Solids Dewatering Evaluation

City of Puyallup

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1.0 Background and Purpose

The Puyallup Water Pollution Control Plant (WPCP) provides secondary treatment to municipal, commercial, and industrial wastewater in the City's service area though primary sedimentation, activated sludge, and UV disinfection. Treated effluent is discharged into the Puyallup River.

Thickened primary sludge and WAS are then pumped to the anaerobic digestion process. A single belt filter press (BFP) is currently used to dewater anaerobically digested solids. The belt filter press is approximately 30 years old and is reaching the end of its useful life. The city would like to procure new equipment with lower operations and maintenance requirements.

1.1 New Flood Mapping

A WPCP Flood Protection Report was recently prepared (Gray & Osborne, 2011), and presents a summary of the most recent Flood Insurance Rate Map (FIRM) results. The FIRM would establish a new base flood elevation in the western portion of the Puyallup WPCP at 29.5 feet, which is approximately 2 feet above the floor of the existing Solids Handling Building. This will require all new mechanical and electrical equipment to be installed above this level to satisfy flood insurance ratings, either retrofit into the existing building or constructed in a new building.

2.0 Current Solids Handling System

The Puyallup solids handling system consists of the following:

- Gravity thickening.
- Centrifuge thickening.
- Anaerobic digestion: two primary anaerobic digesters, one secondary anaerobic digester.
- Digested solids pumping.
- Belt filter press (BFP) dewatering.
- Dry polymer feed system.
- Dewatered cake conveyance.
- Contract hauling and biosolids management.

2.1 Existing Solids Buildings

The existing secondary anaerobic digester and gravity thickener tanks were constructed in approximately 1955. In 1980, the existing Sludge Dewatering Building was constructed adjacent to the tanks. The following equipment was provided with the 1980 expansion:

- BFP.
- Dewatering feed pump.
- Dry polymer feed system.
- Dewatered cake conveyance.

- Modifications to the anaerobic digestion system.
- Chemical feed systems.

In 1998, the existing Solids Handling Building expansion was constructed adjacent to the tanks and the Sludge Dewatering Building. The following was provided with the 1998 expansion:

- Gravity thickening.
- Thickened primary sludge pumping.
- Centrifuge thickening (one unit).
- Thickened waste activated sludge (WAS) pumping.
- Thickened waste activated sludge (WAS) hoppers.
- A new polymer preparation and dilution system.
- Primary sludge degritting system.
- Water heater.
- MCC room.

Space for two future dewatering centrifuges was provided in the Centrifuge Room.

2.2 Belt filter Press Dewatering

One belt filter press dewaters all anaerobically digested solids at the Puyallup WPCP. The Ashbrook filter press was installed in 1980, and has been operating successfully. Typical performance is shown in Table 1:

Table 1: Existing Solids Dewatering System

ITEM	VALUE
Belt Width, meters	2
Dewatered Cake Solids Concentration, percent	16 to 19
Operation Time, hours per week	48 to 90
Average Feed Rate, gallons per minute	30
Maximum Feed Rate, gallons per day	43,200
Polymer Consumption, lb/dry ton of solids	17 to 20

Polymer is added to the blended sludge prior to dewatering using mechanical flocculation or simply injected into the digested solids piping. Currently, polymer is mixed and diluted by a packaged polymer feed system.

2.3 Dewatered Cake Collection and Conveyance

Dewatered solids are conveyed from the discharge of the BFP via a belt conveyor and deposited directly into trucks. The system only provides one drop point, so long trailer

trucks must be moved periodically to allow for complete filling. City staff use a yard goat to move the hauling and biosolids management Contractor's trucks.

3.0 Design Criteria for New Dewatering System

The Puyallup Water Pollution Control Plant (WPCP) is not projected to have significant increases in influent flows and loads in the near future. To properly size the new dewatering system, historical data were reviewed and flow and load projections were developed to size equipment.

3.1 Review of Historical Digested Solids Flow and Load Data

Historical records of the annual sludge production and influent BOD load from 2001-2012 were reviewed and are presented in Figure 1. Influent BOD load and sludge production have been relatively constant since 2006.

The Draft 2008 sanitary sewer system comprehensive plan update (Gray and Osborne, Inc.) provided projections of influent BOD and TSS loads, which are shown in Table 2. The estimate shown in Table 2 is higher compared to the historical data presented in Figure 1. City staff tracks the ratio of total solids to influent BOD, which is shown in Figure 1. This provides for projections of solids quantities in the absence of the other data, and serves as a check on projections using historical data.

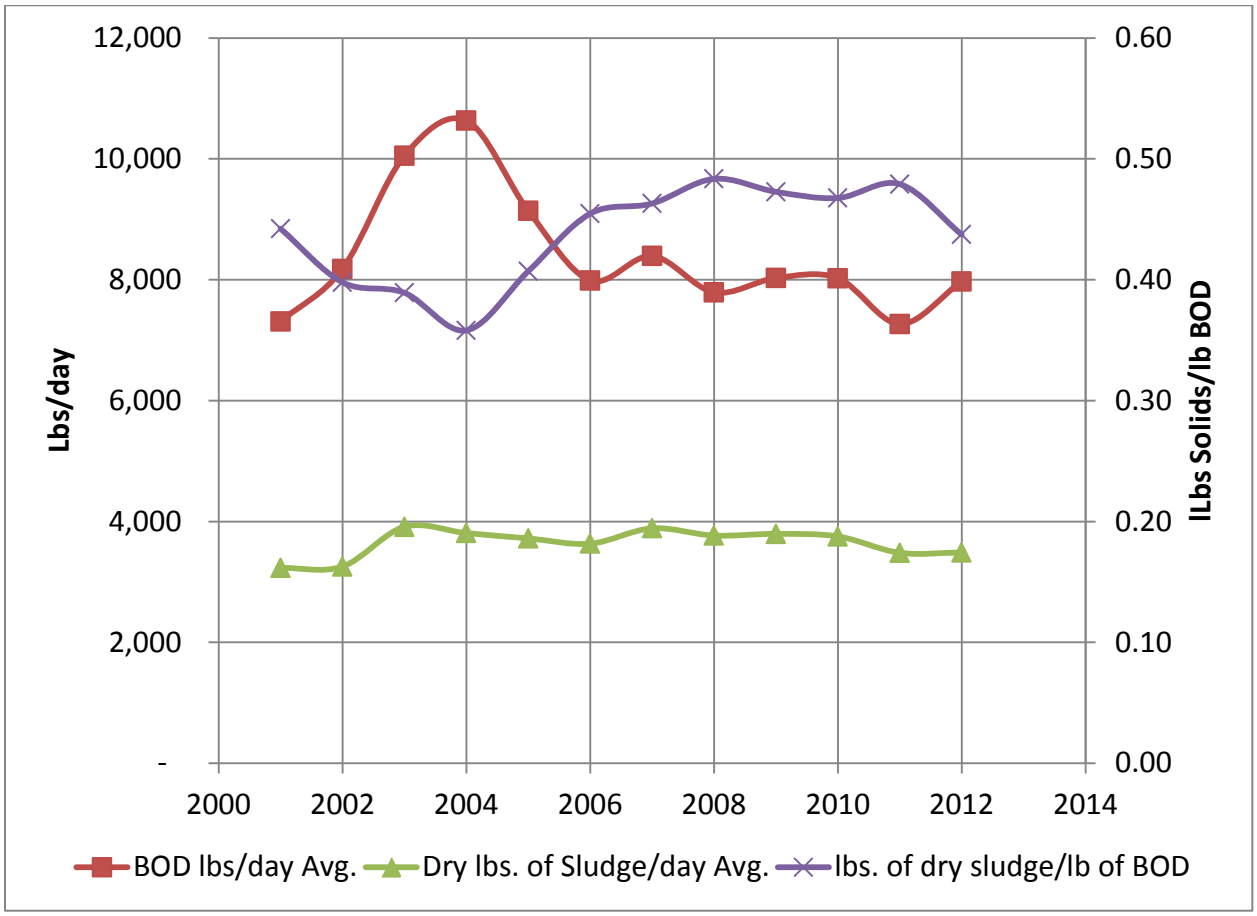

Figure 1: Historical BOD Load and Sludge Production

Table 2: Draft 2008 Sanitary Sewer Comprehensive Plan Update Influent Wastewater Load Projections

PARAMETER	2014	2028	BUILDOUT
Average Annual BOD, lb/d	10,664	15,241	23,380
Max Month BOD, lb/d	13,231	18,910	33,971
Average Annual TSS, lb/d	12,050	17,222	26,419
Max Month TSS, lb/d	14,951	21,368	38,387

3.2 Digested Solids Flow and Load Projections

The design criteria for solids dewatering is typically the maximum week or maximum month flow and load. The City of Puyallup WPCP has anaerobic digestion capacity that provides storage for approximately 30 days. Therefore, the maximum month flow and load will be used as the design criteria. Historical records were reviewed to determine the maximum month flow. The maximum month digested solids flow of approximately 657,000 gallons occurred in June, 2008. The existing belt filter press is operated approximately 75 to 90 hours per week. This equates to approximately 30 gallons per minute (gpm) at maximum month flow and 90 hours per week of operation. The average monthly digested solids flow was approximately 478,000 gallons per month. Therefore, the peaking factor from maximum month to average is approximately 1.38.

Table 3 presents a matrix of flow and load projections based on increased flow and load as well as Table 3 operating hours. The increase in flow and load must include allowances for both maximum month peaking and growth in the service area. The historical maximum month peaking factor is a 38% increase. Therefore, a minimum allowance for increased flow and load of 50% is recommended.

After discussion was city staff, a design criterion of approximately 30 gpm (450 lb/hr at 3 percent solids) was selected. This is approximately a 50% increase in flow compared to historical averages and assumes an operation of 80 hours per week. Therefore, new dewatering equipment will be designed to process a load of 483 lb/hr and a flow of 32 gpm (this assumes a solids concentration of 3%).

Table 3: Flow and Load Projection Matrix - Increase in Load and Operating Hours

INCREASE IN LOAD (LB/HR)	40 HRS/WEEK	80 HRS/WEEK	120 HRS/WEEK	168 HRS/WEEK
25%	804	402	268	191
50%	965	483	322	230
75%	1,126	563	375	268
100%	1,287	643	429	306
INCREASE IN FLOW (GPM) *	40 HRS/WEEK	80 HRS/WEEK	120 HRS/WEEK	168 HRS/WEEK
25%	54	27	18	13
50%	64	32	21	15
75%	75	37	25	18
100%	86	43	29	20

* Flows assume 3% solids.

4.0 New Dewatering System Alternatives

In addition to conventional dewatering equipment, such as belt filter presses and centrifuges, alternative dewatering devices have been developed and offered to the marketplace over the last few years. These devices offer some significance cost savings in operations and maintenance due to their slow speed as well as other performance factors. The main devices that will be reviewed in this memo are centrifuges, screw presses and the rotary presses. Equipment options for cake conveyance and storage are also reviewed.

4.1 Dewatering Equipment Technologies

4.1.1 Centrifuge

Centrifuges separate heavier solids from lighter liquids through centrifugal force. There are three types of centrifuges used in municipal wastewater biosolids processes: basket, disc and decanter. Only decanter centrifuges will be discussed as they are the only ones appropriate for the Puyallup WPCP solids dewatering application.

Decanter centrifuges are comprised of a horizontal scroll or conveyor within a hollow cylinder as shown in the images above. There are two types of decanter centrifuges; co-current and counter current. Co-current centrifuges introduce the feedstock at the end of the centrifuge opposite the cake discharge and have ports along the length of the centrifuge to collect centrate. Countercurrent centrifuges introduce the feedstock at the intersection of the conical and cylindrical portions of the scroll. The centrifuge shown in Figure 2 is a counter current type. Decanter centrifuges are the most common type of centrifuge in use today. They are often referred to as “high solids” centrifuges due to their ability to impart over 3000 Gs, and produced a cake with 25 percent solids or more

The primary differences between thickening and dewatering centrifuges are the configuration of the conveyor (scroll) toward the liquids discharge end of the machine and the location and configuration of the solids discharge ports.

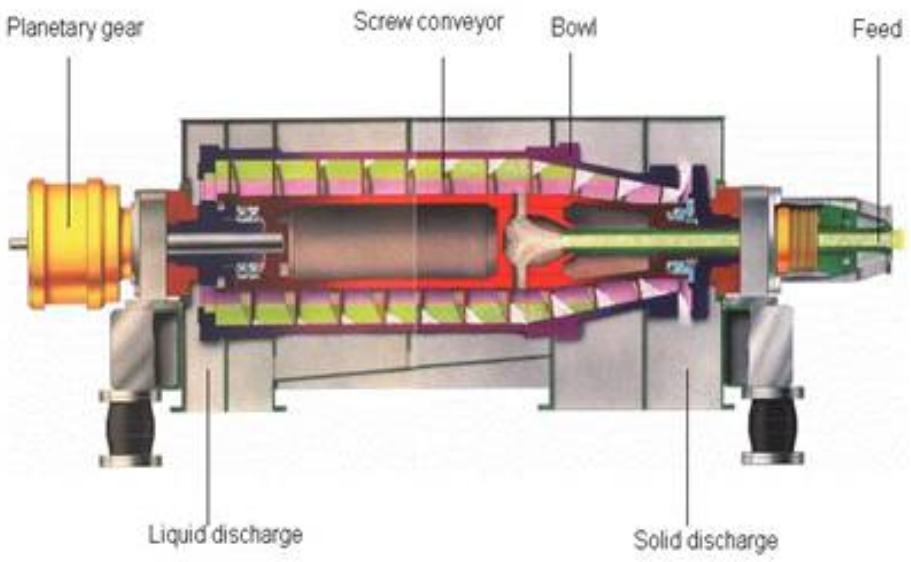

Figure 2: Schematic of a Decanter Centrifuge

The correct choice of polymer type, dilution rate, and application point(s) are critical to optimal centrifuge performance. Other operational considerations include bowl speed, scroll/bowl speed differential, weir setting and loading rate. Upon startup, centrifuges will produce a sloppy product that must be collected and (usually) returned to the feed tank or other point for recycle. Centrifuges should be flushed with water when shut down and hot water is often required to remove grease buildup. Proper lubrication and preventative maintenance are important because the machine operates at high speeds and failures could be catastrophic. The equipment also requires periodic major maintenance to sustain performance.

The most common manufacturers of centrifuges installed in the Pacific Northwest are Andritz, Alfa Laval, Westfalia, and Centrisys. Andritz pilot-tested the centrifuge at the Puyallup WPCP August 27-29, 2013. The pilot test report is found in Appendix B.

4.1.2 Screw Press

A screw press is a mechanical device used for liquid/solid separation for various types of sludges. Liquid/solid separation is accomplished by gradually reducing the volume available for the solids as they are conveyed from the inlet to the outlet end of the screw press. The reduction in volume is achieved by using a tapered shaft that is larger in diameter at the discharge end than at the inlet end, as shown in Figure 3.

4.1.2.1 FKC

A typical FKC installation is shown in Figure 4. FKC can provide screw presses from 4 inches to 53 inches in diameter, with wetted lengths up to 30 feet. The wetted parts of the presses are manufactured from stainless steel. The base is typically manufactured from carbon steel, but is available in stainless steel.

The shaft is surrounded by a screen system that contains small (less than 1/8-inch diameter) punched holes. A typical screen is shown in Figure 5. The screen support housing includes adjustment nuts to correct the screen position to achieve the proper clearance from the screw flights. Steam can be provided to the screw in conjunction with

lime stabilization system for producing Class A biosolids. However, this is generally not recommended in combination with anaerobic digestion.

There are several drive systems available, but the most typical has a VFD-driven motor, cyclogear to reduce speed, and a chain drive. This combination provides for a final rotational speed in the range of 0.05 to 1.5 rpm. With the slow speed and automation provided, screw presses can be operated unattended, which provides a significant savings in operations costs. Maintenance requirements are relatively low as reported by numerous owners of operating screw press facilities. However, one local installation reported problems with hair accumulating on the screw openings.

The inlet to the screw press can be piped directly into the press or introduced through an inlet box. In either case, the inlet box is required to allow waste solids to back up into the box, which places a hydraulic head on the material to force it into the screw area.

FKC manufacturers their screw presses in Japan with lead times up to nine months after a purchase order.

On May 14 and 15, 2013, FKC pilot tested a screw press at the Puyallup WPCP. Seven trials were run using a variety of polymer doses and screw speeds. The Ashland polymer currently used for belt filter press dewatering was used for all trials. Cake solids varied from 17.5 to 23 percent and active polymer dose rate varied from 18.4 to 22.4 pounds of active polymer per dry ton of solids. The filtrate quality and capture rate were not measured. The pilot test report is found in Appendix B.

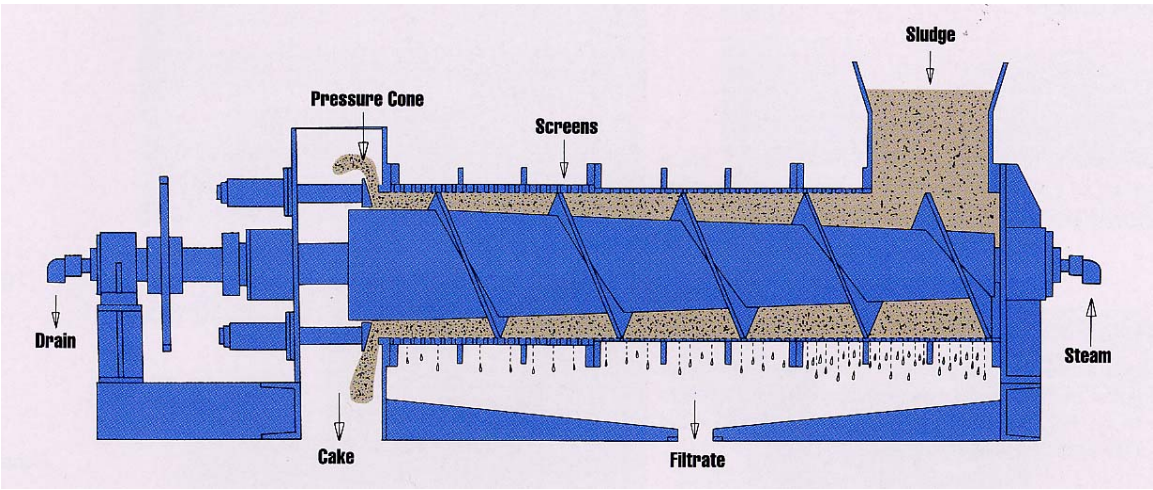

Figure 3: Cross-Section Schematic of Screw Press (courtesy of FKC)

Figure 4: FKC Screw Press Operating in Sequim, Washington

Figure 5: Typical Screw Press Screen

4.1.2.2 Huber

Huber also offers a screw press that has several differences from FKC. The device is set at an angle with solids being moved up through the device and discharged at the top. Huber's equipment is typically smaller in length, with lower flow and load capacity, compared to FKC units.

The RoS 3Q has a conical screw shaft and cylindrical sieves consisting of three zones: inlet and drive zone, dewatering zone, and press zone with a pneumatic cone. In the first part of the thickening and dewatering zone the supernatant is removed by backpressure generated by the feed pump. A pressure probe in the feed area controls the pressure. A

schematic of the Huber unit is shown in Figure 6. Compressed air is required to operate the pneumatic cylinders. The filter basket is periodically flushed with water and brushes are provided to scrape degree of the basket.

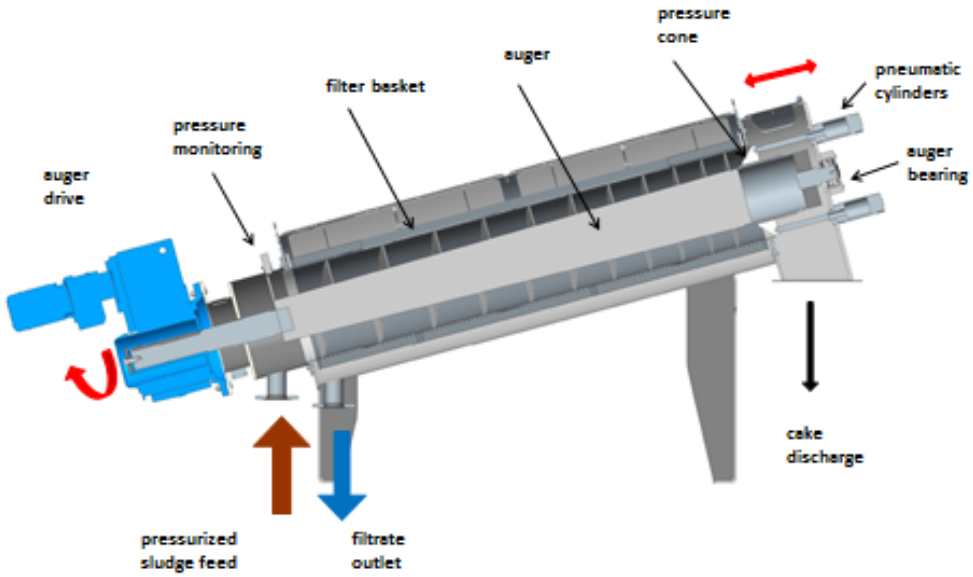

Figure 6: Schematic of Huber Screw Press (courtesy of Huber)

Huber has used two different methods for mixing polymer and sludge prior to screw press dewatering: a pressurized coagulation tank, and a specialty flocculation reactor piping system. The specialty piping system requires up to 35 psi of back pressure. In order to guarantee performance, Huber requires the system be installed with a screw press package. This flocculation reactor pipe system is shown underneath the screw press in Figure 7.

Huber tested a small pilot unit at the Puyallup WPCP from March 8 to March 18th, 2010. Cake solids concentrations varied from 19 to 23%. The solids capture rate varied from 95- 99%. Polymer consumption was high using Ashland polymers, varying from approximately 26 to 44 lb active/dry ton solids. The pilot test report is found in Appendix B.

Figure 7: Huber Screw Press at the Lakehaven Utility District's Lakota Wastewater Treatment Plant

4.1.3 Rotary Press

The rotary press is relatively simple device with low energy requirements. Solids are fed to a rectangular channel, and then rotated between two parallel revolving screens. Rotation is slow compared to a centrifuge, typically less than 3 rpm. Filtrate is squeezed out to the sides of the screen and collected. Sludge is increasingly dewatered as it travels around the circular channel. Figure 8 shows the principle of operation with two cross-section views of the leading rotary press. A rotary press relies on internal pressure to force the sludge through the circular channels. As such, back pressure must be provided to the press in the form of a high-pressure feed pump.

Rotary presses provide optimal dewatering on sludges that have a significant portion of primary sludge or significant fibrous material. With the relatively slow speed and the high level of automation provided, rotary presses can typically be operated unattended. Maintenance requirements are low as reported by owners of operating rotary press facilities.

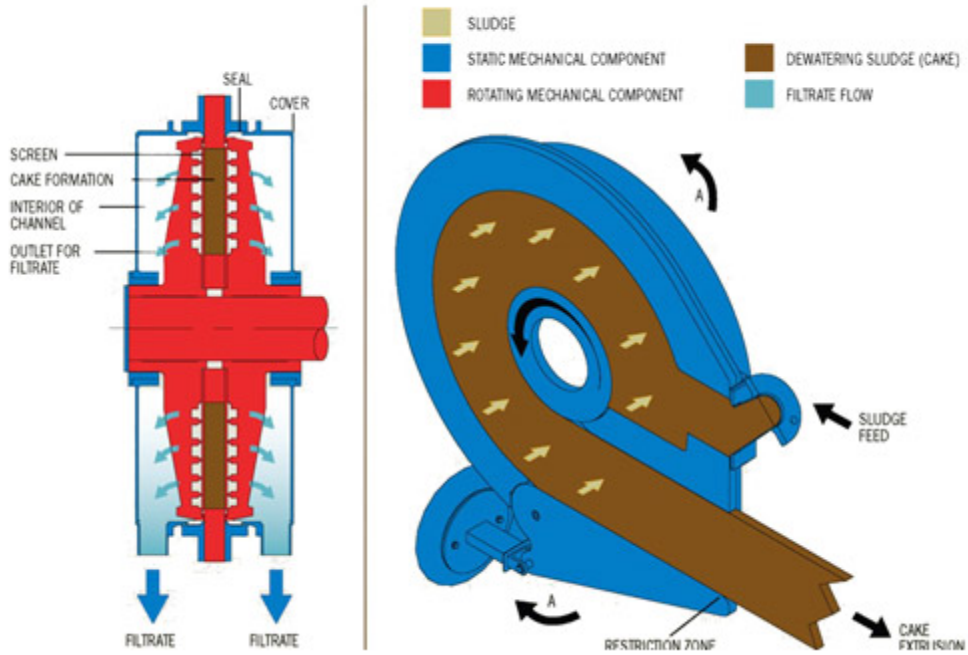

Figure 8: Schematics of Rotary Press Showing Principle of Operation (courtesy of Fournier)

4.1.3.1 Fournier

Fournier makes presses with 2, 4, or 6 channels, with each having a diameter of 32 or 36 inches. Figure 9 shows a six-channel unit.

Pneumatic by-pass valves and pressure control flow balancing on multi-channel units are required for the Fournier rotary press.

On August 12 to 15, 2013, a Fournier (Black Lake, Quebec) rotary press was pilot tested at the Puyallup WPCP. Dewatered cake concentrations were comparable to the current BFP dewatering process at low loadings. However, the polymer use was much higher. Also, cake concentrations were lowest using the city's current polymer (859BS). The pilot test report is found in Appendix B.

Figure 9: Multi-Channel Rotary Press (courtesy of Fournier Industries)

4.1.3.2 Prime Solutions

Prime Solutions offers a similar rotary press as Fournier. A schematic of the Prime Solutions rotary press is shown in Figure 10, and an exterior view is shown in Figure 11.

Repeated contacts to obtain design information from Prime Solutions were never returned. Due to the lack of manufacturer response and the fact that there are limited local installations, further evaluation of the Prime Solutions press is not recommended.

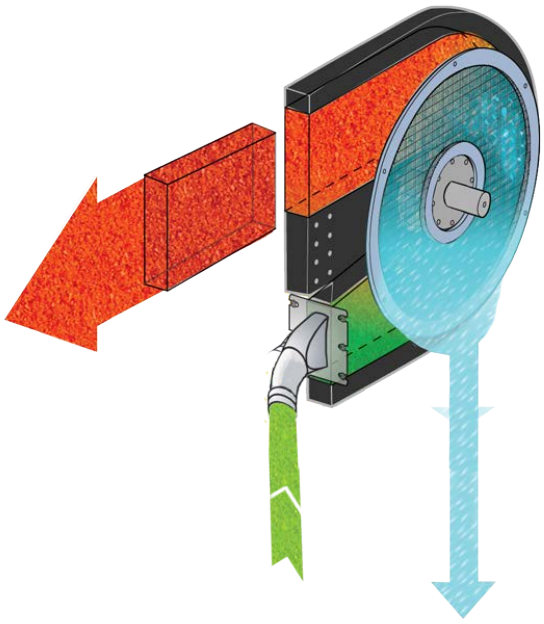

Figure 10: Schematic of Prime Solutions Rotary Press

Figure 11: Exterior View of Prime Solutions Rotary Press

4.1.4 Dewatering Equipment Comparison

Table 4 presents a comparison of model, capacity, and other features of the screw presses, rotary press, and an example centrifuge under consideration.

Table 4: Comparison of Alternative Dewatering Devices

DEVICE TYPE	SCREW PRESS	SCREW PRESS	ROTARY PRESS	CENTRIFUGE
MANUFACTURER	FKC	HUBER	FOURNIER	ANDRITZ
Model/ Capacity	BHX-900x5000 L/ 420 - 500 pounds per hour	RoS3 Q620/ 620 pounds per hour	4-900 /4000 CV 560 pounds per hour	D4L 450/950 pounds per hour
Main drive horsepower	3 (1 flocculator)	3	15 (1 flocculator)	40 (10 back drive)
Main drive speed	0.03-0.3 RPM	0.4-1.0 RPM	0.5-3 rpm	3,600 rpm
Back pressure	None required	Up to 35 psi depending on flocculation method	Up to 10 psi	None required
Cost (one unit)	$210,000	$245,000	$305,000	$314,545*
Cake solids concentration	17-23	19-23	15-20	25.5/24.5
Active polymer dose (lb active/ dry ton based on pilot test results)	20-25	25-40	35	23-27
Wash water requirements	Up to 140 gpm @ 50 psi Three locations 15 to 60 second bursts 10 to 30 min cycles.	95 gpm @ 75 PSI, Maximum 5 minutes/hour cycle	60 psi 5 min/24 hour cycle	35-70 gpm @ 40-60 psi for shift cleaning
Weight	13,228 lbs (17,637 lbs operating)	6,615 lbs (7,716 lbs operating)	11,463 lbs (11,903 lbs operating)	6,600 lbs (8,000 lbs operating)

* Includes a spare scroll.

4.1.4.1 Cake Solids Performance

As shown in Table 4, the screw presses and rotary presses produced similar ranges of cake solids during pilot testing. The centrifuge is capable of producing higher cake solids, with the screw presses and Fournier rotary press in the same order of magnitude around 20 percent solids.

4.1.4.2 Feed Pumping Requirements

The existing feed pump is approximately 30 years old and replacement is recommended as part of a solids dewatering upgrade project. The FKC screw and centrifuge do not require backpressure to operate, while the Huber screw press and Fournier rotary press require up to 35 psi. Backpressure may require larger feed pumps and will use more energy.

4.1.4.3 Power Requirements

The centrifuge has the highest total power requirement at a combined 50 hp (40 + 10), as well as requiring more sophisticated electronics and larger panels. The existing power supply in the Centrifuge Room would not require significant upgrades for a centrifuge nor any of the other devices. However, the existing MCCs are subject to flooding, so new dewatering equipment panels and electrical equipment would require mounting above elevation 29.5 ft. Standard screw press and rotary press manufacturer panels could likely be mounted within the Centrifuge Room using pipe-type supports. However, typical dewatering centrifuge panels are larger and more complex. They would likely require non-standard configurations to be mounted above elevation 29.5 ft and still maintain functionality.

4.1.4.4 Polymer Requirements

Polymer requirements can vary widely between sludges and dewatering devices. The best information available for this study is the results of pilot testing at the Puyallup WPCP for the devices under consideration. Table 4 presents the polymer requirements from the recent pilot testing. The FKC screw press had the lowest polymer requirement, with the Huber and Fournier having the higher requirements using the current Ashland Praestol 859 BS.

4.1.4.5 Washwater Requirements

The FKC screw press requires the most instantaneous wash water. The existing non-potable water supply system in the Centrifuge Room was evaluated and found to be adequate assuming additional piping will be provided to connect existing piping to the new screw press. A new non-potable water system would be required for alternatives that include a new dewatering system in a new building.

4.1.4.6 Structural Requirements

The two screw presses and the rotary press are low speed and have low vibrations. Dead loads were evaluated and the existing floor and foundation appear to be adequate to support any of the units considered.

Since a new centrifuge would operate at high speeds (up to 3,600 rpm) with the potential for vibrations, a dynamic analysis of the existing building would be required during design. This analysis is beyond the scope of this evaluation, and may require structural modifications that would add cost to retrofit options.

4.2 Location of New Dewatering System

4.2.1 Retrofit into Existing BFP Room

Given the size of the FKC screw press will not fit within the footprint of the BFP Room. A centrifuge could be placed in the room, however. Relatively complex dynamic structural analysis is required to ensure that the 33 year old building could adequate withstand the vibrations created by the high speed centrifuge. This analysis is beyond the scope of this study.

Keeping the single BFP in service would not be possible during construction, meaning that temporary rental dewatering facilities would be required. This could create odors and would disrupt truck loadout logistics. For these reasons, retrofit of the BFP Room is not recommended for any new dewatering technologies.

4.2.2 Retrofit into Existing Centrifuge Room

The existing Centrifuge Room houses the thickening centrifuge and was designed with space for two more identically-sized centrifuges for future dewatering use. It may be feasible for at least some options and will be evaluated in Section 5.0. There are some issues that will impact the feasibility of this space for retrofit:

- The space is subject to flooding, so all mechanical and electrical equipment will have to be elevated approximately 2 feet above the finished floor.
- There is also a space in the northwest corner used for polymer storage.
- The MCC room is subject to flooding, so new control panels will need to be located in the Centrifuge Room.

4.2.3 New Building

A new building is feasible for all options and equipment and will be evaluated further in Section 5.0.

4.2.4 Summary

Figure 12 shows the proposed locations of a new building as well as the existing Centrifuge Room. The new building location was chosen due to the fact that the clarifiers in that area are abandoned and there is no other future use selected for this area. Also, it allows for smooth truck traffic logistics through the plant in a similar route as current biosolids truck traffic. It is directly across an access road from the existing Solids Dewatering Building and also close to the Primary Anaerobic Digesters. Feed sludge piping across the access road will be required as the dewatering feed pump will remain in the Solids Dewatering Building.

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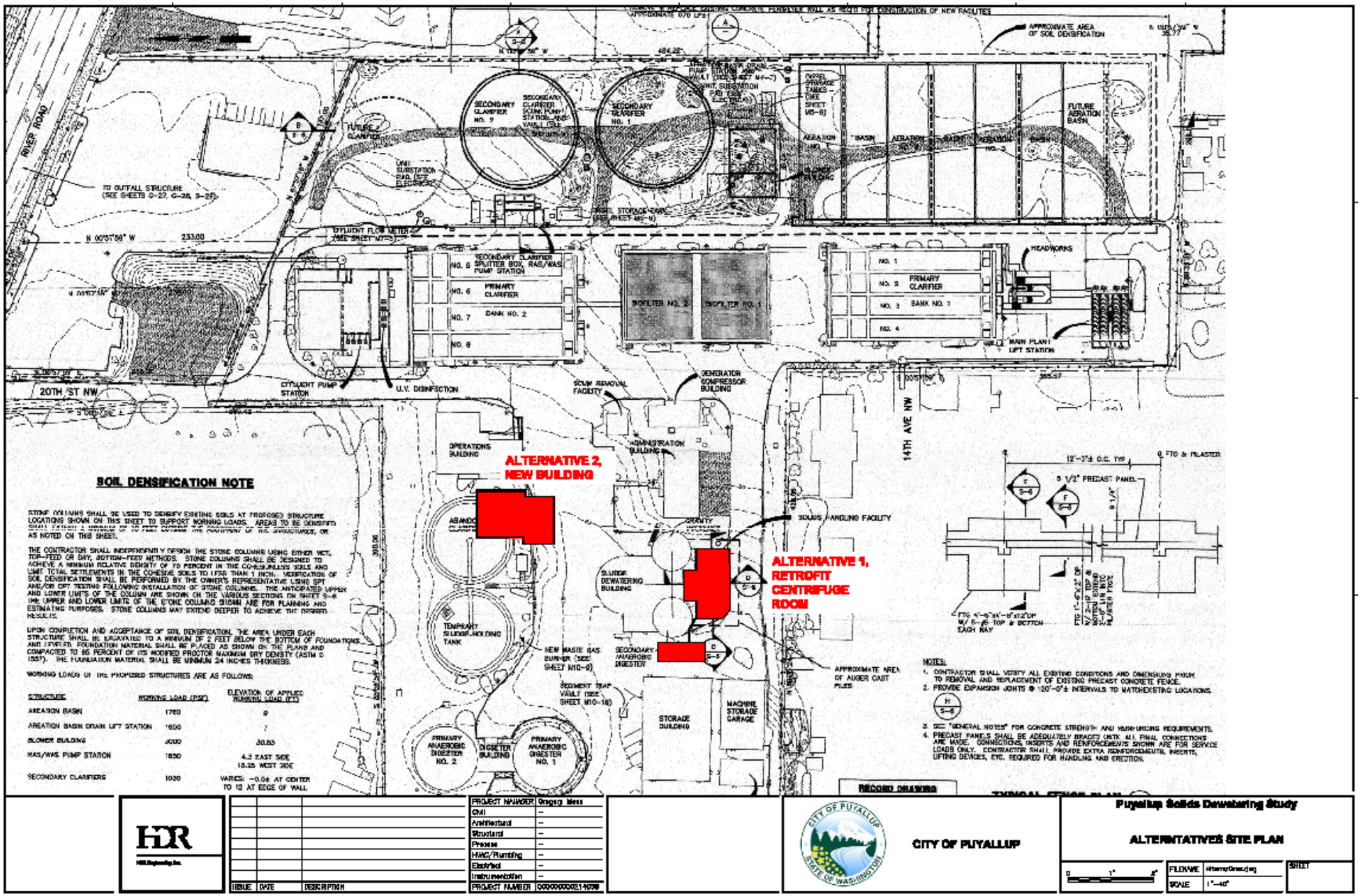

Figure 12: Site Plan

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4.3 Cake Storage and Loadout

4.3.1 Minor Modifications to Existing System

Since this option is only practical in combination with the retrofit existing BFP Room, it is not feasible.

4.3.2 New System

A new cake conveyance, storage, and truck loadout system would allow the City to better manage dewatered cake from the dewatering device to the point it leaves the site on trucks.

Three days of cake storage is desired to allow trucks to be loaded independent of operation of the dewatering process, providing for a long weekend of no hauling. A 125 cubic yard, 100 wet ton capacity hopper was assumed for evaluation purposes, as this would provide adequate capacity at the design criteria of 450 pounds/hour at 20 percent solids concentration. Desired features in a cake storage and loadout system are:

1. Ability to load trucks evenly, unattended, and in a relatively short amount of time.
2. Ability to positively determine the truck weight or alternatively the weight transferred to the truck from the dewatered cake. This can be accomplished by truck scales or load cells in the hoppers. Given the flooding issues at the WPCP, load cells are preferred.
3. Enclosure to control odors, enhance aesthetic features, and maintain a more palatable work environment.

There are several commercially available storage and loadout systems that could satisfy these goals. Typically, sliding frames or live bottom loadout system are employed to evenly spread cake solids across a particular shape. For the trucks employed by the City, a rectangular discharge area is required.

Figure 13 shows a rectangular sliding frame. As can be seen, sliding frames typically require more space on the side (perpendicular to truck length) than other types of positive control load outs.

Figure 14 shows a typical bottom portion of a screw conveyor-type live bottom system. This type of system uses multiple screw conveyors to cover the bottom opening of the storage hopper and distribute the material throughout the length of the screws. The figure does not show opening gates below and the hopper above. Figure 15 shows a live bottom hopper underneath a rectangular hopper.

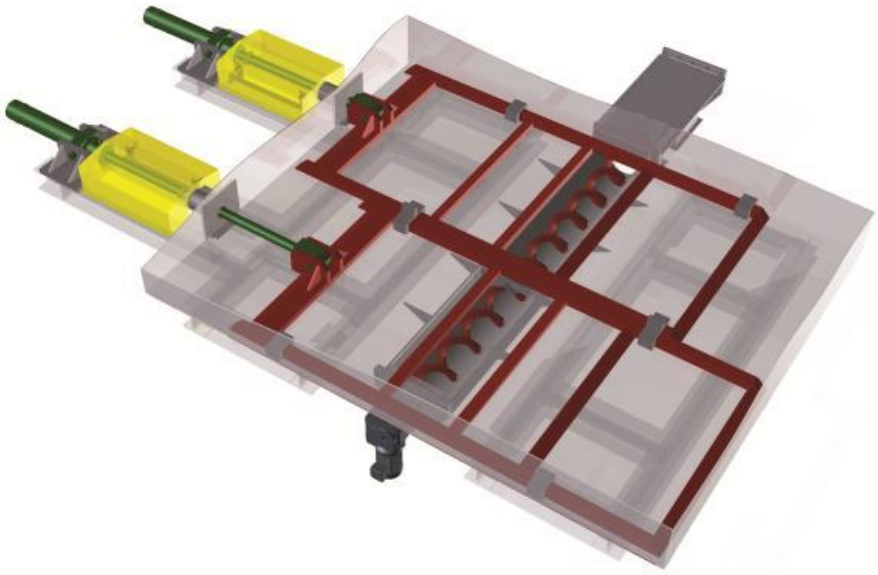

Figure 13: Rectangular Sliding Frame for Solids Removal and Distribution (courtesy of Asdor)

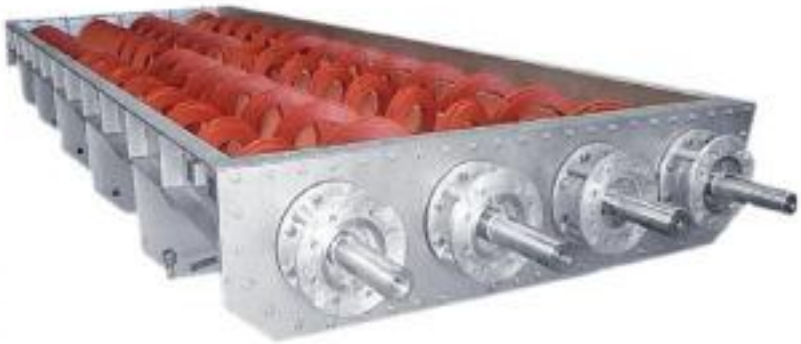

Figure 14: Live Bottom Screw Assembly (courtesy of Asdor)

Figure 15: Rectangular Hopper with Live Bottom Screw Conveyors (courtesy of Asdor)

5.0 Alternatives Analysis

5.1 Alternatives Screening

Feasible dewatering equipment, locations, and cake storage and loadout options will be evaluated in detail in this section. Some equipment and locations were eliminated from further consideration for this analysis.

5.1.1 Dewatering Equipment

Based on the performance during pilot testing, the comparison presented in Section 4.1.4, and City staff preferences, the following equipment was screened from further analysis:

- Huber screw press: high back pressure resulting in additional feed pump energy compared to other alternatives. The press had high polymer use during pilot testing.
- Rotary presses:
  - Fournier: the unit requires high back pressure resulting in additional feed pump energy compared to other alternatives. The Fournier had poor pilot test performance for both polymer use and cake solids compared to other equipment.
  - Prime Solutions: the manufacturer was non-responsive to requests for information, washwater requirements are high, and the performance and materials of construction are of lower quality than Fournier.

5.1.2 Location

As discussed in Section 4.2, the existing BFP Room is not large enough to house any dewatering equipment except a centrifuge, and is undesirable due to construction sequencing issues during construction of a new dewatering system.

Retrofit of the existing Centrifuge Room may be feasible. Therefore, the Centrifuge Room and a new building will be evaluated further.

5.1.3 Cake Storage and Loadout

Cake conveyance/truck loadout alternatives include minor modifications to the existing system and a new system. Since minor modifications to the existing system is only feasible if equipment is in the BFP room, it will not be considered further. All final alternatives will be evaluated with a new cake storage and loadout.

5.2 Final Alternatives

The combination of an FKC screw press, a centrifuge, and the remaining location alternatives results in the following final alternatives:

- Alternative 1A: Screw Press in Centrifuge Room
- Alternative 1B: Screw Press in New Building
- Alternative 2A: Centrifuge in Centrifuge Room
- Alternative 2B: Centrifuge in New Building

5.2.1 Assumptions and Layouts for Final Alternatives

The FKC screw press is used for costs and layouts for Alternatives 1A and 1B, while an Andritz centrifuge was used for costs and layouts of Alternatives 2A and 2B. Different centrifuge manufacturers may have different size and capacity and as such may fit differently and have different costs than the Andritz.

Layouts are conceptual only and are not intended to be construction drawings or final design. They were developed to include major equipment (dewatering, conveyors,etc.), basic building wall outlines, and some access platforms and other structural elements such as monorails. No piping, electrical equipment, etc. was included in the layouts. The layouts form the basis of cost estimates along with other assumptions regarding soils, foundation design, etc.

5.2.2 Alternative 1A: Screw Press in Centrifuge Room

The existing Centrifuge Room houses the thickening centrifuge and was designed with space for two more identically-sized centrifuges for future dewatering use. As such, it was evaluated for both screw press and centrifuge retrofits.

Using three-dimensional Building Information Modeling (BIM), conceptual layouts were developed for locating a FKC screw press and a centrifuge in this area. Conceptual layouts for the FKC screw press as shown in Figure 11, Figure 16, and Figure 17. Space for a future identically-sized screw press is available, and is shown in gray in Figure 16. It was determined that the existing roof needed modification to allow removal of the FKC screw press screens for maintenance due to the required elevation of the flocculator and headbox. The proximity to the existing roof will likely not allow for installation of a monorail or bridge crane. One option that is shown in the conceptual layout is to construct a removable skylight to allow removal of screens and other screw press and flocculator elements by crane.

Figure 16: Section View (Looking North) of Conceptual Layout of FKC Screw Press in Centrifuge Room

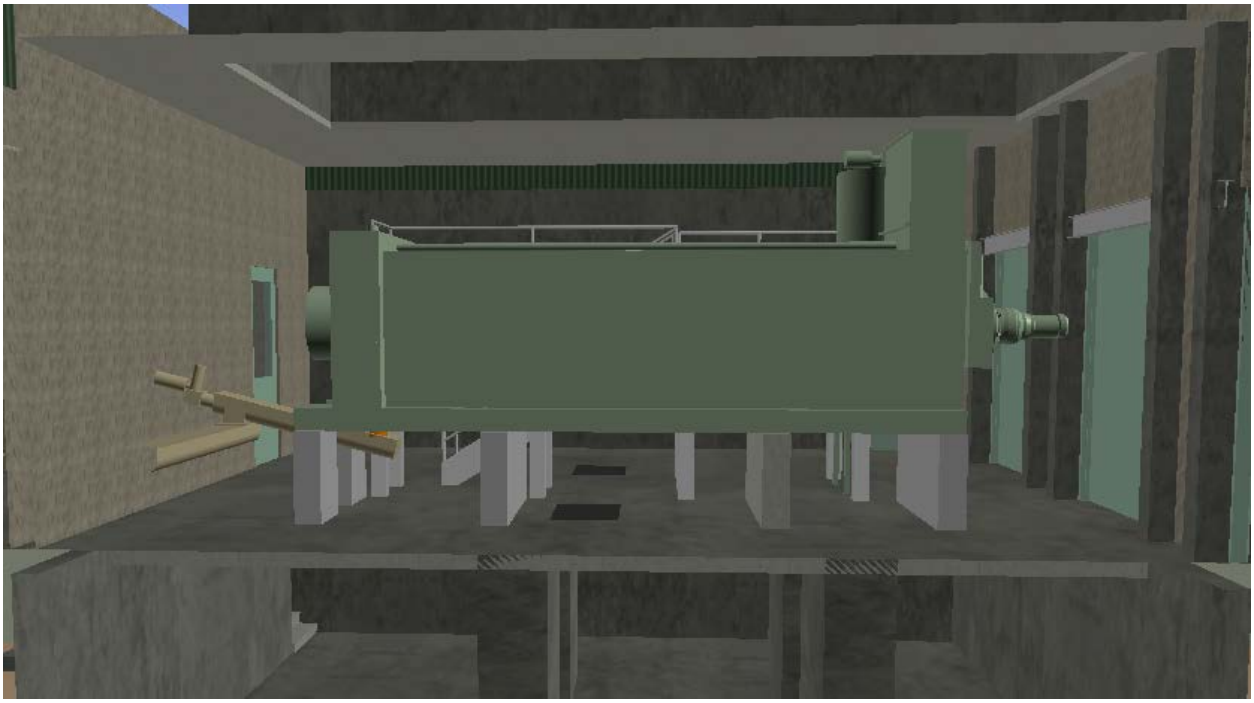

Figure 17: Section View (Looking East) of FKC Screw Presses in Centrifuge Room

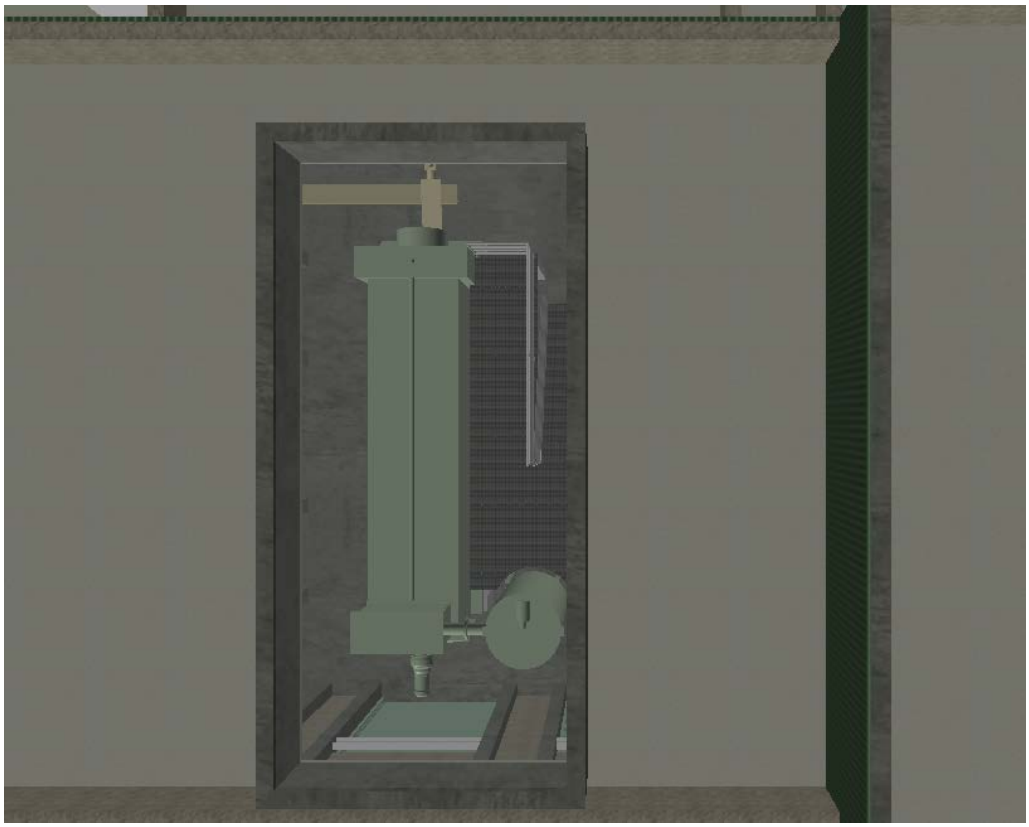

Figure 18: Plan View (from Above Roof) of FKC Screw Press Conceptual Layout in Centrifuge Room

5.2.1 Alternative 2A: Centrifuge in Centrifuge Room

A conceptual layout for an Andritz centrifuge is shown in Figure 19 and Figure 20. The centrifuge must be elevated 5 feet or so to accommodate cake collection, sorting, and conveyance equipment located 2 feet above the existing floor. This still allows for a new monorail to remove the internal scroll from the centrifuge for maintenance.

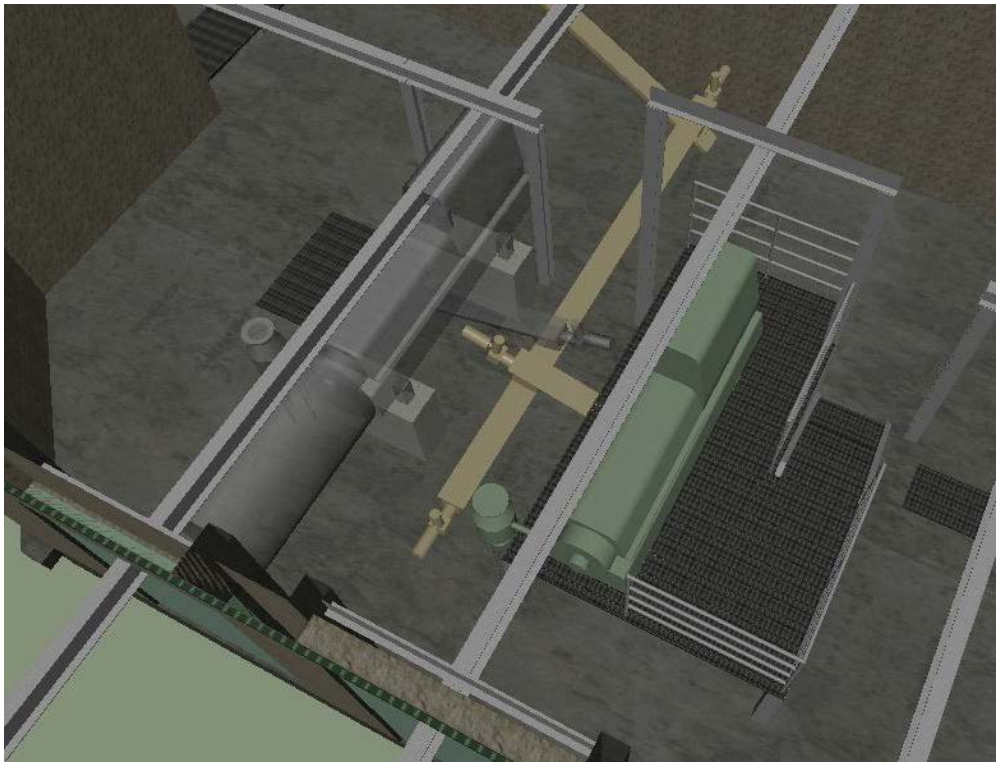

Figure 19: Isometric View (Looking Northwest) of Conceptual Layout of Centrifuge in Centrifuge Room

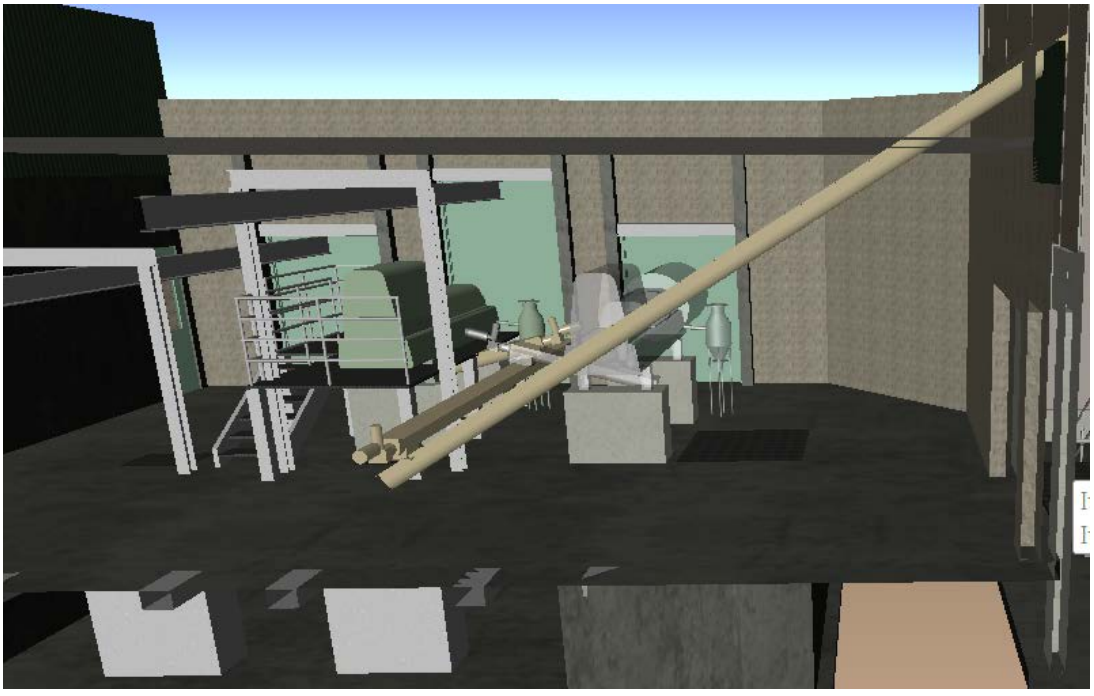

Figure 20: Section View (Looking North) of Centrifuge Conceptual Layout in Centrifuge Room

5.2.1 Alternative 1B: Screw Press in New Building

The following is assumed to be provided for Alternative 1B:

- A two-story building with dewatering equipment on the upper floor.
- Approximately 1,600 square feet of space on each floor.
- A single dewatering device with space allocated for a second unit in the future.
- A bridge crane for removal of internal parts for maintenance.
- Three separate rooms would be provided on the upper floor:
    - Electrical/MCC equipment
    - Control room
    - HVAC or storage
- An internal stairwell to connect the floors.
- A liquid polymer feed and storage system located on the lower floor.
- Shaftless screw conveyors to transfer cake from the dewatering devices to the storage hopper and truck loadout area.

5.2.2 Alternative 2B: Centrifuge in New Building

The same assumptions as for Alternative 1B regarding a new building are applicable. However, the new building for Alternative 1B is assumed to be approximately 90% of the size as the one for Alternative 1A due to the smaller size of the centrifuge compared to the FKC screw press.

6.0 Cost Estimates

Construction, project, annual operations and maintenance (O&M), and life cycle cost estimates were developed for comparison of final alternatives.

6.1 Cost Estimate Assumptions and Methodology

Opinions of probable construction costs (OPCC) were developed by HDR Constructors, a division of HDR comprised of construction contractors. The OPCCs were developed to American Association of Cost Engineering (AACE) Class 4 Study or Feasibility Level standards for final alternatives. Class 4 estimates are as follows:

- For 1 to 15% Project Definition such as this study, so contingency is needed to account for undefined scope of work.
- Accuracy Range: -20% to +40%.

OPCC details for Alternatives 1A, 1B, and 2B are in Appendix A.

Annual operations and maintenance costs were estimated based on the City's current costs and well as HDR experience. Assumptions for the cost estimates are as follows:

- Contractor hauling and biosolids management - $51 per wet ton solids.
- Screw press cake solids – 20%.

- Centrifuge cake solids – 24%.
- O&M labor - $29.36 per hour.
- Administration labor - $40 per hour.
- Polymer (Praestol 859BS) - $2.14 per pound active.
- Polymer dose:
  - Screw press – 23 pounds active per dry ton solids.
  - Centrifuge – 30 pounds active per dry ton solids.
- Unit power rate - $0.077 per kW-hr.

6.2 Construction Costs

Construction cost estimates were developed for the four final alternatives and are presented in Table 5. The costs are broken out by new building, existing building modifications, and truck loadout. The truck loadout is a significant portion of the total construction costs, primarily because it is a large, tall structure and is assumed to include architectural features screening it from the view of the neighbors. Costs could be reduced on this element by removing the screen walls and roll-up doors.

The new building cost was developed by using HDR's Timberline parametric cost model. The model uses previous HDR dewatering project costs and scales the Puyallup facility by sludge feed, building size, and other assumptions related to foundation design, etc. Additional assumptions to those discussed in Sections 5.2.1 and 6.1 are as follows:

- A new feed pump will be provided in the existing Solids Handling Facility given that the current pump is over 30 years old.
- Electrical and instrumentation costs are estimated as a percentage of other construction costs.

For the retrofit alternatives, costs were estimated based on conceptual layouts of the FKC screw press and the Andritz centrifuge in the existing Centrifuge Room. These layouts are not for design and only include dewatering devices, screw conveyors, monorails, access platforms, and pedestals to elevate the dewatering devices above the flood level. Also included are roof modifications, as needed, to accommodate the elevated dewatering devices. The assumptions were as follows:

- A liquid polymer feed and storage system located on the lower floor.
- Shaftless screw conveyors (screw press alternative) to transfer cake from the dewatering devices to the storage hopper and truck loadout area.
- A new feed pump in the existing Solids Handling Facility.
- Electrical and instrumentation costs are estimated as a percentage of other construction costs. For simplicity, these costs are assumed to be the same as the new building alternatives as the equipment to be installed is essentially the same between retrofit and new building alternatives.

A 15 percent markup was applied to the estimated construction cost to account for the City's administrative, engineering, permitting, and other non-construction costs that would be associated with the project.

Table 5: Opinion of Probable Construction and Project Costs

CONSTRUCTION COST	ALT 1A: FKC SCREW PRESS RETROFIT	ALT 1B: FKC SCREW PRESS NEW BUILDING	ALT 2A: CENTRIFUGE RETROFIT	ALT 2B: CENTRIFUGE NEW BUILDING
New Building		$2,627,000		$2,578,000
Existing Building Modifications	$1,212,000		$1,141,000	
Truck Loadout	$725,000		$752,000	
Subtotal	$1,937,000	$2,627,000	$1,893,000	$2,578,000
Field Overhead & Mobilization (10%)	$194,000	$263,000	$189,000	$258,000
Profit, Bonds, Insurance (12%)	$291,000	$396,000	$285,000	$388,000
Undefined Scope of Work (25%)	$605,000	$821,000	$592,000	$806,000
Subtotal	$3,027,000	$4,107,000	$2,959,000	$4,030,000
Sales Tax (9.5%)	$288,000	$390,000	$281,000	$383,000
Estimated Construction Cost	$3,315,000	$4,497,000	$3,240,000	$4,413,000
Engineering, Admin, Legal, Permitting (15%)	$497,300	$674,600	$486,000	$662,000
Project Cost	$3,812,300	$5,171,600	$3,726,000	$5,075,000

Detailed estimates with break downs by Construction Specifications Institute (CSI) construction division are presented in Appendix A.

6.3 Annual Operations and Maintenance Costs

Table 6 and Figure 21 present the annual O&M cost estimates for the final dewatering alternatives. Centrifuge alternatives have lower hauling and management costs due to higher cake solids concentrations, but have much higher labor and maintenance materials costs due to the need to continuous monitoring during operation and the need for frequent overhauls.

Table 6: Estimated Annual Operations and Maintenance Costs for Dewatering Alternatives

	ALT 1A: FKC SCREW PRESS RETROFIT	ALT 1B: FKC SCREW PRESS NEW BUILDING	ALT 2A: CENTRIFUGE RETROFIT	ALT 2B: CENTRIFUGE NEW BUILDING
Contractor hauling and land application	$172,400	$172,400	$143,700	$143,700
General Permit, Administration, Sampling/Analysis	$15,900	$15,900	$15,900	$15,900
Power	$5,300	$5,300	$18,900	$18,900
Labor	$24,400	$24,400	$122,100	$122,100
Polymer	$33,300	$33,300	$43,400	$43,400
Equipment Replacement	$44,200	$44,200	$46,700	$46,700

	ALT 1A: FKC SCREW PRESS RETROFIT	ALT 1B: FKC SCREW PRESS NEW BUILDING	ALT 2A: CENTRIFUGE RETROFIT	ALT 2B: CENTRIFUGE NEW BUILDING
Maintenance Materials	$13,200	$13,200	$48,700	$48,700
Total Annual O&M Cost	$308,700	$308,700	$439,400	$439,400

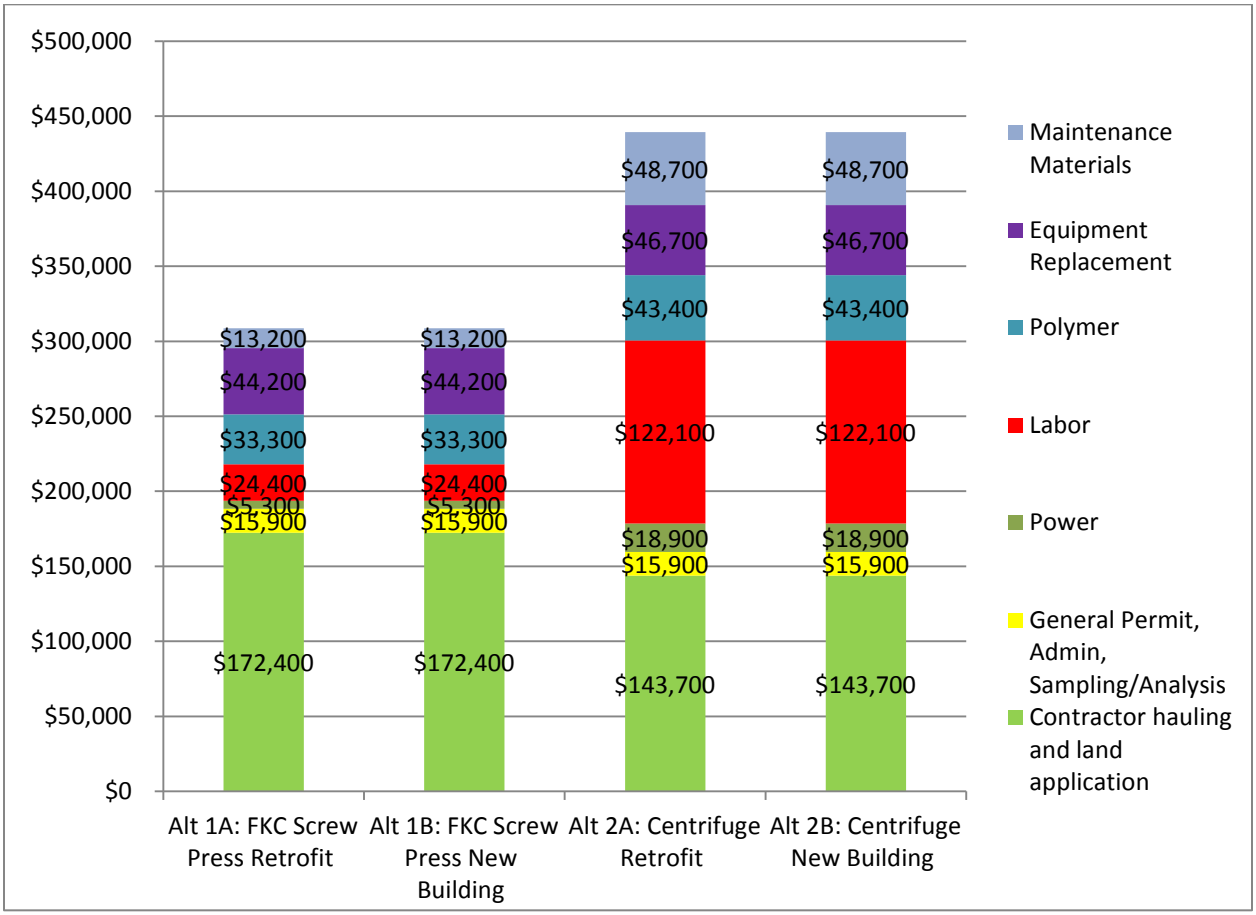

Figure 21: Annual O&M Cost Estimates by Category for Dewatering Alternatives

6.4 Life Cycle Costs

Life cycle costs, which add the project cost and present value of O&M cost, provides the best overall economic comparison of alternatives. For this analysis, a 20 year period at a discount rate of 6 percent was assumed. Table 7 and Figure 22 present the estimated life cycle costs in tabular and graphic form. Table 7 also shows that all four alternatives are within 38 percent of each other, which is within the accuracy range of the cost estimates provided in this evaluation.

Table 7: Life Cycle Cost Estimates for Dewatering Alternatives

	ALT 1A: FKC SCREW PRESS RETROFIT	ALT 1B: FKC SCREW PRESS NEW BUILDING	ALT 2A: CENTRIFUGE RETROFIT	ALT 2B: CENTRIFUGE NEW BUILDING
Project	$3,812,000	$5,172,000	$3,727,000	$5,074,000
Annual O&M	$308,700	$308,700	$439,400	$439,400
Present Value of O&M	$3,541,000	$3,541,000	$5,040,000	$5,040,000
Life Cycle	$7,353,000	$8,713,000	$8,767,000	$10,114,000
Percentage of Lowest Cost Alternative	100%	118%	119%	138%

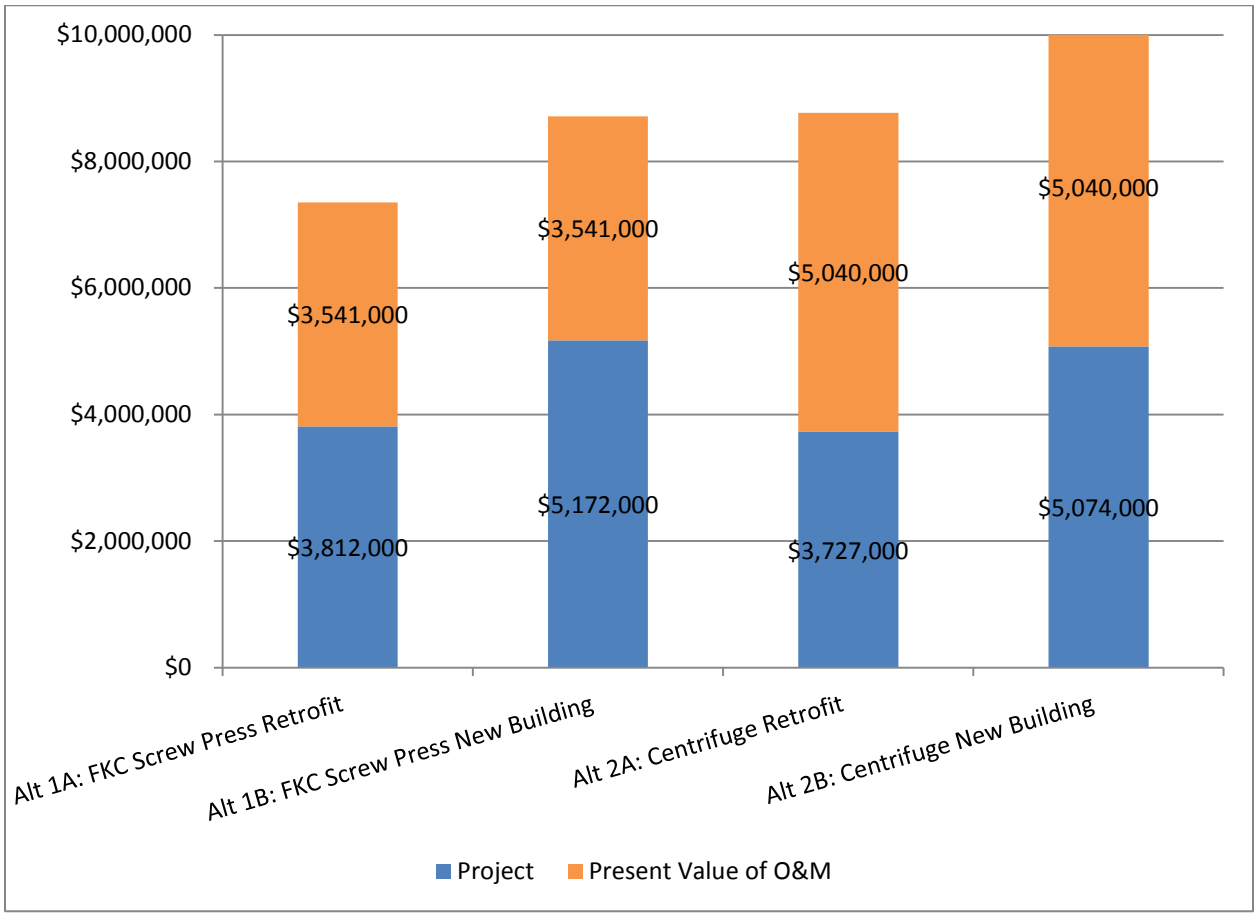

Figure 22: Life Cycle Cost Estimates for Dewatering Alternatives

7.0 Non-Economic Considerations

In addition to economic evaluation, consideration of non-economic criteria is important as the final alternatives have different risks, benefits, and drawbacks that should be compared and considered before a recommendation is made.

7.1 Risks Associated With Retrofit Alternatives (1A and 2A)

Centrifuge Room and overall Solids Handling Facility modifications present risks and unknowns.

7.1.1.1 Ceiling height

Given the flood map elevation that will require mechanical and electrical equipment will be elevated, the ceiling height restricts options for equipment and equipment layout. Equipment evaluated in the conceptual layout appears to fit in a reasonable but restrictive, manner. However, alternate equipment may fit differently than equipment evaluated.

Retrofit of the Centrifuge Room requires removal of:

- Sound panels – removal without complete replacement could create noise issues with a new centrifuge.
- Larger skylight (screw press option), insulation and framing members – energy code evaluation is likely required for obtaining a permit.

7.1.1.2 Structural Design

Dynamic analysis required to confirm high-speed centrifuge acceptable (beyond scope of this study).

Large opening in roof requires additional support (FKC alternative 1A).

Addition of structural frame for monorail (centrifuge alternative 2A).

7.2 Ultimate Fate of Solids Handling Facility

If a new dewatering is located in the Solids Handling Facility, another capital project will likely be required in the next 10-20 years due to the age and condition of the existing building. Costs for such a project were not included in this analysis. The following processes would need to be moved if the SHF was no longer in use:

- Thickening Centrifuge.
- TWAS Storage and Pumping.
- Sludge De-gritting.
- Feed Pumps.

This represents a significant additional cost compared to alternatives that include a new building that could potentially house these processes in the future.

7.3 Non-Economic Criteria

Criteria for evaluation were developed jointly with City staff, and attempt to address the range of non-economic issues that will be important in this decision-making process. Criteria are as follows:

- Construction Disruption – new dewatering system location and whether or not the alternative is a new building or retrofit will determine how much disruption there will be.
- Existing Space Utilization – a retrofit ranks high in this category.

- Space Constraints – retrofit alternatives have more space constraints and the screw press is larger than a centrifuge.
- Condition of Structure/ Building Maintenance – the existing building is older and will require more maintenance than a new structure for the new dewatering process.
- Truck Traffic Flow – the location of the new dewatering process will affect the truck traffic through the plant.
- Storage Space – the Centrifuge Room and Solids Handling Facility currently house chemicals that would be impacted by retrofit alternatives.
- Provides Electrical Room Above Flood Elevation – the existing Solids Handling Facility electrical room is below the flood elevation.
- Ease of Use – accounts for overall dewatering system ease of operation.
- Complexity of Operations and Maintenance – accounts mainly for equipment O&M.
- Reliability – overall robustness of the dewatering process to outages and unplanned down time.
- Noise – although equipped with noise enclosures, typically centrifuges produce more noise at least in the area where they are operating.
- Odor Potential – centrifuges have in some cases produced enough shearing during dewatering to create more odorous biosolids.

Table 8: Non-Economic Criteria Evaluation of Dewatering Alternatives

	ALT 1A: FKC SCREW PRESS RETROFIT	ALT 1B: FKC SCREW PRESS NEW BUILDING	ALT 2A: CENTRIFUGE RETROFIT	ALT 2B: CENTRIFUGE NEW BUILDING
Construction Disruption	2	4	3	4
Existing Space Utilization	5	2	5	2
Space Constraints	1	5	2	5
Condition of Structure/ Building Maintenance	2	5	2	5
Truck Traffic Flow	2	4	2	4
Storage Space	1	5	1	5
Provides Electrical Room Above Flood Elevation	1	5	1	5
Ease of Use	3	5	2	4
Complexity of Operations and Maintenance	5	5	3	3
Reliability	4	5	3	3
Noise	5	5	3	3
Odor Potential	4	4	3	3
Sum	35	54	30	46

1 = worst; 5 = best

8.0 Recommendation

Given the relatively reasonable costs compared to other alternatives and the highest ranking in non-economic criteria evaluation, Alternative 1B, Screw Press in a New Building is recommended.

9.0 Implementation

9.1 Funding

The City has maintained bond funds from a few years ago for funding a dewatering system project. Additional funds have been allocated in the City's recent Capital Improvement Program budget.

9.2 Project Delivery

Multiple methods of project delivery are available to the City, such as traditional design-bid-build, design-build, and general contractor-construction manager (GC/CM). Each have advantages and disadvantages for this project, which are presented in Table 9. Key priorities for the City are:

- Staff would like to have a say in detail design decisions throughout the design process to ensure that staff are comfortable operating and maintaining the system.
- The project schedule is moderately aggressive due to the need to install new equipment quickly as the existing BFP is failing.
- The City would like to select one particular manufacturer of dewatering equipment to ensure that the best system is implemented.

In comparing the project delivery methods, design-bid-build with separate dewatering equipment procurement is recommended.

Table 9: Project Delivery Options for New Dewatering System

PROJECT DELIVERY METHOD	ADVANTAGES	DISADVANTAGES
Design-Bid-Build	Familiar process City involved in detail design and construction decisions throughout Accomodates moderately aggresive schedule	Potential for lower-quality equipment
Design-Build	Accomodates aggresive schedule	Unfamiliar process City not involved in detail design and construction decisions throughout
General Contractor-Construction Manager (GC/CM)	Increased coordination and constructability between designer and contractor Potential for flexibility on equipment selection	Approval from state required, typically for larger projects Separate selection process with RFP for Contractor would delay this project compared with design-bid-build Can be more expensive project overall

9.3 Equipment Procurement

Alternative 1B, Screw Press in a New Building is recommended. The City would like the FKC screw press due to several demonstrated performance, price, and O&M advantages over other equipment evaluated, as discussed in Section 5.1. Several methods for equipment procurement are available:

- During construction bidding:
  - Conventional (design-bid-build) construction contractor selection – relying on specifications for equipment selection
  - Base bid – contractor must provide pricing for preferred equipment
  - Prequalification – contractors are evaluated prior to being allowed to bid
- Separate equipment procurement:
  - Negotiated sole-source - negotiate a price directly with the manufacturer for the model desired. This procurement typically requires justification to satisfy local, state, and federal procurement requirements.
  - Competitive or Evaluated bid - a request for proposals (RFP) could be prepared for equipment and bids evaluated for quality and price. This is typically only done when more than one manufacturer or piece of equipment is under consideration.
  - Independent procurement under a design-build or GC/CM contract

It is recommended that the City pursue a negotiated sole-source contract as it is the most straightforward and likely the quickest method of procurement for the FKC screw press.

Since equipment pre-purchase typically involves a contract between the manufacturer and the City directly, the equipment manufacturer would have no contractual relationship with the construction contractor that would install the equipment. The lack of contractual relationship creates some issues that must be addressed in the construction contract, including delivery, storage, and handling of the equipment on site. In some cases, it is advantageous to assign the equipment to the Contractor in the construction contract. This involves providing detailed information (shop drawings, etc.) for the dewatering equipment and specifying the manufacturer's instructions on handling, warranty, and other installation and start-up requirements.

The time between purchase order and delivery for the FKC screw press is 5 to 9 months. This means that to accelerate and maintain a construction schedule, the equipment should be pre-purchased to avoid delays during construction.

It is recommended that the City evaluate the requirements required for sole-source procurement of the FKC screw press and select the simplest, most straightforward allowable to procure the press.

9.4 Schedule

The City would like to proceed as soon as possible with design, equipment procurement, and construction. Equipment procurement and design of the new facility can move in parallel to ensure that the screw press is delivered so as to not adversely affect the construction schedule. Figure 23 presents an implementation schedule for the project, which would be completed at the beginning of 2016.

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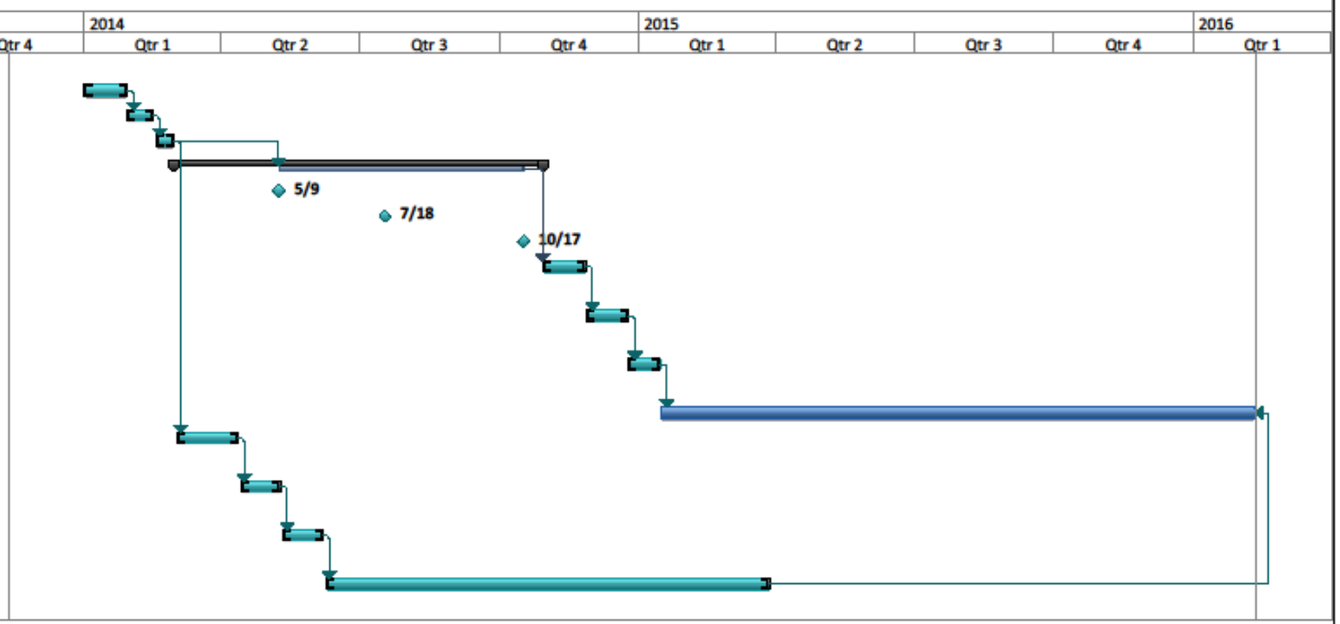
ID	Ta M	Task Name	Duration	Start	Finish
1					
2		Design RFP	20 days	Wed 1/1/14	Tue 1/28/14
3		Engineer Selection	13 days	Wed 1/29/14	Fri 2/14/14
4		Contract Negotiations	10 days	Mon 2/17/14	Fri 2/28/14
5		**Design**	**173 days**	**Fri 2/28/14**	**Wed 10/29/14**
6		30% Submittal	0 days	Fri 5/9/14	Fri 5/9/14
7		60% Submittal	0 days	Fri 7/18/14	Fri 7/18/14
8		90% Submittal	0 days	Fri 10/17/14	Fri 10/17/14
9		City Authorization to Bid	20 days	Thu 10/30/14	Wed 11/26/14
10		Construction Bid Period	20 days	Thu 11/27/14	Wed 12/24/14
11		Contractor Bid Review, Bonds and Insurance	15 days	Thu 12/25/14	Wed 1/14/15
12		Construction	280 days	Thu 1/15/15	Wed 2/10/16
13		Equipment Procurement Contract Documents	30 days	Mon 3/3/14	Fri 4/11/14
14		Screw Press Bid Period/Negotiation	20 days	Mon 4/14/14	Fri 5/9/14
15		Screw Press Submittals Review and Approval	20 days	Mon 5/12/14	Fri 6/6/14
16		Screw Press Fabrication and Delivery	210 days	Mon 6/9/14	Fri 3/27/15



Project: Schedule Puyallup
Date: Tue 11/12/13

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline	
Split	External Tasks	Inactive Summary	Manual Summary	Progress	
Milestone	External Milestone	Manual Task	Start-only		
Summary	Inactive Task	Duration-only	Finish-only		

Page 1

Figure 23: Project Schedule

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APPENDIX A

Opinion of Probable Construction Costs

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Alternative 1A: Screw Press in Centrifuge Room

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Puyallup Solids
Retrofit Screw Press Option Rev 2
Puyallup, WA

Estimators	Email
Dan Blackwell 208-387-7010	daniel.blackwell@hdrinc.com
Scott Bishop 704-338-6770	Scott.bishop@hdrinc.com
Estimate Class Based on AACE International Recommended Practice No. 17R-97 (COST ESTIMATE CLASSIFICATION SYSTEM)	Class 4 - 1% to 15% Project Definition (Accuracy Range Index of 2 = +40% to -20% Range of accuracy)
Cost Basis for Estimate	RS Means 3rd Qtr 2013 Wage Base geographically adjusted for Seattle, WA
	Contractor's Field General Conditions, Mobilization and Demobilization at 10% of Direct cost.
	9.5% Sales Tax on total construction costs.
	Prime Contractor's Office Overhead and Profit of 12%
	Contractor's Bond and Builder's Risk Insurance of 1.5%
	Overall Project Contingency is 25%
	No escalations have been included.
	Estimate based on a construction duration of 6 months

Puyallup Solids
Retrofit Screw Press Option Rev 2
Puyallup, WA

Estimate Dates	10/28/2013
Special Notes	
	RS Means Unit Prices with O&P where used in the case of subcontracted work which are placed in the detailed estimate worksheets in the Subcontract Column
	RS Means Unit Prices for anticipated self perform work do not include O&P which is added as mark ups at the bottom of each worksheet and carried forward to the Summary Worksheet.
	Quantities were estimated using the most current Preliminary drawings or verbal descriptions presented by the design team.
	Field General conditions are included as a percentage of Direct Cost
	Estimate is based on all work except paving, caissons, masonry, roofing, sheet metal, skylight, overhead door, coatings, HVAC, Electrical and Instrumentation being self perform work. No additional subcontractor mark up is included beyond those items of work.
	Estimator's Equipment Installation Experience Standards using Area Labor rates for Appropriate trades

Est. Assumptions

Puyallup Solids
Retrofit Screw Press Option Rev 2
Puyallup, WA

Estimate Area	#	Description
General Project Assumptions		
	1	Any opinions of probable construction cost or cost estimates provided by HDR, Inc. are made on the basis of information available to HDR, Inc. and on the basis of cost estimator's experience and qualifications, and represents its judgment as an experienced and qualified professional engineer. However, since HDR, Inc. has no control over the cost of labor, materials, equipment or services furnished by others, or over the contractor(s') methods of determining prices, or over competitive bidding or market conditions, HDR, Inc. does not guarantee that proposals, bids or actual project or construction cost will not vary from opinions of probable cost or cost estimates prepared by HDR, Inc
	2	OPCC is based on information provided on drawings S9-1 thru S9-6, A9-3, H9-3, M9-8, Navisworks 3D Model Solids Building FKC900, marked up site sketch 8/21/13, and verbal discussions with design team.
	3	Assumes owner will provide all power, water, chemicals, testing, etc. for start-up and testing of the new systems.
	4	
	5	
	6	
WBS 100 - Solids Bldg Screw Press Retrofit		
Division 2 - Site Construction		
02072.005 - Demolition Asphalt Paving	1	Includes removal and disposal of 89 sy of asphalt paving for new Truck Loadout Pad.
02072.010 - Demo Masonry Wall for Screw Conveyor	2	Includes sawcut and removal of 16 sf masonry block at Screw Conveyor wall penetration.
02072.015 - Demo Roof At Skylight	3	Includes demolition and removal of existing roof for installation of new skylight
02200.005 - Excavate/Backfill Truck Loadout Pad	4	Excavate and backfill for 30' x 15' Truck Loadout SOG 12" deep. Includes haul off and disposal of excess excavated material within 3 mile round trip. Excludes disposal fees.
02200.010 - Excavate/Backfill Pile Caps	5	Excavate and backfill for eight (8) pile caps 8' lg x 2' w x 2' dp. Includes haul off and disposal of excess excavated material within 3 mile round trip. Excludes disposal fees
02373.005 - Drilled 18" Caissons	6	Includes twenty four (24) 18" diameter x 25' deep drilled caissons. Includes drilling, concrete, rebar, and casing removal.
02513.005 - Patch Asphalt Paving	7	Includes 350 sf of asphalt paving patch at new Truck Loadout Pad.
	8	
Division 3 - Concrete	9	
03002.105 - Concrete Pile Caps	10	Includes eight (8) formed concrete pile caps 8' lg x 2' w x 2' dp. Includes reinforcing steel at 225 lbs/cy.
03002.705 - Truck Loadout Slab on Grade	11	Includes 30' x 15' x 18" deep cast in place concrete slab on grade. Assumes 4,000 psi concrete with 175 lbs/cy of reinforcing steel. Includes 12" compacted gravel under slab.
03002.710 - Concrete - Screw Press Pad	12	Assumes 25' x 6' x 12" deep cast in place concrete pad. Assumes 4,000 psi concrete with 175 lbs/cy of reinforcing steel.
	13	

Est. Assumptions

Puyallup Solids
Retrofit Screw Press Option Rev 2
Puyallup, WA

Estimate Area	#	Description
Division 4 - Masonry	14	
04220.005 - Concrete Masonry - Truck Loadout	15	Includes 30' long x 15' wide x 25' tall 8" split face CMU walls for Truck Loadout enclosure.
	16	
Division 5 - Metals	17	
05505.005 - Metal Frame/Cover - Conveyor Penetration	18	Includes a budget to frame and seal around screw conveyor at masonry wall penetration.
05505.010 - Screw Press Platform	19	Includes a budget for an aluminum Screw Press access platform approximately 20' lg x 4' w x 5' h with aluminum grating and 1 1/2" aluminum handrail on 2 sides.
	20	
Division 7 - Thermal & Moisture Protection	21	
07501.005 - Built Up Roofing - Truck Loadout	22	Assumes Truck Loadout requires a roof over the hopper. Includes 450 sf of Built Up Roof over metal deck and bar joists. Roof system is similar to system used in the new Dewatering Building estimate.
07600.005 - Aluminum Fascia	23	Includes a budget for 272 sf of Aluminum Fascia installed on 1" x 2" wood furring.
07813.005 - Skylight Over Screw Press	24	Includes an allowance of $10,000 to purchase a removable skylight and install over the new Screw Press.
	25	
Division 8 - Doors & Windows	26	
08120.031 - Aluminum Doors/Frames - Truck Loadout	27	Includes one (1) 3' x 7' aluminum mandoor with hardware at Truck Loadout.
08334.005 - Aluminum Rolling Overhead Door - Truck Loadout	28	Includes one (1) 12' x 12' aluminum overhead door with electric operator at Truck Loadout.
	29	
Division 9 - Finishes	30	
09905.000 - Painting and Protective Coatings	31	Includes touch-up of existing and painting of new equipment and piping in the existing Solids Building.
09905.005 - Painting and Protective Coatings - Truck Loadout Masonry	32	Includes sealing exterior and painting interior masonry walls at new truck loadout.
	33	
Division 11 - Equipment	34	
11005.000 - Equipment: Basic Requirements	35	Includes 2 days start-up and testing of Screw Press and Conveyor.
11069.000 - Pumping Equipment: Progressing Cavity	36	Includes purchasing and installing two(2) 15 hp, 300 gpm progressive cavity pumps. Includes the same purchase price for the pumps ($63,846) as in the new Dewatering Building Estimate.
11365.005 - Screw Press	37	Includes purchasing and installing an FKC Screw Press in the existing Solids Building. Includes the same purchase price for the equipment ($375,465) as in the new Dewatering Building estimate. Assumes Flocculator is included in equipment price. Assumes screw press comes factory assembled and skid mounted. Assumes equipment will fit through existing door.
11923.000 - Polymer System	38	Includes purchasing and installing a Polymer System in the existing Solids Building. Includes the same purchase price for the equipment ($100,000) as in the new Dewatering Building estimate.
	39	
Division 13 - Special Construction	40	
13440.000 - Instrumentation for Process Control	41	Includes a budget for Instrumentation and Control work of $106,273.
	42	

Est. Assumptions

Puyallup Solids
Retrofit Screw Press Option Rev 2
Puyallup, WA

Estimate Area	#	Description
Division 14 - Conveying Systems	43	
14305.005 - Remove/Modify Existing Overhead Hoist	44	Includes a budget to either remove or possibly modify conflicting sections of hoist rail.
14551.000 - Conveyors: Screw	45	Includes purchase and install a stainless steel screw conveyor system 62' long from the new screw press in the existing Solids Building to the Automatic Hopper in the new Truck Loadout. Includes a budget of $96,999 to purchase the conveyor system.
14552.000 - Automated Hopper	46	Includes purchasing and installing an Automated Hopper in the new Truck Loadout. Includes the same purchase price for the equipment ($500,000) as in the new Dewatering Building estimate. Includes the same installation costs as in the new Dewatering Building estimate. Assumes includes all necessary supporting frame for a complete installation.
	47	
Division 15 - Mechanical	48	
01410.000 - Testing	49	Includes 2 days for hydro testing new piping.
15062.005 - Pipe: Ductile - Screw Press Process Pipe	50	Includes a budget to tie into existing sludge lines located in the lower level of the existing Solids Building using 6" ductile iron pipe with Protecto 401 lining. Includes 12 ea spools, 8 each 90 bends, 2 ea tees, 2 each reducers, 2 each motor operated plug valves, 1 each check valve, 2 each expansion joints, and 2 each floor penetrations.
15064.005 - Pipe: Plastic - Polymer Piping	51	Includes 80 lf of 1" sch 80 PVC piping. Includes 2 each ball valves and 1 each ball check valve. Assumes connection to existing polymer feed system within the existing Solids Building. Excludes the purchase or installation of any equipment.
15064.005 - Pipe: Plastic - NPW Piping	52	Includes 80 lf of 1 1/2" sch 80 PVC piping to the Truck Loadout. Assumes connection to existing NPW system within the existing Solids Building. Excludes the purchase or installation of any equipment.
15073.005 - Pipe - CISP - Truck Unloading Drain	53	Includes 30 lf of 6" no hub cast iron soil pipe from Truck Unloading Trench Drain to a connection with existing drain line in Dewatering Building.
15440.005 - Truck Loadout SOG Trench Drain	54	Includes 20 lf of 8" wide concrete encased FRP trench drain with cast iron top.
15605.000 - HVAC: Modifications	55	Includes a subcontract budget of $10,00 for HVAC and Odor Control ductwork modifications.
	56	
Division 16 - Electrical	57	
16010.000 - Electrical Subcontract	58	Includes a budget for Electrical Subcontract work of 318,820.

DEWATERING FACILITY
RETROFIT OPTION - SCREW PRESS - REV 2
PUYALLUP, WA

Project name	Dewater Facility Retrofit Puyallup WA
Labor rate table	CONC2013
Equipment rate table	CONC2013
Bid date	10/16/2013
Project Name 1	Puyallup Dewatering
Project Name 2	Retrofit Option
Project Info 1	Screw Press Rev 2
Design Stage 1	Planning Level
Design Stage 2	Estimate
Estimate Version	1.0
Upper Range +%	40
Lower Range -%	20
Labor Rate Table	3rd Qtr 2013
Equip Rate Table	3rd Qtr 2013
Notes	Any opinions of probable construction cost or cost estimates provided by HDR, Inc. are made on the basis of information available to HDR, Inc. and on the basis of cost estimator's experience and qualifications, and represents its judgment as an experienced and qualified professional engineer. However, since HDR, Inc. has no control over the cost of labor, materials, equipment or services furnished by others, or over the contractor(s') methods of determining prices, or over competitive bidding or market conditions, HDR, Inc. does not guarantee that proposals, bids or actual project or construction cost will not vary from opinions of probable cost or cost estimates prepared by HDR, Inc.
Report format	Sorted by 'WBS_MAIN/MF95_DIV/HDR95SPEC/Group phase/Phase' 'HDR95SPEC' summary Allocate addons Print sort level notes
Cost index	980-WA-SEATTLE

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

Description	Quantity		Labor Amount	Material Amount	Subcontract Amount	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
100 Solids Building Screw Press Retrofit									
DIVISION 02 **SITE CONSTRUCTION**									
02072.005 Demolition - Asphalt Paving	89.00	sy	619	2,314		438	160	39.67 /sy	3,531
02072.010 Demo Masonry Wall for Screw Conveyor	1.00	ls	810	5		621		1,435.96 /ls	1,436
02072.015 Demo Roof For Skylight	1.00	ls	897				500	1,397.07 /ls	1,397
02200.005 Excavate/Backfill Truck Loadout Pad	30.00	cy	714			732		48.191/cy	1,446
02200.010 Excavate/Backfill Pile Caps	40.00	cy	2,130			288		60.461/cy	2,418
02373.005 Drilled 18" Caissons	600.00	vlf	21,284	6,318		14,183		69.641/vlf	41,785
02513.005 Patch Asphaltic Paving	350.00	sf	490	2,376		728		10.27 /sf	3,594
DIVISION 02 SITE CONSTRUCTION			**26,944**	**11,012**		**16,990**	**660**		**55,606**
510.495 Labor hours									
187.02 Equipment hours									
DIVISION 03 **CONCRETE**									
03002.105 Concrete Pile Caps	9.50	cy	2,670	2,492		12		544.65 /cy	5,174
03002.705 Truck Loadout Slab on Grade	25.00	cy	4,011	5,884		355		410.02 /cy	10,250
03002.710 Concrete - Screw Press Pad	6.00	cy	1,181	1,339		12		422.04 /cy	2,532
DIVISION 03 CONCRETE			**7,862**	**9,716**		**379**			**17,957**
141.615 Labor hours									
14.960 Equipment hours									
DIVISION 04 **MASONRY**									
04220.005 Concrete Masonry - Truck Loadout	2,250.00	sf	29,868	20,177		519		22.473/sf	50,564
DIVISION 04 MASONRY			**29,868**	**20,177**		**519**			**50,564**
520.602 Labor hours									
26.974 Equipment hours									
DIVISION 05 **METALS**									
05505.005 Metal Frame/Cover - Conveyor Penetration	1.00	ls	931	2,875			288	4,093.48 /ls	4,093
05505.010 Screw Press Platform	1.00	ls	2,948	18,675		992		22,615.66 /ls	22,616
DIVISION 05 METALS			**3,879**	**21,550**		**992**	**288**		**26,709**
61.80 Labor hours									
8.45 Equipment hours									
DIVISION 07 **THERMAL& MOISTURE PROTECTION**									
07501.005 Built-Up Roofing System - Truck Loadout	450.00	sf	4,512	7,955		232		28.221/sf	12,699

				Labor	Material	Subcontract	Equipment	Other	Total	
Description		**Quantity**		**Amount**	**Amount**	**Amount**	**Amount**	**Amount**	**Unit Cost**	**Amount**
07600.005	Aluminum Fascia	272.00	sf	2,890	2,027		1,174	626	24.693/sf	6,716
07813.005	Skylight Over Screw Press	1.00	ea	3,180	13,089			575	16,843.55 /ea	16,844
DIVISION 07 THERMAL& MOISTURE PROTECTION				**10,582**	**23,072**		**1,405**	**1,201**		**36,259**
165.121	Labor hours									
28.11	Equipment hours									
DIVISION 08	**DOORS & WINDOWS**									
08120.031	Aluminum Doors & Frames - Truck Loadout	1.00	ea	687	2,064				2,751.32 /ea	2,751
08334.005	Aluminum Rolling Overhead Door - Truck Loadout	1.00	ea	1,095	4,975				6,070.45 /ea	6,070
DIVISION 08 DOORS & WINDOWS				**1,782**	**7,039**					**8,822**
27.433	Labor hours									
DIVISION 09	**FINISHES**									
09905.000	Painting and Protective Coatings	1.00	ls			15,000			15,000.00 /ls	15,000
09905.005	Painting and Protective Coatings - Truck Load Out Masonry	1.00	ls	1,408	1,804				3,211.55 /ls	3,212
DIVISION 09 FINISHES				**1,408**	**1,804**	**15,000**				**18,212**
29.05	Labor hours									
DIVISION 11	**EQUIPMENT**									
11005.000	Equipment: Basic Requirements	1.00	ea	1,065	624			400	2,088.93 /ea	2,089
11069.000	Pumping Equipment: Progressing Cavity	2.00	ea	3,503	64,664		2	1,131	34,649.870/ea	69,300
11365.005	Screw Press	1.00	ea	11,863	383,329		2,000	2,000	399,192.73 /ea	399,193
11923.000	Polymer System	1.00	ls	11,440	100,361		1		111,801.47 /ls	111,801
DIVISION 11 EQUIPMENT				**27,871**	**548,978**		**2,003**	**3,531**		**582,383**
453.132	Labor hours									
11.800	Equipment hours									
DIVISION 13	**SPECIAL CONSTRUCTION**									
13440.000	Instrumentation for Process Control	1.00	ls			106,273			106,273.01 /ls	106,273
DIVISION 13 SPECIAL CONSTRUCTION						**106,273**				**106,273**
DIVISION 14	**CONVEYING SYSTEMS**									
14305.005	Remove or Modify Existing Overhead Hoist	1.00	ls	1,497	2,000		147	1,000	4,644.78 /ls	4,645
14551.000	Conveyors: Screw	1.00	ea	16,058	96,999			3,543	116,599.95 /ea	116,600
14552.000	Automated Hopper	1.00	ea	23,998	500,000		4,498		528,495.53 /ea	528,496
DIVISION 14 CONVEYING SYSTEMS				**41,553**	**598,999**		**4,645**	**4,543**		**649,740**
828.260	Labor hours									
48.00	Equipment hours									
DIVISION 15	**MECHANICAL**									

				Labor	Material	Subcontract	Equipment	Other	Total	
Description		**Quantity**		**Amount**	**Amount**	**Amount**	**Amount**	**Amount**	**Unit Cost**	**Amount**
01410.000	Testing	1.00	ls	1,827	300		648		2,775.12 /ls	2,775
15062.005	Pipe: Ductile - Screw Press Process Pipe	1.00	ls	6,312	30,567	400			37,278.78 /ls	37,279
15064.005	Pipe: Plastic - Polymer Piping	1.00	ls	2,030	874				2,903.63 /ls	2,904
15064.010	Pipe: Plastic - NPW Piping	1.00	ls	2,528	1,608				4,136.32 /ls	4,136
15073.005	Pipe: Cast-Iron Soil - Truck Unloading Drain Line	30.00	lf	1,721	2,555			300	152.56 /lf	4,577
15440.005	Truck Loadout SOG FRP Trench Drain	20.00	lf	778	2,873		55		185.30 /lf	3,706
15605.000	HVAC: Modifications	1.00	ls			10,000			10,000.00 /ls	10,000
DIVISION 15 MECHANICAL				**15,196**	**38,776**	**10,400**	**704**	**300**		**65,376**
217.07	Labor hours									
19.00	Equipment hours									
DIVISION 16	**ELECTRICAL**									
16010.000	Electrical Subcontract	1.00	ls			318,820			318,820.01 /ls	318,820
DIVISION 16 ELECTRICAL						**318,820**				**318,820**
100 Solids Building Screw Press Retrofit				***166,945***	***1,281,123***	***450,493***	***27,638***	***10,522***	***1,936,721.16 /LS***	***1,936,721***
1.00	***LS***									
2,954.571	Labor hours									
344.31	Equipment hours									

Estimate Totals

Description	Amount	Totals	Hours	Rate
Labor	166,945		2,954.571 hrs	
Material	1,281,123			
Subcontract	450,493			
Equipment	27,638		344.308 hrs	
Other	10,522			
Direct Cost - Subtotal		**1,936,721**		
Contractor's Fld Ovhd & Mob	193,672			10.000 %
Field Const Cost - Subtotal		**2,130,393**		
Contractor's Fee	255,647			12.000 %
Contractor's Bonds & Insurance	35,791			1.500 %
Undefined SOW (Contingency)	605,458			25.000 %
Subtotal		**3,027,289**		
Escalation (NONE INCLUDED)				0.000 %
Sales Tax Estimate (Total)	287,592			9.500 %
Current OPCC Estimate Budget		**3,314,881**		

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

Project name	Dewater Facility Retrofit Puyallup WA
Labor rate table	CONC2013
Equipment rate table	CONC2013
Bid date	10/16/2013
Project Name 1	Puyallup Dewatering
Project Name 2	Retrofit Option
Project Info 1	Screw Press Rev 2
Design Stage 1	Planning Level
Design Stage 2	Estimate
Estimate Version	1.0
Upper Range +%	40
Lower Range -%	20
Labor Rate Table	3rd Qtr 2013
Equip Rate Table	3rd Qtr 2013
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Cost index	980-WA-SEATTLE

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
		100 Solids Building Screw Press Retrofit										
	DIVISION 02	**SITE CONSTRUCTION**										
	02072.005	*Demolition - Asphalt Paving*										
n	5050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	89.00	sy	446	-	-		279	-	8.152 /sy	726
n	0400	Selective demolition, disposal only, includes loading and 5 mile haul to dump	20.00	cy	108	-	-		118	-	11.294 /cy	226
n	0100	Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	30.00	ton	-	2,303	-		-	-	76.752 /ton	2,303
n	0015	Selective demolition, saw cutting, asphalt, up to 3" deep	80.00	lf	65	11	-		41	160	3.46 /lf	277
		02072.005 Demolition - Asphalt Paving			*619*	*2,314*			*438*	*160*	*39.67 /sy*	*3,531*
		89.00 sy										
		11.853 Labor hours										
		9.69 Equipment hours										
	02072.010	*Demo Masonry Wall for Screw Conveyor*										
n	2440	Selective demolition, cutout, concrete block, to 4 S.F. opening, 8" thick, excludes loading and disposal	1.00	ea	374	-	-		160	-	534.450 /ea	534
n	0800	Concrete sawing, concrete walls, plain, per inch of depth, hydraulic saw (4' x 4' = 16' x 8" deep = 128 lf)	128.00	lf	436	5	-		461	-	7.043 /lf	902
		02072.010 Demo Masonry Wall for Screw Conveyor			*810*	*5*			*621*		*1,435.96 /ls*	*1,436*
		1.00 ls										
		16.192 Labor hours										
		24.384 Equipment hours										
	02072.015	*Demo Roof For Skylight*										
n	3001	Roofing and siding demolition	125.00	sf	897	-	-		-	500	11.18 /sf	1,397
		02072.015 Demo Roof For Skylight			*897*					*500*	*1,397.07 /ls*	*1,397*
		1.00 ls										
		20.00 Labor hours										
	02200.005	*Excavate/Backfill Truck Loadout Pad*										
n	0310	Excavating, bulk bank measure, 1/2 C.Y. capacity = 40 C.Y./hour, backhoe, hydraulic, wheel mounted, excluding truck loading	30.00	bcy	442	-	-		205	-	21.554 /bcy	647
n	1600	Backfill, bulk, 6" to 12" lifts, compaction with vibrating roller	13.00	ecy	228	-	-		446	-	51.802 /ecy	673
n	0450	Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip , 1.9 loads/hour, 12 C.Y. truck, highway haulers, excludes loading	19.55	lcy	44	-	-		82	-	6.43 /lcy	126

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
		02200.005 Excavate/Backfill Truck Loadout Pad			*714*				*732*		*48.191/cy*	*1,446*
		30.00 cy										
		12.920 Labor hours										
		8.920 Equipment hours										
	02200.010	*Excavate/Backfill Pile Caps*										
n	0310	Excavating, bulk bank measure, 1/2 C.Y. capacity = 40 C.Y./hour, backhoe, hydraulic, wheel mounted, excluding truck loading	40.00	bcy	442	-	-		205	-	16.17 /bcy	647
n	0100	Backfill, heavy soil, by hand, no compaction	40.00	lcy	1,351	-	-		-	-	33.79 /lcy	1,351
n	0500	Backfill and compact, by hand, 6" layers, air rammer/tamper, add	32.00	ecy	317	-	-		45	-	11.291 /ecy	361
n	0450	Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip , 1.9 loads/hour, 12 C.Y. truck, highway haulers, excludes loading	9.20	lcy	21	-	-		38	-	6.43 /lcy	59
		02200.010 Excavate/Backfill Pile Caps			*2,130*				*288*		*60.461/cy*	*2,418*
		40.00 cy										
		44.261 Labor hours										
		11.17 Equipment hours										
	02373.005	*Drilled 18" Caissons*										
n	1300	Fixd end cssn pils,open styl wet grnd,50'd,18"d,0.065 cy/l, mchn drll,pull casng and pmpng,incld excvt,cncrt,50lb rnfr/, excld mblzt,bldr remvl,dispsl	600.00	vlf	10,649	6,318	-		12,514	-	49.134 /vlf	29,480
n	4500	Fixed end caisson piles, load and haul excess excavation, 2 miles	47.00	lcy	98	-	-		215	-	6.661 /lcy	313
n	4600	Fixed end caisson piles, for mobilization, 50 mile radius, rig to 36"	1.00	ea	1,188	-	-		1,454	-	2,641.91 /ea	2,642
n	5000	Fixed end caisson piles, bottom inspection, add	24.00	ea	9,349	-	-		-	-	389.56 /ea	9,349
		02373.005 Drilled 18" Caissons			*21,284*	*6,318*			*14,183*		*69.641/vlf*	*41,785*
		600.00 vlf										
		396.112 Labor hours										
		126.112 Equipment hours										
	02513.005	*Patch Asphaltic Paving*										
	0480	Plant-mix asphalt paving, for highways and large paved areas, wearing course, 4" thick, no hauling included	89.00	sy	119	1,710	-		74	-	21.374 /sy	1,902
	0600	Asphaltic concrete paving, parking lots & driveways, binder course, 4" thick, no asphalt hauling included	350.00	sf	90	666	-		90	-	2.42 /sf	846
n	0560	Hauling, asphalt material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	27.00	lcy	281	-	-		564	-	31.321 /lcy	846
		02513.005 Patch Asphaltic Paving			*490*	*2,376*			*728*		*10.27 /sf*	*3,594*
		350.00 sf										
		9.16 Labor hours										
		6.744 Equipment hours										

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	DIVISION 02 SITE CONSTRUCTION			**26,944**	**11,012**	**0**		**16,990**	**660**		**55,606**
	510.495 Labor hours										
	187.02 Equipment hours										
DIVISION 03	**CONCRETE**										
03002.105	*Concrete Pile Caps*										
n 3061	C.I.P. concrete forms, foundation, edge, wood, over 12", 4 use, includes erecting, bracing, stripping and cleaning	320.00	sfca	1,547	268	-		-	-	5.67 /sfca	1,814
n 0605	Reinforcing steel, in place, FOUNDATIONS, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	1.07	ton	912	1,212	-		-	-	1,991.14 /ton	2,125
n 2005	Reinforcing steel, unload and sort, add to base_FOUNDATIONS	1.07	ton	36	-	-		8	-	41.23 /ton	44
n 4602	Structural concrete, placing, foundation, direct chute, over 6" thick, includes vibrating, excludes material	9.481	cy	134	-	-		4	-	14.55 /cy	138
n 0300	Struct FOUNDATION concrete,ready mix,normal wt,4000 psi,includes local aggregate,sand,portland cement and water,delivered,excludes all additives	9.481	cy	-	1,013	-		-	-	106.794 /cy	1,013
n 0105	Concrete finishing, floors, manual screed, bull float_FOUNDATIONS	128.00	sf	41	-	-		-	-	0.32 /sf	41
	03002.105 Concrete Pile Caps			*2,670*	*2,492*			*12*		*544.65 /cy*	*5,174*
	9.50 cy										
	48.23 Labor hours										
	1.005 Equipment hours										
03002.705	*Truck Loadout Slab on Grade*										
n 3050	C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning	135.00	sfca	525	121	-		-	-	4.781 /sfca	646
n 0600	Reinforcing Steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	2.19	ton	1,871	2,486	-		-	-	1,991.143 /ton	4,357
n 2050	Reinforcing steel, unload and sort, add to base_SLAB ON GRADE	2.19	ton	74	-	-		16	-	41.23 /ton	90
n 2220	Reinforcing steel, crane cost for handling, average, add_SLAB ON GRADE	2.19	ton	80	-	-		18	-	44.82 /ton	98
n 4300	Structural concrete, placing, slab on grade, direct chute, up to 6" thick, includes leveling (strike off) & consolidation, excludes material	25.00	cy	530	-	-		15	-	21.82 /cy	546
n 0720	Struct SLAB ON GRADE concrete,ready mix,normal wt,4000 psi,includes local aggregate,sand,portland cement and water,delivered,excludes all additives	25.00	cy	-	2,670	-		-	-	106.794 /cy	2,670
n 0255	Concrete finishing, floors, manual screed, bull float, machine float & steel trowel (walk-behind)_SOG	450.00	sf	335	-	-		14	-	0.78 /sf	349

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	03002.705	*Truck Loadout Slab on Grade*										
n	0310	Concrete surface treatment, curing, sprayed membrane compound_SOG	4.50	csf	35	38	-		-	-	16.26 /csf	73
n	1200	Vapor retarders, building paper, polyethylene vapor barrier, standard, .010" thick	4.50	sq	53	33	-		-	-	18.97 /sq	85
n	1010	Fill, gravel fill, compacted, under floor slabs,	19.00	ecy	374	537	-		25	-	49.27 /ecy	936
n	1136	Hauling, excavated borrow material, loose cubic yards, 20 mile round trip, 0.4 loads/hour, 16.5 c.y. dump trailer, highway haulers, excludes loading	19.00	lcy	135	-	-		266	-	21.123 /lcy	401
		03002.705 Truck Loadout Slab on Grade			*4,011*	*5,884*			*355*		*410.02 /cy*	*10,250*
		25.00 cy										
		72.28 Labor hours										
		12.995 Equipment hours										
	03002.710	*Concrete - Screw Press Pad*										
n	3060	C.I.P. concrete forms, slab on grade, edge, wood, over 12", 4 use, includes erecting, bracing, stripping and cleaning	62.00	sfca	300	52	-		-	-	5.67 /sfca	352
n	5200	Chamfer strip, wood, 3/4" wide	66.00	lf	56	18	-		-	-	1.12 /lf	74
n	0600	Reinforcing Steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	0.53	ton	449	596	-		-	-	1,991.14 /ton	1,045
n	2050	Reinforcing steel, unload and sort, add to base_SLAB ON GRADE	0.53	ton	18	-	-		4	-	41.22 /ton	22
n	2220	Reinforcing steel, crane cost for handling, average, add_SLAB ON GRADE	0.53	ton	19	-	-		4	-	44.84 /ton	24
n	9005	Reinforcing steel, in place, drill and epoxy dowels, deformed, 2' long, #5, A615, grade 60; incl drilling into existing concrete and injected epoxy	24.00	ea	49	20	-		-	-	2.88 /ea	69
n	4300	Structural concrete, placing, slab on grade, direct chute, up to 6" thick, includes leveling (strike off) & consolidation, excludes material	6.00	cy	127	-	-		4	-	21.82 /cy	131
n	0720	Struct SLAB ON GRADE concrete,ready mix,normal wt,4000 psi,includes local aggregate,sand,portland cement and water,delivered,excludes all additives	6.00	cy	-	641	-		-	-	106.793 /cy	641
n	0200	Concrete finishng,floors,basic finishng for unspecfd flatwork,bull float,manual float&manual steel trowel,excludes placing,striking off&consolidating	150.00	sf	151	-	-		-	-	1.01 /sf	151
n	0310	Concrete surface treatment, curing, sprayed membrane compound_SOG	1.50	csf	12	13	-		-	-	16.26 /csf	24
		03002.710 Concrete - Screw Press Pad			*1,181*	*1,339*			*12*		*422.04 /cy*	*2,532*
		6.00 cy										
		21.11 Labor hours										
		0.960 Equipment hours										

Item		Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
		DIVISION 03 CONCRETE			**7,862**	**9,716**	**0**		**379**	**0**		**17,957**
		141.615 Labor hours										
		14.960 Equipment hours										
DIVISION 04		**MASONRY**										
	04220.005	*Concrete Masonry - Truck Loadout*										
n	0090	Scaffolding, steel tubular, regular, labor only to erect & dismantle, building exterior, wall face, 6'-4" x 5' frames, 1 to 5 stories, excl. planks	23.00	csf	3,839	-	-		-	-	166.90 /csf	3,839
n	0906	Scaffolding, steel tubular, regular, rent/month only for complete system for face of walls, 6' -4" x 5' frames, excl. planks	23.00	csf	-	828	-		-	-	36.00 /csf	828
n	2850	Scaffolding, steel tubular, regular, accessory, plank, rent/mo, 2" x 10" x 16' long	15.00	ea	-	90	-		-	-	6.00 /ea	90
n	0020	Grout, bond beams and lintels, 8" deep, 8" thick, 0.20 C.F. per L.F., pumped, excludes blockwork	90.00	lf	116	113	-		10	-	2.66 /lf	239
n	0250	Grout, concrete masonry unit (CMU) cores, 8" thick, 0.258 C.F./S.F., pumped, excludes blockwork	2,250.00	sf	5,985	3,131	-		509	-	4.28 /sf	9,625
n	0020	Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed horizontally, ASTM A615	297.40	lb	185	185	-		-	-	1.244 /lb	370
n	0060	Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed vertically, ASTM A615	2,788.09	lb	2,139	1,731	-		-	-	1.39 /lb	3,871
n	0130	Concrete block,bond beam,normal weight,2000 psi,8"x8"x16",includes mortar,excludes scaffolding,horizontal reinforcing,vertical reinforcing and grout	90.00	lf	366	289	-		-	-	7.281 /lf	655
n	6200	Concrete block, decorative, split face or scored split face, 2000 psi, 8" x 8" x 16", excludes scaffolding, grout and reinforcing	2,250.00	sf	17,238	11,897	-		-	-	12.95 /sf	29,135
n	6500	Concrete block, decorative, split face or scored split face, 8" thick, for special deeper colors, add	2,250.00	sf	-	1,912	-		-	-	0.85 /sf	1,912
		04220.005 Concrete Masonry - Truck Loadout			*29,868*	*20,177*			*519*		*22.473/sf*	*50,564*
		2,250.00 sf										
		520.602 Labor hours										
		26.974 Equipment hours										
		DIVISION 04 MASONRY			**29,868**	**20,177**	**0**		**519**	**0**		**50,564**
		520.602 Labor hours										
		26.974 Equipment hours										
DIVISION 05		**METALS**										
	05505.005	*Metal Frame/Cover - Conveyor Penetration*										
n	2600	Fabricated SS Frame and Cover for Screw Conveyor wall penetration	1.00	ea	931	2,875	-		-	288	4,093.48 /ea	4,093

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
		05505.005 Metal Frame/Cover - Conveyor Penetration			*931*	*2,875*				*288*	*4,093.48 /ls*	*4,093*
		1.00 ls										
		16.00 Labor hours										
	05505.010	*Screw Press Platform*										
n	0020	Aluminum, structural shapes, under 1 ton, 1" to 10" members	2,000.00	lb	1,784	10,134	-		898	-	6.41 /lb	12,815
n	0950	Stair, shop fabricated, aluminum, 4'-0" W, incl pipe railing, stringers, grating treads w/ safety nosing, per riser	8.00	risr	559	3,968	-		45	-	571.51 /risr	4,572
n	0200	Railing, pipe, aluminum, satin finish, 3 rails, 3'-6" high, posts @ 5' O.C., 1-1/2" dia, shop fabricated	24.00	lf	367	1,786	-		30	-	90.931 /lf	2,182
n	0132	Floor grating, aluminum, 1-1/2" x 3/16" bearing bars @ 1-3/16" O.C., cross bars @ 4" O.C., up to 300 S.F., field fabricated from panels	80.00	sf	239	2,787	-		19	-	38.08 /sf	3,046
		05505.010 Screw Press Platform			*2,948*	*18,675*			*992*		*22,615.66 /ls*	*22,616*
		1.00 ls										
		45.80 Labor hours										
		8.45 Equipment hours										
		DIVISION 05 METALS			**3,879**	**21,550**	**0**		**992**	**288**		**26,709**
		61.80 Labor hours										
		8.45 Equipment hours										
	DIVISION 07	**THERMAL& MOISTURE PROTECTION**										
	07501.005	*Built-Up Roofing System - Truck Loadout*										
n	0800	Aluminum coping, stock units, for 12" wall, excludes scaffolding	104.00	lf	1,297	1,533	-		-	-	27.22 /lf	2,830
n	0600	Open web bar joist, K Series, 40-ton job lots, 24K10, 13.1 plf, 30' to 50' spans, shop fabricated, incl shop primer, horizontal bridging	150.00	lf	570	2,266	-		165	-	20.003 /lf	3,000
n	2600	Metal roof decking, steel, open type B wide rib, galvanized, under 50 Sq, 1-1/2" D, 20 gauge	450.00	sf	582	1,485	-		22	-	4.642 /sf	2,089
n	2780	2" x 8" miscellaneous wood blocking, to steel construction, per M.B.F.	0.21	mbf	491	159	-		-	-	3,125.43 /mbf	650
n	0030	Underlayment, plywood, underlayment grade, 3/8" thick	450.00	flr	298	468	-		-	-	1.702 /flr	766
n	1725	Polyisocyanurate Insulation, for roof decks, 2" thick, 2#/CF density, fastening excluded	450.00	sf	130	386	-		-	-	1.15 /sf	516
n	1745	Polyisocyanurate Insulation, for roof decks, 3" thick, 2#/CF density, fastening excluded	450.00	sf	143	596	-		-	-	1.643 /sf	739
n	0825	Asphalt shingles, #30 felt underlayment	5.00	sq	37	59	-		-	-	19.12 /sq	96
n	4800	Ethylene-propylene-diene-monomer roofing, (EPDM), 0.40 psf, fully adhered with adhesive, 60 mils	5.00	sq	374	752	-		45	-	234.242 /sq	1,171
n	0100	Sheet metal flashing, aluminum, flexible, mill finish, .032" thick, including up to 4 bends	180.00	sf	589	252	-		-	-	4.672 /sf	841

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
		07501.005 Built-Up Roofing System - Truck Loadout			*4,512*	*7,955*			*232*		*28.221/sf*	*12,699*
		450.00 sf										
		73.121 Labor hours										
		4.11 Equipment hours										
	07600.005	*Aluminum Fascia*										
n	0170	Rent aerial lift, telescoping boom to 40' high, 500 lb cap	3.00	day	-	-	-		1,174	-	391.20 /day	1,174
n	0300	Furring, wood, on walls, on masonry, 1" x 2", 24" O.C.	140.00	lf	496	45	-		-	-	3.862 /lf	541
n	0100	Fascia, aluminum, reverse board & batten, colored, .032" thick, excl. furring	272.00	sf	2,394	1,983	-		-	626	18.39 /sf	5,002
		07600.005 Aluminum Fascia			*2,890*	*2,027*			*1,174*	*626*	*24.693/sf*	*6,716*
		272.00 sf										
		40.000 Labor hours										
		24.00 Equipment hours										
	07813.005	*Skylight Over Screw Press*										
n	8000	Wood framing, roof curbs, untreated, 2" x 12"	0.12	mbf	992	575	-		-	-	13,055.50 /mbf	1,567
n	9100	Sheet metal flashing, stainless steel, flexible sheets, .018" thick, 26 gauge, including up to 4 bends	125.00	sf	712	1,014	-		-	-	13.81 /sf	1,726
n	2700	Skylights, Removable - Allowance	125.00	sf	1,476	11,500	-		-	575	108.41 /sf	13,551
		07813.005 Skylight Over Screw Press			*3,180*	*13,089*				*575*	*16,843.55 /ea*	*16,844*
		1.00 ea										
		52.00 Labor hours										
		DIVISION 07 THERMAL& MOISTURE PROTECTION			**10,582**	**23,072**	**0**		**1,405**	**1,201**		**36,259**
		165.121 Labor hours										
		28.11 Equipment hours										
DIVISION 08		**DOORS & WINDOWS**										
	08120.031	*Aluminum Doors & Frames - Truck Loadout*										
n	1000	Frames, steel, knock down, hollow metal, single, 16 ga., up to 4-7/8" deep, 7'-0" h x 3'-0" w	1.00	ea	59	196	-		-	-	255.19 /ea	255
n	5050	Doors, aluminum, commercial entrance, flush panel doors, single, 3'-0" x 7'-0", incl. hinges, push/pull, deadlock, cylinder, threshold, excl. glazing	1.00	ea	424	949	-		-	-	1,372.86 /ea	1,373
n	3000	Door hardware, panic device, narrow stile, mortise bar, exit only	1.00	ea	124	756	-		-	-	880.29 /ea	880
n	0011	Thresholds, aluminum, 3' long door saddles	3.00	lf	31	26	-		-	-	18.89 /lf	57
n	1430	Door hardware, hinges, full mortise, high frequency, brass base, US10, 4-1/2" x 4-1/2"	1.50	pr	-	135	-		-	-	90.33 /pr	135
n	1200	Paints & coatings, exterior, door & frame, one side, flush, 1 coat, 3' x 7'	1.00	ea	48	2	-		-	-	50.82 /ea	51

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
		08120.031 Aluminum Doors & Frames - Truck Loadout			*687*	*2,064*					*2,751.32 /ea*	*2,751*
		1.00 ea										
		10.900 Labor hours										
	08334.005	*Aluminum Rolling Overhead Door - Truck Loadout*										
n	0301	Doors,rolling service,aluminum,manual,20 gauge,12'x12'high,includes hardware	1.00	ea	883	2,238	-		-	-	3,121.26 /ea	3,121
n	3300	Doors, rolling service, steel, manual, for enamel finish, add	144.00	sf	-	301	-		-	-	2.09 /sf	301
n	3700	Doors, rolling service, steel, manual, for safety edge bottom bar, electric, add	12.00	lf	-	573	-		-	-	47.75 /lf	573
n	4000	Doors, rolling service, steel, manual, for weatherstripping, extruded rubber, jambs, add	36.00	lf	-	580	-		-	-	16.12 /lf	580
n	4500	Doors, rolling service, steel, manual, motor operators for, to 14' x 14' opening	1.00	ea	212	1,283	-		-	-	1,495.17 /ea	1,495
		08334.005 Aluminum Rolling Overhead Door - Truck Loadout			*1,095*	*4,975*					*6,070.45 /ea*	*6,070*
		1.00 ea										
		16.533 Labor hours										
		DIVISION 08 DOORS & WINDOWS			**1,782**	**7,039**	**0**		**0**	**0**		**8,822**
		27.433 Labor hours										
DIVISION 09		**FINISHES**										
	09905.000	*Painting and Protective Coatings*										
n	9995	Painting, Existing Building Touch-Up	1.00	ls			5,000				5,000.00 /ls	5,000
n	9998	Painting, Equipment	1.00	ls			5,000				5,000.00 /ls	5,000
n	9999	Painting, Piping and Existing Piping Touch-Up	1.00	ls			5,000				5,000.00 /ls	5,000
		09905.000 Painting and Protective Coatings					*15,000*				*15,000.00 /ls*	*15,000*
		1.00 ls										
	09905.005	*Painting and Protective Coatings - Truck Load Out Masonry*										
n	0600	Paints & Coatings, walls, concrete masonry units (CMU), porous, first coat, waterproof sealer, spray	2,250.00	sf	388	683	-		-	-	0.48 /sf	1,071
n	0610	Paints & Coatings, walls, concrete masonry units (CMU), porous, second coat, waterproof sealer, spray	2,250.00	sf	292	683	-		-	-	0.434 /sf	975
n	2880	Paints & coatings, walls & ceilings, interior, masonry or concrete block, latex paint, 2 coats, smooth finish, spray	2,250.00	sf	727	437	-		-	-	0.52 /sf	1,165
		09905.005 Painting and Protective Coatings - Truck Load Out Masonry			*1,408*	*1,804*					*3,211.55 /ls*	*3,212*
		1.00 ls										
		29.05 Labor hours										
		DIVISION 09 FINISHES			**1,408**	**1,804**	**15,000**		**0**	**0**		**18,212**
		29.05 Labor hours										

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	DIVISION 11	**EQUIPMENT**										
	11005.000	*Equipment: Basic Requirements*										
	9995	Contractor Test and Start Up	2.00	dys	1,065	624	-			400	1,044.47 /dys	2,089
		11005.000 Equipment: Basic Requirements			*1,065*	*624*				*400*	*2,088.93 /ea*	*2,089*
		1.00 ea										
		16.00 Labor hours										
	11069.000	*Pumping Equipment: Progressing Cavity*										
n	0850	Anchor bolts, J-type, 3/4" diameter x 18" long, includes nut and washer	12.00	ea	335	300	-		-	-	52.90 /ea	635
n	3550	Struct concrete,place,equipment pad (3000 psi),4'x4'x6",includes forms(4 uses),grade 60 rebar,concrete (portland cement type i),placing and finishing	2.00	ea	185	138	-		2	-	162.92 /ea	326
n	0350	Grout, non-shrink, for column and machine bases, non-metallic, 2" deep	32.00	sf	534	380	-		-	-	28.55 /sf	913
n	03004015	Progressive Cavity Pump, 300 gpm / 40' TDH / 15 HP; 6" diam suction/discharge	2.00	ea	2,448	63,846	-			1,131	33,712.82 /ea	67,426
		11069.000 Pumping Equipment: Progressing Cavity			*3,503*	*64,664*			*2*	*1,131*	*34,649.870/ea*	*69,300*
		2.00 ea										
		55.05 Labor hours										
		2.533 Equipment hours										
	11365.005	*Screw Press*										
n	0850	Anchor bolts, J-type, 1" diameter x 18" long, includes nut and washer	8.00	ea	223	280	-		-	-	62.90 /ea	503
n	0350	Grout, non-shrink, for column and machine bases, non-metallic, 2" deep	52.00	sf	868	617	-		-	-	28.55 /sf	1,484
n	0010	Screw Press with Polymer feed system	1.00	ea	10,772	382,433	-		2,000	2,000	397,205.13 /ea	397,205
		11365.005 Screw Press			*11,863*	*383,329*			*2,000*	*2,000*	*399,192.73 /ea*	*399,193*
		1.00 ea										
		212.000 Labor hours										
		8.00 Equipment hours										
	11923.000	*Polymer System*										
n	0850	Anchor bolts, J-type, 3/4" diameter x 18" long, includes nut and washer	6.00	ea	167	150	-		-	-	52.90 /ea	317
n	3550	Struct concrete,place,equipment pad (3000 psi),4'x4'x6",includes forms(4 uses),grade 60 rebar,concrete (portland cement type i),placing and finishing	1.00	ea	93	69	-		1	-	162.92 /ea	163
n	0300	Grout, non-shrink, for column and machine bases, non-metallic, 1" deep	24.00	sf	297	142	-		-	-	18.30 /sf	439
	0100	Polymer System	1.00	ea	10,882	100,000					110,881.99 /ea	110,882

Item	Description	Takeoff Qty	Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	11923.000 Polymer System		*11,440*	*100,361*			*1*		*111,801.47 /ls*	*111,801*
	1.00 ls									
	170.09 Labor hours									
	1.27 Equipment hours									
	DIVISION 11 EQUIPMENT		**27,871**	**548,978**	**0**		**2,003**	**3,531**		**582,383**
	453.132 Labor hours									
	11.800 Equipment hours									
DIVISION 13	**SPECIAL CONSTRUCTION**									
13440.000	*Instrumentation for Process Control*									
0001	Instrumentation and Controls - Allowance	1.00 ls	-	-	106,273		-	-	106,273.01 /ls	106,273
	13440.000 Instrumentation for Process Control				*106,273*				*106,273.01 /ls*	*106,273*
	1.00 ls									
	DIVISION 13 SPECIAL CONSTRUCTION		**0**	**0**	**106,273**		**0**	**0**		**106,273**
DIVISION 14	**CONVEYING SYSTEMS**									
14305.005	*Remove or Modify Existing Overhead Hoist*									
0210	Remove or Modify existing Overhead Hoist above new screw press	1.00 ls	1,497	2,000	-		147	1,000	4,644.78 /ls	4,645
	14305.005 Remove or Modify Existing Overhead Hoist		*1,497*	*2,000*			*147*	*1,000*	*4,644.78 /ls*	*4,645*
	1.00 ls									
	24.00 Labor hours									
	8.00 Equipment hours									
14551.000	*Conveyors: Screw*									
0100	Conveyor, Screw, Shaftless, SS	62.00 lf	16,058	96,999	-		-	3,543	1,880.644 /lf	116,600
	14551.000 Conveyors: Screw		*16,058*	*96,999*				*3,543*	*116,599.95 /ea*	*116,600*
	1.00 ea									
	324.260 Labor hours									
14552.000	*Automated Hopper*									
0100	Live Bottom Hopper	1.00 ea	23,998	500,000	-		4,498		528,495.53 /ea	528,496
	14552.000 Automated Hopper		*23,998*	*500,000*			*4,498*		*528,495.53 /ea*	*528,496*
	1.00 ea									
	480.000 Labor hours									
	40.00 Equipment hours									
	DIVISION 14 CONVEYING SYSTEMS		**41,553**	**598,999**	**0**		**4,645**	**4,543**		**649,740**
	828.260 Labor hours									
	48.00 Equipment hours									

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	DIVISION 15	**MECHANICAL**										
	01410.000	*Testing*										
n	7000	Pipe Testing, Hydro	2.00	Days	1,827	300	-		648	-	1,387.56 /Days	2,775
		01410.000 Testing			*1,827*	*300*			*648*		*2,775.12 /ls*	*2,775*
		1.00 ls										
		32.00 Labor hours										
		16.00 Equipment hours										
	15062.005	*Pipe: Ductile - Screw Press Process Pipe*										
n	1100	Concrete core drilling, core, reinforced concrete slab, 10" diameter, minimum charge	2.00	ea	126	4	400			-	264.74 /ea	529
n	3370	Pipe hanger / supprt,saddle type pipe supprt,complt,adj,cast iron saddle,6"pipe size,type number 36 per mss-sp58,exclds vertcl pipe riser (uslly 3"dm)	4.00	ea	1,302	1,320	-		-	-	655.44 /ea	2,622
	0690	Gasket and bolt set, for flanges, 150 lb., 6" pipe size Stainless Steel	20.00	ea	2,170	1,188	-		-	-	167.88 /ea	3,358
	0210	Sleeve, pipe, steel with water stop, 12" long, 10" diam. for 6" carrier pipe, includes link seal	2.00	ea	293	424	-		-	-	358.51 /ea	717
	0230	Expansion Joints, bellows type, neoprene cover, flanged spool, 6" face to face, 6" diameter	2.00	ea	350	987	-		-	-	668.53 /ea	1,337
	8702	Fitting,solid sleeve,DIP,cement lined,MJ,6"dia,C153 water piping with Protecto 401 or SP2000 Coating	2.00	ea	185	273	-		-	-	229.14 /ea	458
n	0051	DIP,FLGxFLG,6"dia,1'-0" long,class 53,Protecto 401 Lining,excl excav, backfill	4.00	ea	247	1,259	-		-	-	376.503 /ea	1,506
n	0056	DIP,FLGxFLG,6"dia,2'-6" long,class 53,Protecto 401 Lining,excl excav, backfill	2.00	ea	124	892	-		-	-	507.75 /ea	1,016
n	0061	DIP,FLGxFLG,6"dia,5'-0" long,class 53,Protecto 401 Lining,excl excav, backfill	2.00	ea	124	1,291	-		-	-	707.56 /ea	1,415
n	0066	DIP,FLGxFLG,6"dia,7'-6" long,class 53,Protecto 401 Lining,excl excav, backfill	2.00	ea	124	1,710	-		-	-	916.84 /ea	1,834
n	0071	DIP,FLGxFLG,6"dia,10'-0" long,class 53,Protecto 401 Lining,excl excav, backfill	2.00	ea	211	2,129	-		-	-	1,169.92 /ea	2,340
n	1006	Fitting,DIP,FLG,90 degree bend,6"dia,c 110 water piping with Protecto 401 or SP2000 Coating	8.00	ea	495	3,443	-		-	-	492.27 /ea	3,938
n	3007	Fitting,DIP,FLG,Tee,6"dia,c 110 water piping with Protecto 401 or SP2000 Coating	2.00	ea	124	1,075	-		-	-	599.53 /ea	1,199
n	4002	Fitting,DIP,FLG,Reducer,6"x4",c 110 water piping with Protecto 401 or SP2000 Coating	2.00	ea	124	720	-		-	-	421.78 /ea	844
n	502	Plug Valve Flange: 6" / Handwheel or Lever Operator / Includes Gear Operator	2.00	ea	210	2,175	-		0	-	1,192.54 /ea	2,385
n	202	Check Valve Flange, Swing: 6" / Lever and Spring	1.00	ea	105	1,351	-		0	-	1,455.96 /ea	1,456
n	0130	Valve Operator, Electric, Open/Close, 6" dia	2.00	ea	-	10,326	-		-	-	5,162.850 /ea	10,326

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
		15062.005 Pipe: Ductile - Screw Press Process Pipe			*6,312*	*30,567*	*400*				*37,278.78 /ls*	*37,279*
		1.00 ls										
		94.04 Labor hours										
	15064.005	*Pipe: Plastic - Polymer Piping*										
n	1470	Valves, plastic, PVC, ball, double union, socket or threaded, 1"	3.00	ea	85	247	-		-	-	110.57 /ea	332
n	3260	Valves, plastic, PVC, ball check, socket or threaded, 1"	1.00	ea	28	71	-		-	-	99.60 /ea	100
n	2480	Pipe, plastic, PVC, 1" diameter, schedule 80, includes couplings 10' OC, and hangers 3 per 10'	80.00	lf	1,211	402	-		-	-	20.16 /lf	1,613
n	2140	Elbow, 90 Deg., plastic, PVC, socket joint, 1", schedule 80	12.00	ea	344	71	-		-	-	34.573 /ea	415
n	2430	Tee, plastic, PVC, socket joint, 1", schedule 80	4.00	ea	171	42	-		-	-	53.43 /ea	214
n	2580	Coupling, plastic, PVC, socket joint, 1", schedule 80	3.00	ea	86	22	-		-	-	35.93 /ea	108
n	3813	Reducer, plastic, PVC, insert, socket joint, 1", schedule 80	4.00	ea	104	19	-		-	-	30.83 /ea	123
		15064.005 Pipe: Plastic - Polymer Piping			*2,030*	*874*					*2,903.63 /ls*	*2,904*
		1.00 ls										
		24.95 Labor hours										
	15064.010	*Pipe: Plastic - NPW Piping*										
n	1100	Valves, bronze, angle, rising stem, threaded, 150 lb., 1-1/2"	1.00	ea	50	506	-		-	-	555.88 /ea	556
n	1490	Valves, plastic, PVC, ball, double union, socket or threaded, 1-1/2"	2.00	ea	65	275	-		-	-	170.27 /ea	341
n	2500	Pipe, plastic, PVC, 1-1/2" diameter, schedule 80, includes couplings 10' OC, and hangers 3 per 10'	80.00	lf	1,531	531	-		-	-	25.79 /lf	2,063
n	2160	Elbow, 90 Deg., plastic, PVC, socket joint, 1-1/2", schedule 80	12.00	ea	429	102	-		-	-	44.233 /ea	531
n	2450	Tee, plastic, PVC, socket joint, 1-1/2", schedule 80	4.00	ea	215	117	-		-	-	83.043 /ea	332
n	2600	Coupling, plastic, PVC, socket joint, 1-1/2", schedule 80	3.00	ea	107	36	-		-	-	47.65 /ea	143
n	3815	Reducer, plastic, PVC, insert, socket joint, 1-1/2", schedule 80	4.00	ea	130	41	-		-	-	42.78 /ea	171
		15064.010 Pipe: Plastic - NPW Piping			*2,528*	*1,608*					*4,136.32 /ls*	*4,136*
		1.00 ls										
		31.08 Labor hours										
	15073.005	*Pipe: Cast-Iron Soil - Truck Unloading Drain Line*										
n	1100	Concrete core drilling, 10" x 12" concrete wall, minumum	1.00	ea	63	2	-		0	300	364.74 /ea	365
	0210	Sleeve, pipe, steel with water stop, 12" long, 10" diam. for 6" carrier pipe, includes link seal	1.00	ea	146	212	-		-	-	358.51 /ea	359
n	4200	Pipe, cast iron soil, no hub, 6" diameter, includes couplings 10' O.C., clevis hanger assemblies 5' O.C.	30.00	lf	692	1,060	-		-	-	58.42 /lf	1,752

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	15073.005	*Pipe: Cast-Iron Soil - Truck Unloading Drain Line*										
n	6160	1/4 Bend, cast iron soil, no hub, 6", add 1 coupling per joint for installed price, excludes joint coupling and labor	4.00	ea	-	249	-		-	-	62.16 /ea	249
n	6218	1/8 Bend, cast iron soil, no hub, 6", add 1 coupling per joint for installed price, excludes joint coupling and labor	2.00	ea	-	83	-		-	-	41.44 /ea	83
n	7500	Combination Y and 1/8 bend, cast iron soil, no hub, 6", add 1 coupling per joint for installed price, excludes joint coupling and labor	2.00	ea	-	302	-		-	-	151.13 /ea	302
n	8690	Coupling, cast iron soil, no hub, stainless steel, heavy duty, 6"	18.00	ea	820	647	-		-	-	81.52 /ea	1,467
		15073.005 Pipe: Cast-Iron Soil - Truck Unloading Drain Line			*1,721*	*2,555*				*300*	*152.56 /lf*	*4,577*
		30.00 lf										
		23.25 Labor hours										
	15440.005	*Truck Loadout SOG FRP Trench Drain*										
n	4602	Structural concrete, placing, foundation, direct chute, over 6" thick, includes vibrating, excludes material	2.00	cy	97	-	-		8	-	52.82 /cy	106
n	1020	Struct MISC concrete,ready mix,normal wt,4000 psi,includes local aggregate,sand,portland cement and water,delivered,excludes all additives	2.00	cy	-	214	-		-	-	106.80 /cy	214
n	0200	Concrete finishng,floors,basic finishng for unspecfd flatwork,bull float,manual float&manual steel trowel,excludes placing,striking off&consolidating	40.00	sf	40	-	-		-	-	1.01 /sf	40
n	6830	Drain, trench, fiberglass for cement concrete encasement, 8" internal width, with heavy duty iron grate, not including trenching or concrete	20.00	lf	586	2,659	-		-	-	162.25 /lf	3,245
n	0050	Excavating, trench or continuous footing, common earth, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewatering	3.00	bcy	54	-	-		47	-	33.79 /bcy	101
		15440.005 Truck Loadout SOG FRP Trench Drain			*778*	*2,873*			*55*		*185.30 /lf*	*3,706*
		20.00 lf										
		11.76 Labor hours										
		3.00 Equipment hours										
	15605.000	*HVAC: Modifications*										
	0025	HVAC Duct Modifications - Subcontract	1.00	ls	-	-	10,000		-	-	10,000.00 /ls	10,000
		15605.000 HVAC: Modifications					*10,000*				*10,000.00 /ls*	*10,000*
		1.00 ls										
		DIVISION 15 MECHANICAL			**15,196**	**38,776**	**10,400**		**704**	**300**		**65,376**
		217.07 Labor hours										
		19.00 Equipment hours										

DIVISION 16 ELECTRICAL

Item	Description	Takeoff Qty	Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
16010.000	*Electrical Subcontract*									
0001	Electrical Work - Allowance	1.00 ls	-	-	318,820		-	-	318,820.01 /ls	318,820
	16010.000 Electrical Subcontract				*318,820*				*318,820.01 /ls*	*318,820*
	1.00 ls									
	DIVISION 16 ELECTRICAL		**0**	**0**	**318,820**		**0**	**0**		**318,820**
	100 Solids Building Screw Press Retrofit		***166,945***	***1,281,123***	***450,493***		***27,638***	***10,522***	***1,936,721.16 /LS***	***1,936,721***
	1.00 LS									
	2,954.571 Labor hours									
	344.31 Equipment hours									

Estimate Totals

Description	Amount	Totals	Hours	Rate
Labor	166,945		2,954.571 hrs	
Material	1,281,123			
Subcontract	450,493			
Equipment	27,638		344.308 hrs	
Other	10,522			
Direct Cost - Subtotal		**1,936,721**		
Contractor's Fld Ovhd & Mob	193,672			10.000 %
Field Const Cost - Subtotal		**2,130,393**		
Contractor's Fee	255,647			12.000 %
Contractor's Bonds & Insurance	35,791			1.500 %
Undefined SOW (Contingency)	605,458			25.000 %
Subtotal		**3,027,289**		
Escalation (NONE INCLUDED)				0.000 %
Sales Tax Estimate (Total)	287,592			9.500 %
Current OPCC Estimate Budget		**3,314,881**		

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

Alternative 1B: Screw Press in New Building

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Labor Rate Table - 2nd Qtr 2013
Equipment Rate Table - 2nd Qtr 2013
City Index - 980-WA-SEATTLE

Planning Level Estimate
Estimate Detail Sheet

DEWATERING FACILITY
SEATTLE, WA

Project name	Dewatering Facility Seattle WA
Labor rate table	CONC2013
Equipment rate table	CONC2013
Project Name 1	Dewatering Facility
Design Stage 1	Planning Level
Design Stage 2	Estimate
Estimate Version	1.0
Upper Range +%	40
Lower Range -%	20
Labor Rate Table	2nd Qtr 2013
Equip Rate Table	2nd Qtr 2013
Notes	Any opinions of probable construction cost or cost estimates provided by HDR, Inc. are made on the basis of information available to HDR, Inc. and on the basis of cost estimator's experience and qualifications, and represents its judgment as an experienced and qualified professional engineer. However, since HDR, Inc. has no control over the cost of labor, materials, equipment or services furnished by others, or over the contractor(s') methods of determining prices, or over competitive bidding or market conditions, HDR, Inc. does not guarantee that proposals, bids or actual project or construction cost will not vary from opinions of probable cost or cost estimates prepared by HDR, Inc.
Report format	Sorted by 'WBS_MAIN/MF95_DIV/HDR95SPEC' 'Detail' summary Allocate addons Combine items Print sort level notes
Cost index	980-WA-SEATTLE

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
DEWATERING CENTRIFUG		***DEWATERING FACILITY_CENTRIFUGE***										
DIVISION 01		**GENERAL REQUIREMENTS**										
	01500.100	*Non-Task Specific Equipment*										
n	0400	Rent backhoe-loader 40 to 45 HP 5/8 CY capacity	130.00	day	-	-	-		35,769	-	275.144 /day	35,769
n	5450	Rent truck flatbed 1axle 1-1/2 ton rating	130.00	day	-	-	-		36,454	-	280.42 /day	36,454
n	2100	Rent electric generator gas engine 1.5 kW to 3 kW	130.00	day	-	-	-		4,883	-	37.56 /day	4,883
n	5400	Rent diaphragm pump gas double 4" diameter	130.00	day	-	-	-		15,690	-	120.692 /day	15,690
n	7060	Rent trench box, 9500 lbs, 8' x 20'	130.00	day	-	-	-		17,679	-	135.99 /day	17,679
n	7100	Rent truck pickup 3/4 ton 2 wheel drive	130.00	day	-	-	-		21,203	-	163.103 /day	21,203
n	0900	Rent crawler mounted crane, lattice boom, 1-1/2 CY, 40 ton 12' radius	130.00	day	-	-	-		157,997	-	1,215.36 /day	157,997
n	5000	Crane Operator	130.00	Days	64,787	-	-		-	-	498.37 /Days	64,787
n	5005	Truck and Backhoe Operator Operator	130.00	Days	60,805	-	-		-	-	467.73 /Days	60,805
		01500.100 Non-Task Specific Equipment			*125,592*				*289,675*		*3,194.36 /dys*	*415,267*
		130.00 dys										
		2,080.00 Labor hours										
		7,280.00 Equipment hours										
		DIVISION 01 GENERAL REQUIREMENTS			**125,592**	**0**	**0**		**289,675**	**0**		**415,267**
		2,080.00 Labor hours										
		7,280.00 Equipment hours										
DIVISION 02		**SITE CONSTRUCTION**										
	02200.500	*Earthwork, Structural Excavation*										
n	0300	Excavating, bulk bank measure, 3 C.Y. capacity = 260 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	1,554.00	bcy	775	-	-		2,227	-	1.932 /bcy	3,002
n	0020	Hauling, excavated or borrow material, loose cubic yards, 1/4 mile round trip, 5.0 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading	824.550	lcy	1,906	-	-		2,137	-	4.904 /lcy	4,044
		02200.500 Earthwork, Structural Excavation			*2,681*				*4,364*		*4.534/cy*	*7,045*
		1,554.00 cy										
		45.782 Labor hours										
		39.814 Equipment hours										
	02200.600	*Earthwork, Structural Backfill, Native Material includes compaction*										
n	1300	Backfill, bulk, to 300' haul, dozer backfilling, excludes compaction	963.00	lcy	645	-	-		1,299	-	2.02 /lcy	1,943
n	1600	Backfill, bulk, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller	837.00	ecy	840	-	-		2,209	-	3.643 /ecy	3,049

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
		02200.600 Earthwork, Structural Backfill, Native Material includes compaction			*1,485*				*3,507*		*5.97 /cy*	*4,993*
		837.00 cy										
		22.19 Labor hours										
		23.163 Equipment hours										
	02317.000	*Precast Prestressed Concrete Driven Piling*										
n	0500	Piling special costs, cutoffs, concrete piles, plain	78.00	ea	7,504	-	-		-	-	96.20 /ea	7,504
n	3200	Prestressed concrete piles, square, 40' long, 12" square, priced using 200 piles, excludes pile caps or mobilization	3,120.00	vlf	16,620	100,091	-		10,547	-	40.79 /vlf	127,257
n	4750	Prestressed concrete piles,mobilization,10,000 lf pile job,priced using 200 piles,60'lg,unless specified otherwise,excludes pile caps mobilization,add	3,120.00	vlf	3,424	-	-		2,173	-	1.794 /vlf	5,597
		02317.000 Precast Prestressed Concrete Driven Piling			*27,548*	*100,091*			*12,719*		*44.99 /vlf*	*140,358*
		3,120.00 vlf										
		467.61 Labor hours										
		132.79 Equipment hours										
		DIVISION 02 SITE CONSTRUCTION			**31,714**	**100,091**	**0**		**20,591**	**0**		**152,396**
		535.573 Labor hours										
		195.765 Equipment hours										
	DIVISION 03	**CONCRETE**										
	03002.100	*Concrete_Foundations*										
n	3061	C.I.P. concrete forms, foundation, edge, wood, over 12", 4 use, includes erecting, bracing, stripping and cleaning	642.00	sfca	3,416	626	-		-	-	6.30 /sfca	4,042
n	9011	C.I.P. concrete forms, bulkhead for foundation w/ keyway, 12" and greater, exp metal, includes erecting, bracing, stripping and cleaning	291.100	sfca	645	95	-		-	-	2.543 /sfca	740
n	3005	Waterstop, rubber, center bulb, 1/4" thick x 6" wide_FOUNDATIONS	194.30	lf	659	2,449	-		-	-	15.994 /lf	3,108
n	0605	Reinforcing steel, in place, FOUNDATIONS, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	24.413	ton	23,741	33,437	-		-	-	2,342.11 /ton	57,178
n	2005	Reinforcing steel, unload and sort, add to base_FOUNDATIONS	24.413	ton	938	-	-		216	-	47.25 /ton	1,153
n	2211	Reinforcing steel, crane cost for handling, average, add_FOUNDATIONS	24.413	ton	1,019	-	-		235	-	51.354 /ton	1,254
n	4652	Structural concrete, placing, foundations, pumped, over 6" thick, includes vibrating, excludes material	240.00	cy	4,636	-	-		1,231	-	24.444 /cy	5,866
n	0300	Struct FOUNDATION concrete,ready mix,normal wt,4000 psi,includes local aggregate,sand,portland cement and water,delivered,excludes all additives	240.00	cy	-	26,970	-		-	-	112.373 /cy	26,970
n	0105	Concrete finishing, floors, manual screed, bull float_FOUNDATIONS	3,886.00	sf	1,382	-	-		-	-	0.36 /sf	1,382

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	03002.100	*Concrete_Foundations*										
n	0205	Control joint, clean out control joint of debris_FOUNDATIONS	194.30	lf	16	-	-		-	-	0.084 /lf	16
n	0365	Control joint, joint sealant, polyurethane, 1/4" x 1/4" (308 LF/Gal)_FOUNDATIONS	194.30	lf	363	34	-		-	-	2.043 /lf	397
n	0305	Concrete surface treatment, curing, sprayed membrane compound_FOUNDATIONS	38.86	csf	340	345	-		-	-	17.61 /csf	684
n	1005	Fill, gravel fill, compacted, under floor slabs, alternate pricing method, 4" deep_FOUND	144.00	ecy	3,326	4,199	-		225	-	53.82 /ecy	7,750
n	1135	Hauling, excavated borrow material, loose cubic yards, 20 mile round trip, 0.4 loads/hour, 16.5 c.y. dump trailer, highway haulers, excludes loading	166.00	lcy	1,386	-	-		2,757	-	24.96 /lcy	4,143
		03002.100 Concrete_Foundations			*41,866*	*68,155*			*4,663*		*477.85 /cy*	*114,684*
		240.00 cy 649.80 Labor hours 94.00 Equipment hours										
	03002.300	*Concrete_Walls Exterior*										
n	0500	C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning	176.00	lf	1,904	387	-		-	-	13.02 /lf	2,291
n	2550	C.I.P. concrete forms, wall, job built, plywood, 8 to 16' high, 4 use, includes erecting, bracing, stripping and cleaning	7,040.00	sfca	51,100	6,040	-		-	-	8.12 /sfca	57,140
n	5200	Chamfer strip, wood, 3/4" wide	352.00	lf	330	110	-		-	-	1.25 /lf	439
n	1400	Tie cones, plastic, for coil tie system, for CIP wall forms, 1/2" bolt diameter x 1" setback length, includes material only	7.00	c	-	710	-		-	-	101.36 /c	710
n	3010	Waterstop, rubber, center bulb, 1/4" thick x 6" wide_WALLS	496.00	lf	1,681	6,252	-		-	-	15.994 /lf	7,933
n	0700	Reinforcing Steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	12.863	ton	9,590	17,618	-		-	-	2,115.20 /ton	27,208
n	2020	Reinforcing steel, unload and sort, add to base_WALLS	12.863	ton	494	-	-		114	-	47.25 /ton	608
n	2214	Reinforcing steel, crane cost for handling, average, add_WALLS	12.863	ton	537	-	-		124	-	51.354 /ton	661
n	5100	Structural concrete, placing, walls, pumped, 12" thick, includes leveling (strike off) & consolidation, excludes material	72.00	cy	2,339	-	-		621	-	41.11 /cy	2,960
n	5350	Structural concrete, placing, walls, pumped, 15" thick, includes leveling (strike off) & consolidation, excludes material	75.00	cy	2,233	-	-		593	-	37.683 /cy	2,826
n	0520	Struct WALLS concrete,ready mix,normal wt,4000 psi,includes local aggregate,sand,portland cement and water,delivered,excludes all additives	147.00	cy	-	16,519	-		-	-	112.373 /cy	16,519
n	0210	Control joint, clean out control joint of debris_WALLS	176.00	lf	15	-	-		-	-	0.084 /lf	15
n	0366	Control joint, joint sealant, polyurethane, 1/4" x 1/4" (308 LF/Gal)_WALLS	176.00	lf	329	31	-		-	-	2.043 /lf	359
n	0020	Concrete finishing, walls, includes breaking ties and patching voids	7,040.00	sf	6,568	308	-		-	-	0.98 /sf	6,876

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	03002.300	*Concrete_Walls Exterior*										
n	0050	Concrete finishing, walls, burlap rub with grout, includes breaking ties and patching voids	3,520.00	sf	3,943	154	-		-	-	1.164 /sf	4,097
		03002.300 Concrete_Walls Exterior			*81,062*	*48,127*			*1,451*		*888.71 /cy*	*130,640*
		147.00 cy										
		1,326.535 Labor hours										
		32.86 Equipment hours										
	03002.500	*Concrete_Columns*										
n	6650	C.I.P. concrete forms, column, square, plywood, 24" x 24", 4 use, includes erecting, bracing, stripping and cleaning	264.00	sfca	2,066	329	-		-	-	9.073 /sfca	2,395
n	0202	Ties, for coil tie system, for CIP column forms, 1/2", 6000#, 36", includes material only	4.00	c	-	2,573	-		-	-	643.253 /c	2,573
n	0250	Reinforcing Steel, in place, columns, #8 to #18, A615, grade 60, incl labor for accessories, excl material for accessories	0.46	ton	445	627	-		-	-	2,342.10 /ton	1,073
n	2030	Reinforcing steel, unload and sort, add to base_COLUMNS	0.46	ton	18	-	-		4	-	47.25 /ton	22
n	2216	Reinforcing steel, crane cost for handling, average, add_COLUMNS	0.46	ton	19	-	-		4	-	51.354 /ton	24
n	0600	Structural concrete, placing, column, square or round, pumped, 18" thick, includes leveling (strike off) & consolidation, excludes material	3.67	cy	146	-	-		39	-	50.25 /cy	184
n	0620	Struct COLUMNS concrete,ready mix,normal wt,4000 psi,includes local aggregate,sand,portland cement and water,delivered,excludes all additives	3.67	cy	-	412	-		-	-	112.373 /cy	412
n	0022	Concrete finishing, columns, includes breaking ties and patching voids	264.00	sf	246	12	-		-	-	0.98 /sf	258
		03002.500 Concrete_Columns			*2,940*	*3,953*			*47*		*1,891.06 /cy*	*6,940*
		3.67 cy										
		48.92 Labor hours										
		1.054 Equipment hours										
	03002.550	*Concrete_Elevated Beams*										
n	2000	C.I.P. concrete forms, beams and girders, interior, plywood, 12" wide, 1 use, includes shoring, erecting, bracing, stripping and cleaning	480.00	sfca	4,587	2,158	-		-	-	14.053 /sfca	6,746
n	4000	C.I.P. concrete forms, beams, sides only, vertical, plywood, 36" high, 1 use, includes shoring, erecting, bracing, stripping and cleaning	180.00	sfca	1,540	1,216	-		-	-	15.32 /sfca	2,757
n	0100	Reinforcing Steel, in place, beams and girders, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	1.38	ton	1,922	1,883	-		-	-	2,767.55 /ton	3,805
n	2035	Reinforcing steel, unload and sort, add to base_ELEVATE BEAMS	1.38	ton	53	-	-		12	-	47.25 /ton	65
n	2217	Reinforcing steel, crane cost for handling, average, add_ELEVATED BEAMS	1.38	ton	57	-	-		13	-	51.36 /ton	71
n	0050	Structural concrete, placing, beam, small, elevated, pumped, includes leveling (strike off) & consolidation, excludes material	10.00	cy	596	-	-		158	-	75.37 /cy	754

					Labor	Material	Subcontract		Equipment	Other	Total	
	Item	Description	Takeoff Qty		Amount	Amount	Amount	Name	Amount	Amount	Unit Cost	Amount
	03002.550	*Concrete_Elevated Beams*										
n	0920	Struct ELEV BEAM concrete,ready mix,normal wt,4000 psi,includes local aggregate,sand,portland cement and water,delivered,excludes all additives	10.00	cy	-	1,124	-		-	-	112.373 /cy	1,124
n	9010	Concrete finishing, elev beams, includes patching voids	660.00	sf		29	-		-	-	0.044 /sf	29
		03002.550 Concrete_Elevated Beams			*8,756*	*6,410*			*183*		*1,534.971/cy*	*15,350*
		10.00 cy 152.14 Labor hours 4.23 Equipment hours										
	03002.600	*Concrete_Elevated Slab*										
n	6600	Scaffolding, steel tubular, heavy duty shoring for elevated slab forms, floor area, labor only to erect & dismantle, to 14'-8" high	16.00	csf	2,935	-	-		-	-	183.414 /csf	2,935
n	6610	Scaffolding, steel tubular, heavy duty shoring for elevated slab forms, floor area, rent/month of materials only, to 14'-8" high	32.00	csf	-	1,376	-		-	-	43.00 /csf	1,376
n	2150	C.I.P. concrete forms, elevated slab, flat slab with drop panels, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning	1,600.00	sf	8,433	2,745	-		-	-	6.99 /sf	11,178
n	7000	C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning	160.00	lf	596	37	-		-	-	3.96 /lf	633
n	0400	Reinforcing Steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	6.64	ton	5,120	9,092	-		-	-	2,140.91 /ton	14,211
n	2040	Reinforcing steel, unload and sort, add to base_ELEVATE SLABS	6.64	ton	255	-	-		59	-	47.25 /ton	314
n	2218	Reinforcing steel, crane cost for handling, average, add_ELEVATED SLABS	6.64	ton	277	-	-		64	-	51.354 /ton	341
n	1600	Structural concrete, placing, elevated slab, pumped, over 10" thick, includes leveling (strike off) & consolidation, excludes material	59.00	cy	1,171	-	-		311	-	25.122 /cy	1,482
n	0820	Struct ELEV SLAB concrete,ready mix,normal wt,4000 psi,includes local aggregate,sand,portland cement and water,delivered,excludes all additives	59.00	cy	-	6,630	-		-	-	112.373 /cy	6,630
n	0256	Concrete finishing, floors, manual screed, bull float, machine float & steel trowel (walk-behind)_ELEV SLAB	1,600.00	sf	1,327	-	-		60	-	0.87 /sf	1,387
n	9000	Concrete finishing, elev slabs, includes patching voids	1,600.00	sf	1,493	70	-		-	-	0.98 /sf	1,563
		03002.600 Concrete_Elevated Slab			*21,607*	*19,950*			*493*		*712.72 /cy*	*42,050*
		59.00 cy 350.69 Labor hours 16.431 Equipment hours										
	03002.825	*Concrete_Stairs*										

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	03002.825	*Concrete_Stairs*										
n	6800	Strt cncrt,place,strs (3500 psi),3'-6"wd,free stndn,incld frm(4 us),grade 60 rebar,concrt (prtln cement type i),placng and finshn,excldes safety treads	72.00	nose	2,691	424	-		35	-	43.754 /nose	3,150
n	7000	Strt concrete,place,stair landing (3500 psi),free standing,includes forms(4 us),grade 60 rebar,concrete (portland cement type i),placing and finishing	16.00	sf	248	77	-		3	-	20.504 /sf	328
		03002.825 Concrete_Stairs			*2,939*	*501*			*38*		*173.92 /risr*	*3,478*
		20.00 risr 45.48 Labor hours 7.580 Equipment hours										
		DIVISION 03 CONCRETE 2,573.554 Labor hours 156.15 Equipment hours			**159,170**	**147,097**	**0**		**6,875**	**0**		**313,142**
	DIVISION 04	**MASONRY**										
	04220.080	*Concrete Masonry (8" CMU)*										
n	0090	Scaffolding, steel tubular, regular, labor only to erect & dismantle, building exterior, wall face, 6'-4" x 5' frames, 1 to 5 stories, excl. planks	19.00	csf	3,267	-	-		-	-	171.951 /csf	3,267
n	0906	Scaffolding, steel tubular, regular, rent/month only for complete system for face of walls, 6' -4" x 5' frames, excl. planks	19.00	csf	-	684	-		-	-	36.00 /csf	684
n	2850	Scaffolding, steel tubular, regular, accessory, plank, rent/mo, 2" x 10" x 16' long	15.00	ea	-	90	-		-	-	6.00 /ea	90
n	0020	Grout, bond beams and lintels, 8" deep, 8" thick, 0.20 C.F. per L.F., pumped, excludes blockwork	160.00	lf	203	208	-		18	-	2.682 /lf	429
n	0250	Grout, concrete masonry unit (CMU) cores, 8" thick, 0.258 C.F./S.F., pumped, excludes blockwork	1,920.00	sf	5,027	2,762	-		448	-	4.29 /sf	8,237
n	0020	Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed horizontally, ASTM A615	528.704	lb	324	340	-		-	-	1.26 /lb	664
n	0060	Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed vertically, ASTM A615	2,379.17	lb	1,797	1,529	-		-	-	1.40 /lb	3,326
n	0130	Concrete block,bond beam,normal weight,2000 psi,8"x8"x16",includes mortar,excludes scaffolding,horizontal reinforcing,vertical reinforcing and grout	160.00	lf	641	528	-		-	-	7.303 /lf	1,168
n	6200	Concrete block, decorative, split face or scored split face, 2000 psi, 8" x 8" x 16", excludes scaffolding, grout and reinforcing	1,920.00	sf	14,480	10,424	-		-	-	12.971 /sf	24,904
n	6500	Concrete block, decorative, split face or scored split face, 8" thick, for special deeper colors, add	1,920.00	sf	-	1,676	-		-	-	0.873 /sf	1,676

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
		04220.080 Concrete Masonry (8" CMU)			*25,739*	*18,241*			*466*		*23.15 /sf*	*44,446*
		1,920.00 sf										
		452.91 Labor hours										
		23.493 Equipment hours										
		DIVISION 04 MASONRY			**25,739**	**18,241**	**0**		**466**	**0**		**44,446**
		452.91 Labor hours										
		23.493 Equipment hours										
	DIVISION 07	**THERMAL& MOISTURE PROTECTION**										
	07501.000	*Built-Up Roofing System (BUR)*										
n	0800	Aluminum coping, stock units, for 12" wall, excludes scaffolding	184.00	lf	2,035	2,482	-		-	-	24.55 /lf	4,517
n	0600	Open web bar joist, K Series, 40-ton job lots, 24K10, 13.1 plf, 30' to 50' spans, shop fabricated, incl shop primer, horizontal bridging	480.00	lf	1,132	6,936	-		480	-	17.81 /lf	8,549
n	2600	Metal roof decking, steel, open type B wide rib, galvanized, under 50 Sq, 1-1/2" D, 20 gauge	1,600.00	sf	877	5,051	-		72	-	3.75 /sf	6,000
n	2780	2" x 8" miscellaneous wood blocking, to steel construction, per M.B.F.	0.37	mbf	755	247	-		-	-	2,722.83 /mbf	1,002
n	0030	Underlayment, plywood, underlayment grade, 3/8" thick	1,600.00	flr	919	1,462	-		-	-	1.49 /flr	2,382
n	1725	Polyisocyanurate Insulation, for roof decks, 2" thick, 2#/CF density, fastening excluded	1,600.00	sf	413	1,229	-		-	-	1.03 /sf	1,642
n	1745	Polyisocyanurate Insulation, for roof decks, 3" thick, 2#/CF density, fastening excluded	1,600.00	sf	455	1,898	-		-	-	1.47 /sf	2,352
n	0825	Asphalt shingles, #30 felt underlayment	16.00	sq	105	172	-		-	-	17.281 /sq	276
n	4800	Ethylene-propylene-diene-monomer roofing, (EPDM), 0.40 psf, fully adhered with adhesive, 60 mils	16.00	sq	1,044	2,293	-		128	-	216.59 /sq	3,465
n	0100	Sheet metal flashing, aluminum, flexible, mill finish, .032" thick, including up to 4 bends	320.00	sf	943	390	-		-	-	4.17 /sf	1,333
		07501.000 Built-Up Roofing System (BUR)			*8,678*	*22,160*			*680*		*19.70 /sf*	*31,519*
		1,600.00 sf										
		161.852 Labor hours										
		13.472 Equipment hours										
		DIVISION 07 THERMAL& MOISTURE PROTECTION			**8,678**	**22,160**	**0**		**680**	**0**		**31,519**
		161.852 Labor hours										
		13.472 Equipment hours										
	DIVISION 08	**DOORS & WINDOWS**										
	08120.030	*Aluminum Doors & Frames (3070)*										
n	1000	Frames, steel, knock down, hollow metal, single, 16 ga., up to 4-7/8" deep, 7'-0" h x 3'-0" w	3.00	ea	177	566	-		-	-	247.65 /ea	743

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	08120.030	*Aluminum Doors & Frames (3070)*										
n	5050	Doors, aluminum, commercial entrance, flush panel doors, single, 3'-0" x 7'-0", incl. hinges, push/pull, deadlock, cylinder, threshold, excl. glazing	3.00	ea	1,260	2,745	-		-	-	1,335.12 /ea	4,005
n	3000	Door hardware, panic device, narrow stile, mortise bar, exit only	3.00	ea	370	2,259	-		-	-	876.61 /ea	2,630
n	0011	Thresholds, aluminum, 3' long door saddles	9.00	lf	93	76	-		-	-	18.78 /lf	169
n	1430	Door hardware, hinges, full mortise, high frequency, brass base, US10, 4-1/2" x 4-1/2"	4.50	pr	-	405	-		-	-	90.00 /pr	405
n	1200	Paints & coatings, exterior, door & frame, one side, flush, 1 coat, 3' x 7'	3.00	ea	68	8	-		-	-	25.023 /ea	75
		08120.030 Aluminum Doors & Frames (3070)			*1,967*	*6,060*					*2,675.73 /ea*	*8,027*
		3.00 ea										
		31.112 Labor hours										
	08334.000	*Aluminum Rolling Overhead Doors*										
n	0301	Doors,rolling service,aluminum,manual,20 gauge,12'x12'high,includes hardware	1.00	ea	875	2,158	-		-	-	3,033.32 /ea	3,033
n	3300	Doors, rolling service, steel, manual, for enamel finish, add	144.00	sf	-	290	-		-	-	2.02 /sf	290
n	3700	Doors, rolling service, steel, manual, for safety edge bottom bar, electric, add	12.00	lf	-	553	-		-	-	46.05 /lf	553
n	4000	Doors, rolling service, steel, manual, for weatherstripping, extruded rubber, jambs, add	36.00	lf	-	559	-		-	-	15.541 /lf	559
n	4500	Doors, rolling service, steel, manual, motor operators for, to 14' x 14' opening	1.00	ea	210	1,237	-		-	-	1,447.46 /ea	1,447
		08334.000 Aluminum Rolling Overhead Doors			*1,085*	*4,798*					*5,882.94 /ea*	*5,883*
		1.00 ea										
		16.533 Labor hours										
		DIVISION 08 DOORS & WINDOWS			**3,052**	**10,858**	**0**		**0**	**0**		**13,910**
		47.65 Labor hours										
DIVISION 09		**FINISHES**										
	09905.000	*Painting and Protective Coatings*										
n	9995	Painting, Buildings	1.00	ls			8,678				8,677.68 /ls	8,678
n	9998	Painting, Equipment	1.00	ls			8,678				8,677.68 /ls	8,678
n	9999	Painting, Piping	1.00	ls			5,823				5,822.81 /ls	5,823
		09905.000 Painting and Protective Coatings					*23,178*				*23,178.17 /ls*	*23,178*
		1.00 ls										
		DIVISION 09 FINISHES			**0**	**0**	**23,178**		**0**	**0**		**23,178**
DIVISION 11		**EQUIPMENT**										
	11069.000	*Pumping Equipment: Progressing Cavity*										

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	11069.000	*Pumping Equipment: Progressing Cavity*										
n	03004015	Progressive Cavity Pump, 300 gpm / 40' TDH / 15 HP; 6" diam suction/discharge	2.00	ea	2,448	63,846	-			1,131	33,712.82 /ea	67,426
		11069.000 Pumping Equipment: Progressing Cavity			*2,448*	*63,846*				*1,131*	*33,712.82 /ea*	*67,426*
		2.00 ea										
		36.00 Labor hours										
		2.00 Equipment hours										
	11365.005	*Screw Press*										
n	0010	Screw Press with Polymer feed system	1.00	ea	9,171	375,466	-		1	616	385,253.01 /ea	385,253
		11365.005 Screw Press			*9,171*	*375,466*			*1*	*616*	*385,253.01 /ea*	*385,253*
		1.00 ea										
		160.00 Labor hours										
		0.021 Equipment hours										
	11923.000	*Ploymer System*										
	0100	Polymer System	1.00	ea	10,882	100,000					110,881.99 /ea	110,882
		11923.000 Ploymer System			*10,882*	*100,000*					*110,881.99 /ls*	*110,882*
		1.00 ls										
		160.00 Labor hours										
		1.00 Equipment hours										
		DIVISION 11 EQUIPMENT			**22,501**	**539,312**	**0**		**1**	**1,747**		**563,561**
		356.00 Labor hours										
		3.021 Equipment hours										
DIVISION 13		**SPECIAL CONSTRUCTION**										
	13440.000	*Instrumentation for Process Control: Basic Requirements*										
	0001	Instrumentation and Controls as a percent of project cost (_%)	1.00	ls	-	-	106,273		-	-	106,273.45 /ls	106,273
		13440.000 Instrumentation for Process Control: Basic Requirements					*106,273*				*106,273.45 /ls*	*106,273*
		1.00 ls										
		DIVISION 13 SPECIAL CONSTRUCTION			**0**	**0**	**106,273**		**0**	**0**		**106,273**
DIVISION 14		**CONVEYING SYSTEMS**										
	14305.000	*Bridge Cranes*										
	0210	Crane rail, box beam bridge, running track only, 104 lb per yard, 20' piece, excl. equipment	80.00	lf	1,020	1,884	-		76	-	37.25 /lf	2,980
	0125	Overhead bridge crane, under hung hoist, electric operating, 1 girder, 5 ton, 20' span	1.00	ea	2,317	26,624	-		145	-	29,085.46 /ea	29,085

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
		14305.000 Bridge Cranes			*3,337*	*28,508*			*221*		*32,065.33 /ea*	*32,065*
		1.00 ea 50.00 Labor hours 6.00 Equipment hours										
	14552.000	*Automated Hopper*										
	0100	Live Bottom Hopper	1.00	ea	24,515	500,000	-		4,634		529,149.29 /ea	529,149
		14552.000 Automated Hopper			*24,515*	*500,000*			*4,634*		*529,149.29 /ea*	*529,149*
		1.00 ea 480.000 Labor hours 40.00 Equipment hours										
		DIVISION 14 CONVEYING SYSTEMS			**27,852**	**528,508**	**0**		**4,855**	**0**		**561,215**
		530.000 Labor hours 46.00 Equipment hours										
	DIVISION 15	**MECHANICAL**										
	15062.000	*Pipe: Ductile*										
n	0050	Excavating, trench or continuous footing, common earth, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewatering	22.00	bcy	150	-	-		65	-	9.783 /bcy	215
n	0050	Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, excludes compaction	4.00	lcy	38	109	-		12	-	39.723 /lcy	159
n	8050	Compaction, 3 passes, 6" to 11", 4" lifts, rammer tamper	4.00	ecy	18	-	-		2	-	5.093 /ecy	20
n	1905	Backfill, trench, 4" to 8" Pipe, 3'-10' Deep; excludes compaction	22.00	lcy	19	-	-		9	-	1.29 /lcy	28
n	2200	Backfill COMPACTION, TRENCH, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller	19.00	ecy	22	-	-		57	-	4.164 /ecy	79
n	2020	Distribution piping,DIP,cement lined,fastite, 20' lengths, 4"dia, Press Class 350, Excludes excavation, backfill, bedding	20.00	lf	65	456	-		-	-	26.021 /lf	520
n	4400	Distribution Piping,DIP,Protecto 401-Lining,4"dia,additional per linear foot	20.00	lf	-	344	-		-	-	17.18 /lf	344
	8100	Fitting,wye or tee, DIP, cement lined, MJ, 4" diameter, C110 water piping with Protecto 401 or SP2000 Coating	1.00	ea	65	309	-		-	-	374.09 /ea	374
	8200	Fitting,45 degree bend,DIP,cement lined,MJ,4"dia,C110 water piping with Protecto 401 or SP2000 Coating	2.00	ea	87	344	-		-	-	215.05 /ea	430
n	001	Plug Valve MJ: 4" / 2" Nut Operator / Includes Gear Operator; includes valve box	1.00	ea	281	823	-		-	154	1,258.17 /ea	1,258
n	0185	Valve Operator, Electric, Modulating, 4" dia	1.00	ea	-	7,322	-		-	-	7,321.60 /ea	7,322
		15062.000 Pipe: Ductile			*744*	*9,705*			*146*	*154*	*537.49 /lf*	*10,750*
		20.00 lf 13.27 Labor hours 2.35 Equipment hours										

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	15062.100	*Pipe: Ductile - Interior with Valves, Couplings, Hangers and Supports*										
n	0002	DIP,FLGxFLG,4"dia,1'-0" long,class 53,Protecto 401 Lining,excl excav, backfill	4.00	ea	232	1,027	-		-	-	314.540 /ea	1,258
n	0006	DIP,FLGxFLG,4"dia,2'-6" long,class 53, Protecto 401 Lining,excl excav, backfill	4.00	ea	232	1,699	-		-	-	482.66 /ea	1,931
n	0011	DIP,FLGxFLG,4"dia,5'-0" long,class 53,Protecto 401 Lining,excl excav, backfill	5.00	ea	290	3,039	-		-	-	665.79 /ea	3,329
n	0026	DIP,FLGxFLG,4"dia,10'-0" long,class 53,Protecto 401 Lining,excl excav, backfill	1.00	ea	95	993	-		-	-	1,087.48 /ea	1,087
n	1001	Fitting,DIP,FLG,90 degree bend,4"dia,c 110 water piping with Protecto 401 or SP2000 Coating	3.00	ea	174	844	-		-	-	339.303 /ea	1,018
n	2001	Fitting,DIP,FLG,45 degree bend,4"dia,c 110 water piping with Protecto 401 or SP2000 Coating	1.00	ea	58	265	-		-	-	323.31 /ea	323
n	3001	Fitting,DIP,FLG,Tee,4"dia,c 110 water piping with Protecto 401 or SP2000 Coating	2.00	ea	116	800	-		-	-	458.01 /ea	916
n	501	Plug Valve Flange: 4" / Handwheel or Lever Operator / Includes Gear Operator	3.00	ea	859	2,153	-		645	-	1,219.02 /ea	3,657
n	0185	Valve Operator, Electric, Modulating, 4" dia	3.00	ea	-	21,965	-		-	-	7,321.60 /ea	21,965
		15062.100 Pipe: Ductile - Interior with Valves, Couplings, Hangers and Supports			*2,054*	*32,785*			*645*		*35,484.300/ls*	*35,484*
		1.00 ls										
		38.70 Labor hours										
		6.00 Equipment hours										
	15605.000	*HVAC: Equipment*										
	0025	HVAC System for Buildings	9.143	ton	-	-	37,831		-	-	4,137.70 /ton	37,831
		15605.000 HVAC: Equipment					*37,831*				*37,830.99 /ls*	*37,831*
		1.00 ls										
		DIVISION 15 MECHANICAL			**2,799**	**42,490**	**37,831**		**791**	**154**		**84,065**
		51.97 Labor hours										
		8.35 Equipment hours										
DIVISION 16		**ELECTRICAL**										
	16010.000	*Electrical: Basic Requirements*										
	0001	Electrical Work as a percent of project cost (_%)	1.00	ls	-	-	318,820		-	-	318,820.340 /ls	318,820
		16010.000 Electrical: Basic Requirements					*318,820*				*318,820.340/ls*	*318,820*
		1.00 ls										
		DIVISION 16 ELECTRICAL			**0**	**0**	**318,820**		**0**	**0**		**318,820**
		DEWATERING CENTRIFUG DEWATERING FACILITY_1.00 TILSUGE			***407,097***	***1,408,757***	***486,103***		***323,934***	***1,901***	***2,627,791.77 /LS***	***2,627,792***
		6,789.502 Labor hours										
		7,726.25 Equipment hours										

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

Partial Totals

Description	Amount	Totals	Hours	Rate
Labor	407,097		6,789.502 hrs	
Material	1,408,757			
Subcontract	486,103			
Equipment	323,934		7,726.245 hrs	
Other	1,901			
Direct Cost - Subtotal		**2,627,792**		
Contractor's Fld Ovhd & Mob	315,335			12.000 %
Field Const Cost - Subtotal		**2,943,127**		
Contractor's Fee	294,313			10.000 %
Contractor's Bonds & Insurance	48,562			1.500 %
Undefined SOW (Contingency)	657,200			20.000 %
Subtotal		**3,943,201**		
Escalation (NONE INCLUDED)	0			0.000 %
Sales Tax Estimate (Total)	374,604			9.500 %
Current OPCC Estimate Budget		**4,317,805**		

AACE Classification Accuracy Range

Upper Range +40%

Lower Range -20%

Alternative 2A: Centrifuge in Centrifuge Room

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Puyallup Solids
Retrofit Centrifuge Rev 2 Option
Puyallup, WA

Estimators	Email
Dan Blackwell 208-387-7010	daniel.blackwell@hdrinc.com
Scott Bishop 704-338-6770	Scott.bishop@hdrinc.com
Estimate Class Based on AACE International Recommended Practice No. 17R-97 (COST ESTIMATE CLASSIFICATION SYSTEM)	Class 4 - 1% to 15% Project Definition (Accuracy Range Index of 2 = +40% to -20% Range of accuracy)
Cost Basis for Estimate	RS Means 3rd Qtr 2013 Wage Base geographically adjusted for Seattle, WA
	Contractor's Field General Conditions, Mobilization and Demobilization at 10% of Direct cost.
	9.5% Sales Tax on total construction costs.
	Prime Contractor's Office Overhead and Profit of 12%
	Contractor's Bond and Builder's Risk Insurance of 1.5%
	Overall Project Contingency is 25%
	No escalations have been included.
	Estimate based on a construction duration of 6 months

Puyallup Solids
Retrofit Centrifuge Rev 2 Option
Puyallup, WA

Estimate Dates	10/28/2013
Special Notes	
	RS Means Unit Prices with O&P where used in the case of subcontracted work which are placed in the detailed estimate worksheets in the Subcontract Column
	RS Means Unit Prices for anticipated self perform work do not include O&P which is added as mark ups at the bottom of each worksheet and carried forward to the Summary Worksheet.
	Quantities were estimated using the most current Preliminary drawings or verbal descriptions presented by the design team.
	Field General conditions are included as a percentage of Direct Cost
	Estimate is based on all work except paving, caissons, masonry, roofing, sheet metal, skylight, overhead door, coatings, HVAC, Electrical and Instrumentation being self perform work. No additional subcontractor mark up is included beyond those items of work.
	Estimator's Equipment Installation Experience Standards using Area Labor rates for Appropriate trades

Puyallup Solids
Retrofit Centrifuge Rev 2 Option
Puyallup, WA

Estimate Area	#	Description
General Project Assumptions		
	1	Any opinions of probable construction cost or cost estimates provided by HDR, Inc. are made on the basis of information available to HDR, Inc. and on the basis of cost estimator's experience and qualifications, and represents its judgment as an experienced and qualified professional engineer. However, since HDR, Inc. has no control over the cost of labor, materials, equipment or services furnished by others, or over the contractor(s') methods of determining prices, or over competitive bidding or market conditions, HDR, Inc. does not guarantee that proposals, bids or actual project or construction cost will not vary from opinions of probable cost or cost estimates prepared by HDR, Inc
	2	OPCC is based on information provided on drawings S9-1 thru S9-6, A9-3, H9-3, M9-8, Navisworks 3D Model, marked up site sketch 8/21/13, and verbal discussions with design team.
	3	Assumes owner will provide all power, water, chemicals, testing, etc. for start-up and testing of the new systems.
	4	
	5	
	6	
WBS 100 - Solids Bldg Screw Press Retrofit		
Division 2 - Site Construction		
02072.005 - Demolition Asphalt Paving	1	Includes removal and disposal of 89 sy of asphalt paving for new Truck Loadout Pad.
02072.010 - Demo Masonry Wall for Screw Conveyor	2	Includes sawcut and removal of 16 sf masonry block at Screw Conveyor wall penetration.
02200.005 - Excavate/Backfill Truck Loadout Pad	3	Excavate and backfill for 30' x 15' Truck Loadout SOG 12" deep. Includes haul off and disposal of excess excavated material within 3 mile round trip. Excludes disposal fees.
02200.010 - Excavate/Backfill Pile Caps	4	Excavate and backfill for eight (8) pile caps 8' lg x 2' w x 2' dp. Includes haul off and disposal of excess excavated material within 3 mile round trip. Excludes disposal fees
02373.005 - Drilled 18" Caissons	5	Includes twenty four (24) 18" diameter x 25' deep drilled caissons. Includes drilling, concrete, rebar, and casing removal.
02513.005 - Patch Asphalt Paving	6	Includes 350 sf of asphalt paving patch at new Truck Loadout Pad.
	7	
Division 3 - Concrete	8	
03002.105 - Concrete Pile Caps	9	Includes eight (8) formed concrete pile caps 8' lg x 2' w x 2' dp. Includes reinforcing steel at 225 lbs/cy.
03002.705 - Truck Loadout Slab on Grade	10	Includes 30' x 15' x 18" deep cast in place concrete slab on grade. Assumes 4,000 psi concrete with 175 lbs/cy of reinforcing steel. Includes 12" compacted gravel under slab.
03002.710 - Concrete - Centrifuge Pedestals	11	Assumes two (2) concrete pedestals 5' h x 5' w x 2' long. Assumes 4,000 psi concrete with 225 lbs/cy of reinforcing steel.
	12	
Division 4 - Masonry	13	

Est. Assumptions

Puyallup Solids
Retrofit Centrifuge Rev 2 Option
Puyallup, WA

Estimate Area	#	Description
04220.005 - Concrete Masonry - Truck Loadout	14	Includes 30' long x 15' wide x 25' tall 8" split face CMU walls for Truck Loadout enclosure.
	15	
Division 5 - Metals	16	
05120.005 - Monorail & Support Frames	17	Includes a budget for W12 x 32 Monorail and two (2) Monorail Support Frames.
05505.005 - Metal Frame/Cover - Conveyor Penetration	18	Includes a budget to frame and seal around screw conveyor at masonry wall penetration.
05505.010 - Centrifuge Platform	19	Includes a budget for an aluminum Centrifuge access platform approximately 20' lg x 4' w x 5' h with aluminum grating and 1 1/2" aluminum handrail on 2 sides.
	20	
Division 7 - Thermal & Moisture Protection	21	
07501.005 - Built Up Roofing - Truck Loadout	22	Assumes Truck Loadout requires a roof over the hopper. Includes 450 sf of Built Up Roof over metal deck and bar joists. Roof system is similar to system used in the new Dewatering Building estimate.
07600.005 - Aluminum Fascia	23	Includes a budget for 272 sf of Aluminum Fascia installed on 1" x 2" wood furring.
	24	
Division 8 - Doors & Windows	25	
08120.031 - Aluminum Doors/Frames - Truck Loadout	26	Includes one (1) 3' x 7' aluminum mandoor with hardware at Truck Loadout.
08334.005 - Aluminum Rolling Overhead Door - Truck Loadout	27	Includes one (1) 12' x 12' aluminum overhead door with electric operator at Truck Loadout.
	28	
Division 9 - Finishes	29	
09905.000 - Painting and Protective Coatings	30	Includes touch-up of existing and painting of new equipment and piping in the existing Solids Building.
09905.005 - Painting and Protective Coatings - Truck Loadout Masonry	31	Includes sealing exterior and painting interior masonry walls at new truck loadout.
	32	
Division 11 - Equipment	33	
11005.000 - Equipment: Basic Requirements	34	Includes 2 days start-up and testing of Centrifuge and Conveyor.
11069.000 - Pumping Equipment: Progressing Cavity	35	Includes purchasing and installing two(2) 15 hp, 300 gpm progressive cavity pumps. Includes the same purchase price for the pumps ($63,846) as in the new Dewatering Building Estimate.
11365.000 - Dewatering Centrifuge	36	Includes purchasing and installing an Andritz Centrifuge in the existing Solids Building. Includes a $314,545 (engineering supplied) budget for purchase of the equipment. Includes cost of an "extra" scroll. Assumes freight, manufacture start-up, checkout, and testing are included in the budget. Assumes equipment will fit through existing door.
11923.000 - Polymer System	37	Includes purchasing and installing a Polymer System in the existing Solids Building. Includes the same purchase price for the equipment ($100,000) as in the new Dewatering Building estimate.
	38	
Division 13 - Special Construction	39	
13440.000 - Instrumentation for Process Control	40	Includes a budget for Instrumentation and Control work of $106,273.
	41	
Division 14 - Conveying Systems	42	

Est. Assumptions

Puyallup Solids
Retrofit Centrifuge Rev 2 Option
Puyallup, WA

Estimate Area	#	Description
14305.005 - Overhead Hoist - 3 Ton	43	Includes a 3 ton electric hoist, with 15' lift and an electric 3 ton motorized trolley.
14551.000 - Conveyors: Screw	44	Includes purchase and install a stainless steel screw conveyor system 79' long from the new centrifuge in the existing Solids Building to the Automatic Hopper in the new Truck Loadout. Includes a budget of $123,596 to purchase the conveyor system.
14552.000 - Automated Hopper	45	Includes purchasing and installing an Automated Hopper in the new Truck Loadout. Includes the same purchase price for the equipment ($500,000) as in the new Dewatering Building estimate. Includes the same installation costs as in the new Dewatering Building estimate. Assumes includes all necessary supporting frame for a complete installation.
	46	
Division 15 - Mechanical	47	
01410.000 - Testing	48	Includes 2 days for hydro testing new piping.
15062.005 - Pipe: Ductile - Screw Press Process Pipe	49	Includes a budget to tie into existing sludge lines located in the lower level of the existing Solids Building using 6" ductile iron pipe with Protecto 401 lining. Includes 12 ea spools, 8 each 90 bends, 2 ea tees, 2 each reducers, 2 each motor operated plug valves, 1 each check valve, 2 each expansion joints, and 2 each floor penetrations.
15064.005 - Pipe: Plastic - Polymer Piping	50	Includes 80 lf of 1" sch 80 PVC piping. Includes 2 each ball valves and 1 each ball check valve. Assumes connection to existing polymer feed system within the existing Solids Building. Excludes the purchase or installation of any equipment.
15064.005 - Pipe: Plastic - NPW Piping	51	Includes 80 lf of 1 1/2" sch 80 PVC piping to the Truck Loadout. Assumes connection to existing NPW system within the existing Solids Building. Excludes the purchase or installation of any equipment.
15073.005 - Pipe - CISP - Truck Unloading Drain	52	Includes 30 lf of 6" no hub cast iron soil pipe from Truck Unloading Trench Drain to a connection with existing drain line in Dewatering Building.
15440.005 - Truck Loadout SOG Trench Drain	53	Includes 20 lf of 8" wide concrete encased FRP trench drain with cast iron top.
15605.000 - HVAC: Modifications	54	Includes a subcontract budget of $10,00 for HVAC and Odor Control ductwork modifications.
	55	
Division 16 - Electrical	56	
16010.000 - Electrical Subcontract	57	Includes a budget for Electrical Subcontract work of $318,820.

DEWATERING FACILITY
RETROFIT OPTION - CENTRIFUGE REV 2
PUYALLUP, WA

Project name	Dewater Facility Retrofit Puyallup WA
Labor rate table	CONC2013
Equipment rate table	CONC2013
Bid date	10/16/2013
Project Name 1	Puyallup Dewatering
Project Name 2	Retrofit Option
Project Info 1	Centrifuge Rev 2
Design Stage 1	Planning Level
Design Stage 2	Estimate
Estimate Version	1.0
Upper Range +%	40
Lower Range -%	20
Labor Rate Table	3rd Qtr 2013
Equip Rate Table	3rd Qtr 2013
Notes	Any opinions of probable construction cost or cost estimates provided by HDR, Inc. are made on the basis of information available to HDR, Inc. and on the basis of cost estimator's experience and qualifications, and represents its judgment as an experienced and qualified professional engineer. However, since HDR, Inc. has no control over the cost of labor, materials, equipment or services furnished by others, or over the contractor(s') methods of determining prices, or over competitive bidding or market conditions, HDR, Inc. does not guarantee that proposals, bids or actual project or construction cost will not vary from opinions of probable cost or cost estimates prepared by HDR, Inc.
Report format	Sorted by 'WBS_MAIN/MF95_DIV/HDR95SPEC/Group phase/Phase' 'HDR95SPEC' summary Allocate addons Print sort level notes
Cost index	980-WA-SEATTLE

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

Description		Quantity		Labor Amount	Material Amount	Subcontract Amount	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
100 Solids Building Centrifuge Retrofit										
DIVISION 02	**SITE CONSTRUCTION**									
02072.005	Demolition - Asphalt Paving	89.00	sy	619	2,314		438	160	39.67 /sy	3,531
02072.010	Demo Masonry Wall for Screw Conveyor	1.00	ls	810	5		621		1,435.96 /ls	1,436
02200.005	Excavate/Backfill Truck Loadout Pad	30.00	cy	714			732		48.191/cy	1,446
02200.010	Excavate/Backfill Pile Caps	40.00	cy	2,130			288		60.462/cy	2,418
02373.005	Drilled 18" Caissons	600.00	vlf	21,284	6,318		14,183		69.641/vlf	41,785
02513.005	Patch Asphaltic Paving	350.00	sf	490	2,376		728		10.27 /sf	3,594
DIVISION 02 SITE CONSTRUCTION				**26,047**	**11,012**		**16,990**	**160**		**54,209**
490.495	Labor hours									
187.02	Equipment hours									
DIVISION 03	**CONCRETE**									
03002.105	Concrete Pile Caps	9.50	cy	2,670	2,492		12		544.652/cy	5,174
03002.705	Truck Loadout Slab on Grade	25.00	cy	4,011	5,884		355		410.02 /cy	10,250
03002.710	Concrete - Centrifuge Pedestals	4.00	cy	1,463	1,340		9		703.09 /cy	2,812
DIVISION 03 CONCRETE				**8,144**	**9,716**		**376**			**18,237**
146.661	Labor hours									
14.66	Equipment hours									
DIVISION 04	**MASONRY**									
04220.005	Concrete Masonry - Truck Loadout	2,250.00	sf	29,868	20,177		519		22.473/sf	50,564
DIVISION 04 MASONRY				**29,868**	**20,177**		**519**			**50,564**
520.602	Labor hours									
26.974	Equipment hours									
DIVISION 05	**METALS**									
05120.005	Monorail & Support Frames	1.00	ls	3,115	6,881		198		10,193.94 /ls	10,194
05505.005	Metal Frame/Cover - Conveyor Penetration	1.00	ls	931	2,875			288	4,093.48 /ls	4,093
05505.010	Centrifuge Platform	1.00	ls	2,948	18,675		992		22,615.66 /ls	22,616
DIVISION 05 METALS				**6,994**	**28,431**		**1,190**	**288**		**36,903**
111.141	Labor hours									
17.794	Equipment hours									
DIVISION 07	**THERMAL& MOISTURE PROTECTION**									
07501.005	Built-Up Roofing System - Truck Loadout	450.00	sf	4,512	7,955		232		28.221/sf	12,699

				Labor	Material	Subcontract	Equipment	Other	Total	
Description		**Quantity**		**Amount**	**Amount**	**Amount**	**Amount**	**Amount**	**Unit Cost**	**Amount**
07600.005	Aluminum Fascia	272.00	sf	2,890	2,027		1,174	626	24.693/sf	6,716
DIVISION 07 THERMAL& MOISTURE PROTECTION				**7,402**	**9,983**		**1,405**	**626**		**19,416**
113.122	Labor hours									
28.11	Equipment hours									
DIVISION 08	**DOORS & WINDOWS**									
08120.031	Aluminum Doors & Frames - Truck Loadout	1.00	ea	687	2,064				2,751.33 /ea	2,751
08334.005	Aluminum Rolling Overhead Door - Truck Loadout	1.00	ea	1,095	4,975				6,070.44 /ea	6,070
DIVISION 08 DOORS & WINDOWS				**1,782**	**7,039**					**8,822**
27.433	Labor hours									
DIVISION 09	**FINISHES**									
09905.000	Painting and Protective Coatings	1.00	ls			15,000			15,000.00 /ls	15,000
09905.005	Painting and Protective Coatings - Truck Load Out Masonry	1.00	ls	1,408	1,804				3,211.55 /ls	3,212
DIVISION 09 FINISHES				**1,408**	**1,804**	**15,000**				**18,212**
29.05	Labor hours									
DIVISION 11	**EQUIPMENT**									
11005.000	Equipment: Basic Requirements	1.00	ea	1,065	624			400	2,088.93 /ea	2,089
11069.000	Pumping Equipment: Progressing Cavity	2.00	ea	3,503	64,664		2	1,131	34,649.870/ea	69,300
11365.000	Dewatering Centrifuges	1.00	ea	10,779	315,342		2,249	2,000	330,370.26 /ea	330,370
11923.000	Polymer System	1.00	ls	11,440	100,361		1		111,801.46 /ls	111,801
DIVISION 11 EQUIPMENT				**26,786**	**480,991**		**2,252**	**3,531**		**513,560**
455.29	Labor hours									
23.800	Equipment hours									
DIVISION 13	**SPECIAL CONSTRUCTION**									
13440.000	Instrumentation for Process Control	1.00	ls			106,273			106,273.01 /ls	106,273
DIVISION 13 SPECIAL CONSTRUCTION						**106,273**				**106,273**
DIVISION 14	**CONVEYING SYSTEMS**									
14305.005	Overhead Hoist - 3 Ton	1.00	ea	623	5,381				6,004.14 /ea	6,004
14551.000	Conveyors: Screw	1.00	ea	20,461	123,596			4,514	148,570.91 /ea	148,571
14552.000	Automated Hopper	1.00	ea	23,998	500,000		4,498		528,495.53 /ea	528,496
DIVISION 14 CONVEYING SYSTEMS				**45,081**	**628,977**		**4,498**	**4,514**		**683,071**
905.170	Labor hours									
40.00	Equipment hours									
DIVISION 15	**MECHANICAL**									

				Labor	Material	Subcontract	Equipment	Other	Total	
Description		**Quantity**		**Amount**	**Amount**	**Amount**	**Amount**	**Amount**	**Unit Cost**	**Amount**
01410.000	Testing	1.00	ls	1,827	300		648		2,775.12 /ls	2,775
15062.005	Pipe: Ductile - Screw Press Process Pipe	1.00	ls	6,312	30,567	400			37,278.78 /ls	37,279
15064.005	Pipe: Plastic - Polymer Piping	1.00	ls	2,030	874				2,903.63 /ls	2,904
15064.010	Pipe: Plastic - NPW Piping	1.00	ls	2,528	1,608				4,136.32 /ls	4,136
15073.005	Pipe: Cast-Iron Soil - Truck Unloading Drain Line	30.00	lf	1,721	2,555			300	152.56 /lf	4,577
15440.005	Truck Loadout SOG FRP Trench Drain	20.00	lf	778	2,873		55		185.30 /lf	3,706
15605.000	HVAC: Modifications	1.00	ls			10,000			10,000.00 /ls	10,000
DIVISION 15 MECHANICAL				**15,196**	**38,776**	**10,400**	**704**	**300**		**65,376**
217.07	Labor hours									
19.00	Equipment hours									
DIVISION 16	**ELECTRICAL**									
16010.000	Electrical Subcontract	1.00	ls			318,820			318,820.01 /ls	318,820
DIVISION 16 ELECTRICAL						**318,820**				**318,820**
100 Solids Building Centrifuge Retrofit				***168,710***	***1,236,906***	***450,493***	***27,936***	***9,418***	***1,893,462.45 /LS***	***1,893,462***
1.00	***LS***									
3,016.03	Labor hours									
357.35	Equipment hours									

Estimate Totals

Description	Amount	Totals	Hours	Rate
Labor	168,710		3,016.026 hrs	
Material	1,236,906			
Subcontract	450,493			
Equipment	27,936		357.350 hrs	
Other	9,418			
Direct Cost - Subtotal		**1,893,463**		
Contractor's Fld Ovhd & Mob	189,346			10.000 %
Field Const Cost - Subtotal		**2,082,809**		
Contractor's Fee	249,937			12.000 %
Contractor's Bonds & Insurance	34,991			1.500 %
Undefined SOW (Contingency)	591,934			25.000 %
Subtotal		**2,959,671**		
Escalation (NONE INCLUDED)				0.000 %
Sales Tax Estimate (Total)	281,169			9.500 %
Current OPCC Estimate Budget		**3,240,840**		

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

Project name	Dewater Facility Retrofit Puyallup WA
Labor rate table	CONC2013
Equipment rate table	CONC2013
Bid date	10/16/2013
Project Name 1	Puyallup Dewatering
Project Name 2	Retrofit Option
Project Info 1	Centrifuge Rev 2
Design Stage 1	Planning Level
Design Stage 2	Estimate
Estimate Version	1.0
Upper Range +%	40
Lower Range -%	20
Labor Rate Table	3rd Qtr 2013
Equip Rate Table	3rd Qtr 2013
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Report format	Sorted by 'WBS_MAIN/MF95_DIV/HDR95SPEC' 'Detail' summary Allocate addons Combine items Print sort level notes
Cost index	980-WA-SEATTLE

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
		100 Solids Building Centrifuge Retrofit										
	DIVISION 02	**SITE CONSTRUCTION**										
	02072.005	*Demolition - Asphalt Paving*										
n	5050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	89.00	sy	446	-	-		279	-	8.152 /sy	726
n	0400	Selective demolition, disposal only, includes loading and 5 mile haul to dump	20.00	cy	108	-	-		118	-	11.294 /cy	226
n	0100	Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	30.00	ton	-	2,303	-		-	-	76.752 /ton	2,303
n	0015	Selective demolition, saw cutting, asphalt, up to 3" deep	80.00	lf	65	11	-		41	160	3.46 /lf	277
		02072.005 Demolition - Asphalt Paving			*619*	*2,314*			*438*	*160*	*39.67 /sy*	*3,531*
		89.00 sy										
		11.853 Labor hours										
		9.69 Equipment hours										
	02072.010	*Demo Masonry Wall for Screw Conveyor*										
n	2440	Selective demolition, cutout, concrete block, to 4 S.F. opening, 8" thick, excludes loading and disposal	1.00	ea	374	-	-		160	-	534.450 /ea	534
n	0800	Concrete sawing, concrete walls, plain, per inch of depth, hydraulic saw (4' x 4' = 16' x 8" deep = 128 lf)	128.00	lf	436	5	-		461	-	7.043 /lf	902
		02072.010 Demo Masonry Wall for Screw Conveyor			*810*	*5*			*621*		*1,435.96 /ls*	*1,436*
		1.00 ls										
		16.192 Labor hours										
		24.384 Equipment hours										
	02200.005	*Excavate/Backfill Truck Loadout Pad*										
n	0310	Excavating, bulk bank measure, 1/2 C.Y. capacity = 40 C.Y./hour, backhoe, hydraulic, wheel mounted, excluding truck loading	30.00	bcy	442	-	-		205	-	21.554 /bcy	647
n	1600	Backfill, bulk, 6" to 12" lifts, compaction with vibrating roller	13.00	ecy	228	-	-		446	-	51.802 /ecy	673
n	0450	Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip , 1.9 loads/hour, 12 C.Y. truck, highway haulers, excludes loading	19.55	lcy	44	-	-		82	-	6.43 /lcy	126
		02200.005 Excavate/Backfill Truck Loadout Pad			*714*				*732*		*48.191/cy*	*1,446*
		30.00 cy										
		12.920 Labor hours										
		8.920 Equipment hours										

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	02200.010	*Excavate/Backfill Pile Caps*										
n	0310	Excavating, bulk bank measure, 1/2 C.Y. capacity = 40 C.Y./hour, backhoe, hydraulic, wheel mounted, excluding truck loading	40.00	bcy	442	-	-		205	-	16.17 /bcy	647
n	0100	Backfill, heavy soil, by hand, no compaction	40.00	lcy	1,351	-	-		-	-	33.79 /lcy	1,351
n	0500	Backfill and compact, by hand, 6" layers, air rammer/tamper, add	32.00	ecy	317	-	-		45	-	11.291 /ecy	361
n	0450	Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip , 1.9 loads/hour, 12 C.Y. truck, highway haulers, excludes loading	9.20	lcy	21	-	-		38	-	6.43 /lcy	59
		02200.010 Excavate/Backfill Pile Caps			*2,130*				*288*		*60.462/cy*	*2,418*
		40.00 cy 44.261 Labor hours 11.17 Equipment hours										
	02373.005	*Drilled 18" Caissons*										
n	1300	Fixd end cssn pils,open styl wet grnd,50'd,18"d,0.065 cy/l, mchn drll,pull casng and pmpng,incld excvt,cncrt,50lb rnfr/, excld mblzt,bldr remvl,dispsl	600.00	vlf	10,649	6,318	-		12,514	-	49.134 /vlf	29,480
n	4500	Fixed end caisson piles, load and haul excess excavation, 2 miles	47.00	lcy	98	-	-		215	-	6.661 /lcy	313
n	4600	Fixed end caisson piles, for mobilization, 50 mile radius, rig to 36"	1.00	ea	1,188	-	-		1,454	-	2,641.91 /ea	2,642
n	5000	Fixed end caisson piles, bottom inspection, add	24.00	ea	9,349	-	-		-	-	389.56 /ea	9,349
		02373.005 Drilled 18" Caissons			*21,284*	*6,318*			*14,183*		*69.641/vlf*	*41,785*
		600.00 vlf 396.112 Labor hours 126.112 Equipment hours										
	02513.005	*Patch Asphaltic Paving*										
	0480	Plant-mix asphalt paving, for highways and large paved areas, wearing course, 4" thick, no hauling included	89.00	sy	119	1,710	-		74	-	21.374 /sy	1,902
	0600	Asphaltic concrete paving, parking lots & driveways, binder course, 4" thick, no asphalt hauling included	350.00	sf	90	666	-		90	-	2.42 /sf	846
n	0560	Hauling, asphalt material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	27.00	lcy	281	-	-		564	-	31.321 /lcy	846
		02513.005 Patch Asphaltic Paving			*490*	*2,376*			*728*		*10.27 /sf*	*3,594*
		350.00 sf 9.16 Labor hours 6.744 Equipment hours										
	DIVISION 02 SITE CONSTRUCTION				**26,047**	**11,012**	**0**		**16,990**	**160**		**54,209**
		490.495 Labor hours 187.02 Equipment hours										

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
DIVISION 03		**CONCRETE**										
	03002.105	*Concrete Pile Caps*										
n	3061	C.I.P. concrete forms, foundation, edge, wood, over 12", 4 use, includes erecting, bracing, stripping and cleaning	320.00	sfca	1,547	268	-		-	-	5.67 /sfca	1,814
n	0605	Reinforcing steel, in place, FOUNDATIONS, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	1.07	ton	912	1,212	-		-	-	1,991.14 /ton	2,125
n	2005	Reinforcing steel, unload and sort, add to base_FOUNDATIONS	1.07	ton	36	-	-		8	-	41.23 /ton	44
n	4602	Structural concrete, placing, foundation, direct chute, over 6" thick, includes vibrating, excludes material	9.481	cy	134	-	-		4	-	14.55 /cy	138
n	0300	Struct FOUNDATION concrete,ready mix,normal wt,4000 psi,includes local aggregate,sand,portland cement and water,delivered,excludes all additives	9.481	cy	-	1,013	-		-	-	106.794 /cy	1,013
n	0105	Concrete finishing, floors, manual screed, bull float_FOUNDATIONS	128.00	sf	41	-	-		-	-	0.32 /sf	41
		03002.105 Concrete Pile Caps			*2,670*	*2,492*			*12*		*544.652/cy*	*5,174*
		9.50 cy 48.23 Labor hours 1.005 Equipment hours										
	03002.705	*Truck Loadout Slab on Grade*										
n	3050	C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning	135.00	sfca	525	121	-		-	-	4.781 /sfca	645
n	0600	Reinforcing Steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	2.19	ton	1,871	2,486	-		-	-	1,991.143 /ton	4,357
n	2050	Reinforcing steel, unload and sort, add to base_SLAB ON GRADE	2.19	ton	74	-	-		16	-	41.23 /ton	90
n	2220	Reinforcing steel, crane cost for handling, average, add_SLAB ON GRADE	2.19	ton	80	-	-		18	-	44.82 /ton	98
n	4300	Structural concrete, placing, slab on grade, direct chute, up to 6" thick, includes leveling (strike off) & consolidation, excludes material	25.00	cy	530	-	-		15	-	21.82 /cy	546
n	0720	Struct SLAB ON GRADE concrete,ready mix,normal wt,4000 psi,includes local aggregate,sand,portland cement and water,delivered,excludes all additives	25.00	cy	-	2,670	-		-	-	106.794 /cy	2,670
n	0255	Concrete finishing, floors, manual screed, bull float, machine float & steel trowel (walk-behind)_SOG	450.00	sf	335	-	-		14	-	0.78 /sf	349
n	0310	Concrete surface treatment, curing, sprayed membrane compound_SOG	4.50	csf	35	38	-		-	-	16.26 /csf	73
n	1200	Vapor retarders, building paper, polyethylene vapor barrier, standard, .010" thick	4.50	sq	53	33	-		-	-	18.97 /sq	85
n	1010	Fill, gravel fill, compacted, under floor slabs,	19.00	ecy	374	537	-		25	-	49.27 /ecy	936

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	03002.705	*Truck Loadout Slab on Grade*										
n	1136	Hauling, excavated borrow material, loose cubic yards, 20 mile round trip, 0.4 loads/hour, 16.5 c.y. dump trailer, highway haulers, excludes loading	19.00	lcy	135	-	-		266	-	21.123 /lcy	401
		03002.705 Truck Loadout Slab on Grade			*4,011*	*5,884*			*355*		*410.02 /cy*	*10,250*
		25.00 cy 72.28 Labor hours 12.995 Equipment hours										
	03002.710	*Concrete - Centrifuge Pedestals*										
n	0750	C.I.P. concrete forms, wall, buttress, to 8' high, 2 use, includes erecting, bracing, stripping and cleaning	140.00	sfca	848	367	-		-	-	8.68 /sfca	1,215
n	5200	Chamfer strip, wood, 3/4" wide	60.00	lf	51	16	-		-	-	1.12 /lf	67
n	0600	Reinforcing Steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	0.45	ton	385	511	-		-	-	1,991.16 /ton	896
n	2050	Reinforcing steel, unload and sort, add to base_SLAB ON GRADE	0.45	ton	15	-	-		3	-	41.244 /ton	19
n	2220	Reinforcing steel, crane cost for handling, average, add_SLAB ON GRADE	0.45	ton	17	-	-		4	-	44.80 /ton	20
n	9005	Reinforcing steel, in place, drill and epoxy dowels, deformed, 2' long, #5, A615, grade 60; incl drilling into existing concrete and injected epoxy	20.00	ea	41	17	-		-	-	2.88 /ea	58
n	4300	Structural concrete, placing, slab on grade, direct chute, up to 6" thick, includes leveling (strike off) & consolidation, excludes material	4.00	cy	85	-	-		2	-	21.823 /cy	87
n	0720	Struct SLAB ON GRADE concrete,ready mix,normal wt,4000 psi,includes local aggregate,sand,portland cement and water,delivered,excludes all additives	4.00	cy	-	427	-		-	-	106.80 /cy	427
n	0200	Concrete finishng,floors,basic finishng for unspecfd flatwork,bull float,manual float&manual steel trowel,excludes placing,striking off&consolidating	20.00	sf	20	-	-		-	-	1.01 /sf	20
n	0310	Concrete surface treatment, curing, sprayed membrane compound_SOG	0.20	csf	2	2	-		-	-	16.30 /csf	3
		03002.710 Concrete - Centrifuge Pedestals			*1,463*	*1,340*			*9*		*703.09 /cy*	*2,812*
		4.00 cy 26.155 Labor hours 0.66 Equipment hours										
	DIVISION 03 CONCRETE				**8,144**	**9,716**	**0**		**376**	**0**		**18,237**
		146.661 Labor hours 14.66 Equipment hours										
	DIVISION 04	**MASONRY**										

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	04220.005	*Concrete Masonry - Truck Loadout*										
n	0090	Scaffolding, steel tubular, regular, labor only to erect & dismantle, building exterior, wall face, 6'-4" x 5' frames, 1 to 5 stories, excl. planks	23.00	csf	3,839	-	-		-	-	166.90 /csf	3,839
n	0906	Scaffolding, steel tubular, regular, rent/month only for complete system for face of walls, 6' -4" x 5' frames, excl. planks	23.00	csf	-	828	-		-	-	36.00 /csf	828
n	2850	Scaffolding, steel tubular, regular, accessory, plank, rent/mo, 2" x 10" x 16' long	15.00	ea	-	90	-		-	-	6.00 /ea	90
n	0020	Grout, bond beams and lintels, 8" deep, 8" thick, 0.20 C.F. per L.F., pumped, excludes blockwork	90.00	lf	116	113	-		10	-	2.66 /lf	239
n	0250	Grout, concrete masonry unit (CMU) cores, 8" thick, 0.258 C.F./S.F., pumped, excludes blockwork	2,250.00	sf	5,985	3,131	-		509	-	4.28 /sf	9,625
n	0020	Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed horizontally, ASTM A615	297.40	lb	185	185	-		-	-	1.244 /lb	370
n	0060	Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed vertically, ASTM A615	2,788.09	lb	2,139	1,731	-		-	-	1.39 /lb	3,871
n	0130	Concrete block,bond beam,normal weight,2000 psi,8"x8"x16",includes mortar,excludes scaffolding,horizontal reinforcing,vertical reinforcing and grout	90.00	lf	366	289	-		-	-	7.281 /lf	655
n	6200	Concrete block, decorative, split face or scored split face, 2000 psi, 8" x 8" x 16", excludes scaffolding, grout and reinforcing	2,250.00	sf	17,238	11,897	-		-	-	12.95 /sf	29,135
n	6500	Concrete block, decorative, split face or scored split face, 8" thick, for special deeper colors, add	2,250.00	sf	-	1,912	-		-	-	0.85 /sf	1,912
		04220.005 Concrete Masonry - Truck Loadout			*29,868*	*20,177*			*519*		*22.473/sf*	*50,564*
		2,250.00 sf 520.602 Labor hours 26.974 Equipment hours										
		DIVISION 04 MASONRY			**29,868**	**20,177**	**0**		**519**	**0**		**50,564**
		520.602 Labor hours 26.974 Equipment hours										
	DIVISION 05	**METALS**										
	05120.005	*Monorail & Support Frames*										
n	0450	Anchor bolts, J-type, 3/4" diameter x 18" long, includes nut and washer	16.00	ea	446	240	-		-	-	42.90 /ea	686
n	0300	Grout, non-shrink, for column and machine bases, non-metallic, 1" deep	4.00	sf	217	24	-		-	-	60.133 /sf	241
n	0020	Steel framing, structural steel, shop fabricated	3,500.00	lb	2,452	6,617	-		198	-	2.65 /lb	9,267
		05120.005 Monorail & Support Frames			*3,115*	*6,881*			*198*		*10,193.94 /ls*	*10,194*
		1.00 ls 49.35 Labor hours 9.35 Equipment hours										

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	05505.005	*Metal Frame/Cover - Conveyor Penetration*										
n	2600	Fabricated SS Frame and Cover for Screw Conveyor wall penetration	1.00	ea	931	2,875	-		-	288	4,093.48 /ea	4,093
		05505.005 Metal Frame/Cover - Conveyor Penetration			*931*	*2,875*				*288*	*4,093.48 /ls*	*4,093*
		1.00 ls										
		16.00 Labor hours										
	05505.010	*Centrifuge Platform*										
n	0020	Aluminum, structural shapes, under 1 ton, 1" to 10" members	2,000.00	lb	1,784	10,134	-		898	-	6.41 /lb	12,815
n	0950	Stair, shop fabricated, aluminum, 4'-0" W, incl pipe railing, stringers, grating treads w/ safety nosing, per riser	8.00	risr	558	3,968	-		45	-	571.51 /risr	4,572
n	0200	Railing, pipe, aluminum, satin finish, 3 rails, 3'-6" high, posts @ 5' O.C., 1-1/2" dia, shop fabricated	24.00	lf	367	1,786	-		30	-	90.931 /lf	2,182
n	0132	Floor grating, aluminum, 1-1/2" x 3/16" bearing bars @ 1-3/16" O.C., cross bars @ 4" O.C., up to 300 S.F., field fabricated from panels	80.00	sf	239	2,787	-		19	-	38.08 /sf	3,046
		05505.010 Centrifuge Platform			*2,948*	*18,675*			*992*		*22,615.66 /ls*	*22,616*
		1.00 ls										
		45.80 Labor hours										
		8.45 Equipment hours										
		DIVISION 05 METALS			**6,994**	**28,431**	**0**		**1,190**	**288**		**36,903**
		111.141 Labor hours										
		17.794 Equipment hours										
	DIVISION 07	**THERMAL& MOISTURE PROTECTION**										
	07501.005	*Built-Up Roofing System - Truck Loadout*										
n	0800	Aluminum coping, stock units, for 12" wall, excludes scaffolding	104.00	lf	1,297	1,533	-		-	-	27.22 /lf	2,830
n	0600	Open web bar joist, K Series, 40-ton job lots, 24K10, 13.1 plf, 30' to 50' spans, shop fabricated, incl shop primer, horizontal bridging	150.00	lf	570	2,266	-		165	-	20.003 /lf	3,000
n	2600	Metal roof decking, steel, open type B wide rib, galvanized, under 50 Sq, 1-1/2" D, 20 gauge	450.00	sf	582	1,485	-		22	-	4.642 /sf	2,089
n	2780	2" x 8" miscellaneous wood blocking, to steel construction, per M.B.F.	0.21	mbf	491	159	-		-	-	3,125.43 /mbf	650
n	0030	Underlayment, plywood, underlayment grade, 3/8" thick	450.00	flr	298	468	-		-	-	1.702 /flr	766
n	1725	Polyisocyanurate Insulation, for roof decks, 2" thick, 2#/CF density, fastening excluded	450.00	sf	130	386	-		-	-	1.15 /sf	516
n	1745	Polyisocyanurate Insulation, for roof decks, 3" thick, 2#/CF density, fastening excluded	450.00	sf	143	596	-		-	-	1.643 /sf	739
n	0825	Asphalt shingles, #30 felt underlayment	5.00	sq	37	59	-		-	-	19.12 /sq	96
n	4800	Ethylene-propylene-diene-monomer roofing, (EPDM), 0.40 psf, fully adhered with adhesive, 60 mils	5.00	sq	374	752	-		45	-	234.242 /sq	1,171

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	07501.005	*Built-Up Roofing System - Truck Loadout*										
n	0100	Sheet metal flashing, aluminum, flexible, mill finish, .032" thick, including up to 4 bends	180.00	sf	589	252	-		-	-	4.672 /sf	841
		07501.005 Built-Up Roofing System - Truck Loadout			*4,512*	*7,955*			*232*		*28.221/sf*	*12,699*
		450.00 sf 73.121 Labor hours 4.11 Equipment hours										
	07600.005	*Aluminum Fascia*										
n	0170	Rent aerial lift, telescoping boom to 40' high, 500 lb cap	3.00	day	-	-	-		1,174	-	391.20 /day	1,174
n	0300	Furring, wood, on walls, on masonry, 1" x 2", 24" O.C.	140.00	lf	496	45	-		-	-	3.862 /lf	541
n	0100	Fascia, aluminum, reverse board & batten, colored, .032" thick, excl. furring	272.00	sf	2,394	1,983	-		-	626	18.39 /sf	5,002
		07600.005 Aluminum Fascia			*2,890*	*2,027*			*1,174*	*626*	*24.693/sf*	*6,716*
		272.00 sf 40.000 Labor hours 24.00 Equipment hours										
		DIVISION 07 THERMAL& MOISTURE PROTECTION			**7,402**	**9,983**	**0**		**1,405**	**626**		**19,416**
		113.122 Labor hours 28.11 Equipment hours										
	DIVISION 08	**DOORS & WINDOWS**										
	08120.031	*Aluminum Doors & Frames - Truck Loadout*										
n	1000	Frames, steel, knock down, hollow metal, single, 16 ga., up to 4-7/8" deep, 7'-0" h x 3'-0" w	1.00	ea	59	196	-		-	-	255.19 /ea	255
n	5050	Doors, aluminum, commercial entrance, flush panel doors, single, 3'-0" x 7'-0", incl. hinges, push/pull, deadlock, cylinder, threshold, excl. glazing	1.00	ea	424	949	-		-	-	1,372.86 /ea	1,373
n	3000	Door hardware, panic device, narrow stile, mortise bar, exit only	1.00	ea	124	756	-		-	-	880.30 /ea	880
n	0011	Thresholds, aluminum, 3' long door saddles	3.00	lf	31	26	-		-	-	18.89 /lf	57
n	1430	Door hardware, hinges, full mortise, high frequency, brass base, US10, 4-1/2" x 4-1/2"	1.50	pr	-	135	-		-	-	90.33 /pr	135
n	1200	Paints & coatings, exterior, door & frame, one side, flush, 1 coat, 3' x 7'	1.00	ea	48	2	-		-	-	50.83 /ea	51
		08120.031 Aluminum Doors & Frames - Truck Loadout			*687*	*2,064*					*2,751.33 /ea*	*2,751*
		1.00 ea 10.900 Labor hours										
	08334.005	*Aluminum Rolling Overhead Door - Truck Loadout*										
n	0301	Doors,rolling service,aluminum,manual,20 gauge,12'x12'high,includes hardware	1.00	ea	883	2,238	-		-	-	3,121.25 /ea	3,121

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	08334.005	*Aluminum Rolling Overhead Door - Truck Loadout*										
n	3300	Doors, rolling service, steel, manual, for enamel finish, add	144.00	sf	-	301	-		-	-	2.09 /sf	301
n	3700	Doors, rolling service, steel, manual, for safety edge bottom bar, electric, add	12.00	lf	-	573	-		-	-	47.75 /lf	573
n	4000	Doors, rolling service, steel, manual, for weatherstripping, extruded rubber, jambs, add	36.00	lf	-	580	-		-	-	16.12 /lf	580
n	4500	Doors, rolling service, steel, manual, motor operators for, to 14' x 14' opening	1.00	ea	212	1,283	-		-	-	1,495.17 /ea	1,495
		08334.005 Aluminum Rolling Overhead Door - Truck Loadout			*1,095*	*4,975*					*6,070.44 /ea*	*6,070*
		1.00 ea										
		16.533 Labor hours										
		DIVISION 08 DOORS & WINDOWS			**1,782**	**7,039**	**0**		**0**	**0**		**8,822**
		27.433 Labor hours										
	DIVISION 09	**FINISHES**										
	09905.000	*Painting and Protective Coatings*										
n	9995	Painting, Existing Building Touch-Up	1.00	ls			5,000				5,000.00 /ls	5,000
n	9998	Painting, Equipment	1.00	ls			5,000				5,000.00 /ls	5,000
n	9999	Painting, Piping and Existing Piping Touch-Up	1.00	ls			5,000				5,000.00 /ls	5,000
		09905.000 Painting and Protective Coatings					*15,000*				*15,000.00 /ls*	*15,000*
		1.00 ls										
	09905.005	*Painting and Protective Coatings - Truck Load Out Masonry*										
n	0600	Paints & Coatings, walls, concrete masonry units (CMU), porous, first coat, waterproof sealer, spray	2,250.00	sf	388	683	-		-	-	0.48 /sf	1,071
n	0610	Paints & Coatings, walls, concrete masonry units (CMU), porous, second coat, waterproof sealer, spray	2,250.00	sf	292	683	-		-	-	0.434 /sf	975
n	2880	Paints & coatings, walls & ceilings, interior, masonry or concrete block, latex paint, 2 coats, smooth finish, spray	2,250.00	sf	727	437	-		-	-	0.52 /sf	1,165
		09905.005 Painting and Protective Coatings - Truck Load Out Masonry			*1,408*	*1,804*					*3,211.55 /ls*	*3,212*
		1.00 ls										
		29.05 Labor hours										
		DIVISION 09 FINISHES			**1,408**	**1,804**	**15,000**		**0**	**0**		**18,212**
		29.05 Labor hours										
	DIVISION 11	**EQUIPMENT**										
	11005.000	*Equipment: Basic Requirements*										
	9995	Contractor Test and Start Up	2.00	dys	1,065	624	-			400	1,044.47 /dys	2,089

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
		11005.000 Equipment: Basic Requirements			*1,065*	*624*				*400*	*2,088.93 /ea*	*2,089*
		1.00 ea										
		16.00 Labor hours										
	11069.000	*Pumping Equipment: Progressing Cavity*										
n	0850	Anchor bolts, J-type, 3/4" diameter x 18" long, includes nut and washer	12.00	ea	335	300	-		-	-	52.90 /ea	635
n	3550	Struct concrete,place,equipment pad (3000 psi),4'x4'x6",includes forms(4 uses),grade 60 rebar,concrete (portland cement type i),placing and finishing	2.00	ea	185	138	-		2	-	162.92 /ea	326
n	0350	Grout, non-shrink, for column and machine bases, non-metallic, 2" deep	32.00	sf	534	380	-		-	-	28.55 /sf	913
n	03004015	Progressive Cavity Pump, 300 gpm / 40' TDH / 15 HP; 6" diam suction/discharge	2.00	ea	2,448	63,846	-			1,131	33,712.82 /ea	67,426
		11069.000 Pumping Equipment: Progressing Cavity			*3,503*	*64,664*			*2*	*1,131*	*34,649.870/ea*	*69,300*
		2.00 ea										
		55.05 Labor hours										
		2.533 Equipment hours										
	11365.000	*Dewatering Centrifuges*										
n	0850	Anchor bolts, J-type, 1" diameter x 18" long, includes nut and washer	16.00	ea	446	560	-		-	-	62.90 /ea	1,006
n	0350	Grout, non-shrink, for column and machine bases, non-metallic, 2" deep	20.00	sf	334	237	-		-	-	28.55 /sf	571
	1200	Dewatering Centrifuge & Extra Scroll Cost (Andritz)	1.00	ea	9,999	314,545	-		2,249	2,000	328,792.960 /ea	328,793
		11365.000 Dewatering Centrifuges			*10,779*	*315,342*			*2,249*	*2,000*	*330,370.26 /ea*	*330,370*
		1.00 ea										
		214.154 Labor hours										
		20.00 Equipment hours										
	11923.000	*Polymer System*										
n	0850	Anchor bolts, J-type, 3/4" diameter x 18" long, includes nut and washer	6.00	ea	167	150	-		-	-	52.90 /ea	317
n	3550	Struct concrete,place,equipment pad (3000 psi),4'x4'x6",includes forms(4 uses),grade 60 rebar,concrete (portland cement type i),placing and finishing	1.00	ea	93	69	-		1	-	162.92 /ea	163
n	0300	Grout, non-shrink, for column and machine bases, non-metallic, 1" deep	24.00	sf	297	142	-		-	-	18.30 /sf	439
	0100	Polymer System	1.00	ea	10,882	100,000					110,881.99 /ea	110,882
		11923.000 Polymer System			*11,440*	*100,361*			*1*		*111,801.46 /ls*	*111,801*
		1.00 ls										
		170.09 Labor hours										
		1.27 Equipment hours										

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
		DIVISION 11 EQUIPMENT			**26,786**	**480,991**	**0**		**2,252**	**3,531**		**513,560**
		455.29 Labor hours										
		23.800 Equipment hours										
	DIVISION 13	**SPECIAL CONSTRUCTION**										
	13440.000	*Instrumentation for Process Control*										
	0001	Instrumentation and Controls - Allowance	1.00	ls	-	-	106,273		-	-	106,273.01 /ls	106,273
		13440.000 Instrumentation for Process Control			*-*	*-*	*106,273*		*-*	*-*	*106,273.01 /ls*	*106,273*
		1.00 ls										
		DIVISION 13 SPECIAL CONSTRUCTION			**0**	**0**	**106,273**		**0**	**0**		**106,273**
	DIVISION 14	**CONVEYING SYSTEMS**										
	14305.005	*Overhead Hoist - 3 Ton*										
	2200	Hoists, material handling, electric overhead, chain, hook hung, 15' lift, 3 ton capacity	1.00	ea	-	3,390	-		-	-	3,389.75 /ea	3,390
n	2830	Material Handling Trolley, motorized, for 3 Ton hoists	1.00	ea	623	1,992	-		-	-	2,614.39 /ea	2,614
		14305.005 Overhead Hoist - 3 Ton			*623*	*5,381*					*6,004.14 /ea*	*6,004*
		1.00 ea										
		12.00 Labor hours										
	14551.000	*Conveyors: Screw*										
	0100	Conveyor, Screw, Shaftless, SS	79.00	lf	20,461	123,596	-		-	4,514	1,880.644 /lf	148,571
		14551.000 Conveyors: Screw			*20,461*	*123,596*				*4,514*	*148,570.91 /ea*	*148,571*
		1.00 ea										
		413.170 Labor hours										
	14552.000	*Automated Hopper*										
	0100	Live Bottom Hopper	1.00	ea	23,998	500,000	-		4,498		528,495.53 /ea	528,496
		14552.000 Automated Hopper			*23,998*	*500,000*			*4,498*		*528,495.53 /ea*	*528,496*
		1.00 ea										
		480.000 Labor hours										
		40.00 Equipment hours										
		DIVISION 14 CONVEYING SYSTEMS			**45,081**	**628,977**	**0**		**4,498**	**4,514**		**683,071**
		905.170 Labor hours										
		40.00 Equipment hours										
	DIVISION 15	**MECHANICAL**										
	01410.000	*Testing*										
n	7000	Pipe Testing, Hydro	2.00	Days	1,827	300	-		648	-	1,387.56 /Days	2,775

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
		01410.000 Testing			*1,827*	*300*			*648*		*2,775.12 /ls*	*2,775*
		1.00 ls 32.00 Labor hours 16.00 Equipment hours										
	15062.005	*Pipe: Ductile - Screw Press Process Pipe*										
n	1100	Concrete core drilling, core, reinforced concrete slab, 10" diameter, minimum charge	2.00	ea	126	4	400			-	264.74 /ea	529
n	3370	Pipe hanger / supprt,saddle type pipe supprt,complt,adj,cast iron saddle,6"pipe size,type number 36 per mss-sp58,exclds vertcl pipe riser (uslly 3"dm)	4.00	ea	1,302	1,320	-		-	-	655.44 /ea	2,622
	0690	Gasket and bolt set, for flanges, 150 lb., 6" pipe size Stainless Steel	20.00	ea	2,170	1,188	-		-	-	167.88 /ea	3,358
	0210	Sleeve, pipe, steel with water stop, 12" long, 10" diam. for 6" carrier pipe, includes link seal	2.00	ea	293	424	-		-	-	358.51 /ea	717
	0230	Expansion Joints, bellows type, neoprene cover, flanged spool, 6" face to face, 6" diameter	2.00	ea	350	987	-		-	-	668.53 /ea	1,337
	8702	Fitting,solid sleeve,DIP,cement lined,MJ,6"dia,C153 water piping with Protecto 401 or SP2000 Coating	2.00	ea	185	273	-		-	-	229.14 /ea	458
n	0051	DIP,FLGxFLG,6"dia,1'-0" long,class 53,Protecto 401 Lining,excl excav, backfill	4.00	ea	247	1,259	-		-	-	376.503 /ea	1,506
n	0056	DIP,FLGxFLG,6"dia,2'-6" long,class 53,Protecto 401 Lining,excl excav, backfill	2.00	ea	124	892	-		-	-	507.75 /ea	1,016
n	0061	DIP,FLGxFLG,6"dia,5'-0" long,class 53,Protecto 401 Lining,excl excav, backfill	2.00	ea	124	1,291	-		-	-	707.56 /ea	1,415
n	0066	DIP,FLGxFLG,6"dia,7'-6" long,class 53,Protecto 401 Lining,excl excav, backfill	2.00	ea	124	1,710	-		-	-	916.84 /ea	1,834
n	0071	DIP,FLGxFLG,6"dia,10'-0" long,class 53,Protecto 401 Lining,excl excav, backfill	2.00	ea	211	2,129	-		-	-	1,169.92 /ea	2,340
n	1006	Fitting,DIP,FLG,90 degree bend,6"dia,c 110 water piping with Protecto 401 or SP2000 Coating	8.00	ea	495	3,443	-		-	-	492.27 /ea	3,938
n	3007	Fitting,DIP,FLG,Tee,6"dia,c 110 water piping with Protecto 401 or SP2000 Coating	2.00	ea	124	1,075	-		-	-	599.53 /ea	1,199
n	4002	Fitting,DIP,FLG,Reducer,6"x4",c 110 water piping with Protecto 401 or SP2000 Coating	2.00	ea	124	720	-		-	-	421.78 /ea	844
n	502	Plug Valve Flange: 6" / Handwheel or Lever Operator / Includes Gear Operator	2.00	ea	210	2,175	-		0	-	1,192.54 /ea	2,385
n	202	Check Valve Flange, Swing: 6" / Lever and Spring	1.00	ea	105	1,351	-		0	-	1,455.96 /ea	1,456
n	0130	Valve Operator, Electric, Open/Close, 6" dia	2.00	ea	-	10,326	-		-	-	5,162.850 /ea	10,326
		15062.005 Pipe: Ductile - Screw Press Process Pipe			*6,312*	*30,567*	*400*				*37,278.78 /ls*	*37,279*
		1.00 ls 94.04 Labor hours										
	15064.005	*Pipe: Plastic - Polymer Piping*										
n	1470	Valves, plastic, PVC, ball, double union, socket or threaded, 1"	3.00	ea	85	247	-		-	-	110.57 /ea	332
n	3260	Valves, plastic, PVC, ball check, socket or threaded, 1"	1.00	ea	28	71	-		-	-	99.60 /ea	100

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	15064.005	*Pipe: Plastic - Polymer Piping*										
n	2480	Pipe, plastic, PVC, 1" diameter, schedule 80, includes couplings 10' OC, and hangers 3 per 10'	80.00	lf	1,211	402	-		-	-	20.16 /lf	1,613
n	2140	Elbow, 90 Deg., plastic, PVC, socket joint, 1", schedule 80	12.00	ea	344	71	-		-	-	34.573 /ea	415
n	2430	Tee, plastic, PVC, socket joint, 1", schedule 80	4.00	ea	171	42	-		-	-	53.43 /ea	214
n	2580	Coupling, plastic, PVC, socket joint, 1", schedule 80	3.00	ea	86	22	-		-	-	35.93 /ea	108
n	3813	Reducer, plastic, PVC, insert, socket joint, 1", schedule 80	4.00	ea	104	19	-		-	-	30.83 /ea	123
		15064.005 Pipe: Plastic - Polymer Piping			*2,030*	*874*					*2,903.63 /ls*	*2,904*
		1.00 ls										
		24.95 Labor hours										
	15064.010	*Pipe: Plastic - NPW Piping*										
n	1100	Valves, bronze, angle, rising stem, threaded, 150 lb., 1-1/2"	1.00	ea	50	506	-		-	-	555.88 /ea	556
n	1490	Valves, plastic, PVC, ball, double union, socket or threaded, 1-1/2"	2.00	ea	65	275	-		-	-	170.27 /ea	341
n	2500	Pipe, plastic, PVC, 1-1/2" diameter, schedule 80, includes couplings 10' OC, and hangers 3 per 10'	80.00	lf	1,531	531	-		-	-	25.79 /lf	2,063
n	2160	Elbow, 90 Deg., plastic, PVC, socket joint, 1-1/2", schedule 80	12.00	ea	429	102	-		-	-	44.233 /ea	531
n	2450	Tee, plastic, PVC, socket joint, 1-1/2", schedule 80	4.00	ea	215	117	-		-	-	83.043 /ea	332
n	2600	Coupling, plastic, PVC, socket joint, 1-1/2", schedule 80	3.00	ea	107	36	-		-	-	47.65 /ea	143
n	3815	Reducer, plastic, PVC, insert, socket joint, 1-1/2", schedule 80	4.00	ea	130	41	-		-	-	42.78 /ea	171
		15064.010 Pipe: Plastic - NPW Piping			*2,528*	*1,608*					*4,136.32 /ls*	*4,136*
		1.00 ls										
		31.08 Labor hours										
	15073.005	*Pipe: Cast-Iron Soil - Truck Unloading Drain Line*										
n	1100	Concrete core drilling, 10" x 12" concrete wall, minumum	1.00	ea	63	2	-		0	300	364.74 /ea	365
	0210	Sleeve, pipe, steel with water stop, 12" long, 10" diam. for 6" carrier pipe, includes link seal	1.00	ea	146	212	-		-	-	358.51 /ea	359
n	4200	Pipe, cast iron soil, no hub, 6" diameter, includes couplings 10' O.C., clevis hanger assemblies 5' O.C.	30.00	lf	692	1,060	-		-	-	58.42 /lf	1,752
n	6160	1/4 Bend, cast iron soil, no hub, 6", add 1 coupling per joint for installed price, excludes joint coupling and labor	4.00	ea	-	249	-		-	-	62.16 /ea	249
n	6218	1/8 Bend, cast iron soil, no hub, 6", add 1 coupling per joint for installed price, excludes joint coupling and labor	2.00	ea	-	83	-		-	-	41.44 /ea	83
n	7500	Combination Y and 1/8 bend, cast iron soil, no hub, 6", add 1 coupling per joint for installed price, excludes joint coupling and labor	2.00	ea	-	302	-		-	-	151.13 /ea	302

	Item	Description	Takeoff Qty		Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	15073.005	*Pipe: Cast-Iron Soil - Truck Unloading Drain Line*										
n	8690	Coupling, cast iron soil, no hub, stainless steel, heavy duty, 6"	18.00	ea	820	647	-		-	-	81.52 /ea	1,467
		15073.005 Pipe: Cast-Iron Soil - Truck Unloading Drain Line			*1,721*	*2,555*				*300*	*152.56 /lf*	*4,577*
		30.00 lf										
		23.25 Labor hours										
	15440.005	*Truck Loadout SOG FRP Trench Drain*										
n	4602	Structural concrete, placing, foundation, direct chute, over 6" thick, includes vibrating, excludes material	2.00	cy	97	-	-		8	-	52.82 /cy	106
n	1020	Struct MISC concrete,ready mix,normal wt,4000 psi,includes local aggregate,sand,portland cement and water,delivered,excludes all additives	2.00	cy	-	214	-		-	-	106.80 /cy	214
n	0200	Concrete finishng,floors,basic finishng for unspecfd flatwork,bull float,manual float&manual steel trowel,excludes placing,striking off&consolidating	40.00	sf	40	-	-		-	-	1.01 /sf	40
n	6830	Drain, trench, fiberglass for cement concrete encasement, 8" internal width, with heavy duty iron grate, not including trenching or concrete	20.00	lf	586	2,659	-		-	-	162.25 /lf	3,245
n	0050	Excavating, trench or continuous footing, common earth, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewatering	3.00	bcy	54	-	-		47	-	33.79 /bcy	101
		15440.005 Truck Loadout SOG FRP Trench Drain			*778*	*2,873*			*55*		*185.30 /lf*	*3,706*
		20.00 lf										
		11.76 Labor hours										
		3.00 Equipment hours										
	15605.000	*HVAC: Modifications*										
	0025	HVAC Duct Modifications - Subcontract	1.00	ls	-	-	10,000		-	-	10,000.00 /ls	10,000
		15605.000 HVAC: Modifications					*10,000*				*10,000.00 /ls*	*10,000*
		1.00 ls										
		DIVISION 15 MECHANICAL			**15,196**	**38,776**	**10,400**		**704**	**300**		**65,376**
		217.07 Labor hours										
		19.00 Equipment hours										
DIVISION 16		**ELECTRICAL**										
	16010.000	*Electrical Subcontract*										
	0001	Electrical Work - Allowance	1.00	ls	-	-	318,820		-	-	318,820.01 /ls	318,820
		16010.000 Electrical Subcontract					*318,820*				*318,820.01 /ls*	*318,820*
		1.00 ls										
		DIVISION 16 ELECTRICAL			**0**	**0**	**318,820**		**0**	**0**		**318,820**

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

Item	Description	Takeoff Qty	Labor Amount	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Unit Cost	Total Amount
	100 Solids Building Centrifuge Retrofit		***168,710***	***1,236,906***	***450,493***		***27,936***	***9,418***	***1,893,462.45 /LS***	***1,893,462***
	1.00 LS									
	3,016.03 Labor hours									
	357.35 Equipment hours									

Estimate Totals

Description	Amount	Totals	Hours	Rate
Labor	168,710		3,016.026 hrs	
Material	1,236,906			
Subcontract	450,493			
Equipment	27,936		357.350 hrs	
Other	9,418			
Direct Cost - Subtotal		**1,893,463**		
Contractor's Fld Ovhd & Mob	189,346			10.000 %
Field Const Cost - Subtotal		**2,082,809**		
Contractor's Fee	249,937			12.000 %
Contractor's Bonds & Insurance	34,991			1.500 %
Undefined SOW (Contingency)	591,934			25.000 %
Subtotal		**2,959,671**		
Escalation (NONE INCLUDED)				0.000 %
Sales Tax Estimate (Total)	281,169			9.500 %
Current OPCC Estimate Budget		**3,240,840**		

AACE Classification Accuracy Range

Upper Range +40% **Lower Range -20%**

APPENDIX B

Pilot Testing Reports

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FKC Pilot Test Report

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FKC CO., LTD.

2708 West 18th Street
Port Angeles, WA 98363

(360) 452-9472
FAX (360) 452-6880

By Email

29 August 2013

Don Lange, Manager
City of Puyallup
Water Pollution Control Plant
1602 18th St. NW
Puyallup, WA 98371

(253) 841-5506
donl@ci.puyallup.wa.us

RE: FKC Pilot Sludge Dewatering Trial Report

Don:

On behalf of FKC, I want to thank you and your staff for your time and effort given to the sludge dewatering trial. I appreciate the work of your personnel in connection with the setup, testing and cleanup.

Primary Purposes of the On-Site Dewatering Trial

The three primary purposes of the on-site trial are:

(1) To introduce and demonstrate the applicability of FKC Screw Press technology for your application.

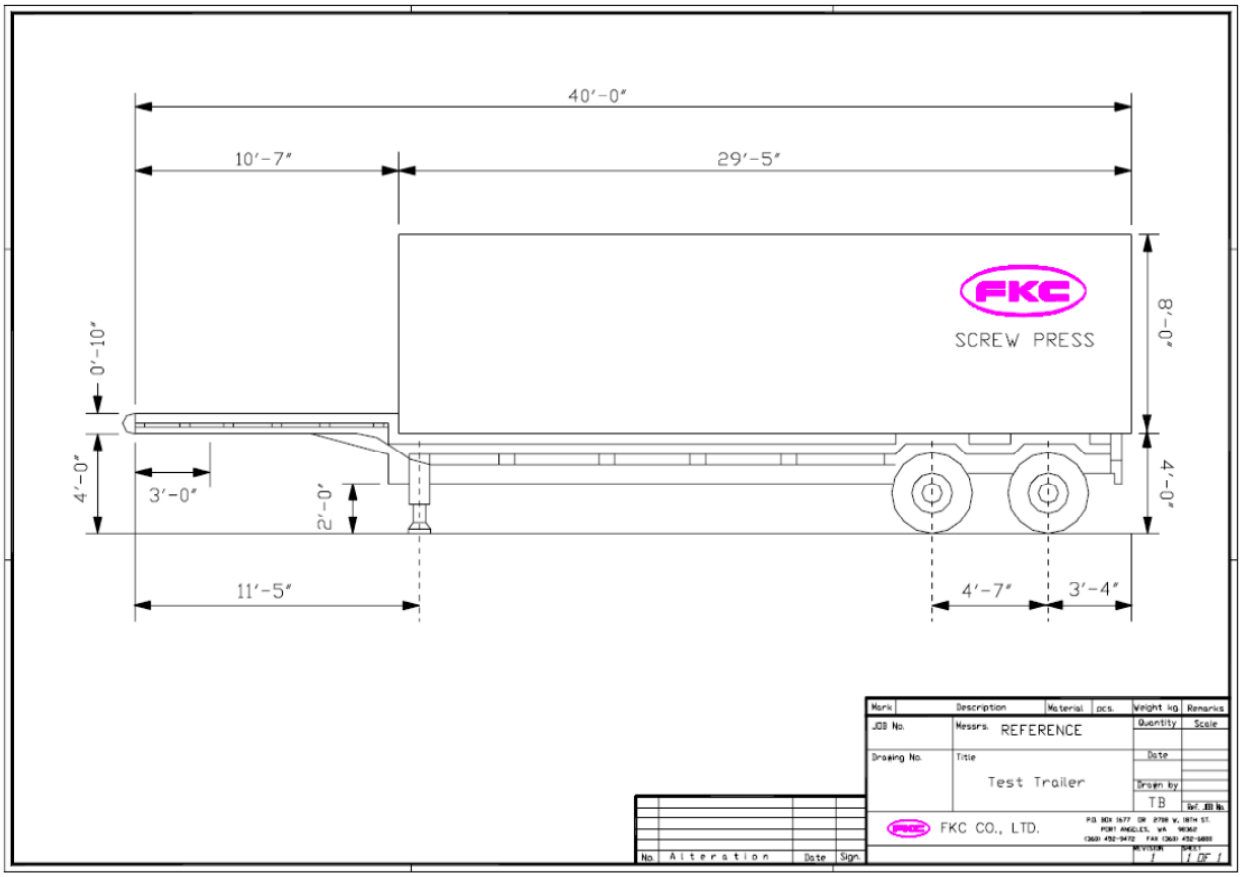
(2) To verify performance and to gather data to assist FKC in the scale up and design of full-scale equipment for possible use in this application.

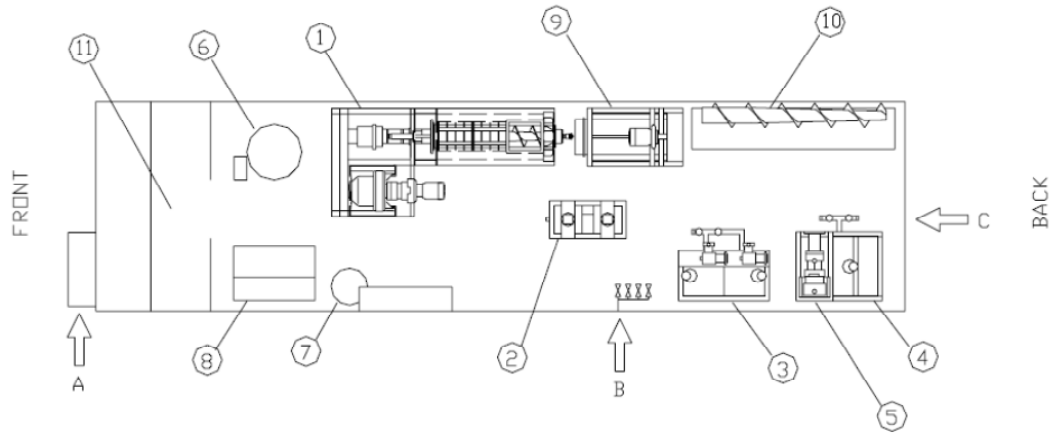
(3) To provide you an opportunity to observe and assess the potential operational, maintenance, and performance benefits of FKC Screw Press technology in this application.

Overview of the FKC On-Site Trial Unit

General Layout and Process Flow

A simple drawing showing major external dimensions of the trial unit trailer is enclosed for your reference. In addition, a general arrangement drawing of the trial unit equipment is also enclosed for your reference.





1	SCREW PRESS
2	FLOCCULATION TANKS W/ AGITATORS
3	POLYMER TANKS W/ AGITATORS
4	SLUDGE TANK W/ AGITATOR
5	SLUDGE FEED PUMP
6	BOILER
7	BOILER FUEL TANK
8	CONTROL PANEL
9	ROTARY SCREEN THICKNER
10	SPARE SCREWS SHELVING
11	LAB

A	ELECTRICAL CONNECTION
	575V or 480V / 3 PH / 15 AMP
B	WATER CONNECTION 3/4″ NPT
C	SLUDGE CONNECTION
	2 1/2″ FEMALE CAMLOCK

Mark
Description
Material
pcs.
Weight kg.
Remarks
JOB No.
Messrs. REFERENCE
Quantity
Scale
Drawing No.
Title
Test Trailer
General Arrangement
Date
Drawn by
TB
Ref. JOB No.
FKC CO., LTD.
P.O. BOX 1677 OR 2708 W. 18TH ST.
PORT ANGELES, WA 98362
(360) 452-9472 FAX (360) 452-6888
No.
Alteration
Date
Sign.
REVISION
1
SHEET
1 OF 1

Sludge Feed to the Trailer

For this pilot study, your anaerobically digested sludge was gravity fed from sludge tank #3. I was told the sludge had been transferred to the tank 3 days before. The sludge was fed by gravity into the agitated sludge holding tank located at the rear of the FKC test trailer. The tank was topped off between trial runs and no sludge was added to the tanks during the trial runs.

Sludge Feed Out of the Sludge Holding Tank

Sludge was pumped from the sludge holding tank using a progressing cavity pump into first flocculation tank located in the middle of the trailer, just in front of the screw press. The sludge flow was controlled by adjusting the speed of the pump using a Variable Frequency Drive. The sludge feed pump speed remained unchanged during the course of each individual trial. Conducting a trial without adjusting the sludge feed pump setting was done intentionally to attain a level of control relating to sludge conditioning (polymer dosage rate) during the trial.

Prior to beginning each trial run, the precise level of sludge in the sludge holding tank was measured and recorded. At the completion of each trial run, the level of the sludge remaining in the holding tank was measured and recorded. The difference between the starting and ending tank levels was used to precisely calculate the volume of sludge used during each trial run.

Polymer Feed

Polymer was made down in and pumped out of one or the other of two identical polymer tanks. The polymer was made down to 0.2% Total Solids (TS). The polymer used for all the trials was Ashland Praestol 859 BS (Dry) which is what the City has been using on the belt filter press This polymer was selected to demonstrate that an FKC Screw Press could produce a dryer cake than the existing belt press with the same polymer and dosage rate. Other polymers at higher dosages could have been used to generate higher cake solids. Variable speed diaphragm-type polymer pumps were used to pump the made-down polymer from the polymer batch tank into the two-stage flocculation tank.

Prior to beginning each trial run, the precise level of polymer in the polymer batch tank was measured and recorded. At the completion of each trial run, the level of the polymer remaining in the batch tank was measured and recorded. The difference between the starting and ending tank levels was used to precisely calculate the volume of polymer used during each trial run.

Flocculation

A two chamber flocculation tank was used during the trails. The flow path of the sludge was from bottom to top in the first chamber then gravity overflow down a conduit to the bottom of the second chamber then from bottom to top in the second chamber. Each chamber was fitted with an independently controlled variable speed agitator designed for optimal flocculation of the sludge.

Polymer was injected into the sludge at two different locations. The first polymer injection location was just before the inlet at the bottom of the first chamber of the flocculation tank with the second location was at the bottom of the second chamber of the flocculation tank. As the sludge / polymer mixture moved up through each chamber of the flocculation tank, optimal agitation and sufficient time were used to complete the flocculation process. The flocculated sludge overflowed from the second chamber of the flocculation tank into the headbox of the trial unit screw press.

Screw Press Headbox Level Control

The screw press was run continuously at a constant speed and stable headbox level for about 30 minutes prior to, and for the duration of each timed trial run. The screw press headbox level was controlled between the maximum and minimum headbox level set points by automatic on-off operation of the sludge and polymer pumps. A three-electrode headbox level controller automatically energized the sludge pump, polymer pumps, and flocculation tank agitators when the minimum headbox level was reached. When the level of sludge in the headbox reached the maximum level, the sludge pump, polymer pumps, and flocculation tank agitators would switch off. To maintain a constant polymer addition rate throughout each test, no speed adjustments were made to any of the pumps.

Dewatered Cake Solids

During each timed trial run, all of the dewatered cake solids discharged from the screw press were collected in a white plastic bin placed directly beneath the discharge box of the screw press. At the end of each trial run, the bin containing the dewatered cake solids was weighed on a scale and the weight of the empty bin was subtracted to determine the weight of the cake solids dewatered and discharged from the press during each trial run. The bin was emptied prior to the start of each trial run into the disposal dumpster provided by your staff.

After weighing the plastic bin with the sludge cake, samples of dewatered cake solids were collected from random locations throughout the bin. The samples were used for consistency analysis utilizing moisture meters located in the laboratory area. Final cake samples were also transported back to our lab in Port Angeles, WA and checked for consistency using a drying oven and checked for % non-volatile solids (ash) using a muffle furnace.

Overview of the On-Site Trial

The on-site trial consisted of a series of separate timed trial runs. Each of the trial runs had a purpose related to identifying and quantifying one or more of the effects of fundamental design and operating parameters on dewatering performance. In general, after one trial run is finished an evaluation is made of what parameter(s) to change and then to note the differences in operation and performance.

Prior to each trial run the equipment and process was set up to run under the specific operating parameters established for the particular trial run (e.g. screw design, screw speed, polymer dose, etc.). Once the operational parameters were established, the trial unit was operated under stable conditions until steady state performance was achieved. After steady state performance was achieved, the unit was temporarily stopped while it was washed down, sludge and polymer tank levels were recorded, and the plastic bin beneath the discharge box of the screw press was emptied.

Each trial run was made by operating the trial unit screw press under the known, stable operating parameters established for the particular run for a period of 20 to 30 minutes. The operating parameters for each trial run were recorded, and at appropriate times prior to, during, or after each trial run operating data and samples were collected.

Successive trial runs were made after a change in one of the design or operational parameters (e.g. screw speed, polymer dose, etc.) to determine the effect of the changes made.

A summary of the data collected during the various trial runs contained in the FKC on-site trial data sheet shown below:

	SCREW PRESS ON-SITE TRIAL DATA SHEET						
							PAGE 1 OF 1
TRIAL DATE:	5/14-15/2013						
LOCATION:	Puyallup WWTP						
PERFORMED BY:	RJO						
SCREW SPECS:	Screw "1003"				Split poly flow / small before 1st tank / big pump before 2nd tank		
SLUDGE TYPE:	Anaerobic Sludge from Holding Tank #3 : 3 days old?						
SLUDGE FIBER CONTENT %							
SLUDGE ASH CONTENT %							
POLYMER TYPE	Ashland Praestol 859 BS, Dry		0.20%				100%
LIME TYPE	none						
SLUDGE TANK VOLUME (liter/mm)	0.5525	Liters / mm	440 L				tanks
POLY TANK VOL (liter/mm)	0.2025	Liters / mm	170 L				tanks
TRIAL I.D.#	TR-1	TR-2	TR-3	TR-4	TR-5	TR-6	TR-7
Date	5/14/13	5/14/13	5/14/13	5/15/13	5/15/13	5/15/13	5/15/13
Polymer							
Screw RPM	0.30	0.50	0.75	0.30	0.30	0.50	0.75
Straight Length (mm)	105	105	105	105	105	105	105
Amps	2	2	2	2	2	2	2
Test Duration. minutes	25	27	11	25	29	29	21
SP Wet Cake Weight (kgs)	17.6	31.3	17.6	16.1	18.3	30.3	32.3
Sludge Tank Level @ Start (mm)	67	310	330	361	395	75	325
Sludge Tank Level @ Finish (mm)	317	707	545	600	600	325	695
Poly Tank #1 Level @ Start (mm)	75	435	805	575	72	400	740
Poly Tank #1 Level @ Finish (mm)	210	640	910	700	160	525	912
Inlet Consist (FKC Onsite Meter)	3.38%	3.42%	3.42%	3.42%	3.42%	3.42%	3.42%
Inlet Consist (FKC Lab Oven)	-	3.33%	3.40%	3.37%	3.37%	-	3.39%
Inlet Consist Cons.% Average	3.38%	3.38%	3.41%	3.40%	3.40%	3.42%	3.40%
Big Poly Pump Stroke Length	14.7	14.7	14.7	14.7	0.9	14.7	14.7
Small Poly Pump Speed	90	90	90	90	80	90	90
Sludge Pump setting(Hz)	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Consistency @ Headbox % (FKC Oven)	8.03%	-	9.78%	-	-	7.27%	-
SP Outlet Cons.% (FKC Onsite Meter)	22.47%	20.52%	19.44%	20.98%	19.70%	20.13%	-
SP Outlet Cons.% (FKC Lab Oven)	23.06%	21.06%	19.48%	21.25%	19.72%	20.22%	17.52%
SP Outlet Cons.% (Plant LAB)	23.37%	19.42%	18.65%				
SP Outlet Cons.% Average	22.97%	20.33%	19.19%	21.12%	19.71%	20.18%	17.52%
Sludge Diff. Level Used (mm)	250	397	215	239	205	250	370
Sludge Flow (LPM)	5.53	8.12	10.80	5.28	3.91	4.76	9.73
Sludge Flow (GPM)	1.46	2.15	2.85	1.40	1.03	1.26	2.57
Sludge Flow (dry lbs/hr)	24.69	36.73	48.82	23.88	17.66	21.53	44.01
Polymer #1 Diff. Level Used (mm)	135	205	105	125	88	125	172
Polymer #1 Flow (LPM)	1.09	1.54	1.93	1.01	0.61	0.87	1.66
Polymer #1 Flow (GPM)	0.29	0.41	0.51	0.27	0.16	0.23	0.44
Polymer #1 Flow (neat lbs/hr)	0.29	0.41	0.51	0.27	0.16	0.23	0.44
Polymer #1 Dosage (Active lb/DT)	23.42	22.14	20.94	22.42	18.40	21.43	19.93
Polymer #1 Dosage (Active kg/BDMT)	11.90	11.25	10.64	11.39	9.35	10.89	10.12
Outlet Cake kg/hr. Wet	42.30	69.44	95.73	38.71	37.96	62.60	92.16
Outlet Cake "Flow" (LPM)	0.71	1.16	1.60	0.65	0.63	1.04	1.54
Outlet Cake "Flow" (GPM)	0.19	0.31	0.42	0.17	0.17	0.28	0.41
Outlet Cake (dry kg/hr.)	9.72	14.12	18.37	8.17	7.48	12.63	16.15
Outlet Cake (dry lbs/hr.)	21.42	31.14	40.51	18.02	16.49	27.85	35.61
Sludge Nonvolitile (Ash) Content	34.38%			36.20%	34.34%	33.80%	

Summary of On-Site Trial Runs

Following is a summary of the objectives of trial runs TR-1 through TR-7 performed May 14th and 15th and the observations made during the runs. FKC has 10 different screws of different designs on the trailer. The trial runs at Puyallup were performed with screw design "1003" which is FKC's typical municipal screw design. During bench scale polymer testing, the plant's Ashland Praestol 859 BS (dry polymer) was compared to a couple other polymers typically used on anaerobic sludge. The plant's Ashland Praestol 859 BS worked as well as the other polymers tested so it was selected for the screw press trails.

Note that trial runs TR-1 thru TR-3 were performed on May 14th while trial runs TR-4 thru TR-7 were performed the following day.

TR-1

The purpose of TR-1 was to establish a baseline from which to judge all the other tests. Screw design "1003" worked well so it was decided to continue to use the same screw for the remainder on the testing. A stated above, Ashland Praestol 859 BS polymer was used. Trial Run #1 was performed at a screw speed of "low" speed of 0.3 rpm screw speed. In general lower screw speeds result in g higher cake dryness. Both flocculation tank chambers were used. The sludge coming into the press was measured at 3.38% Total Solids (TS).

The result was an average discharge cake dryness of 23.0 % TS using 23.4 active lbs of dry polymer per dry ton of sludge solids. The capacity of the press during TR-1 was 21.4 dry lbs per hour output.

TR-2

For TR-2 the screw press speed was increased from a "low" speed of 0.3 rpm to a "medium" speed of 0.5 rpm with all other parameters unchanged. Typically throughput is inversely proportional to cake dryness so if you increase screw speed then capacity increases but cake dryness will decrease, and visa-versa. The sludge coming into the press was measured at 3.38% Total Solids (TS).

The data shows TR-2 generated average discharge cake dryness of 20.3% TS using 22.1 active lbs of dry polymer per dry ton of sludge solids. The capacity of the press during TR-2 increased to 31.1 dry lbs per hour output. As expected, the capacity increased because the screw speed increased while the cake dryness decreased.

TR-3

For TR-3 the screw press speed was again increased. The speed was increased from "medium" speed of 0.5 rpm to a "fast" speed of 0.75 rpm with all other parameters unchanged. The sludge coming into the press was measured at 3.41% Total Solids (TS).

The data shows TR-3 generated average discharge cake dryness of 19.2% TS using 20.9 active lbs of dry polymer per dry ton of sludge solids. The capacity of the press during TR-3 increased to 40.5 dry lbs per hour output. Again as expected, the capacity increased because the screw speed increased while the cake dryness decreased.

A "fast" speed of 0.75 rpm on the test unit is relatively faster than what would run on a full size screw press but the data is of interest because it can predict what would happen if a full size press was over-speeded for any reason.

TR-4

As noted, the anaerobically digested sludge was gravity fed to the FKC test trailer from sludge tank #3 and I was told the sludge had been transferred to the tank 3 days before I arrived. FKC has seen many cases of anaerobically digested sludge getting more difficult to flocculate and dewater the long the sludge sits in an unmixed holding tank.

For the second day of testing with slightly older sludge, trail run TR-4 was setup as a duplicate of TR-1 to see if the results of TR-1 could be reproduced. All equipment settings were kept the same as TR-1 including the "low" screw speed of 0.3 rpm. The sludge inlet consistency was measured at 3.40% TS.

The resulting cake dryness was 21.1% TS which was a little lower than the 22.9% achieved during TR-1 however the polymer dosage for TR-4 was 22.4 active lbs of dry polymer per dry ton of sludge solids which was also a bit lower than the 23.4 active lbs of dry polymer used during TR-1. The capacity of the press during TR-4 was 18.02 dry lbs per hour output which was also lower than achieved during TR-1. It was inconclusive on whether the lower cake dryness was due to the older sludge or the slightly lower polymer dosage.

TR-5

In an effort to learn a little more about the effect of polymer dosage, for TR-5, all operational parameters were left the same as TR-4 except the polymer dosage was further reduced. Testing again was performed at a "low" speed of 0.3 rpm. The sludge inlet consistency was measured at 3.40% TS.

The resulting cake dryness was 19.7% TS which was a little lower than the 21.1% achieved during TR-4 however the polymer dosage for TR-5 was only 18.4 active lbs of dry polymer per dry ton of sludge solids which was also a significantly lower than the 22.4 active lbs of dry polymer used during TR-4. The capacity of the press during TR-5 was 16.5 dry lbs per hour output which was also lower than achieved during TR-4. The lower polymer dosage definitely resulted in lower cake dryness and throughput.

TR-6

For TR-6 the screw press speed was increased from a "low" speed of 0.3 rpm to a "medium" speed of 0.5 rpm and the polymer was bumped back up a little to be in line with the dosage used during TR-2 which was the 0.5 rpm test performed the first day. The sludge coming into the press was measured at 3.40% Total Solids (TS).

The data shows TR-6 generated average discharge cake dryness of 20.2.0% TS using 21.4 active lbs of dry polymer per dry ton of sludge solids. The capacity of the press during TR-2 increased to 27.85 dry lbs per hour output. These results are pretty close to those seen during TR-2

TR-7

For TR-7 the screw press speed was again increased with parameters similar to TR-3 but with a little lower polymer dose. The speed was increased from "medium" speed of 0.5 rpm to a "fast" speed of 0.75 rpm. The sludge coming into the press was measured at 3.40% TS.

The data shows TR-7 generated average discharge cake dryness of 17.5% TS using 19.9 active lbs of dry polymer per dry ton of sludge solids. The capacity of the press during TR-7 was 35.6 dry lbs per hour output. As expected, with a slightly lower polymer dosage, the capacity and cake dryness dropped slightly from TR-3. Note that this was the lowest cake dryness of all of the trial because we were running at the fastest speed with the lowest polymer dosage.

Conclusions

During the on-site trials, FKC demonstrated some points to consider for a full-scale operation:

The results demonstrate that the FKC screw press is easily capable of dewatering your anaerobically digested sludge.

As expected, the lower screw speeds produced the maximum dryness while the faster screw speeds produced the highest capacities. You cannot have maximum cake dryness with maximum throughput at the same time.

We would expect to achieve solids from the discharge of a full size screw press in the range of 18-23% Total Solids depending on the sludge quality, polymer dosage, and screw press speed. Polymer usage in the range of 20-25 lbs active polymer per dry tone of sludge solids could be expected.

A quick bench scale hand dewatering test was performed onsite to compare the sludge being tested from holding tank #3 to warm sludge collected from digester #2. Using identical polymer dosage and dewatering technique, I was able to achieve 1% higher cake dryness with the warm sludge from digester #2. FKC would be willing to perform additional onsite bench scale testing to confirm if these results are reproducible.

Full-Scale Sizing

FKC has discussed two different size screw presses with different capacity ratings with the City and HDR. We have proposed a model BHX900x5000L press for 420-500 dry lbs per hour and a model BHX-1050x5500 for 600 dry lbs per hour. As discussed in the body of this test report, the capacity and cake dryness of a screw press is affected by more than the size of the press alone. Before FKC can offer firm sizing and pricing we need to know what desired discharge dryness and the polymer limitations will be.

FKC would be very happy to meet with you and HDR in person in the near future to go over these results and to discuss sizing and pricing.

Again, thank you for all the help with the on-site trial. Please feel free to call and discuss any part of this report with me.

Thank you,

FKC Co., Ltd.

Roger Olson

Huber Pilot Test Report

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Pilot Test RoS3Q_280
Puyallup, WA

Pilot Test from:	03/08 – 03/18 - 2010	
Execution of the test:	Daniel Trost	Huber Technology, Inc.
Facility:	RoS3 Q 280	
Project:	Puyallup, WA	
Job number:	JO003986	
Attendants:	Daniel Trost Doug Allie	Huber Technology, Inc. Goble Sampson Associates

1. Pilot Unit RoS3 Q 280

The dewatering machine is a screw press with a conical shaft and cylindrical sieves. The machine is subdivided into the entering zone, the three part thickening- and dewatering zone and the pressing zone with pneumatic backpressure cone. The pilot unit is mounted on a trailer that contains all necessary matters to run the dewatering machine.

This includes:

- Screw press RoS3Q 280
- Thin sludge pump: progressive cavity pump, SEEPEX 2-10 LBN
- Polymer station: make Velodyne, inline mixing
- Flow meter for thin sludge and polymer
- Injection - and mixing devices for polymer
- Sludge polymer mixing devices: Reactor pipe (29 feet)
- Controller: Allen Bradley programming control (PLC) and operator interface

The controls are equipped with a PLC and an operator interface (HMI). The screw press can be operated fully automatically.

The most important parameters are:

- Desired volume flow rate of thin sludge and polymer in [GPM]
- Dry solids (DS) of sludge IN and OUT in [%]
- polymer consumption in [lbs poly / ton DS]
- speed of screw press in [%]

Technical Data:

- HUBER ROTAMAT®Screw Press RoS3Q280
  - Screw Drive: BAUER motor and gearbox
    - Type: BF40Z-34/D06XA4-TF/AMUL-C2-SP
    - Class I, Div 2 with 0.37 kW (0.5 HP), 460 V AC, 60 Hz ; speed motor 1680 rpm, shaft 1.4 (with 60 Hz)
      VFD controlled (12 – 120 Hz)
  - Pressure Gauge, inlet of press: make IFM
  - Wash System Solenoid Valves: Burkert type 5282 A
    - 120 V AC, 60 Hz, 2 – 10 bar (30 – 145 PSI)

  - Polymer Feed System: Velodyne
    - Model max. 1 GPH, serial: 21471 (revision: January 2009)
      - Mixing Motor: BALDOR, 90 V AC, 60 Hz
      - Polymer Dosing Pump: progressive cavity
        - Seepex, Model: serial 0505956152-7
        - max. capacity: 1.5 GPH / 50 PSI

- Flocculation System: polymer injection ring, mixing device (mounted to the feed pipe, size: 1 1/2”) and pipe flocculation reactor

- Feed Pump: progressive cavity pump, make: SEEPEX (VFD controlled: max. capacity 20 GPM)

- Flow meters: ENDRESS + HAUSER (Thin Sludge and Polymer)
- Control panel for full automatic operation (manufacturer: EII) including HMI for easy change of set points

Power Supply:	Voltage / Hz	Power [kW] / [hp]	FLA [Amps]	operation mode	VFD
Feed pump	460 V / 60 Hz	4.0 / 5.0	7.5	Continuous, consumption: 3.25 kWh	Yes
Screw press	460 V / 60 Hz	0.37 / 0.5	1.1	Continuous consumption: 0.30 kWh	Yes
Polymer system	120 V / 60 Hz		9.2	Continuous Consumption: 0.83 kWh	Yes
Compressor	120 V / 60 Hz		10.5	Intermittent consumption: 0.1 kWh	No
Flow Meter, solenoid valve	120 V / 60 Hz		0.5	0.1 kWh	No

Water Supply:	requirements	Pressure	Operation mode	Demand
Polymer	Potable water/ filtered plant water	60 - 70 PSI	Continuous	Normal solid load (80 – 100 lbs DS): 1 – 1.5 GPM High solid load (120 – 200 lbs DS): 2 – 3 GPM
Wash water	Filtered plant water	min. 50 PSI	Intermittent; standard setting: every 30 minutes for one wash cycle	Water demand: 15 gallons per wash cycle (at 22.5 GPM)

2. Situation of the waste water treatment plant

- daily flow (design):	13.98 MGD
- System:	¼ inch fine screen (Lakeside) aeration basins, no precipitation,
- Sludge:	anaerobically digested blend of primary and secondary sludge (ratio 60% : 40%))
- sludge age:	10 to 20 days
- waste sludge flow:	approx. 20,000 GPD
- solid content:	3.0 – 4.0 % DS
- volatile solids:	approx. 80%
- existing solid handling system:	belt filter press

Plant Address:

Puyallup WPCP
1602, 18th St. NW
Puyallup, WA 93871

Contact: James Lee
Phone: (253) 425-3658
Cell: (253) 405-4405
E – Mail:

Picture 1: pilot unit set up

3. Polymer jar test:

The first step of the pilot test is conducting tests to determine which polymers are suitable for the sludge generated at the Waste Water Treatment Facility of City of Puyallup, OR. The jar tests were made with the polymers of the manufacturer Ashland. The products were: K260FL, K274FLX, K275FLX, K279FLX and K290FLX by Ashland.

The tests showed that the sludge is reacting well with K274 and K279; but also K260 and K275 are working. There was no significant difference observed in the performance of these polymers. Therefore it was decided to run all of them on the pilot unit to see how they perform. The series K290FLX is not suitable for this sludge.

The pilot unit was installed and the following settings were tested:

1. Throughput
2. Speed of screw press auger
3. Polymer consumption
4. Concentration of polymer solution
5. Various pressures at discharge of screw press
6. Conditions at mixing valve
7. Different polymers

4. Pilot Test and Results

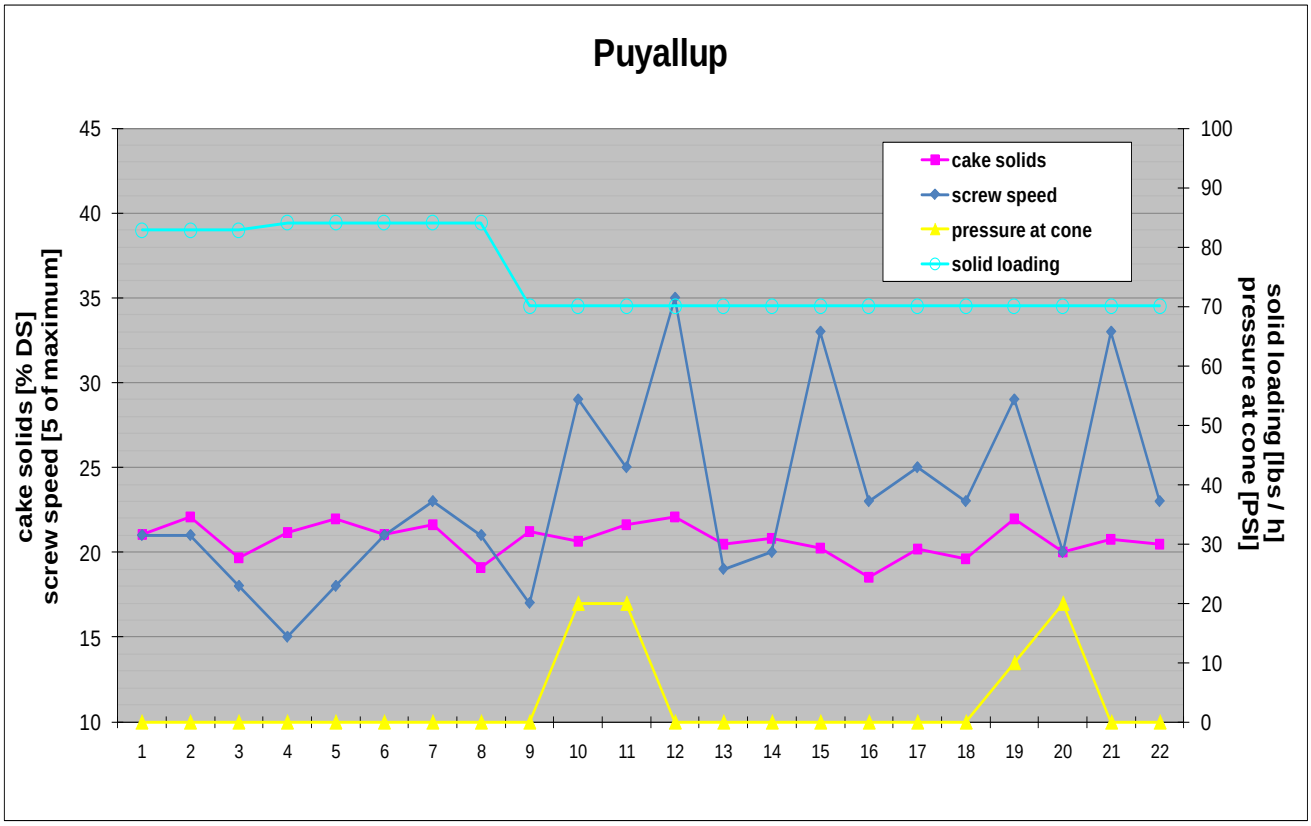
Picture 2: Cake

Picture 3: Pilot Unit

Picture 4: effluent during dewatering mode

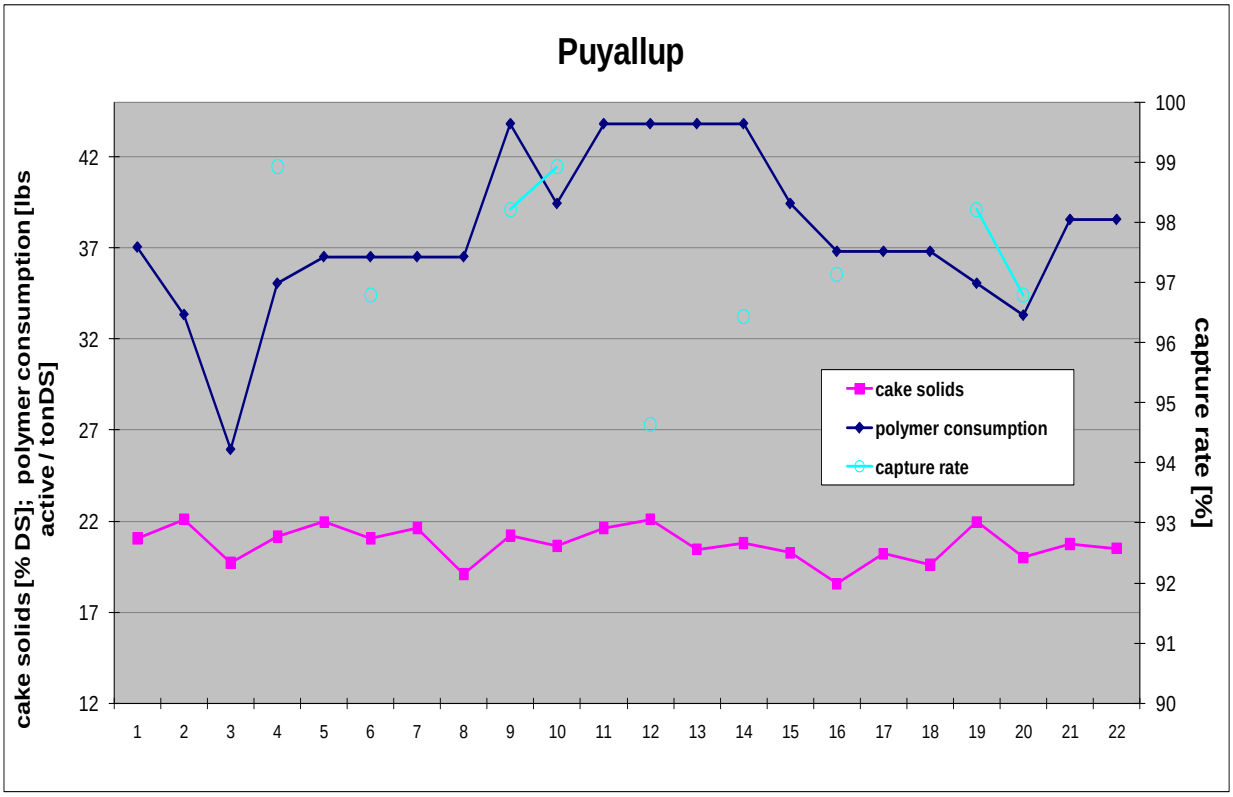
The following two graphs give an overview of the parameters and conditions the screw press was operated with:

- cake solids
- polymer consumption
- capture rate
- pressure at dewatering cone
- screw speed
- solid loading



GRAPH 1: general overview 1

The cake solids are ranging between 18 and 22% DS.



GRAPH 2: general overview 2

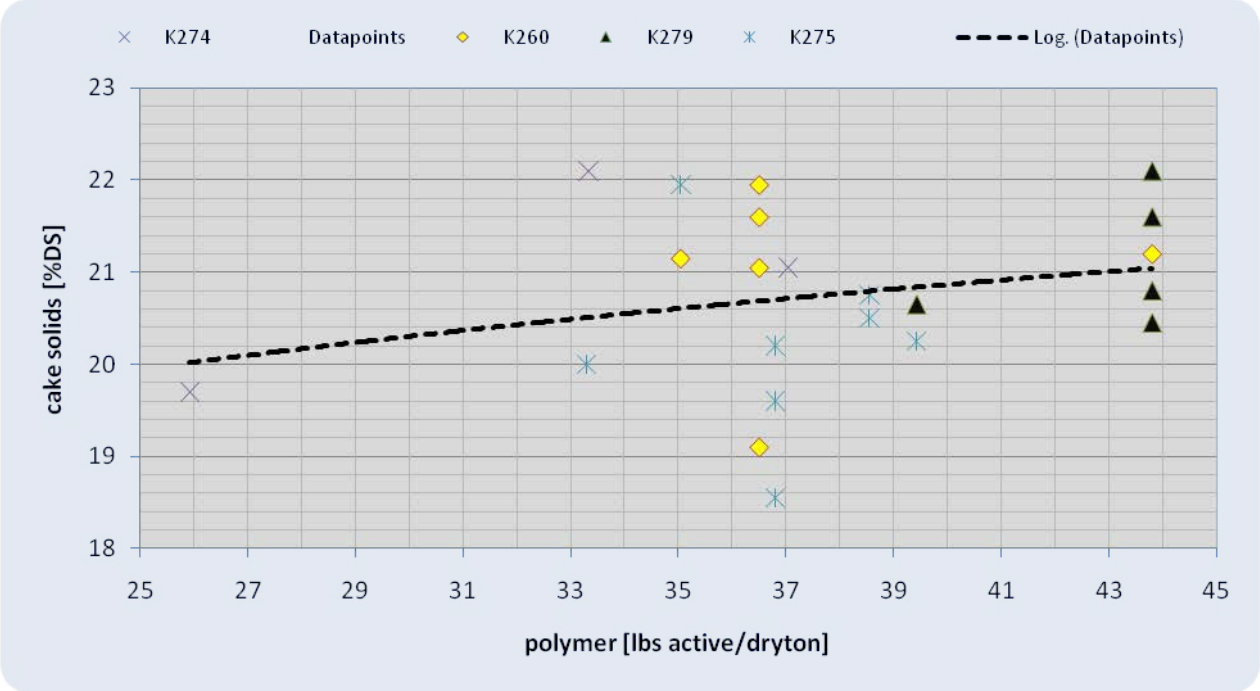
The test were conducted with following set points:

- flow rate: 5 – 6GPM (@ 2.8% DS)
- solid loading: 70 - 84 lbs DS / h
- screw speed: 0.4 – 1.0 rpm
- polymer consumption: 25.9 – 43.8 lbs active / ton DS; bets results with 33 – 37 lbs/ton
- pressure at dewatering cone: 0 - 30 PSI

4.1 Polymer Dose / Response and Effect on Cake Solids

The screw press was operated with different polymers using different dosing rates ranging from 25.9 – 43.8 lbs active / ton DS.

The graph 3 illustrates the effect the polymer dose has on the cake solids depending on the type of polymer and dosing rate.



GRAPH 3: polymer dose on cake solids

The effect the polymer usage has on the cake solid is not very significant. The cake solids vary between 17.8 and 22.2% DS.

The product K275FLX is providing the lowest cake solids. The best results are achieved using K260FL and K274FLX with cake solids in the range of 20 – 22%. The product K279FLX is providing cake solids in the same range but only at much higher polymer consumption of around 40 lbs/ton (10 – 20% higher compared to the previously mentioned polymers).

It is important to understand that the cake solids are affected by several parameters other than the polymer consumption: solids loading, screw speed and applied pressure

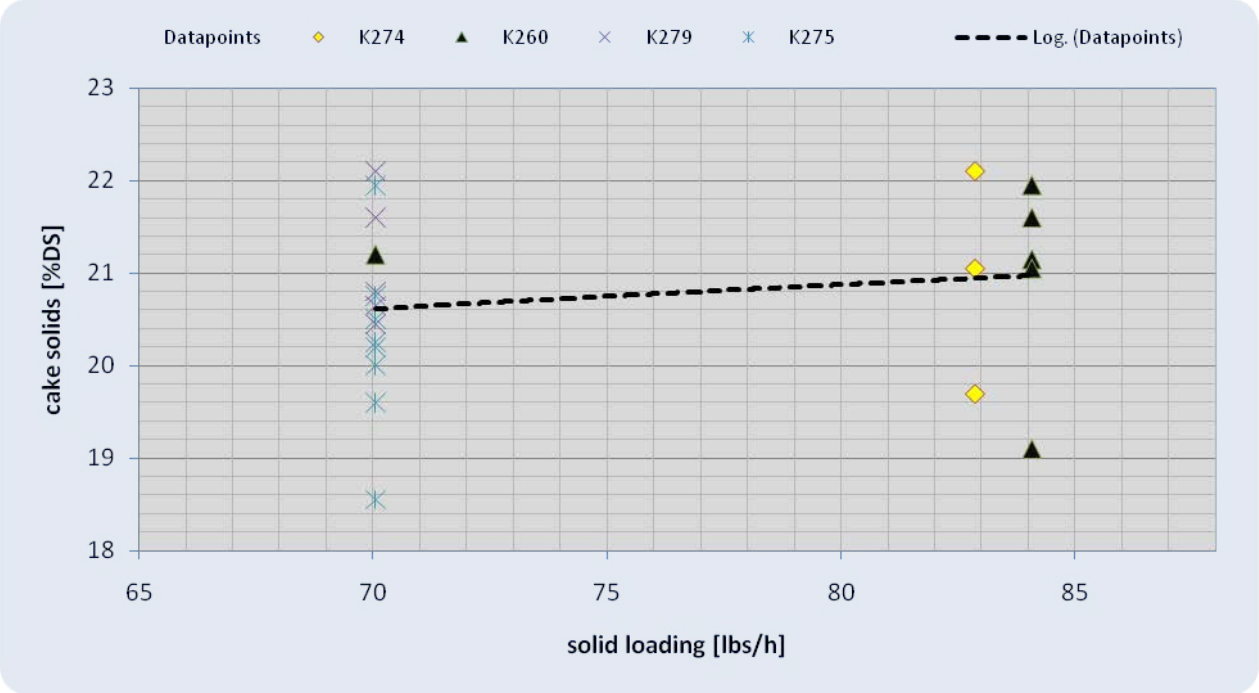
at dewatering cone. There is no simple correlation but nevertheless there seems to be a tendency for increasing cake solids with higher polymer dosing rate; in general the screw press can be operated at a polymer consumption of minimum 33 lbs active /ton DS without sacrifying the cake solids (please see also chapter 4.4 for capture rate).

The screw press can be operated at 25 lbs/ton with slightly reduced cake solids (approx. 19 – 20 % cake) but with much lower capture rate.

4.2 Effect of Hydraulic and Solids Loading on Cake Solids

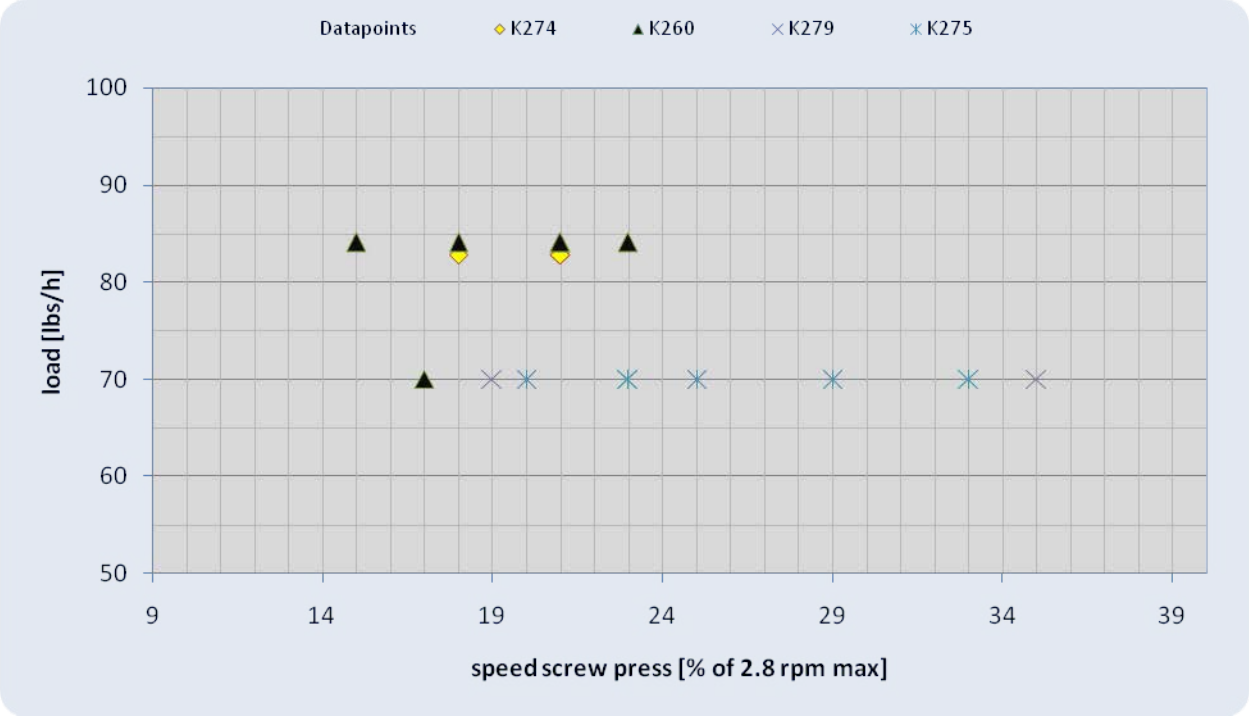
The screw press was operated with sludge containing 2.8 % DS. The sludge flow rates were set between 5 and 6 GPM resulting in a solid loading of 70 – 84 lbs DS / h

The results are presented in graph 4 and 5. The hydraulic loading / solids loading is not significantly affecting the performance of the screw press. The graph 4 shows that the cake solids are most of the time in the range of 20 – 22%.



GRAPH 4: solid loading on cake solids

In general the effect of the solid loading on the cake solids is also related to the screw speed (see graph 5). The solid loading determines the speed of the auger – higher solid loading requires higher screw speed which results in lower cake solids. The graph 5 does not show the expected correlation – mainly caused by the fact that only two different loading rates were tested.



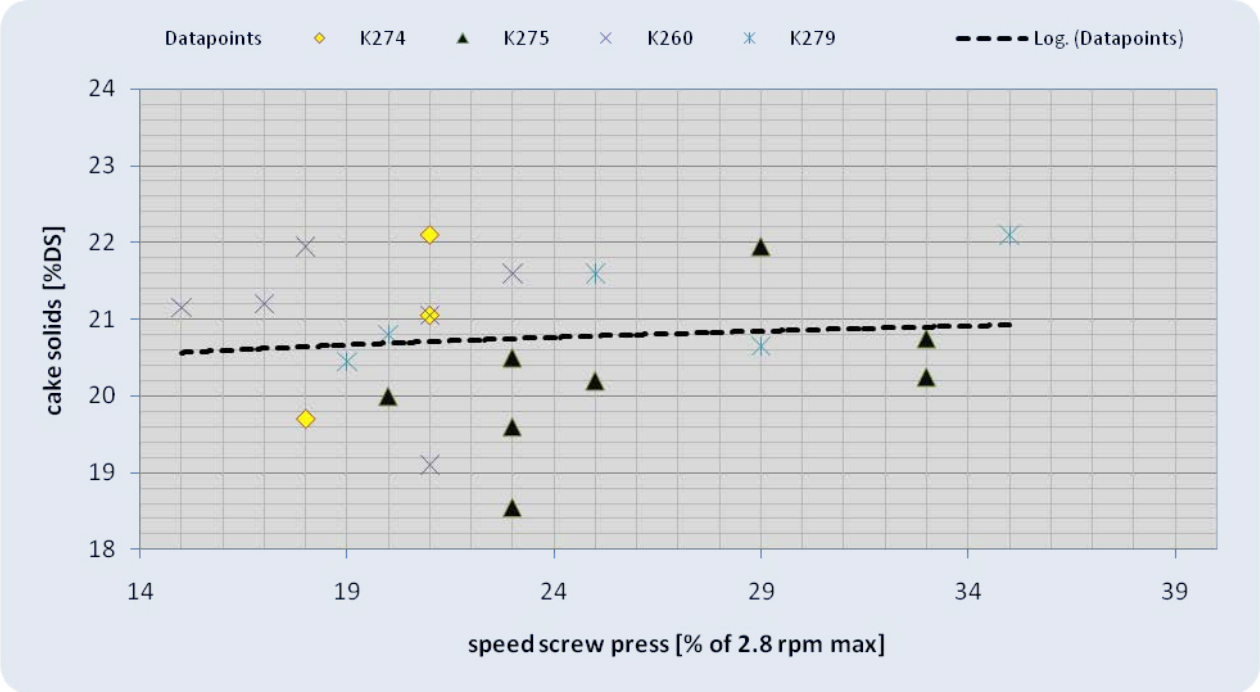
GRAPH 5: Correlation screw speed and solid loading

The settings are always a compromise of trying to achieve high cake solids with maximum throughput. The theoretical optimum is: huge machine with extreme long retention time – but this is not the most cost effective solution. Therefore the system needs to be designed for the optimum: high cake solids with decent throughput and well calculated capital costs.

The highest performance rating is determined by the conveyance capacity of the screw press which is mainly a function of the screw speed and how fast the water drains in the dewatering and thickening zone. The screw press is operated at its optimum when the parameters are in balance and the filling rate of the screw press is at its optimum: 100% of the auger's volume is filled with sludge. This means the maximum dewatering performance can be achieved because the screw press can built up pressure all the way to the discharge point. If the system is not balanced (e.g. screw speed is too high)

the auger is not filled properly and sludge is just conveyed prior building up pressure in the dewatering zone.

This point of operation changes with various parameters: polymer dosing, polymer injection and mixing system, hydraulic and solids loading, screw speed, pressure at cone.

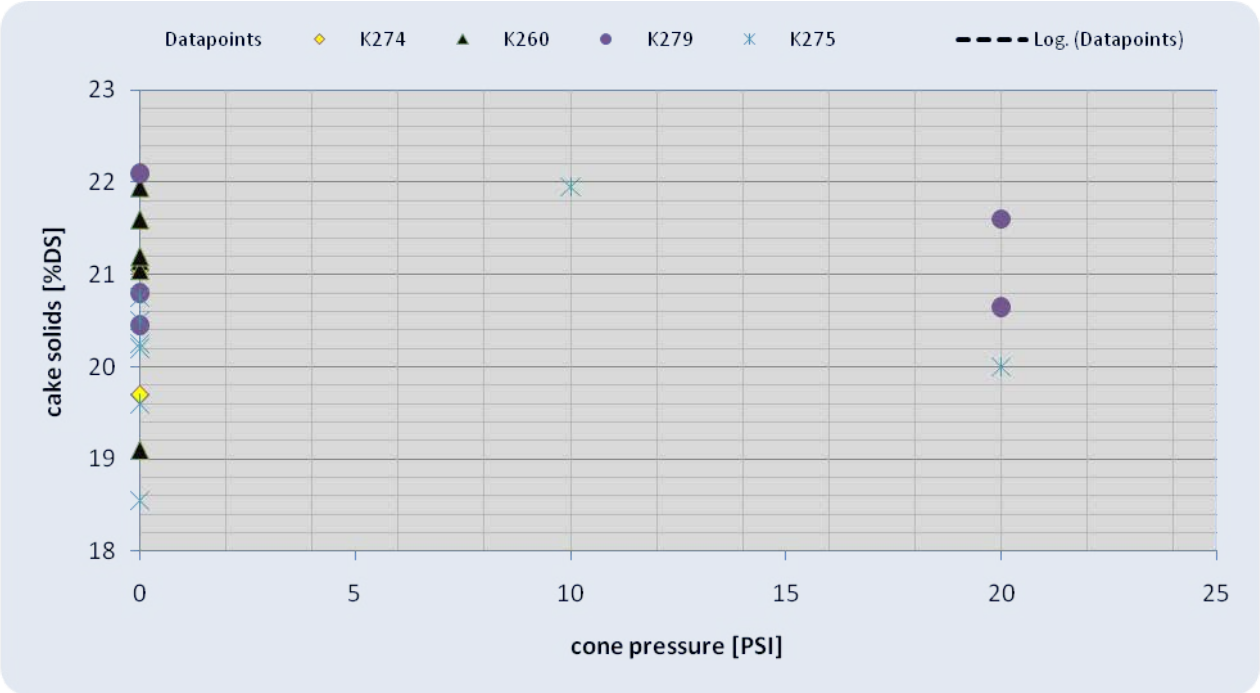


GRAPH 6: screw speed effect on cake solids

If the screw press is overloaded (speed too low for desired hydraulic loading or the desired hydraulic loading is too high for set speed) the pressure built up will continue into the inlet chamber – if this happens the screw press can not operate in a steady state anymore. The system will shut down temporarily because of high pressure at the inlet box (can happen very frequently when overloading the system). In this case the settings need to be adjusted: increase speed or decrease hydraulic loading provided no ther issues are present (e.g. wrong polymer dosing rate).

4.3 Effect of Outlet Pressure Cone Position on Cake Solids

The screw press was operated with several different pressure settings at the cone: ranging from 0 to 30 PSI.



GRAPH 7: cone pressure effect to cake solids

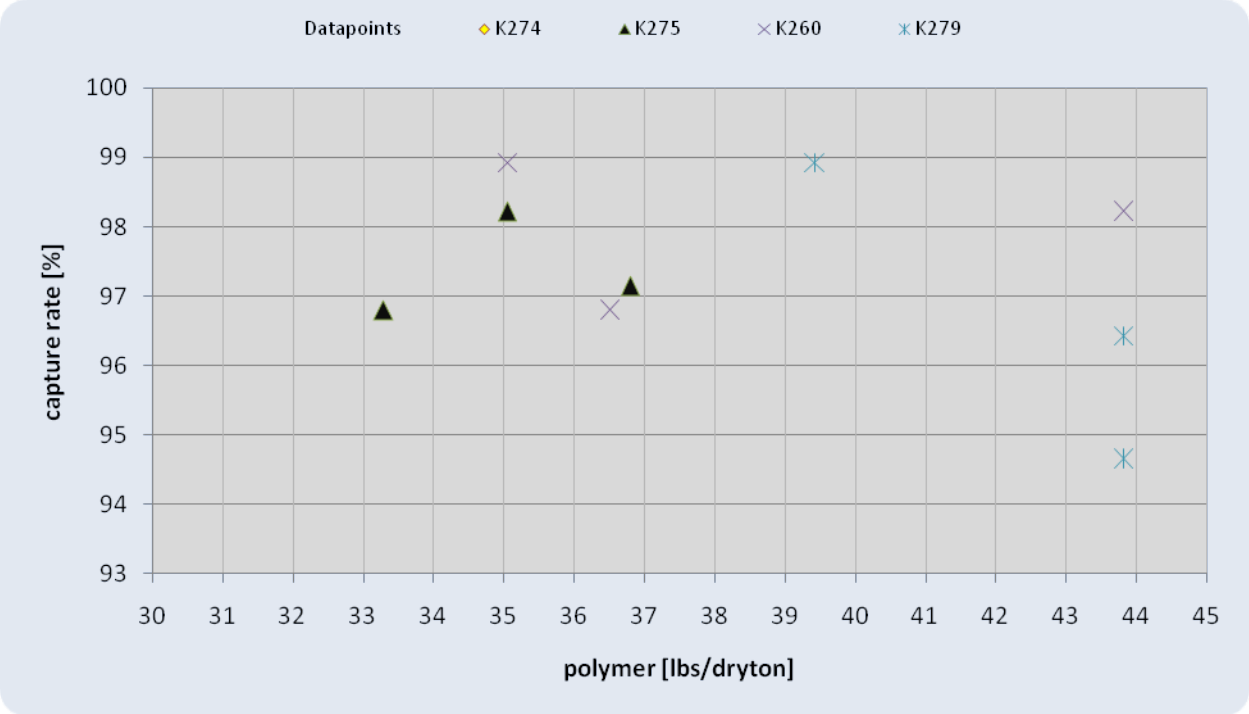
It appears that the pressure has no effect on the cake solids. The cake solids always reach 21 to 22 % cake regardless which pressure is adjusted at the dewatering cone.

4.4 Capture rate

The average capture rate was 94.6 to 98,9%. The average capture rate was 97.3 % which is an excellent result for the operating of a dewatering system.

The capture rate is effected by several parameters:

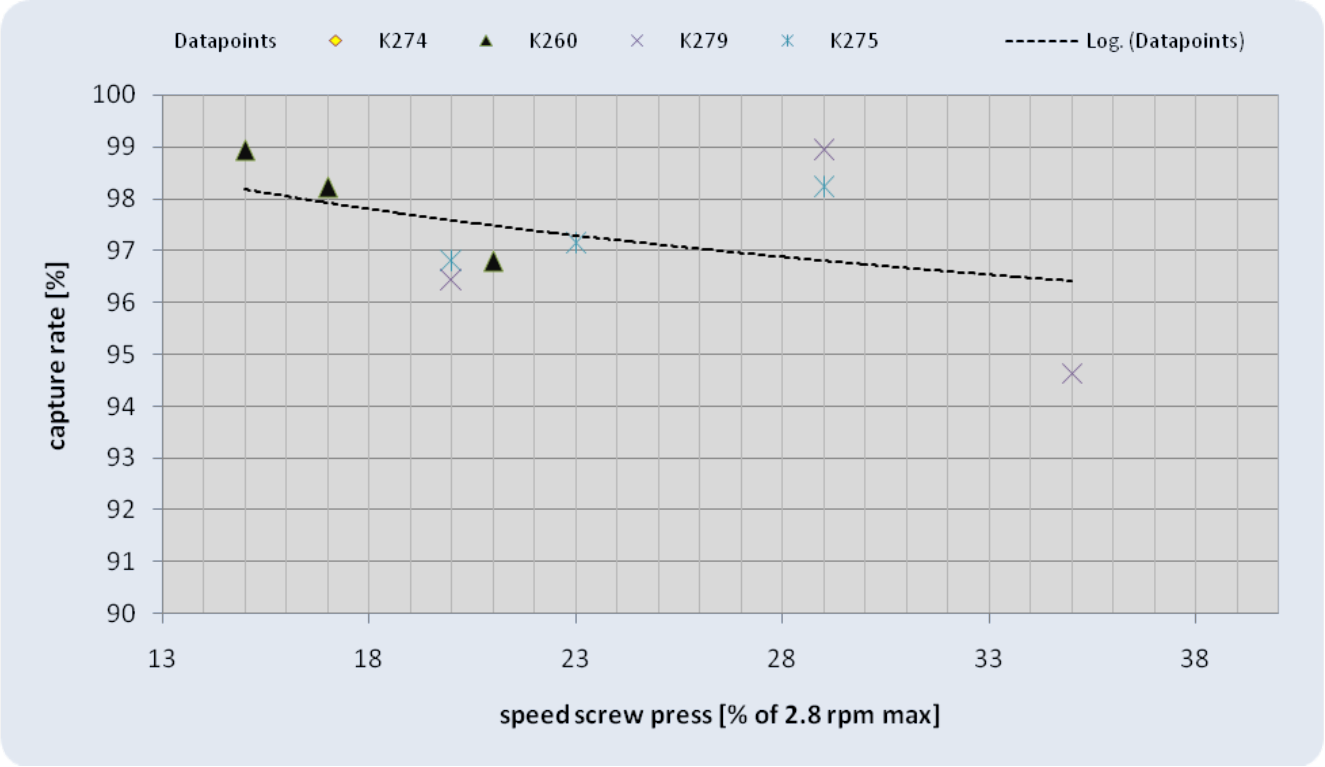
- polymer consumption (graph 8)
- screw speed (graph 9)
- pressure at inlet flange (graph 10)



GRAPH 8: effect of polymer consumption on capture rate

The capture rate is consistently at a very high level. There are no significant differences whichever polymer is tested. The capture rate is in average 97% with the polymer consumption set to 33 to 39 lbs active / ton DS.

The capture rate seems to be not significantly affected by the screw speed (see graph 9).

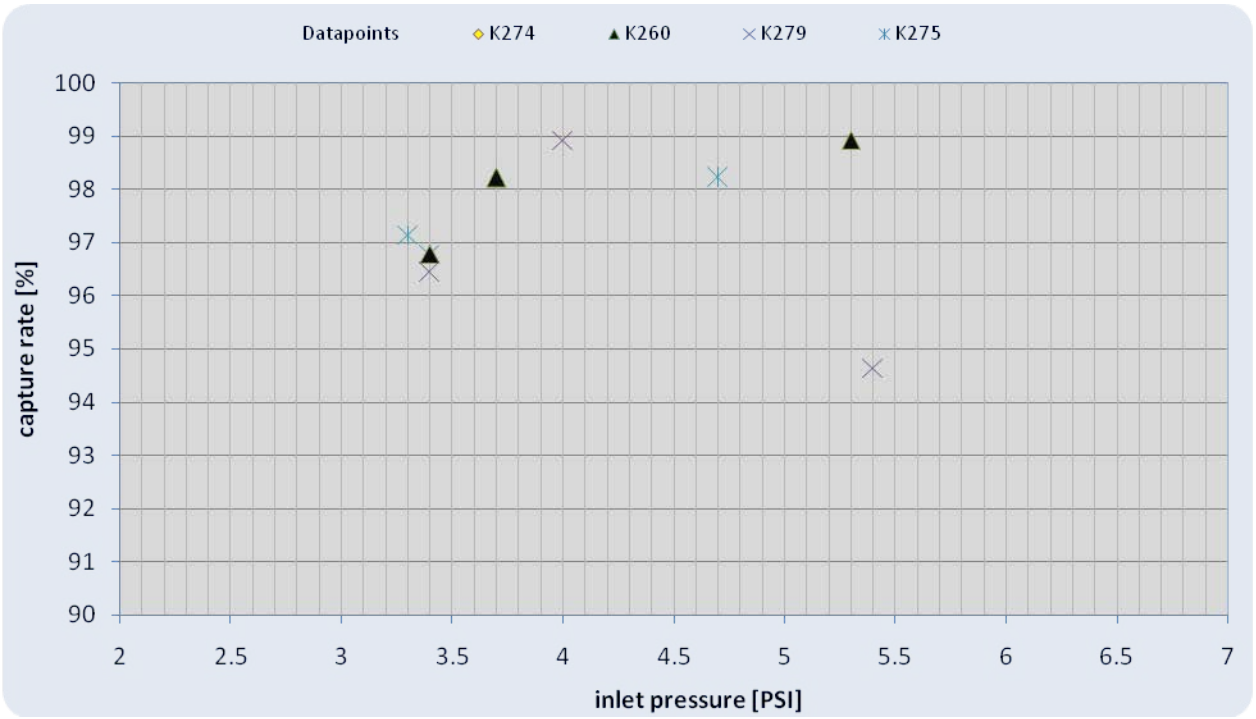


GRAPH 9: capture rate effected by screw speed

The capture rate is a very important parameter for the operation of the dewatering system. It is crucial for the operational costs of the biosolids handling system but also for the operation of the entire WWTF. Therefore it is essential to do the sampling in a way that the results are representing the overall capture rate and not just a small period of time:

- type of sample: composite sample (rather than grab samples)
- it is crucial for the results to schedule sampling according the wash cycle: wash cycle is occurring only every 20 – 30 minutes with constant water flow (approx. 22 GPM @ 50 PSI).

The pressure at the inlet flange is another important factor. The pressure applied to the feed has no significant effect on the capture rate (see graph 10) if nor exceeding 5 PSI.



GRAPH 10: effect of feed pressure on capture rate

Normally we see a decreasing capture rate with the feed pressure exceeding 4 - 6 PSI. There are no tests executed in the range above 5.5PSI – but the test with 5.4PSI already shows a drop in capture rate.

These results are indicating that the used polymers are working very well and the flocculation process is set at its correct settings which means the system is operated with perfectly adjusted mixing energy at the Huber injection and mixing device and correct retention time in the flocculator between the injection ring and the screw press inlet.

5. Conclusion

The pilot test proved the capability of the HUBER screw press to dewater the sludge at the WWTP Puyallup, WA. The screw press is able to handle the sludge and produce cake solids up to 22 % DS.

The best results were achieved with the settings:

- flow rate: 6 GPM
- solid loading: up to 84 lbs DS / h (with feed at 2.8% DS)
- polymer consumption: approx. 37.8 lbs active / ton DS
- screw speed: 20 % (approx. 0.4 – 1.0 rpm)
- pressure at cone: around 0 - 20 PSI

The cake can be expected in the range of 18 – 22 % with a filtrate which is almost without any solids during dewatering mode. The average capture rate of 97 % is very good.

Huber Technology likes to say thank you for the opportunity to present our Screw Press RoS3Q at WWTP Puyallup, WA. We appreciate all the help provided by the plant personnel at WWTP Puyallup, WA to make this pilot possible and a successful one.

6. Activities

Monday
March 15th, 2010

- arrival at the plant
- set up of the pilot unit
- jar tests with all available polymers
- tests with different settings, polymer flows and – concentrations
- different settings, sampling for cake dryness and capture rate

Tuesday
March 16th, 2010

- tests with different settings, polymer flows and – concentrations
- different settings, sampling for cake dryness and capture rate

Wednesday
March 17th, 2010

- tests with different settings, polymer flows and – concentrations
- different settings, sampling for cake dryness and capture rate
- visitors: RoS3Q 280

Thursday
March 18th, 2010

- tests with different settings, polymer flows and – concentrations
- different settings, sampling for cake dryness and capture rate
- visitors: RoS3Q 280
- Disconnected the machine, cleaned it and the pilot site
- loaded and prepared trailer for departure
- leaving Plant

Fournier Pilot Test Report

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FOURNIER ROTARY PRESS TESTING FOR WASTEWATER SLUDGE DEWATERING

PUYALLUP WATER POLLUTION CONTROL PLANT
WASHINGTON

FOURNIER INDUSTRIES INC.
3787 West Frontenac Blvd.
Thetford-Mines (Québec) Canada G6H 2B5

Phone : (418) 423-4241
Fax : (418) 423-7366
E-mail : www.rotary-press.com

/FT

August 27th, 2013

TABLE OF CONTENTS

I. INTRODUCTION

This report presents results from piloting trials with the Fournier Rotary Press technology, performed at the city of Puyallup water pollution control plant located in Puyallup in the State of Washington on August 12th to 15th 2013.

Dewatering trials have been performed on anaerobic digested sludge (35 days retention) from the Puyallup facility.

The conclusion of this report establishes the design parameters for a future Rotary Press installation.

Results are presented and discussed in Section III.

II. PILOT EQUIPMENT AND DESCRIPTION

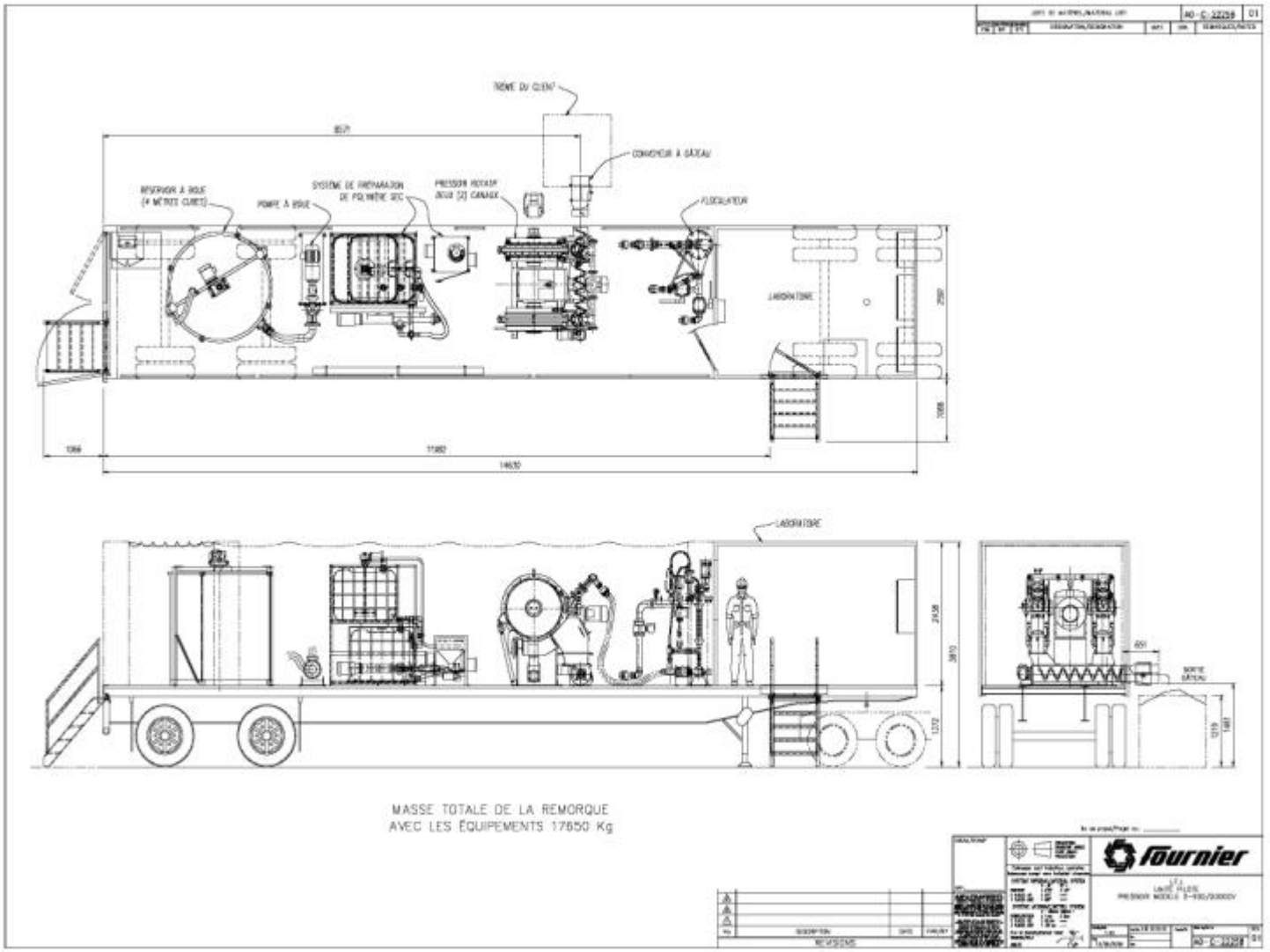
The Fournier Rotary Press pilot unit is placed inside a 48 foot trailer. It consisted of:

- Model 1-900/2000CV Rotary Press
- Flocculator assembly;
- Progressive cavity Feed Pump;
- Sludge holding tank and mixer;
- Progressive Cavity polymer feed pump;
- Polymer preparation tanks and mixers (2 units);
- Cake conveyor;
- Control panel.

Sludge from the plant was hauled by truck, pumped in the pilot unit's holding tank, and then pumped to the flocculation tank for conditioning.


Burnier
ROTARY
PRESS

Figure 1: Mobile Unit General Arrangement




Fournier
DEWATERING
ROTARY PRESS
DESHYDRATATION
PRESSOIR ROTATIF
WWW.ROTARY-PRESS.COM

III. RESULTS AND DISCUSSION

Results from the piloting trials performed on anaerobic digested sludge from the facility are presented in Tables 1- A to D (attached). The table indicates the trial dates and identification number (run) along with polymer type and dosage. The Rotary Press operating parameters (rotation speed and inlet pressures) are noted. Information on the feed sludge follows: its flow rate in gpm and total solids concentration in percentage. Filtrate total suspended solids, cake total solids, cake production rate and capture rate data complete the table.

Four (**4**) polymer types have been selected and used on site to dewater the anaerobic digested sludge from the facility. The polymers (3) are emulsions: Praestol **K-144L from Ashland**, **C-6266 from SNF and Ciba 7878fs40 from BASF**. The last polymer tested is a dry polymer **859BS from Ashland** They are standard cationic polymer, and were offering a good flocculation and a good agglomeration, resulting in good achieved performance during the pilot trials. The polymer solution diluted between down to 0, 16% to 0, 20% active was pumped to the flocculation tank inlet and mixed with the sludge before being fed to the Rotary Press. Polymer dosage required to adequately flocculate the sludge was averaging in the range of **26,4 lbs** of polymer per dry ton of solid

Start-up and shutdown procedures consisted of a simple push-button operation and the Rotary Press is designed for unmanned operation. Cake dryness has remained considerably constant along all runs. Total suspended solids measured in the filtrate demonstrated an excellent capture rate. Through the duration of the trials, the Rotary Press presented a very consistent and reliable operation under automatic mode. The Rotary Press obtained cake dryness up to **20,51%** TS and a capture rate averaging **97,0%**. The production was up to **191 dry lbs/ hour dry lbs / hr** per dewatering channel.

Table 1- A: Results from the pilot

DAY 1 August 12th 2013

FOURNIER INDUSTRIES INC.

ENVIRONMENTAL DIVISION

Location: Puyallup, Washington
ROTARY PRESS Model 900-1000CV — **Total Dewatering Sludge: 2000 gal**
(Channel OPTIMUM) — **Cloth Test: 13,97%** — ***François Turcotte***
Sludge type: anaerobic (35 days retention) — **From: 12th-15th August 2013**

	GENERAL	OPERATING PARAMETERS							CHARACTERISTICS				RESULTS			
		POLYMER			FLOCCU-LATOR	ROTARY PRESS	Energy		FLOW RATE (1 Channel)			FILTRATE	CAKE	PRODUCTION	CAPTURE
DATE	RUN #	TYPE	CONCEN. (% ACTIVE)	DOSAGE (Lb/dry t)	RPM	SPEED (RPM)	Energy usage (kW-hr/ 2000 dry lbs)	PRESSURE INLET (PSI)	OUTLET Lbs	SLUDGE (USGPM)	TS (%)	TSS (%)	TS (%)	(dry Lbs/hr)	RATE TSS (%)
August, 12, 2013	1a	7878 FS40	0,20%	29,0	250	0,50	3,43	4,0	45	8,6	3,03%	0,28	15,97%	118	90,8
August, 12, 2013	1b	7878 FS40	0,20%	31,7	230	0,50	3,42	4,0	45	9,2	3,03%	0,05	15,96%	137	98,3
August, 12, 2013	1c	7878 FS40	0,20%	31,7	230	0,60	3,72	4,0	45	10,3	3,03%	0,10	15,66%	151	96,7
August, 12, 2013	1d	7878 FS40	0,20%	31,5	230	0,60	3,54	4,0	45	10,3	3,05%	0,10	16,70%	152	96,7
August, 12, 2013	1e	7878 FS40	0,20%	31,4	230	0,70	3,87	4,0	45	11,7	3,06%	0,23	15,87%	165	92,5
August, 12, 2013	1f	7878 FS40	0,20%	32,6	230	0,70	3,36	4,0	45	12,7	3,13%	0,11	16,77%	191	96,5
August, 12, 2013	1g	7878 FS40	0,20%	32,8	230	0,70	3,44	4,0	45	12,9	3,11%	0,08	16,51%	194	97,4
August, 12, 2013	1h	7878 FS40	0,20%	33,3	230	0,80	3,86	4,0	45	13,1	3,12%	0,28	15,29%	186	91,0
August, 12, 2013	1i	7878 FS40	0,20%	33,1	230	0,80	3,87	4,0	45	13,3	3,14%	0,32	15,35%	187	89,8
August, 12, 2013	1j	7878 FS40	0,20%	33,3	230	0,40	3,22	4,0	45	7,3	3,12%	0,19	18,20%	106	93,9
August, 12, 2013	1k	7878 FS40	0,20%	33,3	230	0,30	2,68	4,0	45	6,6	3,12%	0,06	18,72%	100	98,1
August, 12, 2013	1l	7878 FS40	0,20%	33,3	230	0,40	3,57	4,0	45	7,1	3,12%	0,20	17,39%	104	93,6
August, 12, 2013	1m	7878 FS40	0,20%	33,3	230	0,30	2,84	4,0	45	6,6	3,12%	0,07	18,84%	101	97,8
AVERAGE		7878 FS40	*0,20%*	*32,3*	*231,5*	*0,56*	*3,45*	*4,0*	*45,0*	*10,0*	*3,09%*	*0,16*	*16,71%*	*146*	*94,9*

Table 1- B: Results from the piloting

DAY 2 August 13th 2013

FOURNIER INDUSTRIES INC.

ENVIRONMENTAL DIVISION

Location: Puyallup, Washington
ROTARY PRESS Model 900-1000CV
(Channel OPTIMUM)
Sludge type: anaerobic (35 days retention)

Total Dewatering Sludge: 2800 gal
Cloth Test: 14,68%

François Turcotte
From: 12th-15th August 2013

	GENERAL	OPERATING PARAMETERS							CHARACTERISTICS				RESULTS			
		POLYMER			FLOCCU-LATOR	ROTARY PRESS	Energy		FLOW RATE (1 Channel)				FILTRATE	CAKE	PRODUCTION	CAPTURE
DATE	RUN #	TYPE	CONCEN. (% ACTIVE)	DOSAGE (Lb/dry t)	RPM	SPEED (RPM)	Energy usage (kW-hr/ 2000 dry lbs)	PRESSURE INLET (PSI)	OUTLET Lbs	SLUDGE (USGPM)	TS (%)		TSS (%)	TS (%)	(dry Lbs/hr)	RATE TSS (%)
August, 13, 2013	2a	K-144L	0,18%	27,5	175	0,40	3,87	3,5	45	6,6	2,88%		0,01	15,51%	95	99,7
August, 13, 2013	2b	K-144L	0,18%	26,2	175	0,40	3,62	3,5	45	7,0	2,89%		0,01	15,09%	101	99,7
August, 13, 2013	2c	K-144L	0,18%	27,5	200	0,40	3,54	3,5	45	7,1	2,88%		0,04	16,43%	100	98,6
August, 13, 2013	2d	K-144L	0,18%	27,5	200	0,40	3,95	4,0	50	6,4	2,88%		0,02	15,67%	91	99,3
August, 13, 2013	2e	K-144L	0,18%	27,6	225	0,40	3,00	4,5	50	8,4	2,87%		0,01	16,54%	120	99,7
August, 13, 2013	2f	K-144L	0,18%	27,9	220	0,40	3,07	4,5	50	7,7	3,10%		0,10	16,00%	115	96,8
August, 13, 2013	2g	K-144L	0,18%	27,7	220	0,30	2,59	4,5	50	7,0	3,12%		0,02	18,32%	108	99,4
August, 13, 2013	2h	K-144L	0,18%	27,8	220	0,50	3,28	4,5	50	9,0	3,11%		0,02	15,24%	138	99,4
August, 13, 2013	2i	K-144L	0,18%	28,9	220	0,50	3,08	4,5	50	9,2	3,11%		0,05	15,08%	141	98,4
August, 13, 2013	2j	K-144L	0,18%	28,8	220	0,60	3,72	4,5	50	9,5	3,12%		0,11	14,69%	142	96,5
August, 13, 2013	2k	K-144L	0,18%	27,7	200	0,60	3,79	4,5	50	10,0	3,12%		0,10	14,41%	151	96,8
August, 13, 2013	2l	K-144L	0,18%	27,8	170	0,30	2,76	4,5	50	5,8	3,11%		0,03	18,53%	89	99,0
August, 13, 2013	2m	K-144L	0,18%	27,7	220	0,30	2,56	4,5	50	6,5	3,12%		0,03	18,50%	100	99,0
August, 13, 2013	2n	K-144L	0,18%	27,7	220	0,25	2,75	4,5	50	5,3	3,12%		0,04	19,92%	81	98,7
August, 13, 2013	2o	K-144L	0,18%	27,7	250	0,25	3,01	4,5	50	5,2	3,12%		0,05	20,12%	80	98,4
August, 13, 2013	2p	K-144L	0,18%	27,7	170	0,25	2,29	4,5	50	6,3	3,12%		0,05	19,96%	96	98,4
August, 13, 2013	2q	K-144L	0,18%	27,8	220	0,70	4,52	4,5	50	10,5	3,11%		0,02	14,14%	162	99,4
August, 13, 2013	2r	K-144L	0,18%	27,7	200	0,70	4,51	4,5	45	10,1	3,12%		0,10	14,03%	153	96,8
August, 13, 2013	2s	K-144L	0,18%	27,8	200	0,25	2,64	4,5	45	5,4	3,11%		0,01	20,51%	84	99,8
August, 13, 2013	2t	K-144L	0,18%	27,8	200	0,25	3,05	4,5	45	5,3	3,11%		0,04	20,29%	82	98,7
AVERAGE		K-144L	*0,18%*	*27,7*	*206,6*	*0,41*	*3,28*	*4,3*	*48,5*	*7,4*	*3,06%*		*0,04*	*16,95%*	*112*	*98,6*

Table 1- C: Results from the piloting

DAY 3 August 14th 2013

FOURNIER INDUSTRIES INC.

ENVIRONMENTAL DIVISION

Location: Puyallup, Washington
ROTARY PRESS Model 900-1000CV — **Total Dewatering Sludge: 3000 gal**
(Channel OPTIMUM) — **Cloth Test: 13,56%** — ***François Turcotte***
Sludge type: anaerobic (35 days retention) — **From: 12th-15th August 2013**

	GENERAL	OPERATING PARAMETERS					CHARACTERISTICS						RESULTS			
		POLYMER			FLOCCU-LATOR	ROTARY PRESS	Energy			FLOW RATE (1 Channel)			FILTRATE	CAKE	PRODUCTION	CAPTURE
DATE	RUN #	TYPE	CONCEN. (% ACTIVE)	DOSAGE (Lb/dry t)	RPM	SPEED (RPM)	kW (Press)	Energy usage (kW-hr/ 2000 dry lbs)	PRESSURE INLET (PSI)	OUTLET Lbs	SLUDGE (USGPM)	TS (%)	TSS (%)	TS (%)	(dry Lbs/hr)	RATE TSS (%)
August, 14, 2013	3a	859BS	0,20%	35,0	170	0,40	0,43	3,27	3,5	50	7,2	3,09%	0,09	16,34%	107	97,1
August, 14, 2013	3b	859BS	0,20%	35,0	200	0,40	0,42	3,30	3,5	50	6,9	3,09%	0,05	16,43%	105	98,4
August, 14, 2013	3c	859BS	0,20%	36,4	200	0,40	0,42	2,96	4,0	50	7,7	3,08%	0,02	16,75%	117	99,4
August, 14, 2013	3d	859BS	0,20%	36,5	200	0,40	0,44	3,24	4,0	50	7,4	3,07%	0,07	16,60%	111	97,7
August, 14, 2013	3e	859BS	0,20%	36,4	200	0,50	0,54	3,25	4,0	50	9,5	3,08%	0,05	16,83%	143	98,4
August, 14, 2013	3f	859BS	0,20%	36,4	200	0,50	0,54	3,26	4,0	50	9,2	3,08%	0,02	14,76%	140	99,4
August, 14, 2013	3g	859BS	0,20%	35,2	200	0,30	0,31	2,59	4,0	50	6,5	3,07%	0,03	16,80%	99	99,0
August, 14, 2013	3h	859BS	0,20%	34,8	200	0,30	0,31	2,84	4,0	50	6,3	3,10%	0,11	17,09%	95	96,5
August, 14, 2013	3i	859BS	0,20%	34,5	200	0,25	0,28	2,84	4,0	50	5,5	3,13%	0,02	18,63%	85	99,4
August, 14, 2013	3j	859BS	0,20%	34,6	220	0,25	0,26	3,14	4,4	50	4,9	3,12%	0,04	18,84%	76	98,7
August, 14, 2013	3k	859BS	0,20%	34,6	220	0,60	0,70	4,27	4,4	50	9,6	3,12%	0,05	14,25%	147	98,4
August, 14, 2013	3l	859BS	0,20%	34,6	250	0,60	0,70	4,13	4,4	50	9,6	3,12%	0,18	14,87%	141	94,2
August, 14, 2013	3m	859BS	0,20%	34,5	250	0,70	0,84	4,57	4,4	50	10,1	3,13%	0,08	13,84%	154	97,4
August, 14, 2013	3n	859BS	0,20%	34,5	250	0,70	0,83	4,66	4,4	50	10,1	3,13%	0,18	14,20%	149	94,2
AVERAGE		859BS	*0,20%*	*35,2*	*211,4*	*0,45*	*0,50*	*3,45*	*4,1*	*50,0*	*7,9*	*3,10%*	*0,07*	*16,16%*	*119*	*97,7*

Table 1- D: Results from the piloting

DAY 4 August 14th 2013

FOURNIER INDUSTRIES INC.

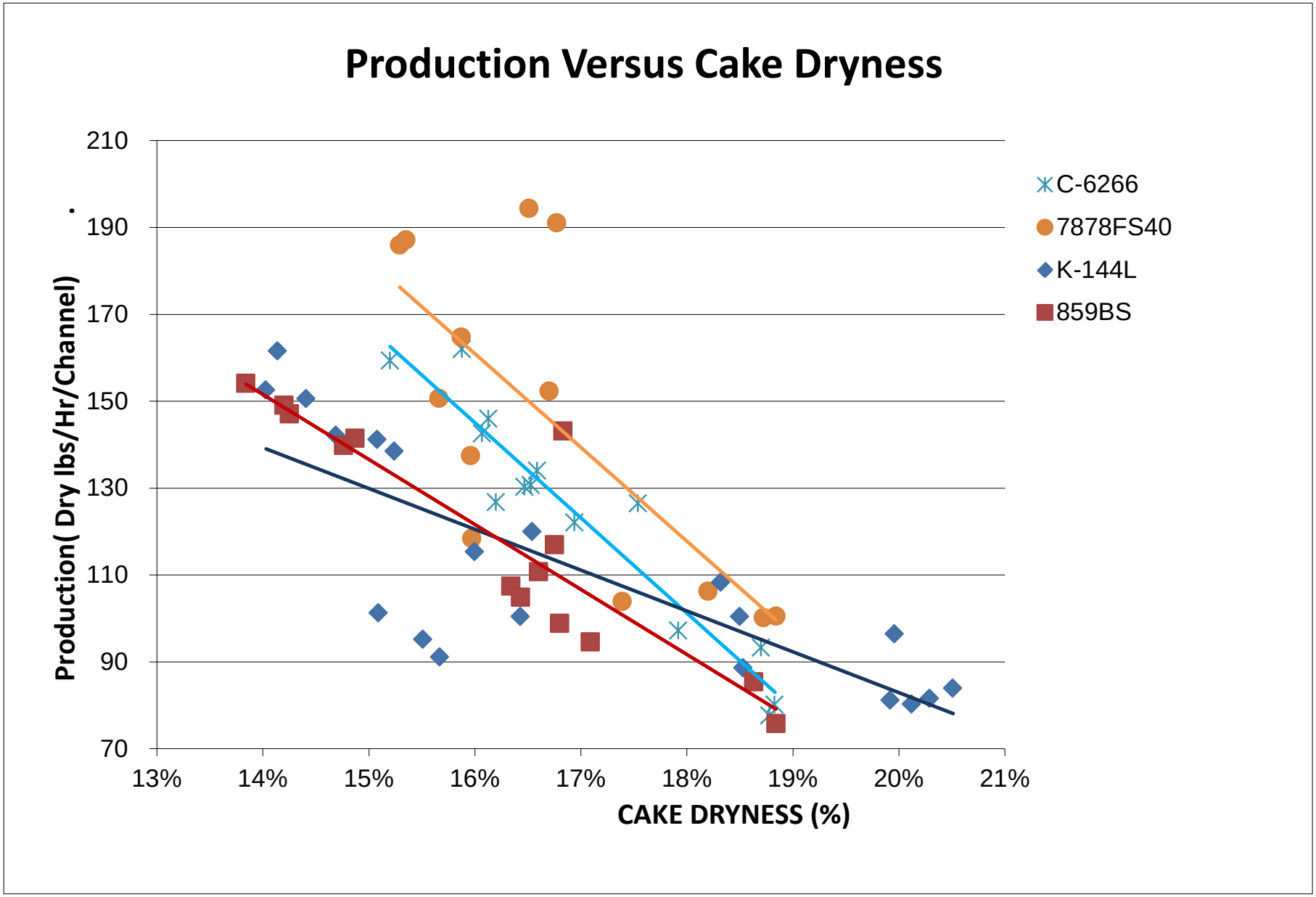
ENVIRONMENTAL DIVISION

Location: Puyallup, Washington
ROTARY PRESS Model 900-1000CV — **Total Dewatering Sludge: 1500 gal**
(Channel OPTIMUM) — **Cloth Test: 14,34%** — ***François Turcotte***
Sludge type: anaerobic (35 days retention) — **From: 12th-15th August 2013**

	GENERAL	OPERATING PARAMETERS					CHARACTERISTICS						RESULTS			
		POLYMER			FLOCCU-LATOR	ROTARY PRESS	Energy		FLOW RATE (1 Channel)				FILTRATE	CAKE	PRODUCTION	CAPTURE
DATE	RUN #	TYPE	CONCEN. (% ACTIVE)	DOSAGE (Lb/dry t)	RPM	SPEED (RPM)	kW (Press)	Energy usage (kW-hr/ 2000 dry lbs)	PRESSURE INLET (PSI)	OUTLET Lbs	SLUDGE (USGPM)	TS (%)	TSS (%)	TS (%)	(dry Lbs/hr)	RATE TSS (%)
August, 15, 2013	4a	C-6266	0,16%	31,3	150	0,40	0,47	3,20	3,5	50	8,4	3,07%	0,05	16,20%	127	98,4
August, 15, 2013	4b	C-6266	0,16%	32,1	170	0,40	0,47	3,10	4,0	50	8,7	3,09%	0,08	16,47%	130	97,4
August, 15, 2013	4c	C-6266	0,16%	32,1	170	0,40	0,47	3,21	4,0	50	8,4	3,09%	0,06	17,54%	126	98,1
August, 15, 2013	4d	C-6266	0,16%	32,1	170	0,50	0,57	3,68	4,0	50	9,0	3,09%	0,10	16,59%	134	96,8
August, 15, 2013	4e	C-6266	0,16%	32,3	170	0,50	0,59	4,17	4,0	50	8,3	3,07%	0,13	16,94%	122	95,8
August, 15, 2013	4f	C-6266	0,16%	33,4	200	0,50	0,57	3,72	4,0	50	8,9	3,07%	0,11	16,53%	131	96,4
August, 15, 2013	4g	C-6266	0,16%	33,2	200	0,60	0,73	4,46	4,0	50	9,7	3,08%	0,13	16,07%	143	95,8
August, 15, 2013	4h	C-6266	0,16%	33,2	200	0,60	0,72	4,31	4,0	50	10,0	3,08%	0,14	16,13%	146	95,5
August, 15, 2013	4i	C-6266	0,16%	35,3	200	0,70	0,88	4,86	4,0	50	11,1	3,08%	0,19	15,20%	159	93,8
August, 15, 2013	4j	C-6266	0,16%	35,3	200	0,70	0,87	4,75	4,0	50	11,3	3,08%	0,20	15,88%	162	93,5
August, 15, 2013	4k	C-6266	0,16%	35,2	200	0,30	0,36	3,27	4,0	50	6,4	3,09%	0,06	17,92%	97	98,1
August, 15, 2013	4l	C-6266	0,16%	35,2	200	0,30	0,37	3,65	4,0	50	6,2	3,09%	0,08	18,70%	93	97,4
August, 15, 2013	4m	C-6266	0,16%	35,4	200	0,25	0,28	3,16	4,0	50	5,2	3,07%	0,05	18,78%	78	98,4
August, 15, 2013	4n	C-6266	0,16%	35,4	200	0,25	0,26	2,86	4,2	55	5,4	3,07%	0,08	18,83%	80	97,4
AVERAGE		C-6266	*0,16%*	*33,7*	*186,9*	*0,46*	*0,54*	*3,74*	*4,0*	*50,4*	*8,3*	*3,08%*	*0,10*	*16,98%*	*123*	*96,6*

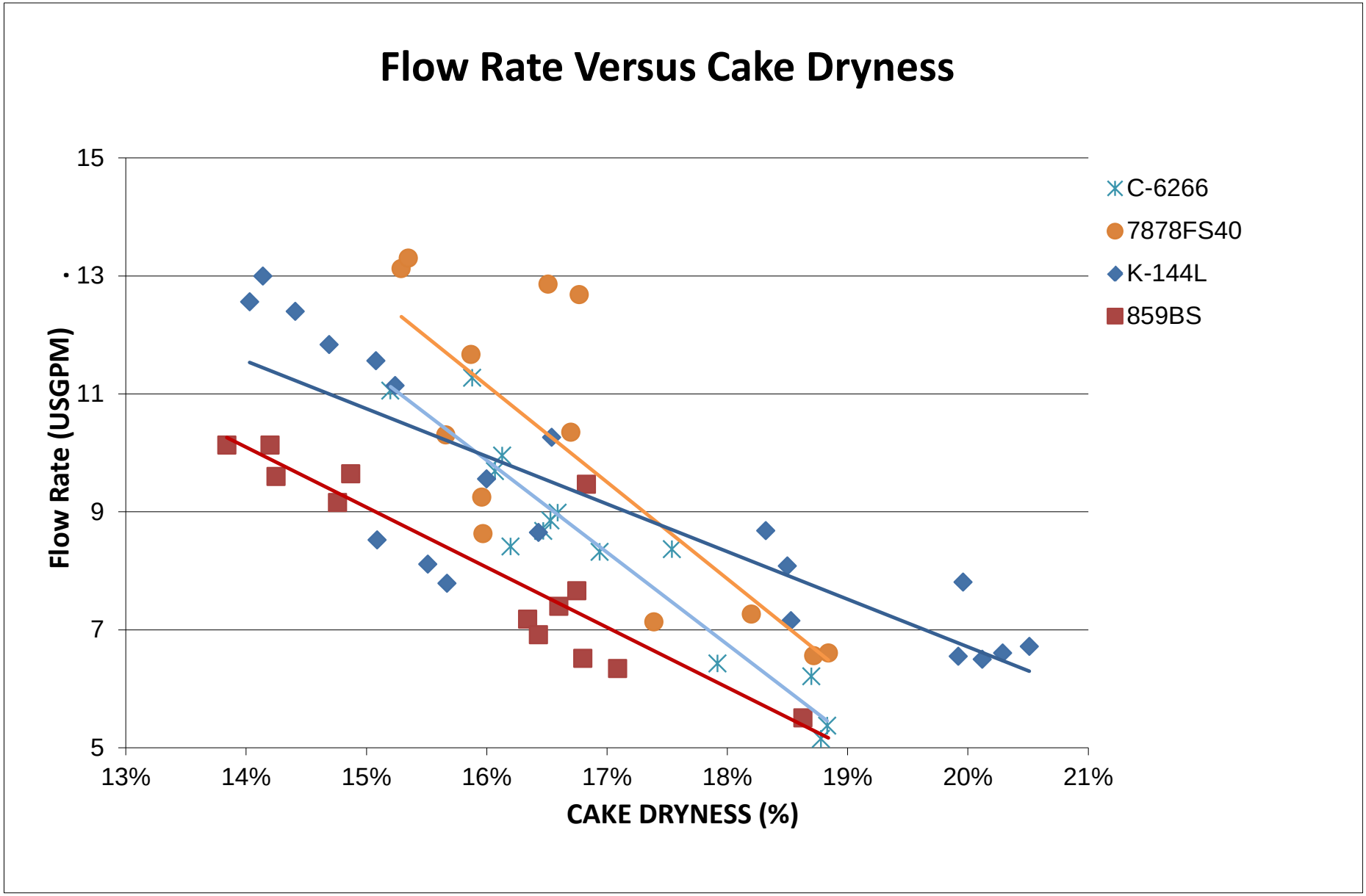
GRAPH 1: 36 inches

Anaerobic digested sludge
PRODUCTION RATE vs. CAKE DRYNESS



GRAPH 2: 36 inches

Anaerobic digested sludge
FLOW RATE vs. CAKE DRYNESS



IV. CONCLUSION

The piloting trials results presented in this report clearly demonstrate the capability of the Fournier Rotary Press dewatering technology to effectively dewater the anaerobic digested sludge from the Puyallup WWTP in the state of Washington.

The Rotary Press is the most advanced dewatering technology available. The piloting trials performed at Puyallup demonstrated its reliability and consistency to produce a good cake dryness using very little power and is designed to operate with minimal operator assistance. The Rotary Press is an extendable technology, allowing other channels, to be added to the unit, in order to accommodate future increases in the flow. Up to six (6) channels can be mounted on the same Press.

Fournier Industries Inc. would like to express its gratitude to all members of the Puyallup authority's staff involved in the execution of these piloting trials.

Andritz Pilot Test Report

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DEMONSTRATION REPORT

Report No.: D-19-13
Opportunity #.: 1346883
Testing Dates: August 27 - 29, 2013

Report Date: October 21, 2012
Author: Mitch Hanson
Copy: SoRelle, Hausegger

Customer: City of Puyallup WA
Plant Name: Puyallup Water Pollution Control Plant
Attention: Mr. James Lee
Address: 1602 18th Street
City, State, Zip: Puyallup, Washington 98371
Phone: (253) 435-3658
E-mail: jamesl@ci.puyallup.wa.us

ANDRITZ Representative: APSCO LLC
Attention: Mr. Joe Kernkamp
Address: 1120 85th Street
City, State, Zip: Kirkland, WA 98033
Phone: (425) 822-3335
Email:jkernkamp@apsco-llc.com

ANDRITZ Separation Inc.
Area Sales Manager: Mr. Bruce SoRelle
Address: 1010 Commercial Blvd. S.
City, State, Zip: Arlington, TX 76001
Phone: (817) 266-9732
Fax: (817) 419-1930
Email: bruce.sorelle@andritz.com
www.andritz.com

ANDRITZ Separation

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Executive Summary

The ANDRITZ Decanter High Solids Centrifuge (D4L model centrifuge) performance capabilities were evaluated at The City of Puyallup, WAS Water Pollution Control Plant (WPCP) on August 26 – 29, 2013. The waste stream evaluated was an anaerobically digested municipal sludge. The plant uses a 2.0m Parkson belt press to dewater the sludge to a cake dryness averaging 17 percent total solids (% TS) at a throughput of 37 gallons per minute (GPM). The polymer dosage rate for the belt press is 17 pounds of active polymer per dry ton of sludge solids (active lbs/ton TS) and the solids capture rate is 87% of the total suspended solids going to the press. The cake is then taken to eastern Washington for disposal.

The ANDRITZ D4L Centrifuge was very effective in dewatering the sludge produced at this facility achieving cake drynesses of 25.9 to 23.6%TS at throughputs of 20 to 60 GPM. The optimum polymer dosage rate for the sludge was 25 ±2 active lbs/ton TS with solids capture rate of ≥ 97%. The volume reduction of cake when comparing the existing belt press, to the ANDRITZ D4L Centrifuge, was as much as one third.

Introduction

ANDRITZ provided a trailer-mounted D4L model centrifuge and technicians for its operation. All ancillary equipment necessary to produce dewatered slurry cake was provided with the trailer. The City of Puyallup WPCP personnel provided all power, water, sludge, and cake disposal. ANDRITZ field and Arlington laboratories analyzed all the samples taken during the demonstration.

ANDRITZ D4L Centrifuge

The City of Puyallup WPCP is looking for the newest technology in dewatering equipment to achieve the driest cake possible using equipment that can be run under continuous operation. They would also like for the equipment to be fully automated with the least amount of operator interaction required while in operation.

The ANDRITZ D4L Centrifuge is perfectly suited for automated operation with minimal operator attention while producing an excellent dry material for easy handling. Unlike other types of dewatering equipment, the ANDRITZ centrifuge does not require the operator to wash down the unit at the end of the day or even during an event where there is a systems upset. All upset conditions (slop), would immediately be diverted to a discharge sump instead of the cake receptacle. Cleaning the centrifuge is automatic and programmed into the shutdown sequence when an operator pushes the stop button.

ANDRITZ centrifuge technology can provide a drier product at an excellent solids capture rate, and at higher throughputs on a continual basis, than any other type of dewatering equipment on the market today.

Plant

The City of Puyallup WPCP currently has an average daily incoming flow of 4.3 million gallons per day (MGD) to a maximum design flow of 27 MGD. The only industrial flow coming to the plant is from an industrial laundry service which contributes about 2 to 4% of the total flow going to the plant.

Wastewater first enters the plant through a bar screen (¼ inch) and grit chamber before going to the primary clarifiers. Effluent from the primary clarifiers is then passed through aeration basins before going to the secondary clarifiers. Effluent from the secondary clarifiers is then sent to the ultra violet light for disinfection before being discharged.

Sludge from the secondary clarifiers is thickened using a Humboldt centrifuge to a consistency of 5%TS and is then mixed with the primary sludge at a ratio of 60% primary to 40% secondary by weight. This blend is then sent to the anaerobic digesters for 35 to 40 days for digestion before being dewatered by a belt filter press to a cake consistency of 17%TS. The cake is then hauled in trucks to be land applied in eastern Washington. A plant diagram is attached as Appendix C.

Sludge Description

The anaerobically digested sludge was black in color and had ammonia to tarry like odor. The average consistency during the demonstration was 2.85%TS. The ash content of the sludge during the demonstration was 35.5%. The sample received in the ANDRITZ Laboratory on August 2, 2013 had a consistency of 3.16%TS with an ash content of 34.8% of the total solids. The CST was 543.9 seconds.

This sludge would be considered a 5 to 6 on the ANDRITZ Abrasive Scale where 1 would be least abrasive and 10 would be most abrasive. When properly flocculated the ANDRITZ D4L Centrifuge produced a cake which resembled a dry rich soil.

Dry Cake from D4L Centrifuge

Clear Centrate from D4L

Testing Objectives

The main objectives of testing were:

1. To determine the optimum polymer and dosage rate for this particular sludge.
2. To determine the performance of the D4L model centrifuge under different throughput conditions.
3. To determine how the torque of the centrifuge relates to cake dryness.

The ANDRITZ D4L centrifuge successfully evaluated each testing objective. This report presents conclusions and recommendations for a future installation. The test results included in this report should not be averaged, as a whole, to reflect the overall performance of D4L High Solids Centrifuge. In most of the test runs, not all of the parameters were optimized in order to help establish how changing a particular variable would affect the outcome of the end results. All test results are attached as Appendix A.

Results

The ANDRITZ D4L centrifuge proved to be very effective for dewatering the anaerobically digested sludge produced at this facility. The results stated are based on the results of ANDRITZ field and Arlington laboratory results.

1. The optimum polymer dosage rate for the lagoon sludge was 25 ±2 active lbs/ton TS.
2. At the above mentioned polymer dosage rate the cake dryness of anaerobically digested sludge on the D4L centrifuge is expected to be 25.5 to 23.5%TS at throughputs between 20 and 60 GPM with a solids capture rate of ≥ 97%.
3. The torque of the centrifuge was an excellent indicator of cake dryness.

Chemical Conditioning

Graph 1 depicts the relationship between polymer dosage rate and cake dryness. In most cases, as the dosage rate increases, the stability of the sludge solids increase which aids in the release of free water and produces a drier material. The sludge can be “overdosed” with polymer which causes poor drainage (reduced cake dryness) and capture rates which can fall below 95%. BASF 7878 FS40 was the best flocculant tested because of the higher cake drynesses achieved at lower polymer dosage rates.

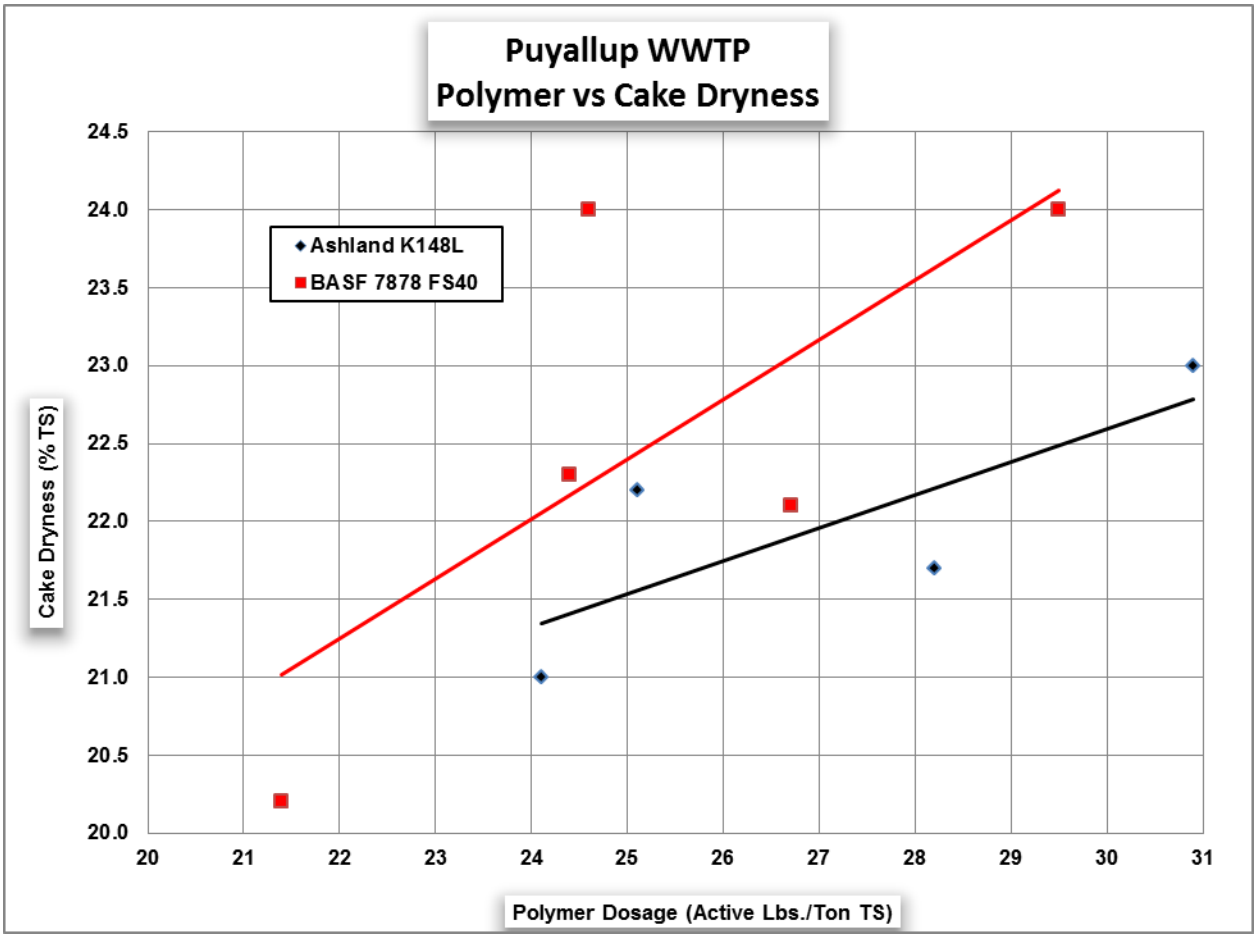
The flocculants tested during the demonstration were:

BASF 7878 FS40: a very high charged, high molecular weight, cationic emulsion polyelectrolyte that is 50% active.

Ashland K148L: a very high charged, high molecular weight, cationic polyelectrolyte that is 46% active.

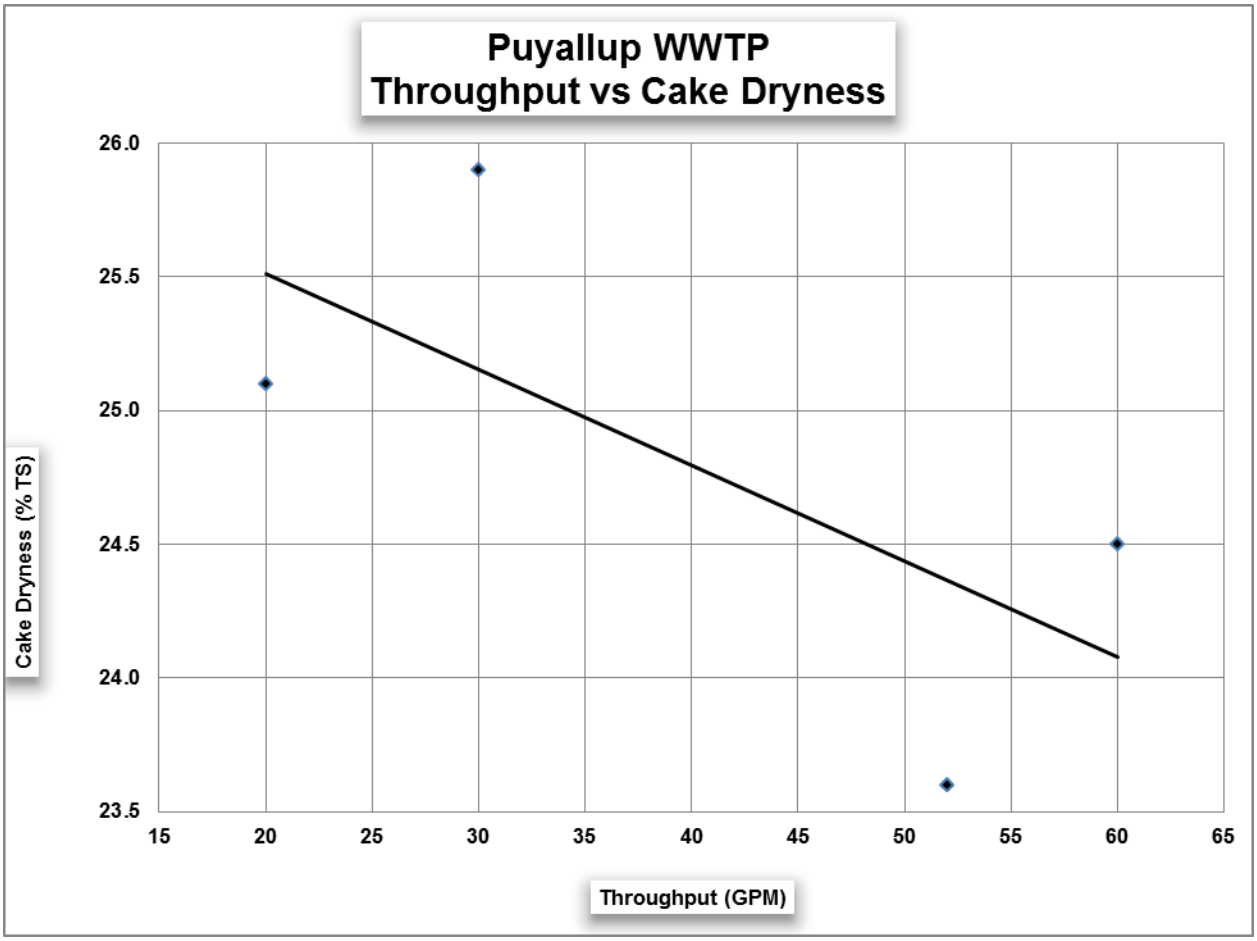
Active: refers to the active ingredients the polymer contains whether it is in dry, emulsion, or Mannich form.

Neat: refers to the polymer, as sold by the vendor, in dry or liquid form.



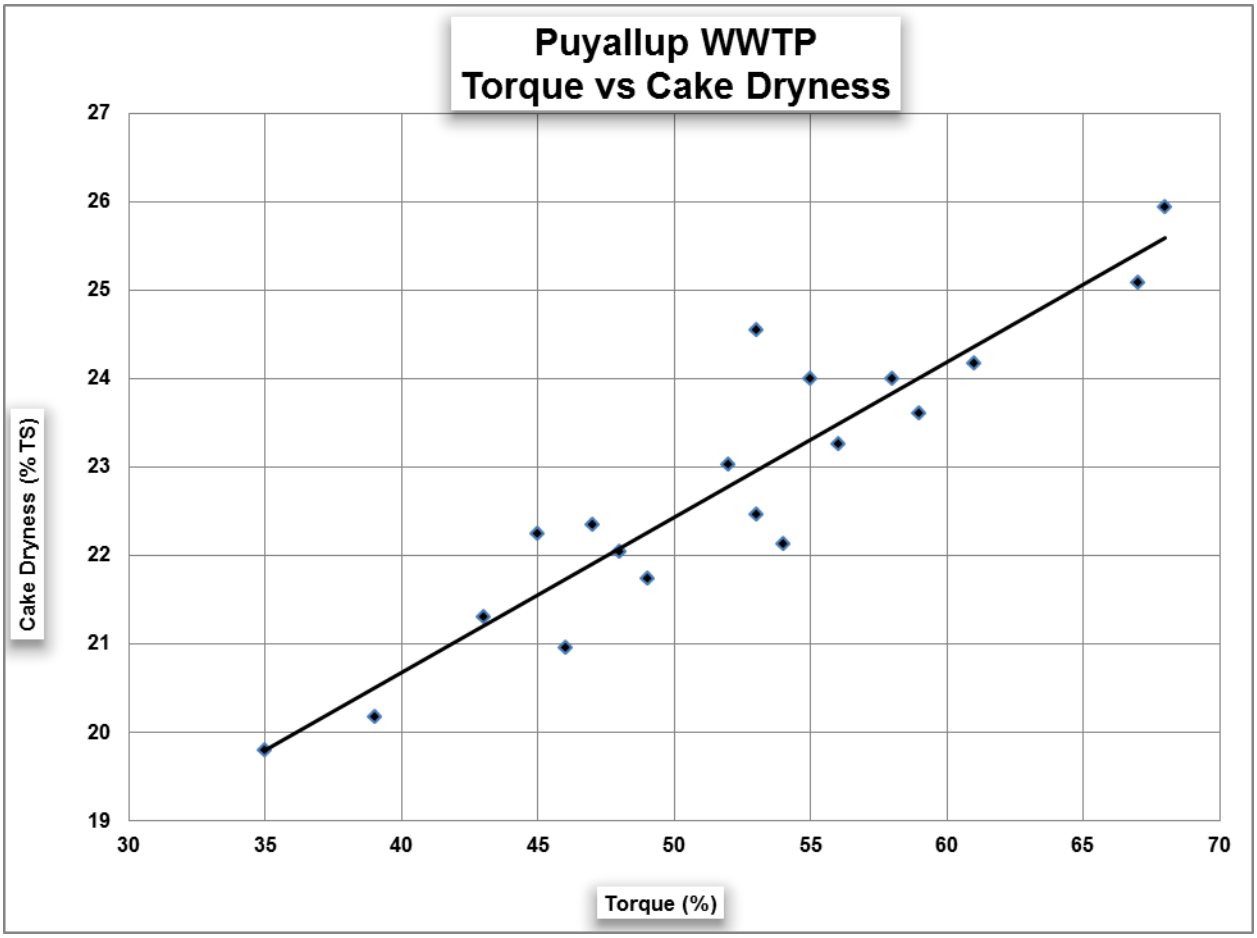
Throughput

Graph 2 represents how throughput affects the performance of the ANDRITZ D4L Centrifuge. As the throughput to the centrifuge increases, the differential speed of the centrifuge has to be increased to maintain an acceptable solids capture rate. By increasing the differential speed, this decreases the amount of retention time the sludge has within the centrifuge thus decreasing the cake dryness as depicted in the graph. The maximum throughput achieved on the ANDRITZ D4L centrifuge was 60 GPM or 874 pounds per hour of dry sludge solids. An attempt at 80 GPM was made but, it was determined that this flow rate might have been too high and caused the centrifuge to "flush out" due to the high differential speed that was required to maintain a good solids capture rate.



Torque

Graph 3 shows how torque relates to cake dryness. As the cake dryness increases, the torque required to move the cake up and out of the conical section of the centrifuge increases. Graphs such as this one can be very helpful in obtaining a "quick and easy" estimate of the cake dryness based on the torque reading from the control panel.



Differential Speed

Graph 4 depicts how differential speed affects the cake dryness and capture rate of the centrifuge. As the differential speed between the bowl and the scroll is increased, the capture rate of the centrifuge increases, but the cake dryness begins to decrease as seen from the graph.

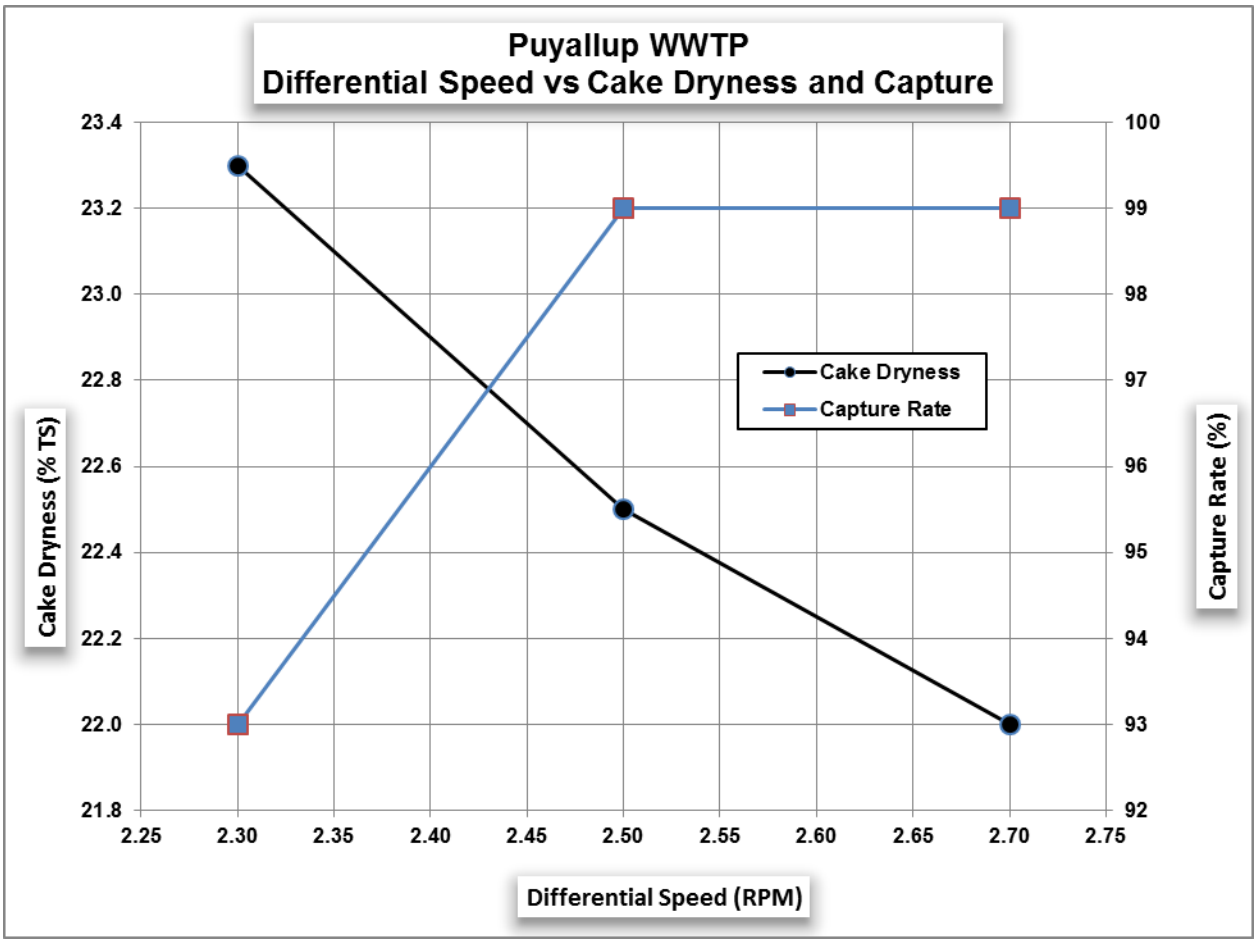


Photo: of centrate increasing the differential speed from left to right. The numbers represent the test runs during the demonstration.

Conclusions and Recommendations

The ANDRITZ D4L Centrifuge was very effective in dewatering anaerobically digested sludge produced at this facility. Based on the data and information gathered, the following performance can be expected from an ANDRITZ D4L model Centrifuge:

Anticipated Performance

Sludge Flow (GPM)	Cake Dryness (%TS)	Polymer Dosage (Active lbs/ton TS)	Capture Rate (%TSS)
20 – 40	25.5 – 24.5	25 ±2	≥ 97
40 – 60	24.5 – 23.5	25 ±2	≥ 97

Note: This performance is based on the sludge characteristics as tested during the demonstration, and using BASF 7878 FS40.

Discussion and Recommendations

For optimum operating conditions and less operator interaction with the ANDRITZ D4L Centrifuge, a homogenous sludge consistency should be fed to the centrifuge. A sludge grinder should be put up-stream of the centrifuge in order to macerate any large particles in the sludge before it enters the centrifuge.

I would like to thank Mr. Jim Lee, and the fine staff at the City of Puyallup WPCP for their outstanding assistance and preparation in making this a successful venture. We at ANDRITZ look forward to working with you on this or any other future project.

Mitch Hanson
Manager of Field Testing Services

Appendix A – Data Sheet

CUSTOMER:	PUYALLUP WATER POLLUTION CONTROL PLANT PUYALLUP, WASHINGTON								MODE:		DEWATERING								
TESTING DATES:	AUGUST 26 - 30, 2013								MACHINE:		D4L HIIGH SOLIDS CENTRIUGE								
OPPORTUNITY #:	1346883				SCROLL #: 55181 100/7864				SLUDGE TYPE:		ANAEROBICALLY DIGESTED								
TEST RUN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
DATE	8/27/2013	8/27/2013	8/27/2013	8/27/2013	8/27/2013	8/27/2013	8/27/2013	8/28/2013	8/28/2013	8/28/2013	8/28/2013	8/28/2013	8/28/2013	8/28/2013	8/28/2013	8/28/2013	8/29/2013	8/29/2013	8/29/2013
TIME	10:40	12:00	1:55	2:15	2:40	3:00	3:30	4:00	9:23	9:47	10:13	10:40	11:05	11:30	2:25	2:51	9:05	9:44	10:10
PLANT FEED SOLIDS (%TSS)	3.06	2.91	2.82	2.78	2.86	2.84	2.9	3.01	2.7	2.64	2.58	2.77	2.84	2.93	2.81	2.98	3.08	3.12	2.91
VOLATILE SOLIDS (% TVS)																		35.5	
OVEN CAKE DRYNESS (%TS)	19.8	21.3	21.0	23.0	21.7	22.2	24.0	24.0	22.1	22.3	20.2	23.3	22.5	22.0	25.1	24.2	25.9	23.6	24.5
PLANT CENTRATE (MG/L TSS)	850	1040	347	1468	1457	708	1167	802	1170	308	538	2092	432	329	1472	1364	746	974	774
SOLIDS CAPTURE (%)	98	97	99	95	96	98	96	98	96	99	98	93	99	99	95	96	98	97	98
SLUDGE FLOW (GPM)	40	40	40	40	40	40	40	40	40	40	40	40	40	40	20	30	30	52	60
THRUPUT (Lbs/Hr TS)	612	582	564	556	572	568	580	602	540	528	516	554	568	586	281	447	462	812	874
POLYMER TYPE	K148L	K148L	K148L	K148L	K148L	K148L	7878 FS40	7878 FS40	7878 FS40	7878 FS40	7878 FS40	7878 FS40	7878 FS40	7878 FS40	7878 FS40	7878 FS40	7878 FS40	7878 FS40	7878 FS40
POLYMER CONSISTENCY (%)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.5	0.5	1.0	1.0
POLYMER FLOW (GPM)	3.49	3.49	3.49	4.40	4.13	3.65	4.39	3.80	3.35	3.00	2.57	3.35	3.35	3.35	3.80	5.87	5.87	4.89	5.82
NEAT CONSUMPTION (Lbs/Ton TS)	57.0	60.0	61.9	79.1	72.2	64.3	75.7	63.1	62.0	56.8	49.8	60.5	59.0	57.2	67.6	65.7	63.5	60.3	66.7
ACTIVE CONSUMPTION (Lbs/Ton TS)	22.2	23.4	24.1	30.9	28.2	25.1	29.5	24.6	26.7	24.4	21.4	26.0	25.4	22.9	27.0	26.3	25.4	25.9	28.7
POLYMER INJECTION POINT	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube
POLMER/SLUDGE MIXING ENERGY	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
BOWL SPEED (RPM)	3599	3599	3599	3599	3599	3599	3599	3599	3599	3599	3599	3599	3599	3599	3599	3599	3599	3599	3599
G FORCE (X G's)	3114	3114	3114	3114	3114	3114	3114	3114	3114	3114	3114	3114	3114	3114	3114	3114	3114	3114	3114
DIFFERENTIAL SPEED (RPM)	2.6	2.5	2.7	2.7	2.5	2.7	2.5	2.6	2.4	2.5	2.6	2.3	2.5	2.7	1.3	2.1	1.6	2.6	3.6
TORQUE (%)	35	43	46	52	49	45	58	55	54	47	39	56	53	48	67	61	68	59	53
POND LEVEL (MM)	210	220	230	230	230	230	230	230	230	230	230	230	230	230	240	240	220	220	220
CENTRIFUGE AMPS (POWER METER)	17.4	17.2	17.7	17.9	18.6	17.3	18.3	18.4	17.3	18.7	17.5	18.2	18.0	17.4	15.7	18.1	17.4	17.9	21.4
AVERAGE VOLTAGE (3 LEGS)	488	487	486	489	488	489	489	489	491	487	488	488	488	490	489	490	489	489	489
ABSORBED POWER (kW)	13	12	13	13	13	12	13	13	12	13	13	13	13	13	11	13	13	13	15
kWh/Ton TS	41	42	45	46	47	44	45	44	46	51	49	47	46	43	80	58	54	32	35
Kilowatts Hr/1000 Gallons	5.22	5.14	5.27	5.36	5.55	5.20	5.49	5.53	5.20	5.58	5.24	5.45	5.40	5.24	9.43	7.26	6.97	4.13	4.27
hp/Gallons per Minute (GPM)	0.42	0.41	0.42	0.43	0.45	0.42	0.44	0.45	0.42	0.45	0.42	0.44	0.43	0.42	0.76	0.58	0.56	0.33	0.34
	Pond Level Curve			Polymer Curve: Ashland K148L			Polymer Curve: BASF 7878 FS40					Differential Speed Curve			Throughput Curve				

Appendix B

Chronological Summary of Testing

Monday, August 26, 2013: We arrived on-site and met with plant personnel from Puyallup WPCP to discuss the trailer's position and necessary connections for operation. All connections were completed by 2:30 p.m. No test runs were completed during the day.

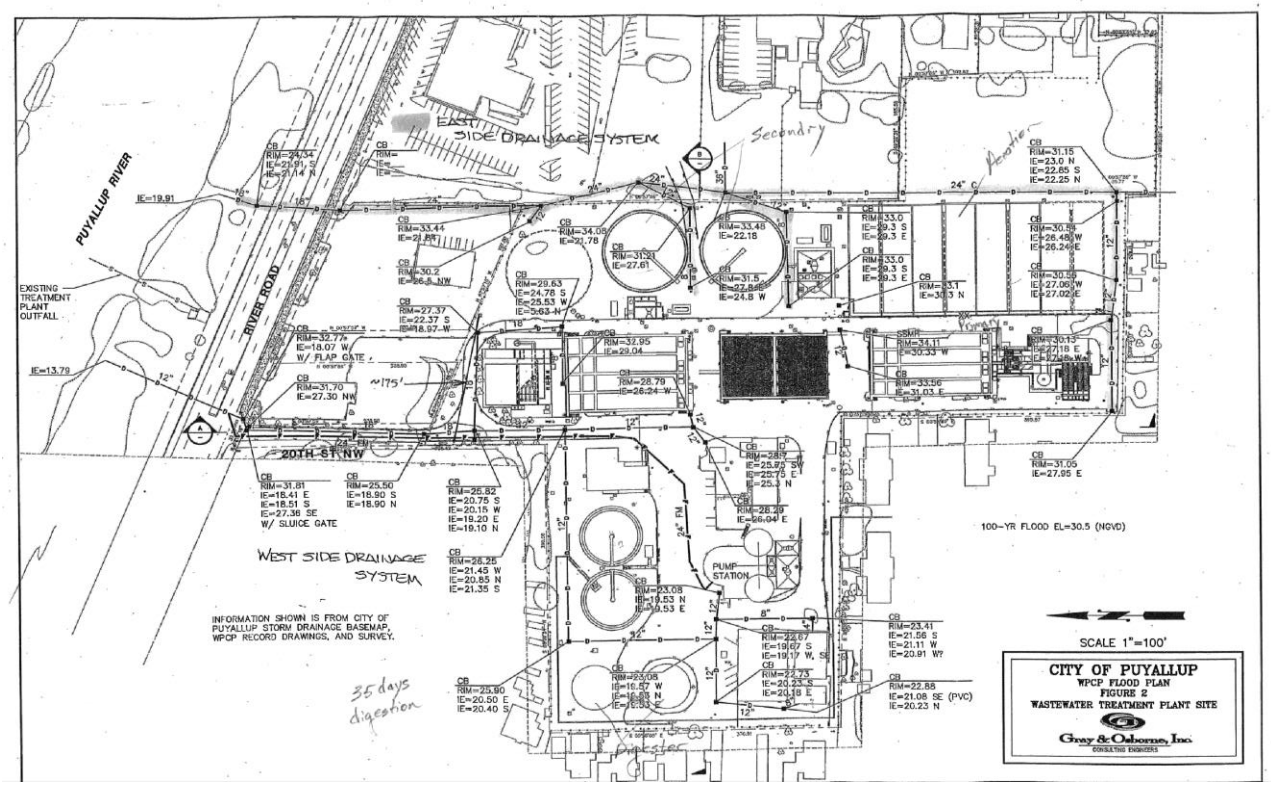
Tuesday, August 27, 2013: Pond level testing was conducted to determine which pond level would provide the best cake and centrate results. Once the pond level was set, a polymer curve was completed using Ashland K148L. Seven (7) test runs were completed.

Wednesday, August 28, 2013: Another polymer curve was completed using BASF 7878 FS40. Once this was completed a differential speed curve was generated and then a throughput curve was begun. Nine (9) test runs were completed.

Thursday, August 29, 2013: The throughput curve that was started yesterday was finished and a demonstration was held on how the scroll is extracted from the bowl along with basic centrifuge operation was given to plant personnel. The trailer was then cleaned, packed, and made ready for transport.

Appendix C

Plant Diagram



Appendix D

General Information About Testing

The ANDRITZ D4L Series Centrifuge employs the principle of accelerated settling to separate solids from a liquid. Feed is introduced through a stationary feed tube into a rotating bowl where G-Force causes the solids to sediment against the bowl wall. The scrolling action of a screw conveyor mounted concentrically within the bowl transports the solids up an incline and out of the machine. The centrate flows axially toward the front of the machine and is discharged over adjustable weirs.

For flocculation, polyelectrolyte is added upstream of the centrifuge, preferably on the discharge side of the feed pump or at the feed tube. Mixing, when necessary, can be achieved by using a Venturi Mixer.

The three (3) primary parameters analyzed during a demonstration test are sludge feed rate, relative speed between the bowl and screw (determines residence time), and flocculant dosage. Variations of these parameters will yield a series of process relationships from which typical performance during full-scale operation can be predicted.

Appendix E

Demonstration Trailer Description

ANDRITZ provided a model D4L Centrifuge on a covered 48-foot trailer. All controls and ancillary equipment necessary for operation of the production unit were mounted on the trailer. The test trailer was furnished with the following equipment:

a. Model D4L solid bowl decanter.

b. Conveyor system to transport separated solids away from the centrifuge.

c. Polymer makeup and metering system:

   Two (2) Moyno variable speed pumps (capacity 0-10 GPM).

   Two (2) 300 gallon polymer makeup tanks with agitators.

   Two (2) dilution water flow meters (0-12 GPM).

d. One (1) variable speed slurry pump (capacity 5-160 GPM).

e. One (1) portable Netzch feed pump (capacity 0-50 GPM).

f. Moyno pipeline grinder.

g. One (1) high pressure water booster pump.

h. One (1) Deming sump pump (capacity 0-100 GPM) for centrate disposal.

i. Control panels to operate auxiliary equipment and production unit.

Appendix F

Calculations

Recovery

$$\%R = \frac{c\,(f - e)}{f\,(c - e)} \times 100$$

Where: R = Recovery
c = Cake concentration (%TS)
F = Feed concentration (%TS)
e = Centrate concentration (%TSS)

Polymer Dosage

$$PD = \frac{2000\,(P)\,(p)}{F\,(f)}$$

Where: PD = Polymer dose (lbs/ton)
P = Polymer rate (GPM)
p = Polymer concentration (%TS)
F = Feed rate (GPM)
f = Feed concentration (%TS)

Relative Speed

$$RS = \frac{BS - IS}{K}$$

Where: RS = Relative speed (RPM)
BS = Bowl speed (RPM)
IS = Inlet shaft speed (RPM)
K = Gear ratio

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