND 45 FEET.
3. FOUNDATION DETAILS SHOWN ON DRAWING DMF1514.
4. RH MACHINE AS SHOWN. LH OPPOSITE AS SHOWN.



| | | |
|---|---|---|
| ESTIMATED WEIGHT IN LBS: – | DRAWN BY: QG | DATE 12/14/18 |
| UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES WITH MILLIMETERS IN [ ] | CHECKED BY: | DATE |
| | APPROVED BY: JB | DATE 12/14/18 |
| | THIRD ANGLE PROJECTION | |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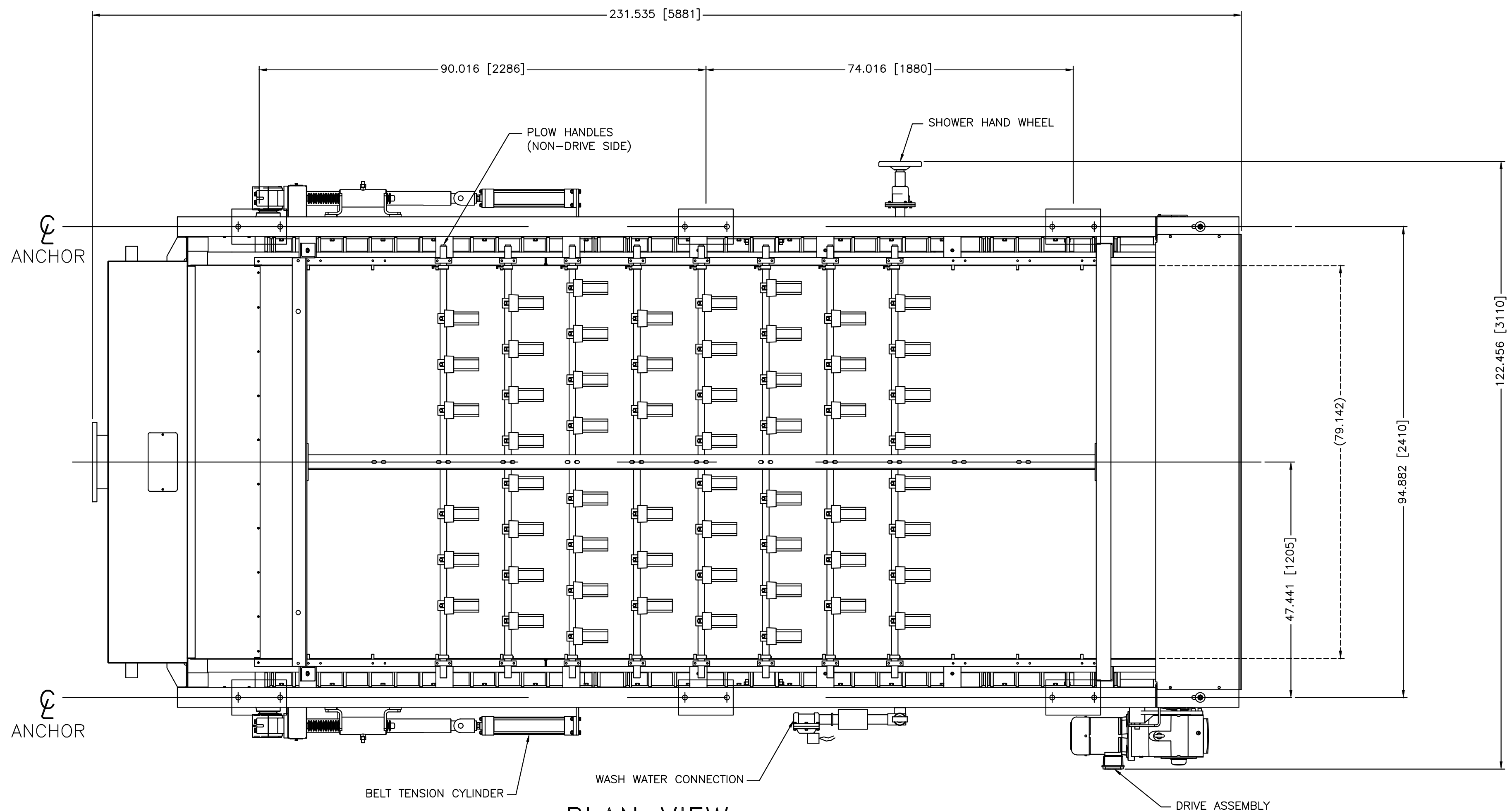
TITLE 3.0m GBT
GENERAL ARRANGEMENT
GBT ELEVATION VIEW

| SIZE | DRAWING NUMBER | REV |
|---|---|---|
| D | DMA2787 | 0 |
| SCALE 1/16 | FILE DMA2787 | SHEET 1 OF 1 |




PLAN VIEW

FOR REVIEW
NOT FOR CONSTRUCTION

AST No.–

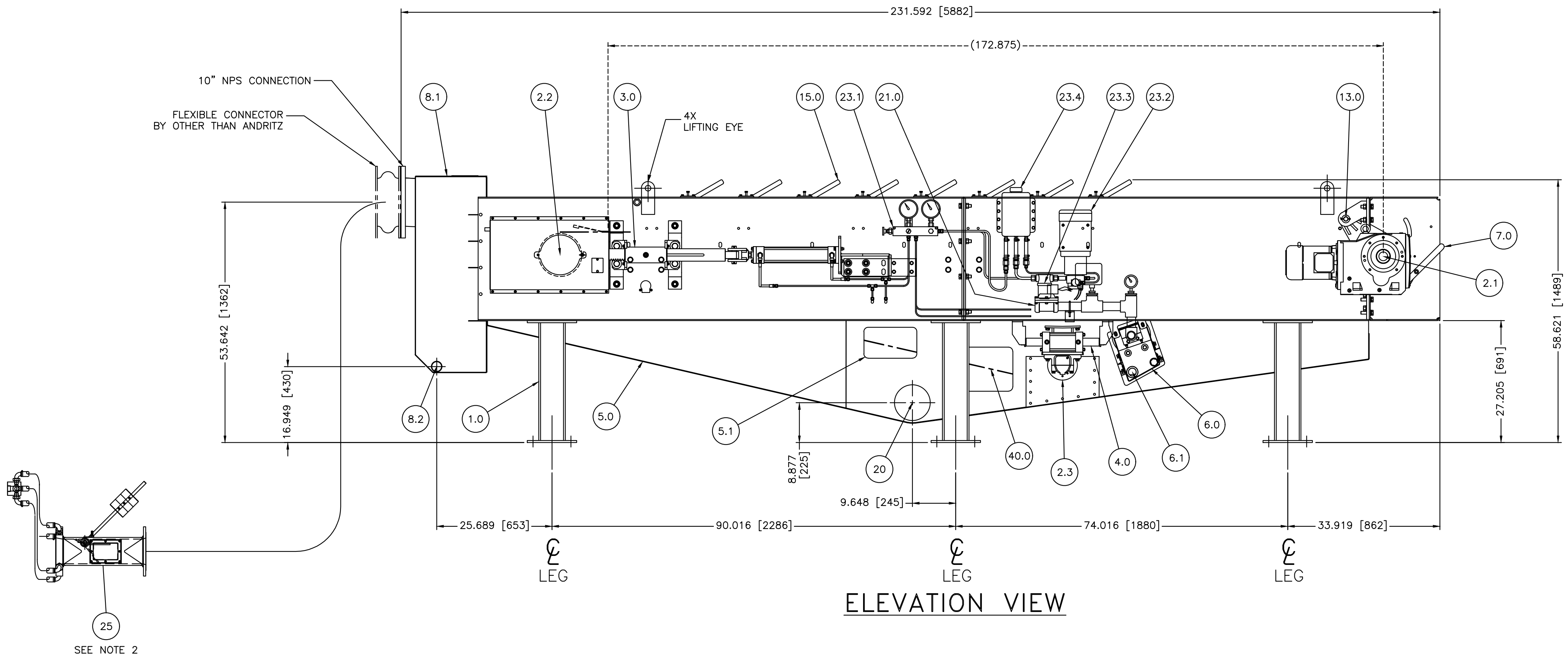
| | | | | |
|---|---|---|---|---|
| ESTIMATED WEIGHT IN LBS: – | DRAWN BY: QG | DATE 03/11/20 | ANDRITZ | TITLE 2.0m QUANTUM GBT GENERAL ARRANGEMENT |
| UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES | CHECKED BY: | DATE | ANDRITZ SEPARATION, INC. 1010 COMMERCIAL BLVD. SOUTH ARLINGTON, TEXAS 76001 PHONE: (817) 465-5611 | SIZE D · DRAWING NUMBER DMA2819 · REV 0 |
| FABRICATION TOLERANCES .XXX±.040 ANG±1° HOLE±.020 | APPROVED BY: KN | DATE 03/16/20 | | SCALE 1/16 · FILE DMA2819 · SHEET 2 OF 2 |
| MACHINING TOLERANCES .XXX±.005 ANG±.5° HOLE±.020 | THIRD ANGLE PROJECTION | | | |
| MILL FINISH ALL OVER | | | | |

1.0 FRAME ASSEMBLY
2.0 ROLL ASSEMBLY
2.1 DRIVE ROLL ASSEMBLY
2.2 TENSION ROLL ASSEMBLY
2.3 TRACKING ROLL ASSEMBLY
3.0 BELT TENSION ASSEMBLY
4.0* TRACKING ASSEMBLY
5.0 FILTRATE PAN ASSEMBLY
5.1 BELT ACCESS WINDOWS
6.0* SHOWER ASSEMBLY
6.1 SHOWER WATER DRAIN CONNECTION, BOTH SIDES, 2" MNPT.
7.0* BELT DOCTOR ASSEMBLY
8.0 HEADBOX ASSEMBLY
8.1 RETENTION TANK
8.2 RETENTION TANK DRAIN, 2" MNPT, BOTH SIDES
10.0 GRID ASSEMBLY (NOT SHOWN)
13.0* DRIVE ASSEMBLY
15.0 PLOW ASSEMBLY
15.1* PLOW HANDLES (NOT SHOWN)
20.0 FILTRATE DRAIN, ø8" O.D. (BOTH SIDES)
21.0* SHOWER INLET PIPING, 2" FNPT, DRIVE SIDE
23.0* HYDRAULIC COMPONENTS
23.1 HYDRAULIC MANIFOLD
23.2 MOTOR/PUMP
23.3 FILTER
23.4 RESERVOIR
25.0 VENTURI MIXER ASSEMBLY
40.0 BELT

* ITEMS MARKED WITH AN * CHANGE SIDES WITH MACHINE HANDINESS.

MINIMUM UTILITIES REQUIRED:

1. ELECTRICAL:
1.1. MAIN MOTOR: 3 HP – 480V/3PH/60HZ
1.2. HYDRAULIC PUMP MOTOR: 1 HP – 480V/3PH/60HZ
2. WATER:
2.1. WASH WATER: 69 GAL/MIN [262 L/MIN] AT AMBIENT TEMPERATURE AND 120 PSIG [828 kPA]. FILTERED TO 200 MICRONS.
3. DRY WEIGHT OF THE MACHINE: 11,030 LBS [5,000 kg]
4. WET WEIGHT OF THE MACHINE: 12,130 LBS [5,500 kg]




ELEVATION VIEW

NOTES:

1. FINAL ROUTING OF SLUDGE FEED PIPING BY OTHERS. SLUDGE FEED PIPING IS TO BE SUPPORTED BY OTHERS. FLEXIBLE CONNECTION MUST BE INSTALLED TO ISOLATE MACHINE FROM PIPING MOVEMENT. SLUDGE FEED PIPING AND FLEXIBLE CONNECTION TO BE SUPPLIED BY OTHERS.
2. VENTURI MIXER LOCATED APPROXIMATELY 15 FEET UPSTREAM FROM THE INLET FLANGE. PROVISIONS (SPOOL PIECES) SHOULD BE MADE IN THE SUPPLY PIPING FOR ALTERNATE DISTANCES OF 30 FEET AND 45 FEET.
3. FILTRATE DRAIN PIPING INSTALLATION BY OTHER THAN ANDRITZ.
4. HEIGHT WILL VARY ACCORDING TO THICKENED SLUDGE HANDLING EQUIPMENT. FOUNDATION DETAILS SHOWN ON DRAWING DMF1522.
5. MAINTENANCE PLATFORM BY OTHER THAN ANDRITZ. RECOMMENDED TOP OF GRATING TO BE LEVEL WITH TOP OF FOUNDATION PIERS.
6. RH MACHINE AS SHOWN. LH MACHINE OPPOSITE AS SHOWN.



SIMILAR TO DMA2808

FOR REVIEW
NOT FOR CONSTRUCTION

AST No.–

| | | |
|---|---|---|
| ESTIMATED WEIGHT IN LBS: – | DRAWN BY: QG | DATE 03/11/20 |
| UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES | CHECKED BY: | DATE |
| FABRICATION TOLERANCES .XXX±.040 ANG±1° HOLE±.020 | APPROVED BY: KN | DATE 03/16/20 |
| MACHINING TOLERANCES .XXX±.005 ANG±.5° HOLE±.020 | THIRD ANGLE PROJECTION | |
| MILL FINISH ALL OVER | | |

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| | | | |
|---|---|---|---|
| TITLE | 2.0m QUANTUM GBT GENERAL ARRANGEMENT | | |
| SIZE D | DRAWING NUMBER DMA2819 | | REV 0 |
| SCALE 1/16 | FILE DMA2819 | SHEET 1 OF 2 | |

# Appendix C. Capital Cost Estimates

## NEW Water
## Green Bay Facility and De Pere Facility
## Facility Plan

## OPCC

| Thickening Alternatives | Equipment | Number of Units |
|---|---|---|
| 1a, 2a, 3a, 3b | 2M GBT | 5 |
| 1a, 2a, 3a, 3b | RDT | 5 |
| 1b, 2b | RDT | 6 |

| Gravity Thickener Rehabilitation | Equipment | Number of Units |
|---|---|---|
| Alternative 1 | GVT | 2 |
| Alternative 2 | GVT | 4 |

| Thickened Well Modifications | Equipment | Number of Units |
|---|---|---|
| Alternative 1 | | |

| Construction Cost | Project Cost |
|---|---|
| $5,455,000 | $6,819,000 |
| $5,230,000 | $6,538,000 |
| $6,227,000 | $7,784,000 |

| Construction Cost | Project Cost |
|---|---|
| $3,365,000 | $4,206,000 |
| $6,683,000 | $8,354,000 |

| Construction Cost | Project Cost |
|---|---|
| $1,142,000 | $1,428,000 |

| Package |
|---|
| Package 1a |
| Package 1b |
| Package 2a |
| Package 2b |
| Package 3a |
| Package 3b |
| |
| Additional Package 1 |
| Additional Package 2 |
| Additional Package 3 |

**Project Costs**

| -15% | +25% | OPCC |
|---|---|---|
| $5,676,725.00 | $8,348,125.00 | $6,678,500.00 |
| $6,616,400.00 | $9,730,000.00 | $7,784,000.00 |
| $5,676,725.00 | $8,348,125.00 | $6,678,500.00 |
| $6,616,400.00 | $9,730,000.00 | $7,784,000.00 |
| $5,676,725.00 | $8,348,125.00 | $6,678,500.00 |
| $5,676,725.00 | $8,348,125.00 | $6,678,500.00 |
| | | |
| $3,575,100.00 | $5,257,500.00 | $4,206,000 |
| $7,100,900.00 | $10,442,500.00 | $8,354,000 |
| $1,213,800.00 | $1,785,000.00 | $1,428,000 |

Package 1a, 3a, 3b
Additional Package 1
Additional Package 3
Total Thickening Infrastructure Package

| | |
|---|---|
| Contractor Overhead and Profit | 25% |
| Contingency | 50% |
| Engineering | 25% |

| Quantity Estimate | Units | Rate | | Notes |
|---|---|---|---|---|
| *Sitework* | | | | |
| Sitework for buildings | SF | $ | - | |
| Excavation | CY | $ | - | |
| Backfill | CY | $ | - | |
| | CY | $ | - | |
| | SF | $ | - | |
| *Steel and Concrete* | | | | |
| Building Cost "large" | SF | $ | - | Approximat |
| Building Cost "small" | SF | $ | - | Approximat |
| | CY | $ | - | |
| | SF | $ | - | |
| *Equipment* | | | | |
| | EA | $ | - | |
| | EA | $ | - | |
| | EA | $ | - | |
| | EA | $ | - | |

te cost per SF
te cost per SF

**NEW Water**
**Green Bay Facility and De Pere Facility**
**Facility Plan**

**Base Costs**
**OPCC**

| | Qtny | Units | Rate |
|---|---|---|---|
| *Demolition* | | | |
| Demo GBTs and Centrifuge | 4 | EA | $ 45,000 |
| Demo Thickening Feed Pumps | 3 | EA | $ 25,000 |
| Demo GBT/Centrifuge Platforms and Stairways | 1 | LS | $ 20,000 |
| *Concrete* | | | |
| GBT Equipment Curbs | | EA | $ 5,000 |
| RDT Pads | | EA | $ 2,500 |
| Centrifugal Pump Pads | | EA | $ 2,500 |
| *Metals* | | | |
| GBT Platform - 5 GBTs | 1,500 | SF | $ 95 |
| RDT Platform - 6 RDTs | 3,000 | SF | $ 95 |
| RDT Platform - 5 RDTs | 2,500 | SF | $ 95 |
| GBT Odor Management | 1 | LS | $ 45,000 |
| RDT Odor Management | 1 | LS | $ 25,000 |
| *Mechanical* | | | |
| *Equipment* | | | |
| Primary Feed Pump - Centrifugal | | EA | $ 50,000 |
| Thickening Feed Pump - Centrifugal | | EA | $ 50,000 |

| Cost | | Notes | |
|---|---|---|---|
| | | | |
| $ | 180,000 | All demo costs are swags | |
| $ | 75,000 | | |
| $ | 20,000 | | |
| | | | |
| $ | - | Assume 1-foot tall curb 6" wide, cost from O'Brien | |
| $ | - | Assume 6" pad, cost from O'Brien (with increase), 7 pumps | |
| $ | - | Assume 6" pad, cost from O'Brien (with increase), 7 pumps | |
| | | | |
| $ | 142,500 | 5 - 2.0 GBTs | Platform cost from Glenbard, includes handrails |
| $ | 285,000 | 6 RDTs | Platform cost from Glenbard, includes handrails |
| $ | 237,500 | 5 RDTs | Platform cost from Glenbard, includes handrails |
| $ | 45,000 | swag | |
| $ | 25,000 | swag | |
| | | | |
| | | | |
| $ | - | Cost from Escanaba | |
| $ | - | 500-700 gpm per pump, cost from Escanaba | |

**NEW Water**
**Green Bay Facility and De Pere Facility**
**Facility Plan**

**Package 1 Five 2M GBT**
**OPCC**

| | Qtny | Units | Rate | | Cost |
|---|---|---|---|---|---|
| *Demolition* | | | | | |
| Demo GBTs and Centrifuge | 4 | EA | $ 45,000 | $ | 180,000 |
| Demo Thickening Feed Pumps | 3 | EA | $ 25,000 | $ | 75,000 |
| Demo GBT/Centrifuge Platforms and Stairways | 1 | LS | $ 20,000 | $ | 20,000 |
| Total | | | | **$** | **275,000** |
| *Concrete* | | | | | |
| GBT Equipment Curbs | 5 | EA | $ 5,000 | $ | 25,000 |
| Centrifugal Pump Pads | 4 | EA | $ 2,500 | $ | 10,000 |
| Total | | | | **$** | **35,000** |
| *Metals* | | | | | |
| GBT Platform - 5 GBTs | 1,500 | SF | $ 95 | $ | 142,500 |
| GBT Odor Management | 1 | LS | $ 45,000 | $ | 45,000 |
| Total | | | | **$** | **187,500** |
| *Mechanical* | | | | | |
| Total | | | | **$** | - |
| *Equipment* | | | | | |
| Thickening Feed Pump - Centrifugal | 4 | EA | $ 50,000 | $ | 200,000 |
| 2M GBT | 5 | EA | $ 225,000 | $ | 1,125,000 |
| Install | | | 30% | $ | 397,500 |
| Subtotal | | | | $ | 1,722,500 |
| Mechanical | | | 20% | $ | 344,500 |
| Electrical & I&C | | | 20% | $ | 344,500 |
| Total | | | | **$** | **2,411,500** |
| Subtotal | | | | **$** | **2,909,000** |
| Contractor Overhead and Profit | | | 25% | $ | 727,300 |
| Subtotal | | | | $ | 3,636,300 |
| Contingency | | | 50% | $ | 1,818,200 |
| **Total Construction Cost** | | | | **$** | **5,455,000** |
| Engineering | | | 25% | $ | 1,363,800 |
| **Total Cost** | | | | **$** | **6,819,000** |

**NEW Water**
**Green Bay Facility and De Pere Facility**
**Facility Plan**

**Package 1 Five RDT**
**OPCC**

| | Qtny | Units | Rate | Cost |
|---|---|---|---|---|
| *Demolition* | | | | |
| Demo GBTs and Centrifuge | 4 | EA | $ 45,000 | $ 180,000 |
| Demo Thickening Feed Pumps | 3 | EA | $ 25,000 | $ 75,000 |
| Demo GBT/Centrifuge Platforms and Stairways | 1 | LS | $ 20,000 | $ 20,000 |
| Total | | | | **$ 275,000** |
| *Concrete* | | | | |
| RDT Pads | 5 | EA | $ 2,500 | $ 12,500 |
| Centrifugal Pump Pads | 4 | EA | $ 2,500 | $ 10,000 |
| Total | | | | **$ 22,500** |
| *Metals* | | | | |
| RDT Platform - 5 RDTs | 2,500 | SF | $ 95 | $ 237,500 |
| RDT Odor Management | 1 | LS | $ 25,000 | $ 25,000 |
| Total | | | | **$ 262,500** |
| *Mechanical* | | | | |
| Total | | | | **$ -** |
| *Equipment* | | | | |
| Thickening Feed Pump - Centrifugal | 4 | EA | $ 50,000 | $ 200,000 |
| RDT | 5 | EA | $ 205,000 | $ 1,025,000 |
| Install | | | 30% | $ 367,500 |
| Subtotal | | | | $ 1,592,500 |
| Mechanical | | | 20% | $ 318,500 |
| Electrical & I&C | | | 20% | $ 318,500 |
| Total | | | | **$ 2,229,500** |
| Subtotal | | | | **$ 2,789,500** |
| Contractor Overhead and Profit | | | 25% | $ 697,400 |
| Subtotal | | | | $ 3,486,900 |
| Contingency | | | 50% | $ 1,743,500 |
| **Total Construction Cost** | | | | **$ 5,230,000** |
| Engineering | | | 25% | $ 1,307,500 |
| **Total Cost** | | | | **$ 6,538,000** |

**NEW Water**
**Green Bay Facility and De Pere Facility**
**Facility Plan**

**Package 2 Six RDT**
**OPCC**

| | Qtny | Units | Rate | | Cost |
|---|---|---|---|---|---|
| *Demolition* | | | | | |
| Demo GBTs and Centrifuge | 4 | EA | $ 45,000 | $ | 180,000 |
| Demo Thickening Feed Pumps | 3 | EA | $ 25,000 | $ | 75,000 |
| Demo GBT/Centrifuge Platforms and Stairways | 1 | LS | $ 20,000 | $ | 20,000 |
| Total | | | | **$** | **275,000** |
| *Concrete* | | | | | |
| RDT Pads | 6 | EA | $ 5,000 | $ | 30,000 |
| Centrifugal Pump Pads | 5 | EA | $ 2,500 | $ | 12,500 |
| Total | | | | **$** | **42,500** |
| *Metals* | | | | | |
| RDT Platform - 6 RDTs | 3,000 | #REF! | $ 95 | $ | 285,000 |
| RDT Odor Management | 1 | LS | $ 25,000 | $ | 25,000 |
| Total | | | | **$** | **310,000** |
| *Mechanical* | | | | | |
| Total | | | | **$** | - |
| *Equipment* | | | | | |
| Thickening Feed Pump - Centrifugal | 5 | EA | $ 50,000 | $ | 250,000 |
| RDT | 6 | EA | $ 205,000 | $ | 1,230,000 |
| Install | | | 30% | $ | 444,000 |
| Subtotal | | | | $ | 1,924,000 |
| Mechanical | | | 20% | $ | 384,800 |
| Electrical & I&C | | | 20% | $ | 384,800 |
| Total | | | | **$** | **2,693,600** |
| Subtotal | | | | **$** | **3,321,100** |
| Contractor Overhead and Profit | | | 25% | $ | 830,300 |
| Subtotal | | | | $ | 4,151,400 |
| Contingency | | | 50% | $ | 2,075,700 |
| **Total Construction Cost** | | | | **$** | **6,227,000** |
| Engineering | | | 25% | $ | 1,556,800 |
| **Total Cost** | | | | **$** | **7,784,000** |

**NEW Water**
**Green Bay Facility and De Pere Facility**
**Facility Plan**

**Additional Package 1 - Two Gravity Thickener Rehabilitation**
**OPCC**

| | Qtny | Units | Rate | Cost |
|---|---|---|---|---|
| *Demolition* | | | | |
| Demo Primary Feed Pumps | 3 | EA | $ 25,000 | $ 75,000 |
| Remove existing covers (2 Total) | 3,927 | SF | $ 7 | $ 25,525 |
| Remove existing mechanisms (2 Total) | 2 | EA | $ 40,000 | $ 80,000 |
| Total | | | | **$ 180,525** |
| *Concrete* | | | | |
| Centrifugal Pump Pads | 3 | EA | $ 2,500 | $ 7,500 |
| Surface Cleaning | 2 | EA | $ 10,000 | $ 20,000 |
| Concrete Repairs | 2 | EA | $ 50,000 | $ 100,000 |
| Total | | | | **$ 127,500** |
| *Metals* | | | | |
| Total | | | | **$ -** |
| *Mechanical* | | | | |
| Piping for Primary Sludge in tunnel | 500 | LF | $ 50 | $ 25,000 |
| Total | | | | **$ 25,000** |
| *Equipment* | | | | |
| Primary Feed Pump - Centrifugal | 3 | EA | $ 50,000 | $ 150,000 |
| Aluminum Covers (45-50ft diameter) | 2 | EA | $ 101,500 | $ 203,000 |
| Circular Gravity Thickener Equipment | 2 | EA | $ 225,000 | $ 450,000 |
| Install | | | 30% | $ 240,900 |
| Subtotal | | | | $ 1,043,900 |
| Mechanical | | | 20% | $ 208,780 |
| Electrical & I&C | | | 20% | $ 208,780 |
| Total | | | | **$ 1,461,460** |
| Subtotal | | | | **$ 1,794,500** |
| Contractor Overhead and Profit | | | 25% | $ 448,600 |
| Subtotal | | | | $ 2,243,100 |
| Contingency | | | 50% | $ 1,121,600 |
| **Total Construction Cost** | | | | **$ 3,365,000** |
| Engineering | | | 25% | $ 841,300 |
| **Total Cost** | | | | **$ 4,206,000** |

**NEW Water**
**Green Bay Facility and De Pere Facility**
**Facility Plan**

**Additional Package 2 - Four Gravity Thickener Rehabilitation**
**OPCC**

| | Qtny | Units | Rate | Cost |
|---|---|---|---|---|
| *Demolition* | | | | |
| Demo Primary Feed Pumps | 6 | EA | $ 25,000 | $ 150,000 |
| Remove existing covers (4 Total) | 7,854 | SF | $ 7 | $ 51,051 |
| Remove existing mechanisms (4Total) | 4 | EA | $ 40,000 | $ 160,000 |
| Total | | | | **$ 361,051** |
| *Concrete* | | | | |
| Centrifugal Pump Pads | 6 | EA | $ 2,500 | $ 15,000 |
| Surface Cleaning | 4 | EA | $ 10,000 | $ 40,000 |
| Concrete Repairs | 4 | EA | $ 50,000 | $ 200,000 |
| Total | | | | **$ 255,000** |
| *Metals* | | | | |
| Total | | | | **$ -** |
| *Mechanical* | | | | |
| Piping for Primary Sludge in tunnel | 500 | LF | $ 50 | $ 25,000 |
| Total | | | | **$ 25,000** |
| *Equipment* | | | | |
| Primary Feed Pump - Centrifugal | 6 | EA | $ 50,000 | $ 300,000 |
| Aluminum Covers (45-50ft diameter) | 4 | EA | $ 101,500 | $ 406,000 |
| Circular Gravity Thickener Equipment | 4 | EA | $ 225,000 | $ 900,000 |
| Install | | | 30% | $ 481,800 |
| Subtotal | | | | $ 2,087,800 |
| Mechanical | | | 20% | $ 417,560 |
| Electrical & I&C | | | 20% | $ 417,560 |
| Total | | | | **$ 2,922,920** |
| Subtotal | | | | **$ 3,564,000** |
| Contractor Overhead and Profit | | | 25% | $ 891,000 |
| Subtotal | | | | $ 4,455,000 |
| Contingency | | | 50% | $ 2,227,500 |
| **Total Construction Cost** | | | | **$ 6,683,000** |
| Engineering | | | 25% | $ 1,670,800 |
| **Total Cost** | | | | **$ 8,354,000** |

**NEW Water**
**Green Bay Facility and De Pere Facility**
**Facility Plan**

**Additional Package 3 - Thickened Sludge Wet Well and Pumping**
**OPCC**

| | Qtny | Units | Rate | Cost |
|---|---|---|---|---|
| *Demolition* | | | | |
| Demo Thickened Feed Pumps | 4 | EA | $ 25,000 | $ 100,000 |
| Demo Thickened Feed Well Walls | 2 | LS | $ 30,000 | $ 60,000 |
| Total | | | | **$ 160,000** |
| *Concrete* | | | | |
| Pumps - Procav Pads | 4 | EA | $ 2,500 | $ 10,000 |
| Reslope Exst Feed Wells | 15 | CY | $ 5,000 | $ 75,000 |
| Total | | | | **$ 85,000** |
| *Metals* | | | | |
| Total | | | | **$ -** |
| *Mechanical* | | | | |
| Total | | | | **$ -** |
| *Equipment* | | | | |
| Thickened Feed Pumps - ProCav | 4 | EA | $ 50,000 | $ 200,000 |
| Install | | | 30% | $ 60,000 |
| Subtotal | | | | $ 260,000 |
| Mechanical | | | 20% | $ 52,000 |
| Electrical & I&C | | | 20% | $ 52,000 |
| Total | | | | **$ 364,000** |
| Subtotal | | | | **$ 609,000** |
| Contractor Overhead and Profit | | | 25% | $ 152,300 |
| Subtotal | | | | $ 761,300 |
| Contingency | | | 50% | $ 380,700 |
| **Total Construction Cost** | | | | **$ 1,142,000** |
| Engineering | | | 25% | $ 285,500 |
| **Total Cost** | | | | **$ 1,428,000** |