Technical Memorandum

Subject: Evaluation of Dewatering Alternatives

Date: April 28, 2009

To: Lorrie B. Gervin, P.E., City of Sunnyvale

From: Lloyd Slezak, P.E., Project Manager, Brown and Caldwell


and Marie Stark, E.I.T., Brown and Caldwell

Reviewed by: Lloyd Slezak P.E., Vice President, CA PE No. C61492 Exp 06/30/2011
1. INTRODUCTION

The purpose of this technical memorandum (TM) is to document the design criteria/requirements (Table 1) and to describe and evaluate the dewatering alternatives for the City of Sunnyvale Wastewater Treatment Plant (WWTP). Solids projections shown in Table 1 were calculated from current biosolids conveyed to drying beds, annual biosolids accumulation in ponds (EOA, Inc., Ray Goebel) and targeted biosolids to remove from ponds (EOA, Inc., Ray Goebel).

<table>
<thead>
<tr>
<th>Year</th>
<th>Solids to Dewatering (1)</th>
<th>20-Year Alternative to Remove Pond Solids Inventory</th>
<th>Annual Solids Accumulation in Pond (2)</th>
<th>Total Biosolids to Dewater (from Digester+Pond Solids 20-year Plan+Annual Accumulation In Pond)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(lb/d)</td>
<td>(lb/d)</td>
<td>(lb/d)</td>
<td>(lb/d) (gal/d)</td>
</tr>
<tr>
<td>2013</td>
<td>13,309</td>
<td>7,123</td>
<td>4,932</td>
<td>25,364 101,376</td>
</tr>
<tr>
<td>2023</td>
<td>13,863</td>
<td>7,123</td>
<td>4,932</td>
<td>25,919 103,591</td>
</tr>
<tr>
<td>2033</td>
<td>14,442</td>
<td>7,123</td>
<td>4,932</td>
<td>19,374 77,433</td>
</tr>
<tr>
<td>2035</td>
<td>14,650</td>
<td>7,123</td>
<td>4,932</td>
<td>19,582 78,266</td>
</tr>
</tbody>
</table>

Note: (1) From BC Solids to Dewatering Calculations, including current primary sludge production plus estimated algae addition to digestion. (2) From Ray Goebel (EOA) email of 3-24-09.

For comparison purposes, the 2006 biosolids production rate was approximately 3400 lb/day of biosolids to dewatering, whereas projected biosolids to dewatering for year 2013 is 25,364 lb/day (about 7 times greater). The addition of algae to the digesters, removal of biosolids from the ponds (both in maintenance dredging and “catch-up” dredging), contribute significantly to the projected biosolids to dewater for the year 2013 and future years as shown in Table 1.

Construction of a dewatering facility is being considered for the Sunnyvale WWTP since planned WWTP expansion will require space presently occupied by the dewatering tiles and open air biosolids drying area. With less area available for open air biosolids drying, a dewatering facility will be needed to process existing and future biosolids loads so they can be hauled to the landfill or beneficially reused.

2. DESCRIPTION OF DEWA TERING ALTERNATIVES

Dewatering is the removal of water from the biosolids to reduce the weight/volume of solids requiring disposal and to reduce the heat demand during drying or other thermal processes. Brown and Caldwell is pleased to provide information comparing the dewatering technologies which could be used for dewatering biosolids for the Sunnyvale WWTP.

2.1 Belt Filter Press

In a belt filter press dewatering process, polymer is added to flocculate the solids in a separate flow-through process just prior to the belt filter press. The flocculated solids are then distributed on a gravity belt section where the free water drains through a moving, porous fabric belt (similar to a gravity belt thickener). The solids are then pressed between two belts as the belts move in a serpentine pattern over a series of rollers. Each pass over a roller provides additional pressing force and removes additional water. Filtrate is returned to the liquid treatment process and the dewatered solids are captured and transported to a truck for disposal.
When using polymer, belt filter presses can typically produce sludge with 18 to 23 percent solids content and can usually capture more than 95 percent of the solids. The belt filter press is an open process and significant odor may result. Therefore, direct odor control over the belt press is required and enclosure of the belt filter presses may be necessary to reduce odor control requirements.

### 2.2 Centrifuge Dewatering

In a centrifuge, the applied centrifugal force causes the suspended solids to migrate through the liquid, away from the axis of rotation due to the difference in densities between the solids and liquids. The increased settling velocity imparted by the centrifugal force, as well as the short settling distance of the particle, creates an efficient sludge dewatering system. Solid bowl-type centrifuges can generally produce cake solid concentrations comparable to or higher than belt filter press for similar applications.

The centrate is returned to the liquid treatment process and the dewatered solids are captured and transported to a truck for disposal. When using polymer, centrifuges can typically produce sludge with 20 to 25 percent solids content and usually capture more than 95 percent of the solids.

Sludge conditioning with polymers is required to prevent floc shear and to improve centrate quality and solids capture. Concurrent solid bowl centrifugation has been shown to work better than countercurrent dewatering because the less turbulent inlet conditions reduce floc shear and a larger retention time for the solids is provided. Only high-speed, concurrent centrifuges were considered for the Sunnyvale dewatering analysis.

Centrifuge dewatering is a closed process, which makes containment of odors easier. Dewatered cake from a centrifuge is generally more odorous and odor control is required on the cake and centrate outlets. Because odor control is at point sources, smaller foul air volumes must be treated.

### 2.3 Rotary Screw Press

In a rotary screw press operation, just as in a belt filter press, polymer is added to flocculate the solids in a separate flow-through process just prior to the rotary screw press. The process is continuous as the flocculated solids drop into a header box that allows the flocculated solids to move through a screw enclosed by an outer screen. Dewatering is accomplished as gravity drainage allows the filtrate to fall out of solution and the biosolids are compressed and dewatered as the screw diameter decreases towards the outlet of the pipe. Rotary screw presses have the lowest solids capture efficiency (less than 95 percent). Two types of rotary screw presses were included in this evaluation: the FKC screw press and the Huber screw press.

### 3. EVALUATION OF ALTERNATIVES

The following section compares the three dewatering alternatives: belt filter presses, centrifuges, and rotary screw presses. The information compares the three alternatives in a technology assessment for the categories below.

1. General Performance Advantages/Disadvantages (Theory)
2. Performance (Based on data provided by the vendor and previous project experience)
   - Percent Solids
   - Solids Capture Efficiency
   - Operator Attention Required
   - Reliability
3. Physical
   - Foot Print
   - Building Requirements

4. Health
   - Noise Potential
   - Odor Potential
   - Operator Exposure

5. Costs:
   - Capital
   - Annual Operations & Maintenance (O&M)
   - Annual Power
   - Annual Chemical

Table 2 provides a brief overview of the pros and cons of the different dewatering options for comparison.

<table>
<thead>
<tr>
<th>Dewatering Alternative</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belt Filter Press</td>
<td>Produces a relatively dry sludge cake</td>
<td>More complex conditioning with additional tanks, mixers and chemical feed systems that will require future replacement</td>
</tr>
<tr>
<td></td>
<td>High solids capture rate</td>
<td>Higher labor requirement</td>
</tr>
<tr>
<td></td>
<td>Moderate Energy Requirements</td>
<td>Large floor area required for equipment</td>
</tr>
<tr>
<td></td>
<td>Relatively low capital and operating costs</td>
<td>Skilled maintenance personnel required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Additional solids mass due to large chemical addition required for disposal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Higher odor potential</td>
</tr>
<tr>
<td>Centrifuge</td>
<td>Clean appearance, good odor containment, fast startup and shut down capabilities</td>
<td>Scroll wear potentially a high maintenance item</td>
</tr>
<tr>
<td></td>
<td>Highest Cake Solid Concentration</td>
<td>Skilled maintenance personnel required</td>
</tr>
<tr>
<td></td>
<td>Low capital cost to capacity ratio</td>
<td>Adequate solids capture rate</td>
</tr>
<tr>
<td></td>
<td>High installed capacity to building area ratio</td>
<td>Higher energy requirements</td>
</tr>
<tr>
<td></td>
<td>Continuous feed instead of batch</td>
<td></td>
</tr>
<tr>
<td></td>
<td>In-line sludge conditioning can be used (polymer)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low odor potential while dewatering</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Smallest floor area required for equipment</td>
<td></td>
</tr>
<tr>
<td>Rotary Screw Press</td>
<td>Fully enclosed system prevents odor nuisance</td>
<td>Lowest cake solids concentration</td>
</tr>
<tr>
<td></td>
<td>Little operator attendance required</td>
<td>Cleansing of outer casing required periodically</td>
</tr>
<tr>
<td></td>
<td>Low operating costs</td>
<td>Fewer sales records (fewer installations)</td>
</tr>
<tr>
<td></td>
<td>Low energy requirements</td>
<td>Moderate floor area required for equipment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Higher recycle rate due to lower capture rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lower solids capture rate</td>
</tr>
</tbody>
</table>

Table 3 provides a brief overview of the three dewatering alternatives based on performance, physical, and health criteria.
Table 3. Performance, Health and Maintenance

<table>
<thead>
<tr>
<th>Selection Criteria</th>
<th>Belt Filter Press</th>
<th>Centrifuge</th>
<th>Rotary Screw Press (FKC)</th>
<th>Rotary Screw Press (Huber)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Discharge Solids</td>
<td>20</td>
<td>25</td>
<td>20</td>
<td>17</td>
</tr>
<tr>
<td>Solids Capture Efficiency</td>
<td>&gt;98%</td>
<td>95%</td>
<td>90-95%</td>
<td>&gt;95%</td>
</tr>
<tr>
<td>Operator Attention Required</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Reliability</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Physical Footprint (ft²) each unit</td>
<td>406.56</td>
<td>43</td>
<td>228</td>
<td>124</td>
</tr>
<tr>
<td>Health</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise Potential</td>
<td>Low</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Odor Potential</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Operator Exposure</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

It was assumed that progressing cavity feed pumps would deliver solids to the dewatering equipment from a day storage tank.

Table 4 shows preliminary equipment sizing and cost for the dewatering alternatives based on a one shift period (8-11 hr/day). Horsepower for the belt filter press alternative was increased to compensate for significantly higher ventilation horsepower requirements compared to the other alternatives.

Table 4. Dewatering Equipment Preliminary Sizing and Cost

<table>
<thead>
<tr>
<th></th>
<th>Manufacturer</th>
<th>Model No.</th>
<th>Connected power, hp (each)</th>
<th>No. of Units</th>
<th>Installed Equipment Cost (each)</th>
<th>Installed Total Equipment Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belt Filter Press</td>
<td>BDP Industries, Inc.</td>
<td>2.0 Meter Model 3DP</td>
<td>35</td>
<td>3</td>
<td>$398,500</td>
<td>$1,195,500</td>
</tr>
<tr>
<td>Centrifuge</td>
<td>Westfalia Separator, Inc.</td>
<td>UCD536 High Solids Centrifuge</td>
<td>100</td>
<td>2</td>
<td>$794,400</td>
<td>$1,588,800</td>
</tr>
<tr>
<td>Rotary Screw Press</td>
<td>FKC, Company</td>
<td>BHX 1250X7000</td>
<td>7.5</td>
<td>3</td>
<td>$503,580</td>
<td>$1,510,740</td>
</tr>
</tbody>
</table>
Table 4. Dewatering Equipment Preliminary Sizing and Cost

<table>
<thead>
<tr>
<th>Single Shift Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufacturer</strong></td>
</tr>
<tr>
<td>Rotary Screw Press</td>
</tr>
</tbody>
</table>

Note: Installed Equipment costs include cost of equipment, percent sales tax, 40 percent installation, and shipping

As information was developed for the rotary screw press alternative, it became apparent that, due to low operating horsepower and reported ease of operation, this equipment may be capable of unmanned operation on a continuous basis. The Tremonton, Utah, installation reports that they operate their Huber screw presses 24 hr/day and have done so for over 5 years with good results. For this reason, equipment sizing and facility layouts were developed for two scenarios: operation of the dewatering equipment for either a single long shift operation (8-11 hr/day) or on a continuous basis (19 hr/day). Continuous operation is described herein as 19 hr/day to account for equipment availability of 80 percent with equipment operating 24 hr/day (24*.8 = 19 hr/day).

Table 5 shows preliminary equipment sizing and cost based on a continuous operation of 19 hours/day (24 hr/day with 80 percent availability).

Table 5. Dewatering Equipment Preliminary Sizing and Cost

<table>
<thead>
<tr>
<th>Continuous Shift Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufacturer</strong></td>
</tr>
<tr>
<td>Belt Filter Press</td>
</tr>
<tr>
<td>Centrifuge</td>
</tr>
<tr>
<td>Rotary Screw Press</td>
</tr>
<tr>
<td>Rotary Screw Press</td>
</tr>
</tbody>
</table>

Note: Installed Equipment costs include cost of equipment, 8 percent sales tax, 40 percent installation, and shipping
4. PRELIMINARY OPINION OF CAPITAL, OPERATION AND MAINTENANCE COSTS

Table 6 provides a cost summary of the capital cost and annual operation and maintenance costs for each dewatering alternative, based on single shift operation. This planning-level cost opinion does not include all elements which may be in the final design, such as the feed sludge storage tank, odor control systems, etc.

Costs shown are planning level costs in 2009 dollars, and are expected to be accurate to within plus 50 percent to minus 30 percent of the actual cost, based on the American Association of Cost Engineers definition of a Class 5 cost estimate.

<table>
<thead>
<tr>
<th></th>
<th>Belt Filter Press</th>
<th>Centrifuge</th>
<th>Rotary Screw Press (FKC)</th>
<th>Rotary Screw Press (Huber)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed Dewatering Equipment Cost ($)</td>
<td>1,195,500</td>
<td>1,588,800</td>
<td>1,510,740</td>
<td>2,349,373</td>
</tr>
<tr>
<td>Polymer Mixers/Flocculation Tanks ($)</td>
<td>18,404</td>
<td>NA</td>
<td>40,160</td>
<td>106,760</td>
</tr>
<tr>
<td>Polymer Mix Feed Units ($)</td>
<td>69,320</td>
<td>46,380</td>
<td>69,320</td>
<td>184,020</td>
</tr>
<tr>
<td>Feed Pump to Dewatering System ($)</td>
<td>138,090</td>
<td>92,060</td>
<td>138,090</td>
<td>368,240</td>
</tr>
<tr>
<td>Cake Handling System ($)</td>
<td>228,200</td>
<td>228,200</td>
<td>228,200</td>
<td>228,200</td>
</tr>
<tr>
<td>Dewatering Building- To House Equipment ($250/ft²)</td>
<td>5,841,000</td>
<td>1,026,000</td>
<td>2,702,700</td>
<td>2,028,000</td>
</tr>
<tr>
<td>Engineering (15 percent of total costs)</td>
<td>1,123,577</td>
<td>447,216</td>
<td>703,382</td>
<td>789,689</td>
</tr>
<tr>
<td><strong>Total Capital Costs</strong></td>
<td><strong>8,614,000</strong></td>
<td><strong>3,429,000</strong></td>
<td><strong>5,393,000</strong></td>
<td><strong>6,054,000</strong></td>
</tr>
<tr>
<td>Maintenance ($/yr)</td>
<td>80,000</td>
<td>80,000</td>
<td>40,000</td>
<td>40,000</td>
</tr>
<tr>
<td>Power ($/yr)</td>
<td>32,585</td>
<td>62,067</td>
<td>6,983</td>
<td>6,207</td>
</tr>
<tr>
<td>Polymer ($/yr)</td>
<td>104,151</td>
<td>312,453</td>
<td>104,151</td>
<td>166,641</td>
</tr>
<tr>
<td>Contract Biosolids Handling and Disposal ($/yr)</td>
<td>1,013,648</td>
<td>786,094</td>
<td>962,618</td>
<td>1,156,021</td>
</tr>
<tr>
<td><strong>Total Annual O&amp;M Costs</strong></td>
<td><strong>1,230,000</strong></td>
<td><strong>1,241,000</strong></td>
<td><strong>1,134,000</strong></td>
<td><strong>1,369,000</strong></td>
</tr>
</tbody>
</table>

Power costs were calculated using $0.20/kwh. Polymer costs were calculated using $2.25/lb polymer. Contract biosolids handling and disposal costs were based on the City’s existing contract with Synagro, using 2009 costs at $44.69/wet ton.

Table 7 provides a cost opinion of the 10-year net present value of capital, operation and maintenance costs for the different dewatering alternatives.

Ten (10)-year present worth costs were calculated using a 2 percent inflation rate and 5 percent interest rate.
Table 7. 10-Year Life Cycle Cost Opinion (Capital, Operation and Maintenance)

### Single Shift Operation

<table>
<thead>
<tr>
<th></th>
<th>Belt Filter Press O&amp;M Costs</th>
<th>Centrifuge Total O&amp;M Costs</th>
<th>Rotary Screw Press (FKC) O&amp;M Costs</th>
<th>Rotary Screw Press (Huber) O&amp;M Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance ($)</td>
<td>684,469</td>
<td>684,469</td>
<td>342,235</td>
<td>342,235</td>
</tr>
<tr>
<td>Power ($)</td>
<td>278,795</td>
<td>531,039</td>
<td>59,742</td>
<td>53,104</td>
</tr>
<tr>
<td>Polymer ($)</td>
<td>891,102</td>
<td>2,673,305</td>
<td>891,102</td>
<td>1,425,762</td>
</tr>
<tr>
<td>Contract Biosolids Handling and Disposal ($)</td>
<td>8,672,636</td>
<td>6,725,718</td>
<td>8,407,147</td>
<td>9,890,761</td>
</tr>
<tr>
<td><strong>Total O&amp;M Life Cycle Cost ($)</strong></td>
<td><strong>10,527,000</strong></td>
<td><strong>10,615,000</strong></td>
<td><strong>9,700,000</strong></td>
<td><strong>11,712,000</strong></td>
</tr>
<tr>
<td>Total Capital Cost ($)</td>
<td>8,614,000</td>
<td>3,429,000</td>
<td>5,393,000</td>
<td>6,054,000</td>
</tr>
<tr>
<td>Total Project Cost ($)</td>
<td>19,141,000</td>
<td>14,044,000</td>
<td>15,093,000</td>
<td>17,766,000</td>
</tr>
</tbody>
</table>

For single shift operation, the centrifuge alternative shows the lowest total project costs, followed closely by the FKC rotary screw press. The centrifuge costs are lower primarily due to its smaller building footprint and lower biosolids handling and disposal costs (since it produces the highest percent cake solids). The FKC rotary screw press costs are low due to lower maintenance costs, power use, and polymer use, while maintaining a moderate capital cost and biosolids handling and disposal cost.

Table 8. 10-Year Life Cycle Cost Opinion (Capital, Operation and Maintenance)

### Continuous Shift Operation

<table>
<thead>
<tr>
<th></th>
<th>Belt Filter Press O&amp;M Costs</th>
<th>Centrifuge O&amp;M Costs</th>
<th>Rotary Screw Press (FKC) O&amp;M Costs</th>
<th>Rotary Screw Press (Huber) O&amp;M Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance ($)</td>
<td>684,469</td>
<td>684,469</td>
<td>342,235</td>
<td>342,235</td>
</tr>
<tr>
<td>Power ($)</td>
<td>220,713</td>
<td>504,487</td>
<td>63,061</td>
<td>47,296</td>
</tr>
<tr>
<td>Polymer ($)</td>
<td>891,102</td>
<td>2,673,305</td>
<td>891,102</td>
<td>1,425,762</td>
</tr>
<tr>
<td>Contract Biosolids Handling and Disposal ($)</td>
<td>8,672,636</td>
<td>6,725,718</td>
<td>8,407,147</td>
<td>9,890,761</td>
</tr>
<tr>
<td><strong>Total O&amp;M Life Cycle Cost ($)</strong></td>
<td><strong>10,469,000</strong></td>
<td><strong>10,588,000</strong></td>
<td><strong>9,704,000</strong></td>
<td><strong>11,706,000</strong></td>
</tr>
<tr>
<td>Total Capital Cost ($)</td>
<td>3,386,104</td>
<td>2,727,386</td>
<td>4,188,093</td>
<td>2,843,128</td>
</tr>
<tr>
<td>Total Project Cost ($)</td>
<td>13,855,000</td>
<td>13,315,000</td>
<td>13,892,000</td>
<td>14,549,000</td>
</tr>
</tbody>
</table>

As mentioned earlier, continuous operation was considered since operators of the rotary screw presses state that they feel comfortable operating these units on a continuous basis, some of the time unattended. This reduces the number of rotary screw presses required – the FKC screw presses went from 3 (one-shift operation) to 2 (continuous operation), and the Huber screw presses went from 8 (one-shift operation) to 3 (continuous operation). Continuous operation could also reduce the number of belt filter presses required from 3 (one-shift operation) to 1 (continuous operation); however, belt filter presses cannot be operated continuously unattended. The centrifuge facility went from 2 ea. 100 hp units to 2 ea. 40 hp units, which did not significantly change equipment or building cost as much as for the other alternatives.
Since continuous operation reduces the number of dewatering units required, it also reduces building footprint, so capital costs were lower for continuous operation as shown in Table 8 compared to single-shift operation as shown in Table 7.

Overall, continuous operation levels the playing field in regard to total life cycle cost, so that all alternatives were within 10% of each other. Given the level of accuracy of the cost opinion, the 10-year life cycle costs for all alternatives are approximately equal.
5. RECOMMENDATIONS

Single Shift Operation

Based on information presented in Table 7 for single shift operation, centrifuges and FKC rotary screw presses are nearly equivalent on 10-year life cycle costs, given the margin of error of the planning level cost opinion. They appear to be the most economical choice for dewatering equipment for the Sunnyvale WWTP if single shift operation is preferred.

The additional power and chemical costs for the centrifuge alternative are offset somewhat by lower biosolids handling and disposal costs (primarily hauling costs) at today’s rates. Biosolids handling and disposal costs are the most probable cost category to increase at a rate higher than inflation. Therefore, a cost sensitivity analysis would likely show the centrifuge alternative in an even more favorable light, allowing for the future potential increase in biosolids handling and disposal costs.

Continuous Operation

Continuous operation could reduce capital cost by more than 25% and 10-year life cycle costs by more than 8%. Therefore, we recommend that Sunnyvale consider continuous operation.

It is recommended that Sunnyvale staff tour dewatering installations which have rotary screw presses, belt filter presses, and centrifuges, and visit with operators of these facilities in order to gather information regarding physical and operational requirements for the different technologies. Sunnyvale staff could gain an understanding and level of comfort with which equipment is most suited to continuous operation prior to final dewatering technology selection.
6. APPENDIX A: MANUFACTURERS INFORMATION
March 31, 2009

Proposal for 3 M model 3DP Belt Presses For Sunnyvale, CA WWTP

N Kelly Brown, Director
BDP Industries, Inc.
5 / 12 / 2008
The information provided indicates the belt press is being fed a blend of primary, algae and solids dredged from a lagoon. The ratio of the blend between the various sludge types is not indicated. Considering the following facts:

- influent concentration is 3%, unusually high for most municipal sludges,
- past pond cleaning operations generated 17.5% cake solids even though there was no primary sludge,

It is felt the projected sludge blend is going to dewater well. For “100% primary sludge” the expected performance is:

- Solids Loading: 2500lb/hr,m
- Polymer Dosage: 3 to 5lb/ton
- Discharge Cake Solids: 28% to 35%
- Solids Capture: +98%

For “100% algae sludge” expected performance is:

- Solids Loading: 300 to 400lb/hr,m
- Polymer Dosage: 10 to 15lb/ton
- Discharge Cake Solids: 12% to 14%
- Solids Capture: +98%

For “100% anaerobic pond dredge sludge” expected performance is:

- Solids Loading: 700 to 800lb/hr,m
- Polymer Dosage: 10 to 15lb/ton
Based on the above process parameters it is expected that a very conservative estimate of performance for a blend of the above materials would be:

- Solids Loading: 650lb/hr,m
- Polymer Dosage: 8 to 10 lb/ton
- Discharge Cake Solids: 18% to 22%
- Solids Capture: +98%

It is suggested that the installation be sized to handle the required 2013 year capacity in 7 hours of actual operation each 8 hour day, rather than 11 hours to eliminate overtime. This would mean a throughput capacity of 3,480lb/hr. Two (2) 3 meter model 3DP belt presses would have a capacity of 3,900lb/hr and is the company’s recommendation.

Table 1 below presents a material balance and utility requirements for each 3 meter unit.

Table 2 shows the assumptions made to calculate expected operating costs and Table 3 summarizes the expected operating costs. On an annual basis the expected operating costs are $209,000/yr or $66/ton.
Table 1, Material Balance and Utility Requirements

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<th>Belt Press Matl Balance, Utility Requirements</th>
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<tr>
<td>Recommended Design solid loading</td>
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<td>Expected Cake Discharge</td>
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<td>No of belt presses</td>
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<td>Actual Solid Loading Rate per belt press</td>
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<td>Polymer Dosage (Active)</td>
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<td>Polymer Emulsion Flow</td>
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<td>Polymer Dilution Flow (Dilute to 0.25%)</td>
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<td>Discharge Cake Flow</td>
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<td>Horsepower:</td>
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Table 2, Operating Cost Assumptions

Table 3, Expected Operating Costs
BDP Industries, Inc. is pleased to offer our quotation for two (2) 3 meter 3DP Belt Filter Presses and accessories. Also attached are General Arrangement drawings of the unit.

Below is a summary description of the scope.

**EQUIPMENT DESCRIPTION**

Two (2) 3meter BDP Model 3DP Belt Filter Presses equipped to dewater blend of primary and lagoon sludge. The 3DP equipment package includes complete presses and appurtenant equipment described as follows:

1. Two (2) 316L stainless steel polymer injection and polymer/sludge mixing system consisting of an injection ring, variable vortex mixer, and reducing fittings.
2. Two (2) 3.0 meter effective width model 3DP with the following design features:
a.) Hot-dipped galvanized tubular frame.
b.) Machined bearing pads.
c.) Up-flow, high solids feedbox with variable speed paddle wheel.
d.) 12ft long gravity zone providing 126ft² overall filtration area.
e.) Six (6) rows of adjustable, furrowing plows.
f.) Curved wedge section.
g.) Eight (8) s-wrap pressure section providing 180ft² effective filtration area.
h.) Nylon covered rollers.
i.) 316 stainless steel wetted parts.
j.) 316 stainless steel hardware
k.) Hydraulic tensioning and tracking.
l.) Composite cylinders with 316 stainless steel rod and hardware.
m.) Self-cleaning, adjustable angle belt showers.
n.) Dodge pillow block spherical split case housing bearings rated for 700,000 hours at 50 PLI.
o.) Nylon coated bearings with 316 stainless steel hardware.
p.) TEFC variable speed motors.
q.) PVC Coated Rigid Conduit.
r.) Separate 480 volt machine mounted junction box.
s.) Cake Conveyor Discharge Chute constructed of 316 stainless steel.

3. Two (2) 2 HP hydraulic unit with 20 gallon 304 stainless steel reservoir.

4. Two (2) Gould’s model 3565 centrifugal wash water booster pump with 15 hp TEFC motors.

5. Two (2) complete 316 stainless steel NEMA 4X electrical control panels, for all Belt Press control functions and drives including the polymer system, sludge pump, booster pump, hydraulic unit, and discharge conveyor. The panels shall be based on PLC controller.

6. Two (2) Fluid Dynamics Polymer make up and metering systems.

7. Start-up, mechanical checkout and operator training, a total of eight (8) days on site, two (2) trips to site.

8. Freight to job site.

Each model 3DP Belt Press will come completely factory-assembled, tested and will be shipped fully assembled. The polymer injection devices, hydraulic unit, belt media, booster pump, and electrical control panel will be packed separately. This quotation is for furnishing equipment only and does not include any other installation labor or field services other than checkout, start up and testing services as listed above. All installation, on-site assembly, anchorage, pads and other work required to facilitate the setting of the equipment is to be by others. All material and
labor for interconnecting between the press and the auxiliary equipment is to be completed by others.

**SUBMITTAL DATA**

Submittals will be made in the number of copies specified and will be available within 4 to 8 weeks after firm purchase order and all information is received at the factory.

**SHIPMENT**

Approximate shipping weight of belt press is 35,000lbs. The accessory items are estimated at 7,500pounds. Estimated fabrication time is 16 to 20 weeks after receipt of submittal approval.

**FIELD SERVICE**

Installation observation, testing and operator instruction services as specified will be supplied.

**PRICING**

Prices for the above equipment items are:

- Two (2) 3.0 meter Model 3DP Belt Press: $750,000
- Two (2) Control Panels: $30,000
- Two (2) In Line Polymer Sludge Mixers: $8,200
- Two (2) Gould manufacture Booster Pumps: $9,000
- Two (2) Fluid Dynamic manufacture polymer make up units: $31,000
- One (1) Lot of Field Service: $8,500
- Freight to Job Site: $20,000
- Total: $856,700

These prices include the shipping cost to Job Site. Prices do not include unloading cost and applicable taxes of any kind. This quotation will be valid for sixty (60) days from the date of this proposal.
TERMS
Terms of payment are 30% with order 60% upon presentation of shipping documents that the unit is ready to ship, and 10% upon issuing of the performance test report or the expiration of 3 months from shipment, whichever occurs first. The attached Conditions of Sale are hereby made a part of this proposal.
We appreciate this opportunity to extend our quotation and if we can answer questions or supply additional information, please do not hesitate to contact Alex Ambrosi, Aquadyn Associates.

Sincerely,

Kelly Brown
Director Sales and Marketing
BDP Industries, Inc.
cc:    AJ Schmidt, BDP Industries,

Goble Sampson Associates, Inc. (Young, Rob)
3500 South Main Street, Suite 200
Salt Lake City, Utah  84115
Bus: (801) 268-8790
Mobile: (801) 699-4148
Bus Fax: (801) 268-8792
E-mail: ryoung@goblesampson.com
3.0 METER MODEL 3DP
BELT FILTER PRESS

1 GENERAL

A. Except as otherwise specified, steel plates and shapes shall have a minimum thickness of ¼ " and bolts shall have a minimum diameter of ½ ". All welding shall be in accordance with the latest acceptable codes of the American Welding Society ANSI/AWS D1.1.

B. All material used in the construction of the sludge dewatering equipment shall be of the best quality and entirely suitable in every respect for the service required. All structural steel shall conform to the ASTM standard specification for structural steel, designation A36-77A. All iron casting shall conform to the ASTM standard specification for gray iron casting, designation A48-76, and shall be of a class suitable for the purpose intended. Other materials shall conform to ASTM specifications where such specifications exist; the use of such material shall be based on continuous and successful use under the similar conditions of service.

C. Unless otherwise specified herein, all metal parts in contact with polyelectrolyte or sludge shall be type 304 (316 stainless steel optional) stainless steel. All fasteners, pins, and anchor bolts shall be type 316 stainless steel.

D. All fiberglass-reinforced plastics (FRP) shall be manufactured in conformance with NBS standards PS15-69.

2 SURFACE PROTECTION

A. Ferrous metals shall be hot-dipped galvanized per the latest revision of ASTM A123 specification.

B. All pre-painted purchased equipment such as electrical motors, gear boxes, etc., are to be painted with a final coat of the following system.
1. First coat of Tnemec #104 epoxy of contrasting color to a minimum of four (4) dry mils thickness.

2. Apply a second coat of Tnemec #104, finished color, minimum of four (4) mils thickness. Total thickness of the two (2) coats will be a minimum of eight (8) mils dry.

C. All hydraulic cylinders are to be painted with a final coat of the above system.

D. The control panel enclosure shall be Nema 4 X constructed of type 304 (316 stainless steel optional) stainless steel. The inside of the control panel box shall be white.

3. **MECHANICAL DETAILS**

A. **Main Structural Frame**

1. The frame shall be fabricated from steel structural members (stainless steel is option) designed to adequately support all components and accessories. Steel shall meet the requirements of ASTM A36; all welding shall be performed in accordance with ANSI/AWS D1.1. Where frame components are bolted, stainless steel fasteners shall be used. The frame moment of inertia shall be a minimum of \(79.7\) in.\(^4\) in the xx axis and \(51.2\) in.\(^4\) in the yy axis.

2. The fabricated steel frame shall be designed to withstand the maximum stresses imposed on the individual members with a safety factor of 10. Specifically, the maximum actual stress on any member, connection, plate, etc., shall not exceed 1/10 of the yield strength of the frame material used. The deflection ratio of any structural member shall not exceed \(L/600\) where \(L\) is the member span. The tension used for the calculations shall be at least 50 lbs. per linear inch of actual belt width.

3. Drip pans shall be fabricated of a minimum 14-gauge type 304, (316 is an option) stainless steel and shall collect filtrate from all gravity and pressure sections.
4. The framework shall be constructed in such a manner that it will insure absolute plane parallelism of all rolling elements by machined bearing pads.

5. The framework shall be of welded and/or bolted construction. No disassembled component, excluding the belt filter frame, shall weigh more than 3500 lbs.

6. Provide adjustable leakage seals to contain the sludge on the belt through the gravity drainage zone. Seals shall be 304 (316 stainless steel optional) stainless steel with rubber skirts, designed to provide an effective seal without causing wear to the belt.

B. Flocculation/Conditioning/Distributor System

To achieve rapid contact between sludge particles and a solution of dilute polyelectrolyte, provide:

1. A static, in-line, adjustable energy non-clogging Venturi mixer shall be provided. The mixer shall be equipped with a Vortex polymer injection ring with four (4) tangentially mounted polymer injectors. The mixer shall be located upstream of the belt filter press. The belt filter press manufacturer shall recommend the proper layout of the system. The contractor shall provide spool pieces of the size and number shown on the drawings at alternate locations. The in-line Venturi mixer shall be fabricated of bronze fitted cast iron with an adjustable open throat area.

2. An inlet feed distributor shall be provided after the in-line venturi mixer, to condition the sludge, dissipate the feed pipe velocity, and evenly distribute the conditioned sludge over the full width of the moving filter belt. The feed distributor shall consist of an up-flow rectangular cross section conditioning tank that transitions from the feed pipe diameter at floor level to the full width of the filter belt at the gravity deck level with a minimum volume of 65 gallons per meter of belt width. This conditioning tank shall be vertically baffled and discharged into a stainless steel weir trough distributor. Inside the weir trough there will be a variable speed paddle wheel with six 4” wide rubber paddles driven by a 3/4 hp DC/SCR drive that will push the slurry over the weir trough on to the filter cloth. Tank and trough to be constructed of 304 (316 stainless steel optional) stainless steel, rubber blades are SBR material.

C. Independent Gravity Drainage Area
1. The press shall be furnished with an independent gravity zone. The drainage belt in this zone shall have a separate belt drive, tensioning and tracking to allow operation independent from the pressure zone. The belt system shall be sealed to prevent leakage and shall be easily accessible for operating, viewing, cleaning, and adjusting.

2. All materials in contact with the sludge in the distributor area shall be 304 (316 stainless steel optional) stainless steel with adjustable angle furrowing plows of UHMW plastic.

3. The gravity belt thickener shall have a minimum horizontal area of 118 ft². Plastic slide strips shall support the gravity drainage section. Supports shall be designed to prevent deflections greater than 0.05 inches with a loading of 100 lbs. per square foot. Slide strips shall be easily removable without disassembly of any components.

4. The belt support shall be a series of UHMW wear strips within a 304 (316 stainless steel optional) stainless frame. The strips shall be every 12" and be of a design to not only to provide support but also enhance gravity dewatering.

5. Provide adjustable leakage seals to contain the sludge on the belt through the gravity drainage zone. Seals shall be neoprene rubber with 304 (316 stainless steel optional) SS deckle supports, designed to provide an effective seal without causing wear to the belt.

6. Six (6) rows of swing up type furrowing plow devices shall be supplied in the gravity drainage section and shall be readily removable.

7. The adjustable plows shall be mounted on a support system that can be raised for cleaning via lifting handles.

8. Plows will be high-density polyethylene with hot dipped galvanized support holders. Plow position will be adjustable from 0 to 30 degrees with respect to the direction of belt travel. All plows will be adjustable in unison for each plow row. To facilitate cleaning, each row of plows will include a singe-lifting handle, designed to raise the entire row of plows at least six inches from the belt.
9. The independent gravity unit shall be equipped with a 5 hp variable speed VFD drive, powered and controlled from the main press panel.

10. The independent gravity section shall be provided with hydraulic tension and tracking system as specified in this specification. Manual tensioning or tracking systems will not be acceptable.

11. The gravity section provided shall be constructed at operator level for easy viewing and operation. For equipment with elevated gravity section, catwalks must be supplied on both sides of each machine. The platform height shall be such that the gravity deck of the belt filter press is easily visible and accessible. The platform shall be constructed such that its placement will not interfere with routine maintenance of the belt filter presses. All additional costs for foundation and anchor supports shall be at no extra cost to the customer. Handrails and vertical stairs shall be provided for the platform. Kick plates (toe plates) shall be provided which shall project a minimum of 4 inches above the walking surface. The platform and all supports shall be constructed of structural aluminum or Type 304 stainless steel and it shall be designed to carry a live load of 200 pounds per square foot not to exceed the working stresses for materials in 1990 BOCA Code. All walking surfaces shall be non-slip. Minimum platform width shall be 30 inches.

D. Wedge Section

1. The belt filter press shall be furnished with a distribution chute to receive sludge from the primary gravity dewatering section for purposes of even distribution of the sludge to the wedge section.

2. The wedge section shall be constructed to contain the sludge on the belts with adjustable sealed deckles. This area shall be easily accessible for operating, viewing, cleaning, and adjusting.

3. Movement through the wedge section shall be designed to insure a uniform layer of sludge across the entire working width of the belt. It further shall be adjustable to allow operator determination of proper relationship between belt speed and cake height, in order to insure optimum dewatering.

4. The materials in contact with the sludge shall be fabricated from type 304 (316 stainless steel optional) stainless steel. All fasteners, along with mounting and adjustment hardware shall be 316 stainless steel.
5. The upper and lower press section filter belts, while in the wedge section, shall be supported by construction equal to that of the gravity belt section except the profile will be curved, and shall be a minimum of 2" wider than the width of the belt and so designed to reduce belt wear.

6. Curvature of the wedge zone shall start with a radius of curvature of 24 inches and gradually reduce to a radius of curvature of 16 inches. This provides a gradual increase in applied cake pressure. Curvature also causes the belts to encapsulate the filter cake and eliminate cake extrusion. The wedge section shall have a minimum horizontal area of 60 ft². This calculation is based on contact area of filter cloth and cloth support contact area.

E. Vertical Pressure Zone

1. The vertical belt filter press shall have a minimum of eight (8) rolls with the first roll being perforated. Each roll in the pressure section must be wrapped a minimum of 220 degrees to maximize filter cloth to roll contact area, the effective filtration area, and time under pressure of the filter cake.

2. The first perforated roll shall be constructed of steel and hot-dipped galvanized coated. Construction must provide means for eliminating pooling of filtrate in the bottom of the roll that can re-wet the filter cake. It shall be a minimum 30 in diameter, followed by a 16 in. diameter.

3. The next stage of the pressure zone shall consist of an arrangement of a minimum of five (5) rollers developing a continued 200° S-shaped belt travel. The rolls shall decrease from 12 in diameter to 10 in diameter.

4. The decreasing roll diameter is to provide an increasing pressure profile in the pressure zone, made adjustable by changing the belt tension.

5. The final or eighth roll in the pressure section shall be a 10 in. diameter drive roll forming the last 200° turn.

6. The minimum journal size in the press section shall be 3 15/16 in diameter and the
ends of each shaft on the rollers shall be equipped with support bearings as specified under bearings.

7. The pressure section shall have a minimum area of 180 ft². This calculation is based on belt to roll surface contact area.

8. The vertical pressure zone configuration shall include a tray beneath each roll such that the filtrate is removed from the sludge cake without rewetting of the downstream cake. Each drip pan shall be directed to a final collection pan and piped to the sump area. The collection pans must eliminate filtrate from landing on the filter belt.

F. Dewatering Belts

1. Belts shall be seamed and fabricated of monofilament polyester, wear resistant plastic material or combination monofilament polyester and stainless steel material. The mesh design shall be selected for optimum dewatering of the sludge to be processed with a minimum blinding of the filter fabric.

2. Belt selection shall be based on the manufacturer's experience obtained at other installations dewatering similar sludge with similar polyelectrolyte conditioning chemicals.

3. The belts shall be warranted for 2,000 hours operation. Any belt that fails before that time, provided that the belt press has been operated per the instructions in the operation and maintenance manual, will be replaced on a pro rata basis.

4. Each belt and connecting splice shall be designed for a minimum tensile strength equal to five times the normal maximum dynamic tension to which the belt shall be subjected. The splice shall be designed to fail before the belt.

5. Belt shall be designed for ease of replacement with a minimum of belt filter downtime. Belt replacement shall be such that disassembly is not required.

G. Belt Wash System

1. A belt wash station shall wash each filter belt. The belt wash system shall use high-
pressure water spray nozzles equipped with manually operated wire brushes for internal nozzle cleaning. The spray assembly shall be housed in an enclosure in a manner that limits the spray pattern within the housing assembly. The housing and nozzle assembly shall be readily removable. The housing shall be fabricated from type 304 (316 stainless steel optional) stainless steel.

2. The housing shall be sealed against the belt with rubber seals. The belt shall be protected from excessive wear by the edges of the wash station housing by replaceable guide surfaces. The belt wash station shall extend over the full width of the filter belt by a minimum of 2 inches.

3. Wash water required shall not exceed 142 gpm at 120 psig. The manufacturer shall provide a complete pressure boosting system for the press to achieve the above.

4. Each shower header shall be supplied through a globe valve for throttling.

H. Belt Aligning System

1. The belt aligning devices shall be hydraulically operated to align each belt and locate it centrally on the rollers by means of a sensing arm, which detects the position of the belt edge. This arm shall operate a pilot valve, which in turn affects the position of the hydraulic actuator. The actuator shall be connected to a pivoting belt aligning roller, causing this roller to skew from its traverse position.

2. The alignment system shall function as a continuous automatic belt guidance system and shall be an integral part of the press. The alignment system shall operate with smooth and slow motions resulting in a minimum of belt travel from side to side.

3. Backup limit switches for the belt aligning system shall be provided on the machine with sufficient contacts to de-energize all drives and sound an alarm in case of a belt over travel.

4. All hydraulic lines shall be 316 stainless steel and be rigidly supported on the structural frame and be properly sized for the intended use with adequate factors of safety for the rated pressure.

5. All belt alignment control equipment shall be fabricated from corrosion resistant materials or effectively coated not to rust or stain.
I. Belt Tensioning System

1. Each belt shall be provided with a belt tensioning system. The belt tensioning system shall be hydraulically actuated. The design of the tensioning system shall be such that the dewatering pressure is directly proportional to belt tension and that adjustments in the tension shall result in immediate changes in dewatering pressure. Manual or electric servo-tensioning systems are not acceptable.

2. Each belt tensioning shall be furnished with an individual control station such that independent adjustment for each belt is possible. The control stations shall incorporate an on/off selector, calibrated pressure regulating valve and a pressure gauge to indicate actual operating pressure on each system.

3. The design of the belt tensioning system shall insure parallel movement of the tensioning cylinders. The tensioning roller shall be mounted on a rugged yoke assembly, with hydraulic cylinders at each end. The belt tensioning system shall accommodate a minimum of 2.5% increase in belt length.

4. Sensing devices shall be furnished to determine belt travel beyond normal operating limits. The sensing devices shall be electrically connected within the alarm system to cause "an alarm shut down". Manual reset shall be required.

J. Press Drives

1. The two belt drives shall be 5 and 10 HP respectively for the gravity and press sections. Each shall be variable speed with a variable frequency AC drive unit. The feedbox distributor shall be driven by a 3/4 hp DC/SCR TEFC motor. Speed indicator readout for each shall be installed in the main press control panel.

2. The gravity belt drive shall be capable of varying output speed from 8 to 75 feet per minute and the press section drive, 3 to 25 ft. per minute.

3. The nominal input horsepower rating of each gear or speed reducer shall be at least
equal to the nameplate horsepower of the drive motor. Each drive unit shall be
designed for 24-hour continuous service.

4. Each gear reducer shall be totally enclosed, water spray proof, oil lubricated with
anti-friction bearings throughout. All motors shall be TEFC.

5. The drives shall be furnished with provisions for use on 480 volt, 60 hertz, and 3-
phase power supply.

6. A single roller shall drive the belt drive for the pressure section. The gearbox shall be
shaft mounted. Spur gears or chain driven rollers shall not be acceptable.

K. Safety Guards

All equipment having exposed moving parts such as fans, V-belts, gears, couplings,
chains, and including the pressure roll section, shall be provided with safety guards as
required by OSHA standards.

L. Discharge Blades

1. Discharge blades shall be provided to scrape dewatered sludge from the belt at the
final discharge rollers. The doctor blade shall be made of wear resistant UHMW
plastic. The blades shall be readily removable. The blade holders shall be secured in
place by means of counterweights. Spring tension type fasteners are not acceptable.

2. The minimum discharge height shall be 6’6” high. If necessary, the belt presses and
catwalks shall be supplied with additional support legs by the press manufacturer.

M. Bearings
1. The shafts of all rollers shall be equipped with heavy-duty grease able type, self-aligning ball or roller bearings in triple lip sealed, splash proof housings. All bearings in the press section shall be spherical roller bearings. The housings shall allow the changing of the bearings without changes in the factory alignment of the roller. The housing shall be sealed to provide adequate sealing from moisture and grime. The outside of the housing on roller bearings shall also incorporate a sealed end cap.

2. All bearings shall have a minimum B-10 bearing life of 500,000 hours based on ANSI-B13.6-1972. The B-10 bearing life of 500,000 hours shall be based on the maximum summation of all forces applied to the bearing and a belt speed of 15ft/min.

3. Bearings and housings shall be US manufactured and shall be manufactured by FMC Corporation, Link-Belt Division, Indianapolis, Indiana; Reliance Electric Company, Dodge Division, Greenville, South Carolina; or equal.

N. Rollers

1. All rollers shall be of solid steel or double-separated plate stub end shaft construction. The stub end shafts and roller heads shall be welded in place. Bolted and or through shaft roll construction is unacceptable. All rollers shall be designed to have a maximum deflection of 0.05 inches at their center when under maximum loading.

2. All rollers except drive and tracking rolls, shall be of carbon steel construction, coated with a minimum of 30 mils of thermoplastic nylon, selected for intended service. Drive, and tracking shall incorporate 50 mils of thermoplastic nylon with a 65 durometer surface or 3/8” vulcanized rubber for abrasion resistance and proper belt tracking and drive. Other types of roller coatings shall not be acceptable.

O. Drainage Pans

Drainage pans shall be supplied as necessary to contain all filtrate and wash water within the belt filter press and to reduce rewetting of down stream cake. Filtrate and wash water pans shall be constructed of minimum 14-gauge type 304 (316 stainless steel optional) stainless steel. All drainage piping shall be furnished adequately sized for the intended service and rigidly attached to the press frame.

P. Hydraulic Power Unit for Tensioning/Tracking
A complete simplex hydraulic system shall be provided. This package shall include adjustable pressure, adjustable flow pump, 2 hp TEFC motor, valves, 20 gallon storage reservoir, all controls and piping as necessary to provide a complete and operating system. The unit shall include a low-pressure switch, relief valve, temperature gauge, and tank level gauge. The system shall include the necessary pressure and return filters. The hydraulic unit will be floor mounted away from the press to eliminate wash down spray. The power unit shall be mounted on a 12” high 304 stainless steel support stand to elevate the unit off the floor to facilitate oil draining and reduce corrosion.

4 ELECTRICAL

A. General Requirements

1. The belt filter press shall be provided with a local full operating panel complete with all motor control and supervisory devices for press-mounted equipment. The panel shall also include such ancillary drives as hereafter specified. The panel shall be designed to interface with main control power and other plant control provided by others. All electrical work shall be performed in accordance with applicable local and national electric codes.

2. Three phases, 480 volt, 60-Hertz power shall be supplied to the main control panel.

3. A control transformer will be provided in the control panel to provide a 120-volt, single phase power source for motor starter coils, lights, relays, timers, controllers, local operating panel and other related items.

4. The local control panel shall be provided with terminal blocks for power wiring to and from the panel. The incoming terminal blocks shall be provided with a single magnetic circuit breaker disconnect switch. Fuse protected motor starters with thermal overloads shall be supplied for each motor furnished with the press.

5. All electrical equipment controls located on the belt filter press shall have NEMA 4X enclosures and wired, through PVC conduit, to a single common NEMA 4X terminal box.

6. All devices within the panel shall be permanently identified. Nameplates shall be provided on the face of the panel or on the individual devices as required.
Nameplates shall be made of laminated phenolic materials with a white face and a black core.

7. The panel shall be designed for manual starting and stopping of all drives. A master run-jog switch shall be supplied to override the alarm system and allow operation of any drive through a momentary contact push button.

8. All drive stations shall be equipped with a start/stop switch and run light. The main press drive and gravity belt drive drives as herewith specified, shall also incorporate a variable speed potentiometer and speed indicator.

9. Alarm lights, sensors, and related circuitry shall be provided for the following functions: belt misalignment, high and low belt tension, emergency trip cord on each side of the press, and low hydraulic pressure. In the event of any of the above malfunctions, the machine will shut down and an alarm will sound. The alarm system shall include an audible horn rated at 90 DBA at 10'. The system shall include silencing provisions, but the function alarm indicating light shall remain lit until the alarm condition is satisfied. A separate set of alarm contacts shall be provided for remote alarm indication and for interruption of ancillary drives such as polymer and feed sludge pumping.

10. Additional controls shall be provided for auxiliary equipment. This shall include start/stop pushbuttons, run lights, and motor starters for the booster pump, hydraulic unit, and conveyor system. Start/stop pushbuttons, run lights, potentiometer, 4 to 20 signal generators, and speed indication meters shall be provided for the sludge pumps and polymer pumps. The variable frequency drives the sludge shall be shipped loose and installed in the customers MCC room. The polymer pump DC drive shall be mounted in the polymer control panel. The press panel shall include a start/stop, potentiometer and local/remote controls for the polymer system.

B. Electric Motors furnished with this equipment shall meet the following requirements:

1. Rated for continuous duty at 40°C ambient and insulated with a minimum of Class F insulation, with Class B temperature rise. All motors shall be totally enclosed, fan cooled or non-ventilated. All motors supplied shall be rated at 150% nameplate horsepower of the required horsepower maximum service condition.
5 INSTALLATION

A. The manufacturer can provide the services of a qualified factory representative to advise the installing contractor on proper installation, setting, piping, and wiring procedures. It is recommended that one day of on site service be included in the purchase order.

5.01 OPERATION MANUALS

A. Three (3) copies of operation and maintenance manuals shall be furnished. The manuals shall be prepared specifically for this installation and shall include detailed operating and maintenance instructions and specifications relative to the following; assembly, alignment, checking, lubrication, placing in operation, adjustment, maintenance of each unit of equipment, auxiliaries furnished under this contract, together with complete parts lists, and copies of dimension drawings.

5.02 MECHANICAL DETAILS

A. Before the equipment is started, the manufacturer shall make a thorough inspection of the installation to make sure the press has been installed properly and that all equipment relating to it has been installed according to the needs of the press. A recommended start-up service is 3 days of on-site service.

B. The manufacturer will provide the services of a qualified factory representative to place the units in operation. The owner shall assist the manufacturer by starting up and operating all support systems such as water, sludge pumping, polymer mixing and feed, electrical power and instrumentation, and other ancillary equipment as needed. The services provided by the manufacturer shall be as detailed in the O&M manuals and shall include at a minimum the following:

1. Check equipment alignment and assure that there are no unusual internal stresses.

2. Calibrate all instrumentation such as hydraulic systems.
3. Check hydraulic systems to insure proper operation.
4. Check lubrication in all drives.
5. Adjust all edge seals, discharge scraper blades, drive chains, etc.
6. Adjust spray wash, cloth tension, and belt aligning system.
7. Start the drives and assure they are operating properly with no binding and with correct rotation.
8. Insure that all ancillary systems have been properly adjusted, including polymer and sludge feed.

C. Start-up services shall be considered completed when the manufacturer and contractor have demonstrated that the units are operating without mechanical problems.

5.03 TRAINING

A. During the start up procedures, the equipment manufacturer shall provide training to the owner's employees for proper operation and maintenance of the sludge dewatering equipment.
Technical Data
Decanter UCD 536
Equipped with standard gear drive
Operating principles and constructional features

Decanter type UCD 536 with gravity discharge of the clarified liquid and 2-gear drive

A Drying zone
B Clarifying zone

1 Main motor
2 Bowl drive
3 Secondary gear
4 Scroll drive
5 Secondary motor
6 Bowl bearings
7 Primary gear
8 Scroll bearings
9 Solids discharge
10 Bowl
11 Separation chamber
12 Distributor
13 Oil cooler
14 Oil lubrication unit
15 Scroll
16 Scroll bearings
17 Centrate discharge
18 Bowl bearings
19 Housing
20 Feed tube
21 Regulating ring
22 Feed
The Westfalia Separator UCD 536 decanter centrifuge is a continuously operating horizontal solid wall bowl centrifuge for maximum dewatering requirements of municipal and industrial waste water sludge. The frame is of open design with either gravity or pressure discharge of the clarified phase.

Materials

All parts coming into contact with the product are made of CrNiMo stainless steel. All gaskets coming into contact with the product are made of NBR (Perbunan). The machine is coated in Seevenax RAL 6011 green, a synthetic resin paint.

Housing

The housing consists of a welded frame with feet, motor bracket, guards and catcher of stainless steel grade 1.4401 for the product discharge.

Vibration dampers between housing and foundation frame prevent largely the transfer of vibrations and are included in the scope of supply.

Bowl and scroll

The decanter is equipped with a flat angle cone bowl with grooves in cylinder and cone. The solids discharge is equipped with exchangeable bushes made out of tempered cast iron for protection against wear and tear. The conveyor scroll is of single-thread design.

Drive

The decanter bowl is driven by a standard 3-phase AC motor designed for controlled torque starting in a star delta circuit. Power transmission is via V-belts.

For the decanter type with standard gear drive the motor drives the bowl and scroll with only one gear.

Equipped with a 2-gear drive system the differential speed is adjusted automatically, which ensures constant solids drying in case of fluctuating feed concentration and product volumes. The differential speed is analogue controlled for the solids loading as soon as a preset threshold value is exceeded. The differential speed adjustment could be necessary to react to a change in torque depending on the control gradient.

The following adjustments are possible:

- basic differential speed
- beginning of control (threshold value = torque at which control begins)
- control gradient (differential speed change as a function of the current and hence of the torque)

Protected by power consumption limit with 2 switching values and thus torque limitation.

Stage 1: stops product feed into the decanter
Stage 2: stops the main motor of the decanter to enable the bowl to empty during slowing down of the machine

The main and secondary motor are installed between the feet of the frame for space savings.

Piping connections

The product supply line is provided with a DN 80 feed tube according to DIN 2633. Polymer feed line size DN 25 is connected directly on the feed tube.
Technical data
Decanter type UCD 536

Technical data

<table>
<thead>
<tr>
<th>Component</th>
<th>Standard</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bowl diameter</td>
<td>530 mm</td>
<td></td>
</tr>
<tr>
<td>L/D</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>3600 rpm</td>
<td></td>
</tr>
<tr>
<td>g-Force, (z)</td>
<td>3839 g</td>
<td></td>
</tr>
<tr>
<td>Motor rating</td>
<td>75 kW</td>
<td></td>
</tr>
<tr>
<td>Speed at 50 Hz</td>
<td>1500 rpm</td>
<td></td>
</tr>
<tr>
<td>Speed at 60 Hz</td>
<td>1800 rpm</td>
<td></td>
</tr>
<tr>
<td>Comparative capacity</td>
<td>max. 75 m³/h</td>
<td></td>
</tr>
</tbody>
</table>

Dimensions in mm

Application
Dewatering and thickening of municipal and industrial waste water sludge.

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Take the Best – Separate the Rest
A company of mg technologies group

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FKC Class A System
Simultaneous Dewatering & Pasteurization

APPLICATIONS
- Municipal WWTP Sludges of All Types (Aerobically Digested, Anaerobically Digested, Raw)
- Primary, Secondary, or Mixed Sludges
- Industrial Biosolids
- Septage

FEATURES OF THE FKC CLASS A SYSTEM
- Single process to both dewater and produce Class A biosolids.
- Uses significantly less lime than competing Class A technologies using lime
- Produces a homogenous, dry product resembling soil
- Low capital and operational costs
- Simple, Unattended Operation

FKC Class A System operating at Sequim, WA
Produces 35-40% solids on waste activated sludge

Dewatered and Pasteurized Biosolids from Sequim, WA FKC Class A Installation
First lime is added to liquid biosolids to raise the pH to 12 to meet EPA vector attraction reduction requirements. The lime treated biosolids are then flocculated with polymer, prethickened in an FKC rotary screen thickener, and then fed to a steam heated FKC screw press. Inside the screw press the biosolids are dewatered and heated to meet EPA pathogen reduction requirements. Screw press outlet consistencies are usually 30 to 50% dry solids.