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Memo

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Date: March 21, 2019

Subject: SWMU 15 Groundwater Treatability Study
NIPSCO Bailly Generating Station

1.0 Introduction

Beginning in 2005, a Resource Conservation and Recovery Act (RCRA) Facility Investigation was implemented at the Bailly Generating Station, located at 246 Bailly Station Road in Chesterton, IN. The RCRA investigation identified three areas A, B and C. Area C includes Solid Waste Management Unit (SWMU) 15 (**Figure 1**), a low-lying area that was backfilled with coal combustion residuals (CCR), primarily fly ash. Placement of CCR at SWMU 15 ceased in 1979, and the area was covered.

A Draft Area C Corrective Measures Study (CMS) Report was issued in August 2015 (Amec Foster Wheeler, 2015), which recommended encapsulation of the CCR at SWMU 15. In response to EPA comments dated December 3, 2015, a Revised Draft Area C CMS Report was filed on March 18, 2016 (Amec Foster Wheeler, 2016). The revised report kept encapsulation as the recommended corrective measure for SWMU 15, comprised of a perimeter slurry wall installed to the underlying confining clay layer where present and an engineered, impermeable cover. To further evaluate the corrective measure options, a geotechnical investigation was completed in July, August and September 2016. Findings from that investigation were documented in a memo to EPA dated January 23, 2017 (Amec Foster Wheeler, 2017a). In the conclusions of that memo Northern Indiana Public Service Company (NIPSCO) proposed to revise the conceptual designs and associated cost estimates in a separate memo to EPA for: (1) encapsulation, (2) full excavation for off-site disposal, and (3) partial excavation for off-site disposal with in situ stabilization and solidification (ISS) of CCR left below the water table. Revised costs were presented in a memo dated June 2, 2017 (Amec Foster Wheeler, 2017b). As detailed in the Revised Recommendation section of that memo, based on the geotechnical investigation findings and the cost re-evaluation, NIPSCO changed its prior recommendation of encapsulation to partial excavation with ISS for SWMU 15.

To finalize the CMS report, updated costs for each of the Corrective Measures Alternatives (CMAs) must be prepared, including those CMA's that require treatment of water generated as part of the alternative. Total excavation (CMA #1) and encapsulation (CMA #6) require groundwater treatment during implementation of CMA #1 (short-term) or for the life of the O&M period for CMA #6 (long-term). The first two submittals of the CMS Report (Draft and Revised Draft CMS Report, Amec Foster Wheeler, 2015 and 2016) included estimates of the cost to treat water generated during the corrective action; however, these costs were not based on treatability testing conducted on site water. Although neither of these two options is currently being recommended by NIPSCO as the selected remedy for the site, the costs for the water treatment component of these CMAs is a significant proportion of the overall costs and require updates. Additional treatability study work has been completed to further evaluate both Ion Exchange (IX) and Reverse Osmosis (RO). The results of treatability studies were completed to support the overall cost development and comparative analysis for CMA #1 and #6. This memo presents the technology evaluation, treatability studies, and cost estimate development for IX and RO options for treating groundwater generated in the course of implementation and O&M of CMA #1 and #6, respectively.

2.0 Groundwater Sampling, Likely Discharge Standards, and Design Basis

Groundwater sampling was conducted to support the boron-driven, bench-scale studies for groundwater treatment technologies and to evaluate options for discharge of extracted groundwater to either surface water pursuant to an NPDES permit or a publicly-owned treatment works (POTW). Two rounds of groundwater sampling were conducted in March and May 2017. The initial round of sampling was conducted to provide up-to-date characterization data for wells representing the quality of extracted groundwater to be treated during remediation and to provide water quality data necessary to evaluate IX and RO. The wells sampled included MW-119 and MW-125 (both screened in CCR) and MW-124 (located immediately downgradient of SWMU 15). The parameter list analyzed for the two sampling events was expanded relative to the standard parameter list for the site. The purposes of the expanded parameter list and the related parameters included the following:

- NPDES discharge application, routine compliance monitoring (metals, ammonia)
- Potential for fouling IX and RO (calcium, magnesium, and manganese)
- Biomonitoring (selenium)
- Compliance and control, scaling and fouling (pH, specific conductivity, TDS)
- Compliance and potential to form precipitates with calcium (sulfate)
- Compliance, potential NPDES permit parameters, establish levels of filtration required for IX and RO (ammonia, nitrite, nitrate, phosphorous, sulfide, total organic carbon, total phosphate, total suspended solids, alkalinity)
- Compliance, potential NPDES permit (chemical oxygen demand, biological oxygen demand, volatile organic compounds, semi-volatile organic compounds)
- Potential for scaling of the RO membranes (silica and strontium)
- Potential for scaling of RO membranes (alkalinity)

The first sampling event was conducted on March 28, 2017. Samples were analyzed for the following:

- metals: Al, As, Bo, Cd, Ca, Cr, Cu, Fe, Pb, Mg, Mn, Hg, Mo, K, Se, Ag, Na, and Zn via EPA Methods 200.7, 245.1

- pH – Standard Method SM 4500-H+
- specific conductivity – EPA Method 120.1
- sulfate – EPA 300
- Ammonia – EPA Method 350.1
- Nitrite and nitrate – EPA Method 353.2
- Phosphorus – Standard Method 4500-P.E.
- Sulfide – Standard Method SM 4500-S2-F
- total organic carbon – SM 5310C
- total suspended solids – Standard Method 2540D

The second round of groundwater sampling was conducted on May 3, 2017. On that date, groundwater was collected from the same three wells and analyzed for the same parameters as listed above. All three wells were also analyzed for the following parameters for NPDES permit evaluation and treatability purposes:

- Total metals (silica and strontium); EPA Method 200.7
- Alkalinity – EPA Method 310.2

Samples collected from MW-119 (only) in May 2017 were also analyzed for:

- Chemical Oxygen Demand – EPA Method 410.4
- Biological Oxygen Demand – Standard Method 5210B
- Volatile Organic Compounds – EPA Method 624
- Semi-Volatile Organic Compounds – EPA Method 625

During the May 2017 sampling event an additional three gallons of groundwater were collected from each of the three wells and shipped to Dow Chemical Company (DOW) for an IX bench-scale study of boron treatment. Validated results for the samples submitted to TestAmerica from the March and May 2017 groundwater sampling events were included in Attachment A to Quarterly Progress Report 17-02, dated July 12, 2017 (Amec Foster Wheeler, 2017c). The DOW treatability study results are discussed herein.

2.1 Results of Initial Groundwater Sampling and Design Basis

Table 1 provides the results for the groundwater sampling analyses conducted for the March and May 2017 rounds. **Table 1** also includes the average concentrations of each constituent for the two rounds of sampling. **Table 2** summarizes the average concentrations for the March 2017 event and the design basis concentration used in the treatability evaluations and cost estimates. The design basis concentrations were developed by calculating a weighted average of the March 2017 event and previous sampling events at the same wells plus two additional downgradient IDNL wells.

2.2 Permitted Levels for Direct Discharge

Wood researched the relevant standards for direct discharge of treated groundwater to either Lake Michigan, a nearby POTW (Burns Harbor), or the wetland adjacent to SWMU15. **Table 3** is a summary of

the pollutants, their expected discharge concentrations allowed under a NPDES permit, and the probable pre-treatment limits allowed under 40 CFR Part 403 (Categorical Limits) and Local Limits (set by the POTW). Actual standards for direct discharge would be based on the Great Lakes Initiative (GLI) database.

3.0 Corrective Measures Alternatives

Wood presented various CMA's in the Draft CMS Report including two remedial alternatives that would require the treatment of groundwater either during remedial construction activities or during the long-term O&M of the alternative. The two alternatives include the following:

- CMA #1, where the CCR material would be excavated from both above and below the water table and removed for off-site disposal. Treatment of collected dewatering fluids (extracted groundwater, rainfall/run-on, and drainage from excavated materials) is limited to a 1- to 2-year period where dewatering fluids would require treatment at a rate of approximately 100 gallons per minute (gpm). This flow rate was developed for and presented in the Draft CMS Report (Amec Foster Wheeler, 2016). For purposes of this analysis, a period of two 6-month operating periods over 2 years has been assumed.
- CMA #6, where the CCR material would be encapsulated in place by installing a slurry wall around the CCR with an impermeable cap over the residuals. The groundwater to be treated in this case would be at a much lower flow rate based upon the likely leakage through the slurry wall and upwelling of groundwater into the encapsulated CCR. A flow rate of 5-10 gpm, operating 12 months per year over a 30-year period has been assumed for purposes of this analysis. This flow rate was developed for and presented in the Revised Draft CMS Report (Amec Foster Wheeler, 2016).

For each CMA, given the need to reduce boron and other constituent concentrations, two technologies were identified for treatment of groundwater and dewatering fluids during excavation of CCR or groundwater extracted from the encapsulated CCR, including:

- Option A: IX Treatment
- Option B: RO Treatment

3.1.1 Ion Exchange

IX is a unit process in which ions of a given species are removed from solution and replaced with other similarly charged ions. IX has been used successfully in wastewater applications for the removal of heavy metals and dissolved solids and can be operated in a batch or continuous mode. In a batch process, the resin containing the ions that will replace the ions in the wastewater is stirred with the water that needs treatment until the reaction is complete. The spent resin is removed by settling and is then regenerated for further usage. In a continuous process, the exchange material is placed in a bed or packed column, and the water to be treated is passed through it. Continuous IX processes are usually of the down-flow and packed-bed column type. When the resin capacity is exhausted, it is then regenerated. Important properties of this technology include IX capacity, particle size, and stability. IX capacity is defined as the quantity of exchangeable ions that can be taken up.

Different types of synthetic IX resin in use include strong- and weak-acid cation resins, strong- and weak-base anion resins, and heavy metal selective chelating resins.

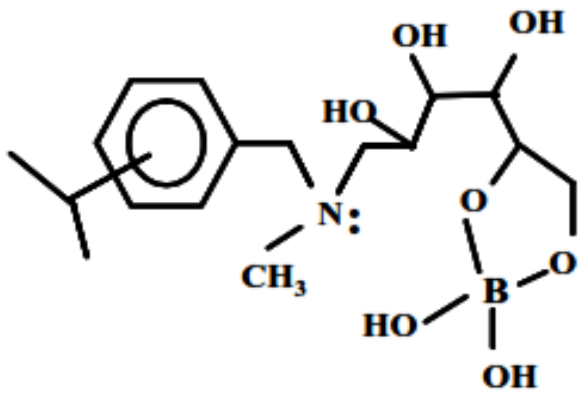
- In a cation exchange process, positively charged ions present in the water are replaced with positively charged ions available on the resin surface (typically sodium). The calcium reaction, as a typical cation exchange process, is shown below:

  $2Na^{+}R^{-} + Ca^{2+} \leftrightarrow Ca^{2+}R_2^{-} + 2Na^{+}$ (R: cation exchange resin)

- In an anion exchange process, negatively charged ions present in the water are exchanged for hydroxide ions from the surface of the resin. An example of typical anion exchange is shown below:

  $R^{+}OH^{-} + HCl \leftrightarrow R^{+}Cl^{-} + H_2O$ (R: anion exchange resin)

- Metal selective chelating resin behaves like weak acid-cation resins but exhibits a high degree of selectivity for heavy metal cations. For example, synthesized resins with N-methyl-D-glucamine (NMDG) functional groups can remove boron. The principle for the boron removal is the complexation reaction between boron and the NMDG functional group. It should be noted that the NMDG functional group consists of a tertiary amine and five hydroxyl groups; the complexation reaction happens between a hydroxyl group and boron.
- Boron selective resin (BSR) is a weakly basic anion exchange resin having an N-methyl-D-glucamine functional group that is selective for boron via chelation. This chemistry is based on the cis-diol group, which will bind the boron in a five-member borate ester ring complex as illustrated in the figure below depicting DOW's styrenic BSRs.



The resulting boron complex is fairly stable and can bind and hold boron at very low concentrations, even in the presence of other ions. The complex can be broken, and the resin regenerated by displacing the borate with either hydrochloric (HCl) or sulfuric (H_2SO4) acid, followed by a water rinse and then converting the resin back to the free base form by washing with sodium hydroxide (NaOH). The final step in the regeneration process is water washing to an application appropriate pH. The resin is regenerable and can be applied in a process for several hundred process cycles depending upon the quality of the incoming feed waters.

Backwash from resin regeneration and spent resin will require off-site disposal at appropriate facilities including deep well injection and landfill disposal in accordance with the permit requirements of the receiving facilities.

DOW selected DOWEX Marathon A, Marathon C, AMBERSEP™ GT74, and Adsorbia As600 resins for evaluation in the treatability study. Some of these resins were selected based on their potential to remove boron in a water high in Ca and Mg. Others are used by DOW for treatment of water generated in oil and gas production that contain boron. These resins have the following properties/purposes:

- Marathon A – strong base anion exchange resin, for potable and industrial demineralization applications.
- Marathon C – strong acid cation exchange resin, for softening and demineralization applications.
- Adsorbia As600 – selective media for oxyanions such as arsenate, chromate, and selenite, potable water applications.
- AMBERSEP™ GT74 – a weakly acidic cation exchange chelating resin for calcium removal with selectivity for certain metals such as mercury, rhodium, copper, silver, cadmium, and lead.

DOW evaluated IX by conducting isotherm studies using groundwater collected from MW-119 in May 2017, the well screened in CCR with the highest in boron concentration. DOW detected boron in the pre-treated groundwater at a concentration of 950 micrograms per liter (ug/L) as measured in the blank sample included with the test sequences. The DOW study showed:

- Marathon A was successful in boron removal at of doses 1.0 and 10 g resin per 50 mL of site water, producing effluent of 280 and 190 ug/L boron, respectively, which are both below the 500 ug/L NDPDES discharge limit.
- Marathon A at a dose of 0.1 g resin per 50 mL site water was not successful at achieving the NPDES standard of 500 ug/L boron, with a resulting concentration of 580 ug/L boron.
- Marathon C at a dose of 10 g resin per 50 mL site water resulted in a concentration of 460 ug/L boron, achieving the NPDES standard of 500 ug/L boron. Other doses of Marathon C did not achieve the NPDES standard.
- Adsorbia As600 and AMBERSEP™ GT74 did not achieve the NPDES standard at any of the three doses.
- The boron concentration of the water from MW-119 that was tested as a control for the resin study was much lower (950 ug/L) than the results obtained from samples analyzed by TestAmerica (12,000 and 13,000 ug/L collected from MW-119 during the March and May 2017 rounds, respectively). Both labs used the same analytical method – EPA 6010B. These initial concentrations affect the usage of resins and therefore costs. The lower initial concentration could be the result of precipitates forming due to the high concentrations of calcium and magnesium in the water, which also cause difficulties with boron removal via IX. A sensitivity analysis was prepared to highlight the potential for varying resin use depending on variations in influent boron concentrations. The following table shows the varying projected resin use based on different influent Boron concentrations. Note that a concentration of 7,580 ug/L boron was used as the design basis.

PROJECTED RESIN USE VS INFLUENT CONCENTRATION OF BORON, FLOW =100 GPM			
Influent, ug/L	**Effluent, ug/L**	**Boron removed, lbs/day**	**Resin used, lbs/year**
12,000	250	14.1	7,681
10,000	250	11.7	6,374
8,000	250	9.3	5,066
6,000	250	6.9	3,759
4,000	250	4.5	2,451
2,000	250	2.1	1,144
1,000	250	0.9	490
500	250	0.3	163
Projected Resin Use vs Influent Concentration of Boron, Flow =10 gpm			
Influent, ug/L	**Effluent, ug/L**	**Boron removed, lbs/day**	**Resin used, lbs/year**
12,000	250	1.4	768
10,000	250	1.2	637
8,000	250	0.9	507
6,000	250	0.7	376
4,000	250	0.5	245
2,000	250	0.2	114
1,000	250	0.1	49
500	250	0.0	16

These estimates include resins that can no longer be cleaned through regeneration.

Dow characterized the results as disappointing and cautioned that further studies may be required to improve reliability and concluded that the site water is not a good candidate for IX. They cited that high concentrations of calcium and magnesium resulted in inhibition of boron exchange.

3.1.2 Reverse Osmosis

RO is a pressure-driven separation technology in which the separation occurs through a permeable membrane, allowing the water molecules to permeate through the membrane while retaining the ions. A different chemical potential will exist across the membrane when two solutions having different solute concentrations are separated by a semipermeable membrane. Water will tend to diffuse through the membrane from the lower concentration (lower potential) side to higher concentration side (higher potential), and over time the two sides will approach equilibrium concentrations. The balancing pressure difference between the two sides is termed osmotic pressure. If a pressure gradient opposite in direction and greater than the osmotic pressure is applied across the membrane, flow from the more concentrated to the less concentrated region will occur. Based on Wood's expertise in RO technology; 95% removal efficiency of the ions is predicted. Also, as the boron is of greatest concern among the different constituents within the recovered groundwater, scientific literature was reviewed to evaluate the operating conditions that can maximize the boron removal efficiency. For example, it has been shown that boron precipitation (in this case with calcium) is increased when the pH is higher; therefore, pH must be adjusted. In this scenario (high pH), boron will precipitate and foul the RO membranes with scaling rather than stay in solution and be removed by the membrane.

RO simulation modeling was performed by three vendor companies (H2O Innovation, Hydronautics, and Suez). Each agreed that the system to achieve low boron would require two stages:

- The first stage of RO is treatment to remove all cations, including boron, at pH 5.5-6.5.
- "Reject" is the concentrated brine left behind on the influent side of the membrane, whereas water that moves to the effluent side of the membrane ("permeate" or treated water), would be subjected to a second stage of RO to recover more permeate at pH 4.5 to 5.0.
- The combined permeate would have less than 100 ug/L boron and less than 100 mg/L total dissolved solids (TDS).
- The process efficiency would be a minimum of 95%, with an expected efficiency of 97.5%, and potentially an efficiency as high as 99%.
- The primary membranes would last 3-5 years if cleaned once per week.
- The reject secondary membranes would last on average 6 months, even with cleaning twice per week.

The permeate would require caustic pH adjustment to a pH >6.1 for discharge.

The key benefits of RO treatment are:

- This technology is proven and is used in many applications including metal removal, wastewater treatment, and desalination.
- The technology allows NIPSCO to achieve desirable treatment for the recovered groundwater.
- The option is easy to operate.

- It has low risk of execution issues.
- It produces a smaller volume of concentrated brine requiring disposal relative to IX.

3.1.3 Projected Effluent Quality

The projected effluent quality of the two technologies, based on laboratory bench scale testing and modeling, is shown in **Table 4**.

4.0 Conceptual Process Development and Cost Estimate Development

As described above in Section 1.0, Introduction, following submittal of the Revised Draft CMS Report (Amec Foster Wheeler, 2016) treatability studies were conducted on IX and RO to evaluate effectiveness and costs of the two technologies. These results were then used to develop a design basis, which in turn was used to develop cost estimates.

The design basis flow rates, contaminant concentrations, and discharge limits were used to develop a conceptual engineering approach. The preliminary engineering was then used as a basis to specify equipment and O&M requirements to obtain vendor quotes and develop estimates of labor, equipment, materials, and disposal of process wastes. **Figure 3** presents the conceptual location of the key features of both CMA #1 and CMA #6 with respect to water treatment. This figure depicts the groundwater collection location at the northwest corner of SWMU 15, which is then conveyed by pipeline to the treatment plant located towards the northwest adjacent to an existing wastewater treatment plant. Treated water would then be conveyed via underground pipeline and discharged to the wetland to the north of SWMU-15 to maintain a hydrologic balance in the IDNL wetlands.

The following subsections describe the assumptions and conceptual processes for the two CMAs and the two water treatment options. Attachment A includes the conceptual design details including preliminary process flow diagrams, material balances, and equipment lists for both IX and RO for CMA #1 and #6.

4.1 CMA # 1 – Full Excavation - Conceptual Process and Cost Estimate Development

4.1.1 Preliminary Process Description

In CMA #1, CCR from above and below the water table would be excavated and transported off site for disposal. The excavation and off-site removal of CCR is assumed to proceed over a 6-month period each year (non-freezing weather) for a period of 2 years. Dewatering fluids would be treated during the two excavation seasons, assumed to be approximately 6 months each, for a total of 12 months of water treatment. Groundwater flow is estimated at approximately 100 gpm, which would be treated using IX (CMA #1A) or RO (CMA #1B). **Figure 4** depicts the plant layout for CMA #1A (IX at 100 gpm) and **Figure 5** depicts the layout for CMA #1B (RO at 100 gpm). Attachment A includes the design details for CMA #1.

4.1.1.1 CMA 1A – IX, 100 gpm, 2 years

Drawing No. PFD 01A in Attachment A depicts the preliminary process flow diagram developed for CMA #1A. The following key process components and assumptions for CMA #1A are described below:

1. Recovered groundwater would be pumped from the excavation site into an onsite tank by the excavation contractor. In CMA #1, which is the short term (2 years, 6 months per year) application, the groundwater would be pumped from this tank by a diesel pump controlled from the water

treatment building. The assumed rate of transfer by the GW Pump is 200 gpm for 12 hours per day maximum.

2. Recovered groundwater would be conveyed to one of the three (3) Equalization (EQ) Tanks (T-XXX1A, T-XXX1B, and T-XXX1C). Each EQ tank has been designed as a 10,000-gallon, double-walled, high-density polyethylene (HDPE) tank, with an assumed retention time of 4 hours. Three tanks are used so that extensive foundations are not required as would be the case for large diameter tanks. The tanks would be vented to the atmosphere. The EQ tanks would equalize flow for the downstream processes and settle any dirt or other large contaminant particles from the flow. A drain and manway would allow periodic removal of sediments from the bottom of the tanks.
3. The effluent from the EQ tanks would be pumped using one of two (2) centrifugal Groundwater Treatment Feed Pumps (P-XXX1A or P-XXX1B, capacity 100 gpm @ 45 psi) to one of two (2) Cartridge Filters (C-XXX1A or C-XXX1B, capacity 100 gpm), where solids and debris would be removed as necessary to protect the IX columns. Because the excavation pump can transfer 200 gpm x 12 hours per day, the Groundwater Treatment Feed Pumps are each set at 100 gpm x 24 hours per day. The pumps would be controlled by the Programmable Logic Controller (PLC) on the IX Unit skid, and the pumps would operate at a flow rate coordinated with tank level. As the EQ tank level rises, the flow rate would be increased. If the first pump fails to start an alarm would sound and the second pump would be started and run until an operator is able to respond.
4. Cartridge filters are used to protect the IX columns from large particles. The filters would be pressure vessels that hold fabric thimbles with 10 um pores. There are local pressure gauges before and after the cartridge filters so that the operator can see the pressure drop across each filter. The operator can isolate one filter and place the other filter in service to allow for changing out the filter thimbles.
5. The effluent from the Cartridge Filters (C-XXX1A or C-XXX1B, capacity 100 gpm) would be routed through a calcium and magnesium specific IX column (I-XXX1A) and then through a boron specific IX column (I-XXX2A). Column I-XXX1A would use DOW AMBERSEP™ GT74, which is a weakly acidic cation exchange resin with selectivity for certain metals (not including boron) to remove these metals and calcium, which can interfere with boron removal. Column I-XXX2A would use DOW MARATHON A, which is a chelating macro-porous, weak base anion resin for boron removal. The IX columns would ultimately reach their maximum adsorption capacity, at which point the resins would be regenerated or replaced. Operation of the IX columns would be monitored daily by the operator. Depending on the type of resin, a specific regeneration procedure would be followed. The first step would be backwashing the bed up-flow with water fluidizing the bed. The next step would be the application of a specific regenerator to the column. AMBERSEP™ GT74 would require acid as a regenerator. MARATHON A would need acid addition to remove adsorbed boric acid from the media, followed with slow caustic injection to recover hydroxyl functional groups. The final step of regeneration would be rinsing of the column to remove contaminates and regenerates. Backwash flow and rinsing flow would be routed to the Backwash Tank (T-XXX3A).
6. The discharge from the IX columns (I-XXX1A and I-XXX2A, capacity 100 gpm each) would flow to the Effluent Tank (T-XXX2A), which would be the collection point at the end of the treatment train before discharge. Tank T-XXX2A would be a 6,000-gallon HDPE tank, with approximately one hour of retention time. Two Effluent Transfer Pumps (P-XXX2A, P-XXX2B capacity 100 gpm @ 40 psi),

with one operating and one installed spare, would convey the treated groundwater to the adjacent wetland. The pumps would operate on level control.

7. Backwash (T-XXX3A, capacity 10,000 gallons) would be collected and hauled away once per week for off-site disposal of the backwash, likely through deep well injection. The deep well injection facility identified for potential use on this project is the Waste Management Vickery Deepwell hazardous waste facility in Vickery, OH.

4.1.1.2 CMA #1B – RO, 100 gpm, 2 years

Drawing No. PFD 01B in Attachment A depicts the preliminary process flow diagram developed for CMA #1B. The following key process components and assumptions are described below:

1. Recovered groundwater would be pumped from the excavation site to the EQ tanks in the treatment building as described above for CMA #1A in Subsection 4.1.1.1 item No. 1.
2. The effluent from the EQ tank would be pumped using one of two (2) centrifugal Groundwater Treatment Feed Pumps (P-XXX1A or P-XXX1B) with a capacity of 100 gpm @ 40 pounds per inch (psi) to one of two (2) Media Filters (C-XXX1A or C-XXX1B) each with a capacity of 200 gpm, where solids and debris would be removed to protect the RO unit. During filtration by the media filter, the groundwater is applied at the filter bed, which typically consists of sand or anthracite. As the water passes down through the filter bed, some of the suspended solids in the groundwater are removed by a variety of removal mechanisms, principally by straining. After some period of filter operation, the operating head loss would increase to a pre-determined value, and the filter must be cleaned to remove the accumulated particles from the media. There are local pressure gauges before and after the filters so that the operator can see the pressure drop across them. The backwash waste flow is collected in the Backwash Collection Tank (T-XXX6A). Because the excavation pump can transfer 200 gpm for 12 hours per day, the Groundwater Treatment Feed Pumps are each set at 100 gpm for 24 hours per day. The pumps would be controlled by the PLC on the RO Unit skid, and the pumps would operate at a flow rate coordinated with tank level. As the EQ tank level rises, the flow rate would be increased. If the first pump fails to start an alarm would sound and the second pump would be started and run until an operator is able to respond.
3. The effluent from the Media Filters would discharge into the RO feed tank (T-XXX2A) which has been designed as a 5,500-gallon (6,000 gallon commercially available), double walled HDPE tank.
4. The effluent from the RO Feed Tank would be pumped using one of two (2) centrifugal Low-Pressure RO Feed Pumps (P-XXX2A or P-XXX2B) with a capacity of 200 gpm @ 40 psi to one of two (2) Cartridge Filters (C-XXX2A or C-XXX2B), with a capacity of 200 gpm. Cartridge filters are used to protect the RO unit from particles that were not removed by the media filters as described above for CMA 1A.
5. The effluent from the Cartridge Filters (C-XXX2A or C-XXX2B) would be pumped to the RO unit using one of the two centrifugal RO Feed Pumps (P-XXX3A or P-XXX3B, capacity 200 gpm @ 250 psi). Pumps on the RO skid would apply high pressure to force the groundwater through the RO membranes, leaving the TDS behind.

   Acid, typically sulfuric acid [H2SO4] or hydrochloric acid [HCl], would be injected into the RO feed to lower the pH. The primary reason for reducing the feed pH is to reduce the development of calcium carbonate (CaCO3) scale. The degree of CaCO3 saturation is measured by the Langelier

Saturation Index (LSI). The LSI value is calculated by subtracting the calculated pH at saturation of calcium carbonate from the actual feed pH. The scaling criteria for the LSI are:

- LSI > 0 Water is supersaturated with respect to calcium carbonate and scaling may occur
- LSI < 0 Water is undersaturated with respect to calcium carbonate
- LSI = 0 Water is considered to be natural (i.e., neither scale forming nor scale removing)

The LSI value can be lowered by reducing pH by the injection of an acid into the RO feed water.

In addition, an anti-scalant chemical solution may be dosed to the RO feed to disperse the responsible constituent in scaling (i.e., calcium carbonate, carbonate sulfate, etc.).

6. The discharge from the RO unit would flow to the Permeate Tank (T-XXX3A), which would be the collection point at the end of the treatment train before discharge. Tank T-XXX3A would be a 6,000-gallon HDPE tank, with approximately one hour of retention time. Two Permeate Transfer Pumps (P-XXX4A, P-XXX4B), with a capacity of 100 gpm @ 40 psi, with one operating and one installed spare, would convey the treated groundwater to the adjacent wetland.
7. To achieve a high RO recovery, a portion of the reject may be recycled to the RO Feed Tank (T-XXX2A, capacity 5,500 gallons) by using one of two (2) centrifugal Concentrate Recycle Pumps (P-XXX5A or P-XXX5B, 100 gpm @ 40 psi). The remainder of the reject flows under pressure from the RO unit to the Reject Tank (T-XXX4A) with a capacity of 10,000 gallons.
8. The Reject Tank (T-XXX4A, capacity 10,000 gallons) contents would be collected and hauled away once per week for off-site disposal of the RO reject, likely through deep well injection.

4.1.2 Other Operational Notes for CMA #1

- In CMA #1, rental equipment may be used where possible; the equipment would be commissioned in the spring and decommissioned and demobilized in the late fall.
- HDPE plastic piping at grade is acceptable with daily inspection for visual leaks, and then drained when the system is idled for winter.
- HDPE piping would be used underground where necessary.
- Though the budget includes a building, the RO or IX treatment units can be a trailer-mounted, mobile unit. The unit would be stored off site for the winter. It would be commissioned in the spring and decommissioned and demobilized in the late fall. The trailer would have its own electrical panel, thus eliminating the need for electrical allowance line items.
- Alternatively, if an onsite building or a building at the non-operational wastewater plant is available, the equipment could be located inside that building.
- The RO or IX equipment may have to be purchased if it is so specialized that it cannot be rented; however, it would have a resale value (see, for example www.watersurplus.com). The spent membranes and IX resins would be disposed of and replaced by the buyer. We assumed 30% cost recovery.

A full-time (8 hours per day x 5 days per week, for 26 weeks per year) operator is included in the budget, as operation of the equipment is essential.

4.2 CMA #6 – Encapsulation Preliminary Process Description

4.2.1 Preliminary Process Description

In CMA #6, the CCR landfill would be encapsulated by installing a slurry wall around and impermeable cap over the residuals. Groundwater would be extracted from the encapsulated area to maintain inward gradients and is estimated at a maximum 10 gpm over the assumed 30-year life. Groundwater would be treated using IX (CMA #6A) or RO technologies (CMA #6B). **Figure 6** depicts the plant layout for CMA #6A (IX at 10 gpm) and **Figure 7** depicts the layout for CMA #6B (RO at 10 gpm). Attachment A includes the design details for CMA #6.

4.2.1.1 CMA #6A – IX, 10 gpm

Drawing No. PFD 02A in Attachment A depicts the preliminary process flow diagram developed for CMA #6A. The following key process components and assumptions for CMA #6A are described below:

1. Infiltrating groundwater would be pumped from the CCR containment periodically into an onsite tank. For this option, which is a long-term option (operating for 30 years, 12 months per year treatment), an electric pump(s) would operate on level control of liquids within the slurry wall and would be controlled by a PLC or similar system at the containment site. The groundwater would be pumped from this tank by an electrically-driven pump controlled from the water treatment building. The assumed rate of transfer by the GW Pump is 10 gpm for 24 hours per day maximum.
2. Groundwater from the slurry wall would be conveyed to the EQ Tank (T-XXX1A). Tank T-XXX1A has been designed as a 2,500-gallon, double-walled, HDPE tank, with an assumed retention time of 4 hours. This tank would be vented to the atmosphere. EQ Tank T-XXX1A would be constructed and would function the same as described under No. 2 in Subsection 4.1.1.1 for CMA #1A.
3. Effluent from the EQ Tank would be handled as described under item No. 3 in Subsection 4.1.1.1 for CMA #1A, with the exception that the Groundwater Treatment Feed Pumps will be set to handle an average flow rate of 10 gpm 24 hours per day.
4. Cartridge filters would be used as described in Item No. 4 in Subsection 4.1.1.1.
5. The effluent from the Cartridge Filters (C-XXX1A or C-XXX1B) would then be treated using DOW AMBERSEP™ GT74 and MARATHON A resins, as described under Item No. 5 in Subsection 4.1.1.1.
6. The discharge from the IX columns (I-XXX1A and I-XXX2A) would flow to the Effluent Tank (T-XXX2A) and be discharged as described above under Item No. 6 in Subsection 4.1.1.1, with the exception that Tank T-XXX2A would be a 1,200-gallon HDPE tank, with approximately two hours of retention time.
7. Backwash would be collected and hauled away as described above in Item No. 7 in Subsection 4.1.1.1.

4.2.1.2 CMA #6B – RO, 10 gpm

Drawing No. PFD 02B in Attachment A depicts the preliminary process flow diagram developed for CMA #6B. The following key process components and assumptions for CMA #6B are described below:

1. Groundwater would be pumped from the encapsulated CCR as described above for CMA #6A in Subsection 4.2.1.1 Item No. 1. Groundwater removed from within the encapsulated CCR would be conveyed to equalization Tank T-XXX1A, similar to as described above under Item No. 2 in

Subsection 4.1.1.2, with the exception that the tank has a capacity of 2,500 gallons with an assumed retention time of 4 hours.

2. The effluent from the EQ Tank would be pumped using one of two (2) centrifugal Groundwater Treatment Feed Pumps (P-XXX1A or P-XXX1B) as described above under Item No. 3 in Subsection 4.1.1.2 with the exception that the pumps will each have a capacity of 25 gpm at 45 psi to one of two (2) Media Filters (C-XXX1A or C-XXX1B) each with a capacity of 20 gpm at 60 psi. The backwash waste flow is collected in the Backwash Collection Tank (T-XXX6A). The Groundwater Treatment Feed Pumps are each set at 10 gpm for 24 hours per day. The pumps would be controlled as described above in Subsection 4.1.1.2 in Item No. 2.
3. The effluent from the media filters would discharge into the RO Feed Tank (T-XXX2A) which has been designed as a 55-gallon (75-gallon commercially available), double-walled HDPE tank.
4. The effluent from the RO Feed Tank would be pumped as described above under Item No. 4 in Subsection 4.1.1.2 with the exception that the two (2) centrifugal Low-Pressure RO Feed Pumps (P-XXX2A or P-XXX2B) will have a capacity of 20 gpm @ 40 psi and the two (2) Cartridge Filters (C-XXX2A or C-XXX2B) will have a capacity of 20 gpm.
5. The effluent from the Cartridge Filters (C-XXX2A or C-XXX2B, capacity 20 gpm) would be pumped to the RO unit using one of the two centrifugal RO Feed Pumps (P-XXX3A or P-XXX3B). Pumps on the RO skid would apply high pressure to force the groundwater through the RO membranes, leaving the TDS behind. Acids and anti-scalants would then be added as described above in Item No. 5 in Subsection 4.1.1.2.
6. The discharge from the RO unit would be handled as described above under Item No. 6 in Subsection 4.1.1.2, with the exceptions that Permeate Tank (T-XXX3A), would have a capacity of 1,200 gallons with approximately 2 hours of retention time. The two Permeate Transfer Pumps (P-XXX4A, P-XXX4B), would have a capacity of 24 gpm @ 45 psi.
7. A portion of the reject would be handled as described above under Item No. 7 in Subsection 4.1.1.2 with the exception that the RO feed Tank (T-XXX2A) would have a capacity of 55 gallons and two (2) centrifugal Groundwater Concentrated Recycle Pumps (P-XXX5A or P-XXX5B) would have a capacity of 25 gpm @ 45 psi. The remainder of the reject flows under pressure from the RO unit to the Reject Tank (T-XXX4A, 2,500 gallon).
8. The Reject Tank (T-XXX4A, capacity 2,500 gallons) contents would be collected and hauled away once per week for off-site disposal of the RO reject, likely through deep well injection.

4.2.2 Other Operational Notes for CMA #6

- In CMA #6, the RO or IX treatment units would be permanent. Resins and membranes are assumed to have a 5-year life. All equipment possible would be located inside the process building which would have HVAC (and is electrically unclassified).
- HDPE piping would be used underground.
- Alternatively, if an onsite building or a building at the non-operational wastewater plan is available, the equipment could be located inside that building.
- At the end of the facility life, the equipment would be of no value.

- No operator is required as the facility is automated. However, it is assumed the client would have part time help to energize the system for each run.
- Annual maintenance is higher due to aging of equipment over its lifetime. The membrane and resin replacements are included in the cost estimate.

5.0 Cost Estimate for CMA #1A, #1B, #6A, and #6B

Wood prepared cost estimates for implementation of the two water treatment options for the two CMAs. **Attachment B** includes equipment data sheets and vendor quotes as backup to the cost estimates. **Attachment C** includes backup cost information for instruments, tanks, pumps, and other small equipment. The estimated costs for CMAs #1A, #1B, #6A, and #6B are summarized in the table below. Additional cost estimate details are provided in **Tables 5 through 8**.

CMA	Total Installed Cost	Annual Operating Cost	Total Lifecycle Cost	Salvage Value
#1A (Full excavation/ 100 gpm IX), 2 years	$2,639,000	$694,000	$3,929,000	$168,000
#1B (Full excavation/ 100 gpm RO), 2 years	$2,808,000	$510,000	$3,756,000	$240,000
#6A (Encapsulation/10 gpm IX), 30 years	$1,575,000	$368,000	$7,232,000	$0
#6B Encapsulation/10 gpm RO), 30 years	$1,739,000	$445,000	$8,580,000	$0

Notes:

1. General contingency has not been included in the above costs; however, a 20% contingency is included for each full CMS Alternative.
2. O&M costs have been discounted at a rate of 5% per year.

6.0 Comparisons, Conclusions and Recommendations

This memo presents the evaluation of two groundwater treatment technology options (IX and RO) each for the Excavation (CMA #1) and Encapsulation (CMA #6) alternatives detailed in the CMS Report.

In CMA #1, the CCR material would be excavated from above and below the water table and removed for off-site disposal. Groundwater extraction would be required at a rate of approximately 100 gpm and treatment is limited to a 1- to 2-year period. In CMA #6, the CCR material would be encapsulated through the installation of a slurry wall and covered with an impermeable cap. The groundwater to be treated in this case is only the low flow rate of 5-10 gpm, which would be pumped from within the encapsulated area to maintain inward gradients over the 30-year analysis period.

Each option (CMAs #1 and #6) includes sub-options that employ different water treatment technologies. CMAs #1A and #6A include groundwater treatment by means of IX. CMA #1B and #6B include groundwater treatment by means of RO.

In both CMAs #1A and #1B, given the greater flow rates, the required tanks are larger than those for CMA #6A and #6B. For both CMA #1 cases, water treatment equipment would be located inside a new water treatment building with major tanks located outside, while for both CMA #6 cases, all equipment including all tanks would be located inside the building.

CMA #1A has a capital cost of **$2.64M,** an annual operating cost of **$694k,** and a 2-year lifecycle cost with a present value of **$3.93M**. These costs will be offset very slightly by an equipment salvage value of **$168K**. This option is acceptable, but DOW has expressed concern about the reliability of IX to meet effluent discharge requirements for boron. At lower discharge limits, (i.e., NPDES) IX is less desirable relative to RO due to the uncertainty that discharge limits will be consistently met. Additional testing would need to be done to determine whether treated water would pass the Acute Biomonitoring requirements for direct discharge.

CMA #1B has a capital cost of **$2.81M,** an annual operating cost of **$510k,** and a 2-year lifecycle cost with a present value of **$3.76M**. These costs will be offset very slightly by an equipment salvage value of **$240K**. RO is the most reliable treatment option and achieves the lowest discharge limits. The RO effluent is likely to achieve all NPDES limits and is preferred in a direct-discharge scenario.

CMA #6A has a capital cost of **$1.58M,** an annual operating cost of **$368k,** and a 30-year lifecycle cost with a present value of **$7.23M**. No salvage value is assumed for the equipment given the 30-year lifecycle. This option is acceptable, but DOW has expressed concern about the reliable treatment of boron in the IX effluent. There is also a concern about the TOC content of the IX effluent and its ability to pass Acute Biomonitoring. At lower discharge limits, (i.e., NPDES) IX is less desirable relative to RO due to the uncertainty that discharge limits will be consistently met.

CMA #6B has a capital cost of **$1.74M,** an annual operating cost of **$445k** and a 30-year lifecycle cost with a present value of **$8.58M**. No salvage value is assumed for the equipment given the 30-year lifecycle. The RO effluent is suitable for direct discharge or reuse.

Based on our analysis, RO technology is recommended (CMA #1B or CMA #6B). However, it is important to note that our conclusions are based on the POTW and NPDES limits presented in **Table 3**, particularly for boron. The technology selection will ultimately be affected by what the actual negotiated values for discharge criteria are at the time of project implementation, if selected. A lower number will tend to favor RO while a higher number would favor IX based on the results of these studies.

7.0 References

Amec Foster Wheeler, 2015. Draft Area C Corrective Measures Study, NIPSCO Bailly Generating Station, RCRA Corrective Action Program, EPA ID# 000718114. August 14, 2015.

Amec Foster Wheeler, 2016. Revised Draft Area C Corrective Measures Study, NIPSCO Bailly Generating Station, RCRA Corrective Action Program, EPA ID# 000718114. March 18, 2016.

Amec Foster Wheeler, 2017a. Memo to Michelle Kaysen (USEPA) from Peter Guerra and Russ Johnson, Subject: SWMU 15 Geotechnical Investigation Summary, Corrective Measures Study for Area C, NIPSCO Bailly Generating Station. January 23, 2017.

Amec Foster Wheeler, 2017b. Memo to Michelle Kaysen (USEPA) from Peter Guerra and Russ Johnson, Subject: Revised Costs for SWMU 15, Corrective Measures Study for Area C, NIPSCO Bailly Generating Station. June 2, 2017.

Amec Foster Wheeler, 2017c. Memo to Michelle Kaysen (USEPA) from Dan Sullivan (NIPSCO) and Russ Johnson (Amec Foster Wheeler), Subject: NIPSCO Bailly Generating Station RCRA Corrective Action Program, Quarterly Progress Report 17-02, Reporting Period April 1 through June 30, 2017. July 12, 2017.

List of Figures

List of Tables

List of Attachments

Figures

Lake Michigan

Bailly Generating Station

Indiana Dunes National Lakeshore

Dunes Creek

Route 12

SWMU 15

ArcelorMittal Steel

Sitewide Overview

Northern Indiana Public Service Company

Bailly Generating Station
Chesterton, Indiana

Legend

- Bailly Generating Station Property Boundary
- Approximate Slurry Wall Location
- Railroad
- Area A
- Area B
- Area C
- SWMU 15

Location of Site

Notes and Sources

FIGURE 1

Aerial Photo: March 2003
Courtesy of Indiana Spatial Data Portal

0 750 1,500 Feet

wood.
Wood Environment & Infrastructure Solutions, Inc.
271 Mill Road
Chelmsford, MA 01824
(978) 692-9090

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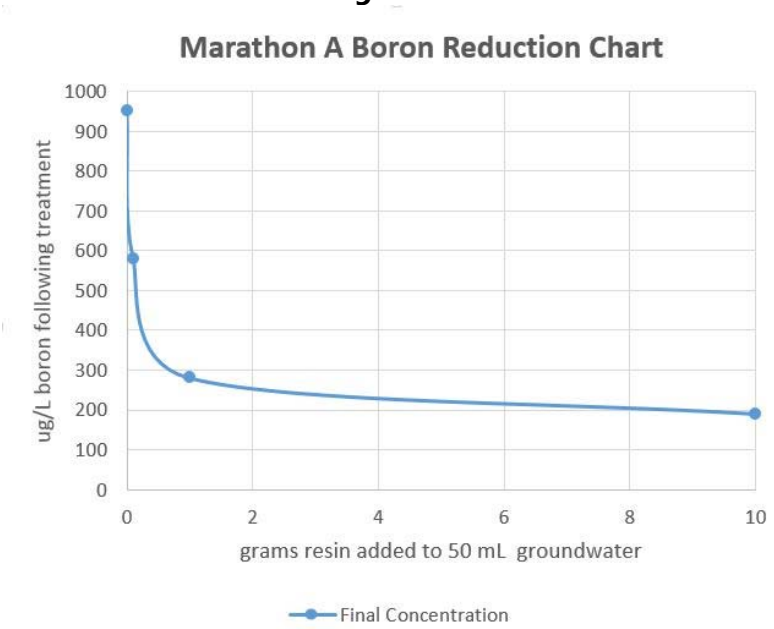
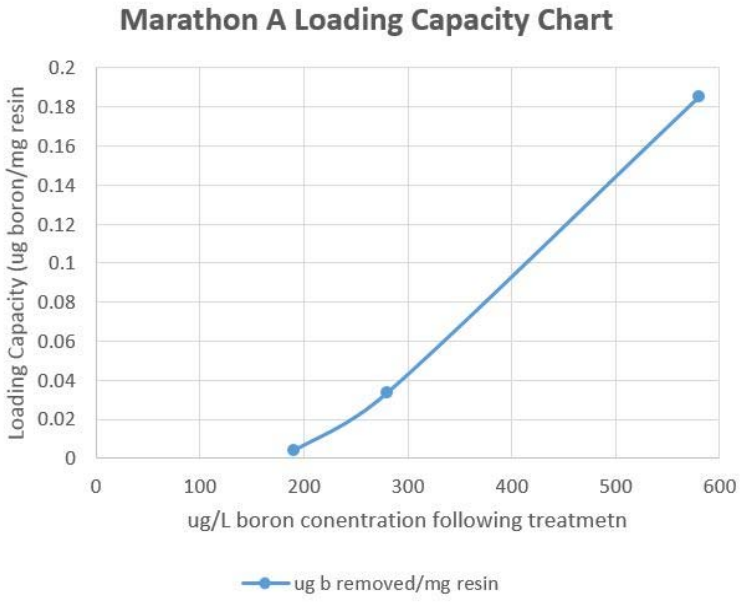
Figure 2a



Note: Chart represents the ending concentration of boron following addition and mixing of a pre-determined amount (0.1, 1.0, and 10 g) of Marathon A resin with 50 mL of water from MW-119.

Figure 2b

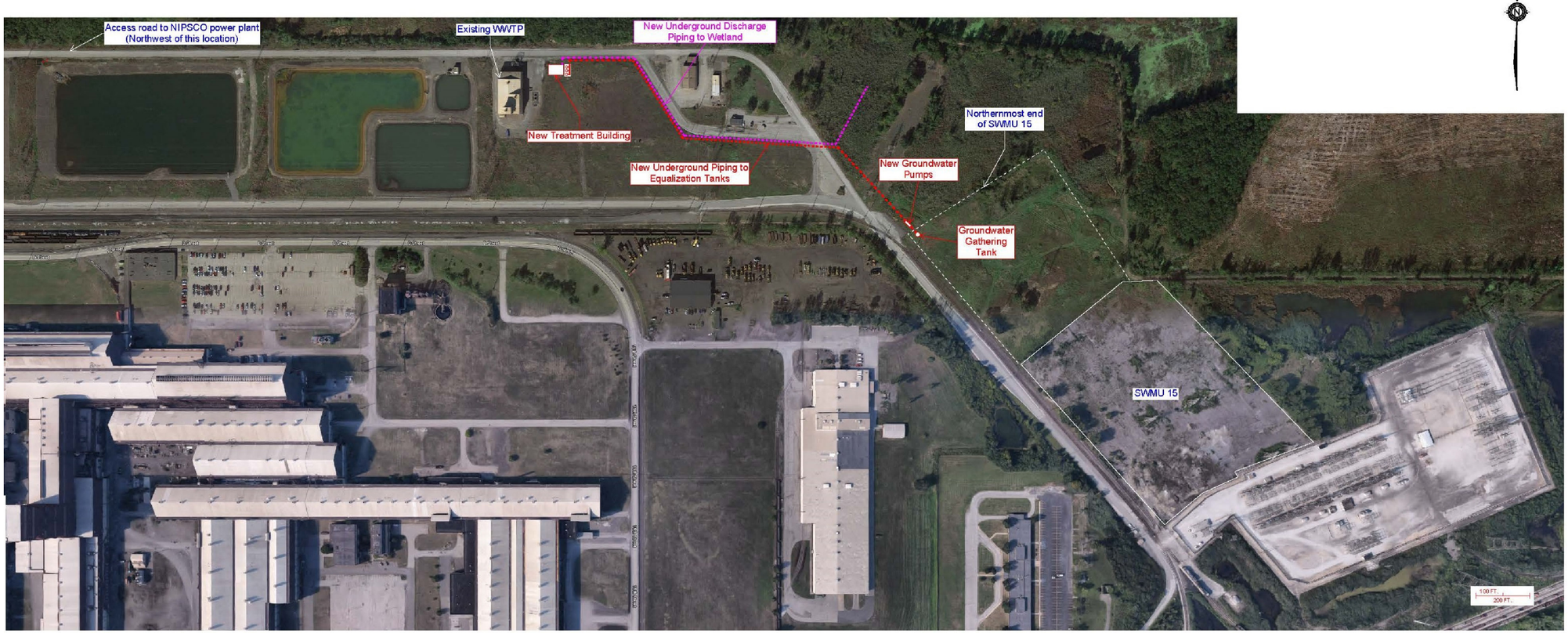


Note: Chart represents the mass of B removed in micrograms per mass of resin added in milligrams for each of the three ending concentrations of boron following addition and mixing of a pre-determined amount of Marathon A resin (0.1g, 1.0g, and 10g) with 50 mL of water from MW-119.

Aerial Plot Plan
Groundwater Treatment and Discharge
CMA #1 and #6

Northern Indiana Public Service Company

Bailly Generating Station
Chesterton, Indiana



Location of Site

Notes and Sources

FIGURE 3

wood.
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Chelmsford, MA 01824
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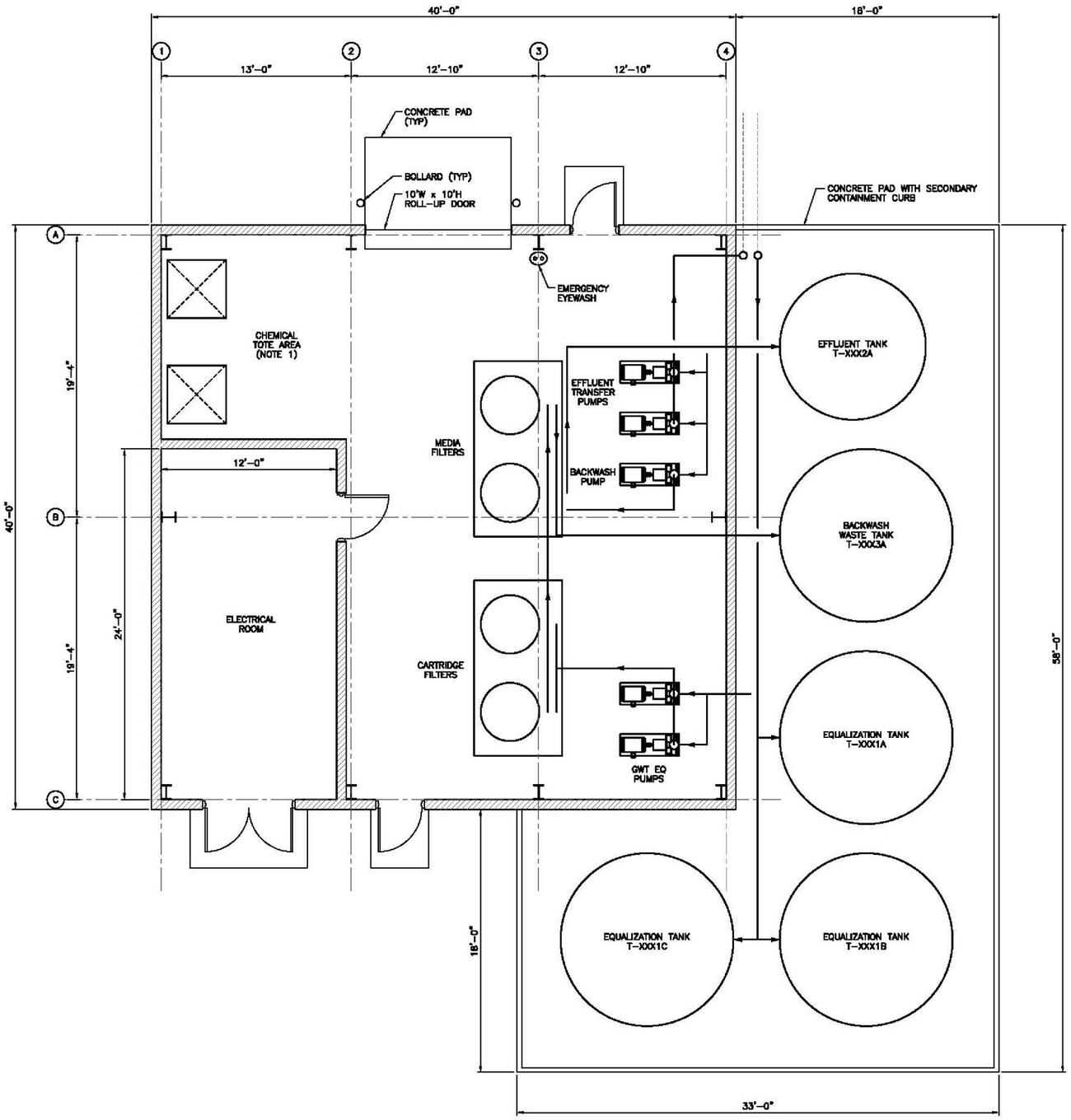

SCALE BAR (1/4" = 1'-0")

0 5' 10' 15'

Treatment Facility Equipment Layout Plan CMA #1A - IX @ 100 GPM

Northern Indiana Public Service Company

Bailly Generating Station
Chesterton, Indiana

Location of Site

Notes and Sources

FIGURE 4

wood.
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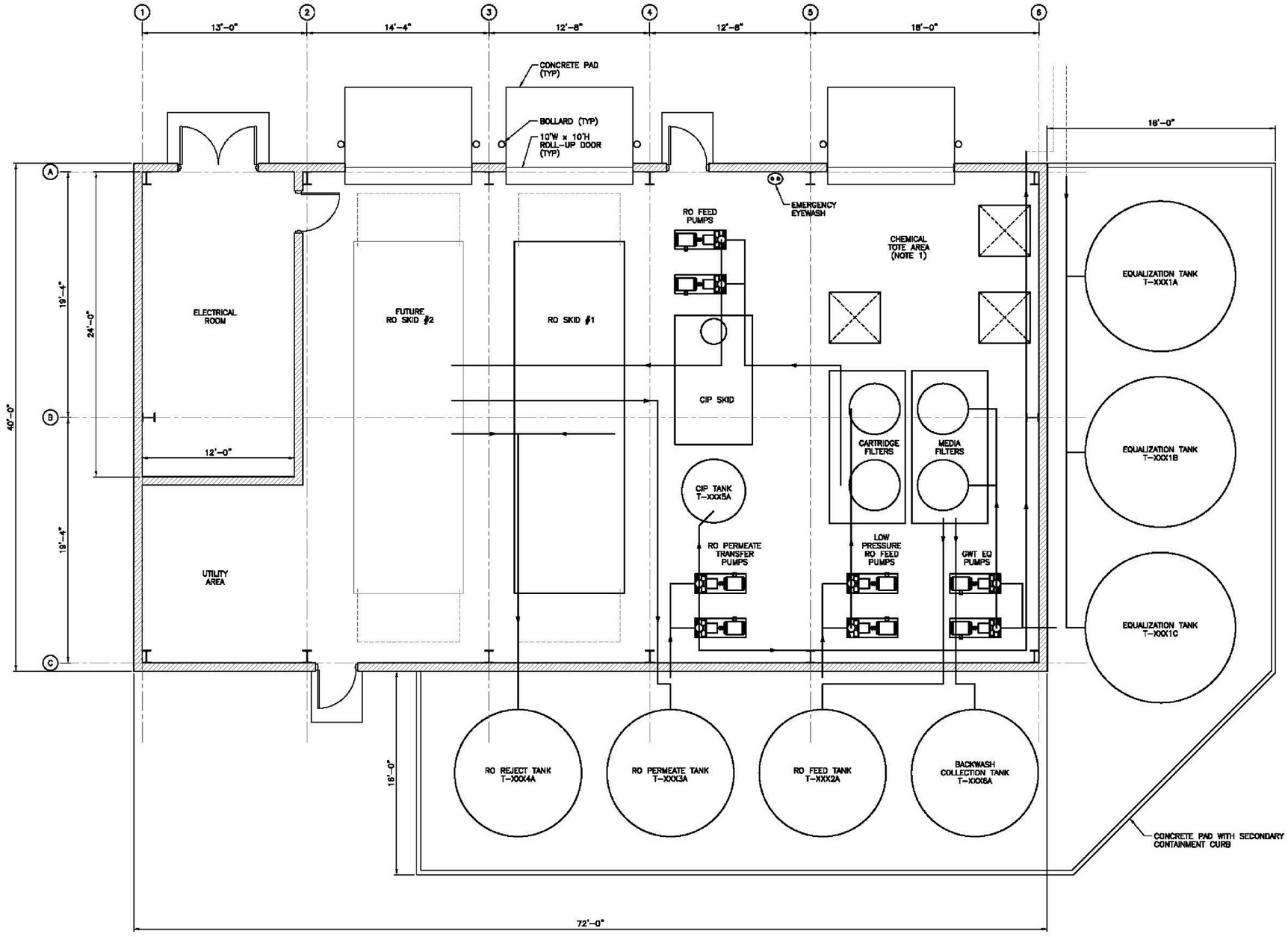
Treatment Facility
Equipment Layout Plan
CMA #1B - RO @ 100 GPM

Northern Indiana Public
Service Company

Bailly Generating Station
Chesterton, Indiana



FLOOR PLAN

SCALE BAR (1/4" = 1'-0")
0 5' 10' 15'

Location of Site

Notes and Sources

FIGURE 5

wood.
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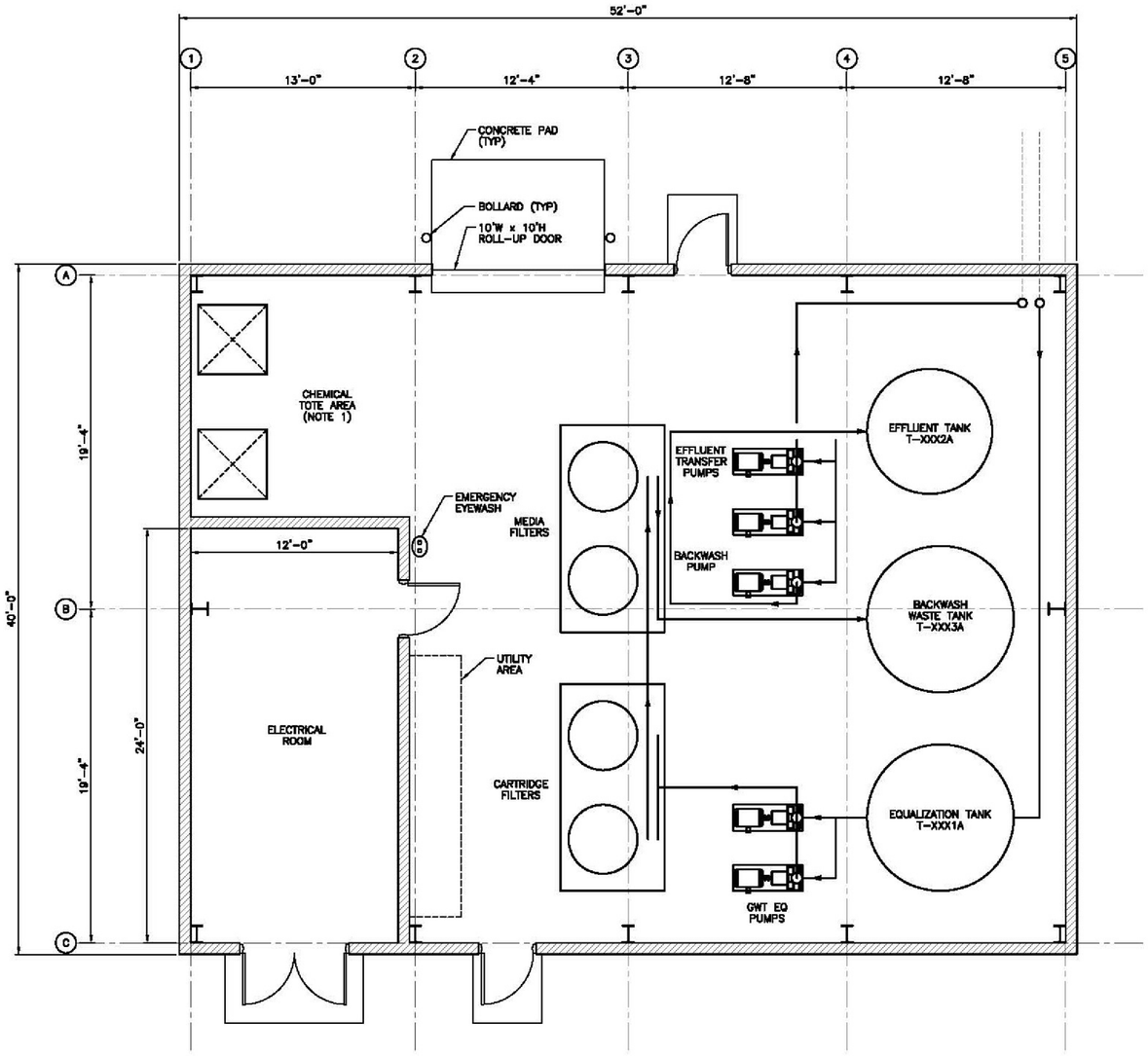

SCALE BAR (1/4" = 1'-0")

0 5' 10' 15'

Treatment Facility Equipment Layout Plan CMA #6A - IX @ 10 GPM

Northern Indiana Public Service Company

Bailly Generating Station
Chesterton, Indiana

Location of Site

Notes and Sources

FIGURE 6

wood.
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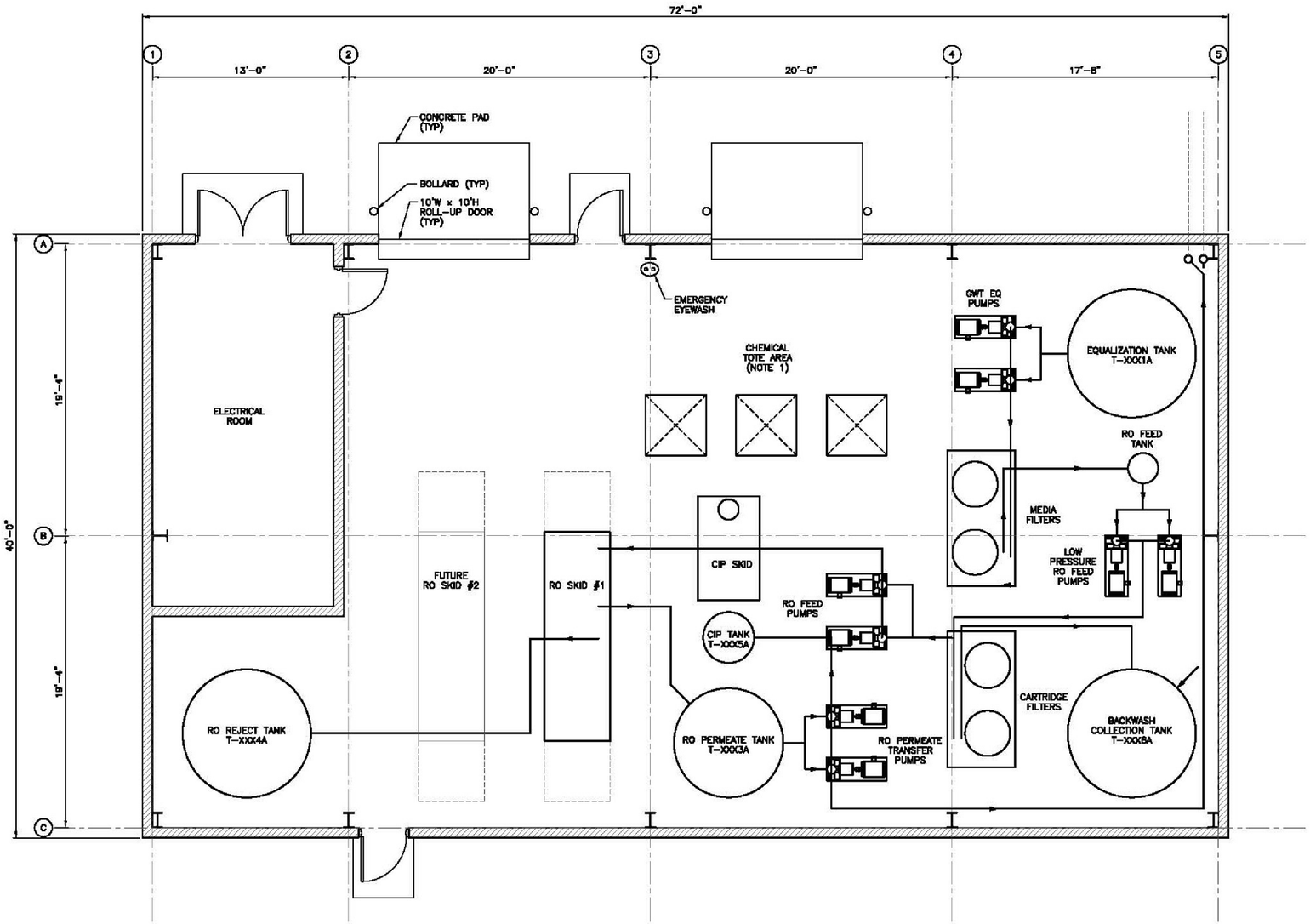
Treatment Facility
Equipment Layout Plan
CMA #6B - RO @ 10 GPM

Northern Indiana Public
Service Company

Bailly Generating Station
Chesterton, Indiana



SCALE BAR (1/4" = 1'-0")
0 5' 10' 15'

Location of Site

Notes and Sources

FIGURE 7

wood.
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Tables

Table 1

Groundwater Sampling Results: 3/28/2017 and 5/3/2017

Method	Parameter	Units	MW11944A 3/28/2017	MW11945A 5/3/2017	MW12444A 3/28/2017	MW12445A 5/3/2017	MW12544A 3/28/2017	MW12545A 5/3/2017	Average of 3/28/2017	Average of 5/3/2017
E624	VOLATILE ORGANIC COMPOUNDS	ug/L		ND						
E625	SEMIVOLATILE ORGANIC COMPOUNDS	ug/L		ND						
E200.7	ALUMINUM	ug/L	730	1900	200 U	200 U	67 J	260	332	787
E200.7	ARSENIC	ug/L	420	420	35	37	8 J	5.8 J	154	154
E200.7	BARIUM	ug/L		19		21		64		35
E200.7	BORON	ug/L	12000	13000	970	970	3600	3500	5523	5823
E200.7	CADMIUM	ug/L	2 U	2 U	0.58 J	2 U	0.5 J	2 U	1.03	2.0
E200.7	CHROMIUM	ug/L	4 U	4.8	2 J	1.4 J	1.3 J	1.7 J	2.4	2.6
E200.7	COPPER	ug/L	10 U	6.4 J	2.7 J	1.8 J	10 U	10 U	7.6	6.1
E200.7	IRON	ug/L	240	2400	1600	1600	120	500	653	1500
E200.7	LEAD	ug/l	4.8 J	7.2 J	6.5 J	7.8 J	3.8 J	5.7 J	5.0	6.9
E200.7	MANGANESE	ug/L	4	10	280	140	17	13	100	54
E200.7	MOLYBDENUM	ug/L	1200	1200	84	95	200	210	495	502
E200.7	SELENIUM	ug/L	11 J	9.9 J	19 J	25 U	74	300	35	112
E200.7	SILVER	ug/L	6 U	6 U	6 U	6 U	6 U	6 U	6.0	6.0
E200.7	STRONTIUM	ug/L		170		200		1100		490
E200.7	ZINC	ug/L	5.5 J	23	46	10 U	4.3 J	7.5 J	19	14
E245.1	MERCURY	ug/L	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.20	0.20
E200.7	CALCIUM METAL	ug/L	44000	48000	150000	140000	150000	150000	114667	112667
E200.7	MAGNESIUM	ug/L	2000	2100	44000	41000	24000	24000	23333	22367
E200.7	POTASSIUM	ug/L	33000	36000	3700	3900	11000	12000	15900	17300
SM4500-P E	PHOSPHORUS	ug/L	70	63	17	66	180	28	89	52
E200.7	SILICA	ug/L		13000		42000		26000		27000
E200.7	SODIUM	ug/L	8300	8700	13000	2600	5100	5500	8800	5600
E300	SULFATE (AS SO4)	ug/L	75000	75000	98000	75000	41000	78000	71333	76000
SM4500-S2-F	SULFIDE	ug/L	1000 U	2000 U	1000 U	1000 U	1000 U	1000 U	1000	1333
E350.1	AMMONIA AS N	ug/L	3300	2700	260	360	220	260	1260	1107
E353.2	NITRATE (AS N)	ug/L	50 U	50 U	50 U	50 U	50 U	45	50	48
E353.2	NITROGEN, NITRITE	ug/L	110	1000	50 U	50 U	50 U	50 U	70	367
SM5310C	TOTAL ORGANIC CARBON	ug/L	4400	4600	3700	3400	940	1100	3013	3033
A2540D	TOTAL SUSPENDED SOLIDS	ug/L	4000 U	64000	5600	4000 U	6400	11000	5333	26333
SM5210B	BIOLOGICAL OXYGEN DEMAND (BOD)	ug/L		8400						8400
E410.4	CHEMICAL OXYGEN DEMAND (COD)	ug/L		10000 U						10000
E120.0	SPECIFIC CONDUCTIVITY	umhos/cm	350	380	940	870	860	860	717	703
SM4500-H	pH	pH units	9.4	9.6	7.6	7.8	7.1	7.2	8.0	8.2
SM4500-H	TEMPERATURE	degrees C	20.2	20.1	19.8	19.8	19.9	19.6	20.0	19.8

Notes: ND - no volatile organic or semi-volatile organic compounds were detected.

U - not detected above the reporting limit

J - estimated below the reporting limit

If no result is shown, the parameter was not analyzed.

Prepared by: AKN 11/15/18

Reviewed by: TD 12/5/18

Table 2 – Summary Site Chemical Characteristics and Design Basis

PARAMETER	AVERAGE CONCENTRATIONS AT THE SITE[1] (UG/L)	DESIGN BASIS OF RECOVERED GROUNDWATER[2] (UG/L)
Aluminum	330	412
Arsenic	150	172
Barium	35[3]	48.4
Boron	5,500	7,580
Cadmium	1	1
Calcium Metal	115,000	99,300
Chromium	2.4	3.0
Copper	7.6[4]	6.9
Iron	650	650[1]
Lead	5.0[5]	5.1
Magnesium	23,000	19,425
Manganese	100	127
Mercury	0.2[4]	0.2[2,4]
Molybdenum	500	842
Potassium	16,000	16,000[1]
Selenium	35	30
Silver	6[4]	9.8
Sodium	8,800	8,800[1]
Zinc	19	19[1]
Total Dissolved Solids (TDS)	Unknown	Unknown
Sulfate	71,300	71,300[1]
pH	8.0	8.0[1]
Total Organic Carbon (TOC)	3,000	3,000[1]

Notes:

1. The average of results from MW-119, MW-124, and MW-125 for groundwater sampling date 3/28/2017
2. Values represent a weighted average of results from the 3/28/2017 sampling data and historical results from MW-119, MW-124, and MW-125, plus two other downgradient wells IDNL-GW12, and IDNL-GW-13.
3. May 3, 2017 sampling date only.
4. Includes undetected values.
5. Includes estimated values.

Table 3 – Regulatory Limits

PARAMETER	DRINKING WATER STANDARD[1], (UG/L)	POTW LIMIT[2], (UG/L)	PROBABLE NPDES LIMIT[3], (UG/L)
Aluminum	200	2,000	1,000
Arsenic	10	680	340
Barium	2,000	2,000	1,000
Boron	--	1,000	500
Cadmium	5	1,000	500
Calcium Metal	--	10,000	5,000
Chromium	100	32	16
Copper	1,000	100	500
Iron	300	6,000	3,000
Lead	150	1,000	500
Magnesium	--	2,000	1,000
Manganese	50	2,000	1000
Mercury	2	2.8	1.4
Molybdenum	--	2,000	1,000
Selenium	5	1,000	500
Silver	100	200	100
Sodium	--	--	--
Zinc	5,000	--	--
Total Dissolved Solids	500	1,000,000	500,000
Sulfate	250,000	--	--
PH	6.5 to 8.5	6.5 to 8.5	6.5 to 8.5
Total Organic Carbon	--	--	15,000
Chemical Oxygen Demand	--	500,000	250,000
Biochemical Oxygen Demand	--	250	150,000
Oil & Grease	--	100,000	15,000
Ammonia	--	100,000	5,000
Phosphorus	--	--	1,000
Total Suspended Solids	--	250	20,000
Biomonitoring	--	--	48-hour acute toxicity

Notes:

1. USEPA Primary and Secondary Drinking Water Standards
2. Indiana Department of Environmental Management administers pretreatment programs where municipalities use categorical standards (industry based) and local limits; we telephone interviewed the pretreatment staff at Burns Harbor to identify probable limits based on the staff notation that they had been issued in remediation applications
3. Based on EPA CWA guidance and GLI database

-- = No value established.

Table 4 – Projected Effluent Quality

PARAMETER	POTW LIMITS (UG/L)	PROBABLE NPDES LIMITS (UG/L)	Projected IX Effluent (UG/L)	Projected RO Effluent (UG/L)
Aluminum	2,000	1,000	412	<50
Arsenic	680	340	100-120	<18
Barium	2,000	1,000	<20	<5
Boron	1,000	500	<500	<300
Cadmium	1,000	500	<1	<1
Calcium Metal	10,000	5,000	<2,000	<300
Chromium	32	16	<3	<1
Copper	100	500	<5	<1
Iron	6,000	3,000	<200	<100
Lead	1,000	500	<5	<1
Magnesium	2,000	1,000	<2,000	<100
Manganese	2,000	1,000	<100	<100
Mercury	2.8	1.4	0.2	0.2
Molybdenum	2,000	1,000	<500	<100
Selenium	1,000	500	<1,500	<500
Silver	200	100	30	<25
Sodium	--	--	10,000	<10
Total Dissolved Solids	1,000,000	500,000	10,000-50,000	<1,000
Sulfate	--	--	71,000	<5,000
PH	6.5 to 8.5	6.5 to 8.5	7.5	6.1[4]
Total Organic Carbon	--	15,000	<3000	<1,000
Biomonitoring, 100% Acute	--	48 hour acute toxicity	Questionable	Pass[1]

Notes:

1. The RO effluent has the lowest ionic and organic content. It is likely to pass 48 hour acute biomonitoring tests and is suitable for NPDES discharge.
2. Yellow highlights indicate potential exceedance of POTW and NPDES limits.
3. Blue highlights indicate potential exceedance of NPDES limits only.
4. Indicated pH adjustment may be needed.

UG/L = micrograms per liter
-- = no value established

Table 5
CMA #1A Cost Estimate - Water Treatment - Excavation and IX@100 gpm
Water Treatment Treatability Study
Bailly Generating Station

CMA #1A - Capital Cost							
Item No.	**Category**	**Element**	**Quantity**	**Unit**	**Unit Cost**	**Cost**	**Note & Cost Basis**
1	Equipment	Equalization Tank (10,000 Gal)	3	EA	$ 23,999	$ 71,997	Bailiff Tank, Freight is not included, 3 Tanks used to allow tanks which can be isolated if any leaks occur. double wall, no secondary containment required. Total volume of 30,000 gallons = 5 hours HRT if treatment goes down or is in backwash
2	Equipment	Backwash Waste Tank (10,000 Gal)	1	EA	$ 23,999	$ 23,999	Bailiff Tank, Freight is not included. Tanks are double wall no secondary containment. Total volume of 10,000 gallons = 2 x 4000 gallon tanker load if the waste is hauled off for disposal
3	Equipment	Effluent Tank (6,000 Gal)	1	EA	$ 11,455	$ 11,455	Bailiff Tank, Freight is not included. Size of tank is dictated by pump suction (both pumps operating =180 gpm)
4	Equipment	Cartridge Filters	2	EA	$ 3,496	$ 6,992	Suez, Freight is not included
5	Equipment	Ion Exchange Skid (Package) - Two (2) Contactors with Pneumatic Valves and Backwash Pumps	1	EA	$ 339,000	$ 339,000	Trussell Technologies San Diego, CA (recommended by DOW)
6	Equipment	Hydrochloric Acid Pump	1	EA	$ 1,154	$ 1,154	Foust Marketing, Freight is not included
7	Equipment	50% Caustic Pump	1	EA	$ 1,101	$ 1,101	Foust Marketing, Freight is not included
8	Equipment	GW Treatment Feed Pumps (100 gpm @ 45 psi)	2	EA	$ 6,361	$ 12,722	DXP, Freight is not included
9	Equipment	Effluent Transfer Pumps (100 gpm @ 45 psi)	2	EA	$ 6,361	$ 12,722	DXP, Freight is not included
10	Equipment	Backwash Pump	1	EA	$ -	$ -	Part of IX Skid
11	Instrumentation	I&C Allowance	1	EA	$ 39,200	$ 39,200	This is raw cost of bubbled instruments not on vendor skids only.
12	Instrumentation	Instrument Installation Allowance	1	EA	$ 117,600	$ 117,600	3X Instrument Installation Allowance
13	Civil-Structural	Pump Pedestals	6	EA	$ 1,500	$ 9,000	RS Means 2017 facilities Cost Book (on line)
14	Civil-Structural	Treatment Building-Package	1	EA	$ 60,425	$ 60,425	Giles Incorporated Quote plus installation and HVAC allowance $27,000, building erection included
15	Civil-Structural	Site Preparation	1	LS	$ 27,500	$ 27,500	RS Means 2017 facilities Cost Book (on line)
16	Civil-Structural	EQ and BW Tanks Foundation	1	LS	$ 28,444	$ 28,444	Based on 30 x 40 slab on grade, 24" with 4' deep engineered fill RS Means 2017 Facilities Cost Book (on line)
17	Civil-Structural	Building Foundation	1	LS	$ 39,253	$ 39,253	Based on 40 x 72 slab on grade, 18" with 3' deep engineered fill RS Means 2017 Facilities Cost Book (on line)

Table 5
CMA #1A Cost Estimate - Water Treatment - Excavation and IX@100 gpm
Water Treatment Treatability Study
Bailly Generating Station

Item No.	Category	Element	Quantity	Unit	Unit Cost	Cost	Note & Cost Basis
18	Civil-Structural	Backwash Waste Tank Foundation	1	EA	$ -	$ -	Included in Tank Foundation above
19	Civil-Structural	Effluent Tank Foundation	1	EA	$ -	$ -	Included in Tank Foundation above
CMA #1A - Capital Cost							
20	Civil-Structural	Cartridge Filters Foundation	3	EA	$ -	$ -	Included in building foundation above
21	Electrical	Electrical Material, Labor, and Equipment	1	LS	$ 265,000	$ 265,000	AMD (AFW) based on one line, included utility service, transformer, ductbank to building panel, build panel and equipment wiring
22	Mechanical	All Piping	1	LS	$ 380,000	$ 380,000	Based on line list using PVC piping
23	Mechanical	Pumps Installation	1	LS	$ 38,000	$ 38,000	Based on RS means, 2017, 4 man crew and truck, 10 days
24	Mechanical	Install all major equipment	1	LS	$ 228,000	$ 228,000	Based on RS means, 2017, 4 man crew and truck, 60 days
25				**Subtotal Direct Cost**		**$ 1,714,000**	Items directly related to construction

Table 5
CMA #1A Cost Estimate - Water Treatment - Excavation and IX@100 gpm
Water Treatment Treatability Study
Bailly Generating Station

Item No.	Category	Element	Quantity	Unit	Unit Cost	Cost	Note & Cost Basis
26	Freight	Freight	6%	Factor	$ 31,220.50	$ 31,220	AFW project guidance
27	Bond	Bonds for Subcontractors	2%	Factor	$ 34,280	$ 34,280	AFW project guidance
28	OH	Contractor Insurance	2%	Factor	$ 34,280	$ 34,280	AFW project guidance
29	OH	Contractor Field, Office, and OH Expenses	5	LS	$ 1,750	$ 8,750	GE Offices
30	Engineering	Engineering design	15%	Factor	$ 257,100	$ 257,100	FEL Guidance AFW
31	Procurement	Procurement/Management Support	5%		$ 85,700	$ 85,700	FEL Guidance AFW
32	Tax	Sales Tax (Equipment Only)	7%		$ 33,680	$ 33,680	Indiana Sales Tax
33	Construction	Field Supervisor	1,200		$ 110	$ 132,000	Job Superintendent
34	Construction	Office Admin	960		$ 55	$ 52,800	Clerk/Inventory/Invoice/Payables
35	Construction	Safety	320		$ 75	$ 24,000	Part Time Safety manager
36	Construction	OH Profit	14%		$ 231,390	$ 231,390	AFW project guidance; contractor OH&P
37	**Subtotal Indirect Cost**					**$ 925,000**	

Table 5
CMA #1A Cost Estimate - Water Treatment - Excavation and IX@100 gpm
Water Treatment Treatability Study
Bailly Generating Station

Item No.	Category	Element	Quantity	Unit	Unit Cost	Cost	Note & Cost Basis
39	Contingency	Contingency				$ -	A 20% contingency is included for the entire CMA cost.
40					**CMA #1A - Total Installed Cost**	**$ 2,639,000**	
CMA #1A - Operating Cost							
Item No.	**Category**	**Element**	**Quantity**	**Unit**	**Unit Cost**	**Cost**	**Note**
1	Chemical, $/year	50% Caustic Tote	10	EA	$ 1,548	$ 15,480	Estimate based on flow
2	Chemical, $/year	93% Sulfuric Acid Tote	10	EA	$ 1,668	$ 16,680	estimate based on flow
3	Maintenance, $/year	Maintenance	1	LS	$ 79,170	$ 79,170	Engineering practices, weighted percent of capital cost (low in beginning of project), 3% of total installed cost
4	Electrical Operating Cost, $/year	Electrical Operating	326,748	kWh	$ 0.10	$ 32,675	Based on one line, 100 h.p, 6 months of year
5	Ion Exchange Resin, $/year	Material	1	LS	$ 55,000	$ 55,000	Allowance (DOW Conversation)
6	Labor to operate	Labor Contract	1,500	hours	$ 68	$ 102,000	Based on 50 hours per week x 26 weeks plus 200 hours during winter
7	Disposal of Backwash	Disposal	1,310,400	gallons	$ 0.30	$ 393,120	30 cents/gallon including hauling to Deep Well disposal, Backwash @ 5% of flow rate
8					**Total Annual Expense, $/year**	**$ 694,000**	
9					**CMA #1A - Lifecycle Cost (2 years)**	**$ 3,929,000**	5% discount rate applied

Table 5
CMA #1A Cost Estimate - Water Treatment - Excavation and IX@100 gpm
Water Treatment Treatability Study
Bailly Generating Station

Item No.	Category	Element	Quantity	Unit	Unit Cost	Cost	Note & Cost Basis
Salvage Costs (estimated by vendors)							
1	Equipment	Equalization Tank (10,000 Gal)	3	EA	$ 8,400	$ 25,199	Estimate @ 35% of original cost
2	Equipment	Backwash Waste Tank (10,000 Gal)	1	EA	$ 8,400	$ 8,400	Estimate @ 35% of original cost
3	Equipment	Effluent Tank (6,000 Gal)	1	EA	$ 4,009	$ 4,009	Estimate @ 35% of original cost
4	Equipment	Cartridge Filters	2	EA	$ 1,224	$ 2,447	Estimate @ 35% of original cost
5	Equipment	Ion Exchange Skid (Package) - Two (2) Contactors with Pneumatic Valves and Backwash Pumps	1	EA	$ 118,650	$ 118,650	Estimate @ 35% of original cost
8	Equipment	GW Treatment Feed Pumps (100 gpm @ 45 psi)	2	EA	$ 2,226	$ 4,453	Estimate @ 35% of original cost
9	Equipment	Effluent Transfer Pumps (100 gpm @ 45 psi)	2	EA	$ 2,226	$ 4,453	Estimate @ 35% of original cost
CMA #1A - Total Salvage Value						**$ 168,000**	

Table 6
CMA #1B Cost Estimate - Water Treatment - Excavation and RO@100 gpm
Water Treatment Treatability Study
Bailly Generating Station

CMA #1B - Capital Cost							
Item No.	**Category**	**Element**	**Quantity**	**Unit**	**Unit Cost**	**Cost**	**Note & Cost Basis**
1	Equipment	Equalization Tank (10,000 Gal)	3	EA	$ 23,999	$ 71,997	Bailiff Tank, Freight is not included, 3 Tanks used to allow tanks which can be isolated if any leaks occur. double wall no secondary containment required. Total volume of 30,000 gallons = 5 hours HRT if treatment goes down or is in backwash
2	Equipment	GW Treatment EQ Pumps (100 gpm @ 45 psi)	2	EA	$ 4,697	$ 9,394	DXP, freight is not included
3	Equipment	RO Package	1	EA	$ 529,500	$ 529,500	H2O Innovation Quote for Package System
4	Equipment	Media Filters	2	EA	Included in the RO Package quote	$ -	These remove colloidal particulate to protect the membranes
5	Equipment	Media Filter Backwash System (Skidded)	1	EA	Included in the RO Package quote	$ -	Transfer backwash to EQ Tank; EQ tank may be cleaned once per year
6	Equipment	RO Feed Tank (5,500 Gal)	1	EA	$ 11,455	$ 11,455	Reservoir for pump feed, Bailiff Tank, freight is not included
7	Equipment	Low Pressure Feed Pump (200 gpm@ 45 psi)	2	EA	$ 5,227	$ 10,454	Transfer pump for GW from media filters to RO Pumps
8	Equipment	Cartridge Filters	2	EA	Included in the RO Package quote	$ -	Protect membranes from debris; Suez, freight is not included
9	Equipment	RO Feed Pump (200 gpm @ 250 psi)	2	EA	Included in the RO Package quote	$ -	High Pressure RO Pump Stage 1; reject flows to Stage 2
10	Equipment	Primary RO Train	1	EA	Included in the RO Package quote	$ -	RO membranes
11	Equipment	RO CIP System	1	EA	Included in the RO Package quote	$ -	A system with dry chemical feed, which when mixed with effluent, is a solution to clean the membranes when off line for 30-60 minutes; cleaning frequency is typically 1/week
12	Equipment	Permeate Tank (6,000 Gal)	1	EA	$ 11,455	$ 11,455	Effluent from the RO which is pumped to effluent
13	Equipment	Reject Tank (10,000 Gal)	1	EA	$ 23,999	$ 23,999	Reject tank, holds sufficient liquid for two Tanker trips incase tanker is delayed; Bailiff Tank, freight is not included
14	Equipment	Permeate Transfer Pumps (100 gpm @ 45 psi)	2	EA	$ 4,697	$ 9,394	Permeate or effluent transfer pumps, DXP, freight is included
15	Equipment	Hydrochloric Acid Pump	1	EA	$ 1,154	$ 1,154	Added before the RO, Foust Marketing, freight is not included
16	Equipment	50% Caustic Pump	1	EA	$ 1,101	$ 1,101	Added to permeate to to raise pH, Foust Marketing, freight is not included

Table 6
CMA #1B Cost Estimate - Water Treatment - Excavation and RO@100 gpm
Water Treatment Treatability Study
Bailly Generating Station

Item No.	Category	Element	Quantity	Unit	Unit Cost	Cost	Note & Cost Basis
17	Equipment	Permeate Transfer Pumps (100 gpm @ 45 psi)	2	EA	$ 4,697	$ 9,394	Permeate or effluent transfer pumps from Stage 2, DXP, freight is included
18	Instrumentation	I&C Allowance	1	EA	$ 40,900	$ 40,900	This is raw cost of bubbled instruments not on vendor skids only.
CMA #1B - Capital Cost							
19	Instrumentation	Instrument Installation Allowance	1	EA	$ 122,700	$ 122,700	3X I&C Allowance
20	Civil-Structural	Pump Pedestals	11		$ 1,500	$ 16,500	RS Means 2017 facilities Cost Book (on line)
21	Civil-Structural	Treatment Building-Package	1	EA	$ 60,425	$ 60,425	Giles Incorporated Quote plus installation and HVAC allowance $27,000, building erection included
22	Civil-Structural	Site Preparation	1		$ 27,500	$ 27,500	RS Means 2017 facilities Cost Book (on line)
23	Civil-Structural	EQ and BW Tanks Foundation	1		$ 28,444	$ 28,444	Based on 30 x 40 slab on grade, 24" with 4' deep engineered fill RS Means 2017 Facilities Cost Book (on line)
24	Civil-Structural	Building Foundation	1		$ 39,253	$ 39,253	Based on 40 x 72 slab on grade, 18" with 3' deep engineered fill RS Means 2017 Facilities Cost Book (on line)
25	Civil-Structural	Backwash Waste Tank Foundation	1		$ -	$ -	Included in Tank Foundation above
26	Civil-Structural	Effluent Tank Foundation	1		$ -	$ -	Included in Tank Foundation above
27	Civil-Structural	Cartridge Filters Foundation	3		$ -	$ -	Included in building foundation above
28	Electrical	Electrical Material, Labor, and Equipment	1	LS	$ 345,000	$ 345,000	AMD (AFW) based on one line, included utility service, transformer, duct bank to building panel, build panel and equipment wiring
29	Mechanical	All Piping	1	EST	$ 180,000	$ 180,000	Based on line list using PVC piping
30	Mechanical	Pumps Installation	1	LS	$ 38,000	$ 38,000	Based on RS means, 2017, 4 man crew and truck, 10 days
31	Mechanical	Install all major equipment	1	LS	$ 228,000	$ 228,000	Based on RS means, 2017, 4 man crew and truck, 60 days
32					**Subtotal Direct Cost**	**$ 1,816,000**	

Table 6
CMA #1B Cost Estimate - Water Treatment - Excavation and RO@100 gpm
Water Treatment Treatability Study
Bailly Generating Station

Item No.	Category	Element	Quantity	Unit	Unit Cost	Cost	Note & Cost Basis
CMA #1B - Capital Cost							
33	Freight	Freight	6%	Factor	$ 42,684.54	$ 42,685	AFW project guidance
34	Bond	Bonds for Subcontractors	2%	Factor	$ 36,320	$ 36,320	AFW project guidance
35	OH	Contractor Insurance	2%	Factor	$ 36,320	$ 36,320	AFW project guidance
36	OH	Contractor Field, Office, and OH Expenses	5	LS	$ 1,750	$ 8,750	GE Offices
37	Engineering	Engineering design	15%	Factor	$ 272,400	$ 272,400	FEL Guidance AFW
38	Procurement	Procurement/Management Support	5%		$ 90,800	$ 90,800	FEL Guidance AFW
39	Tax	Sales Tax (Equipment Only)	7%		$ 51,114	$ 51,114	Indiana Sales Tax
40	Construction	Field Supervisor	1,200	hrs	$ 110	$ 132,000	Job Superintendent
41	Construction	Office Admin	960	hrs	$ 55	$ 52,800	Clerk/Inventory/Invoice/Payables
42	Construction	Safety	320	hrs	$ 75	$ 24,000	Part Time Safety manager
43	Construction	OH Profit	14%		$ 245,160	$ 245,160	AFW project guidance; contractor OH&P
44					**Subtotal Indirect Cost**	**$ 992,000**	
46	Contingency	Contingency				$ -	A 20% contingency is included for the entire CMA cost.
47					**CMA #1B - Total Installed Cost**	**$ 2,808,000**	

Table 6
CMA #1B Cost Estimate - Water Treatment - Excavation and RO@100 gpm
Water Treatment Treatability Study
Bailly Generating Station

Item No.	Category	Element	Quantity	Unit	Unit Cost	Cost	Note & Cost Basis
CMA #1B - Operating Cost							
1	Chemical, $/year	50% Caustic Tote	10	EA	$ 1,548	$ 15,480	
2	Chemical, $/year	93% Sulfuric Acid Tote	10	EA	$ 1,668	$ 16,680	
3	Maintenance, $/year	Maintenance			$ 84,240	$ 84,240	3% of total installed cost
4	Electrical Operating Cost, $/year	Electrical Operating	653,496	kWh	$ 0.10	$ 65,350	200 h.p. 6 months of year
5	PRO Membrane Cost, $/year	Material	1		$ -	$ -	This is the allocation to replace every 5 years; so there is no costs if the RO lasts <5 years
6	Secondary RO	Material	1		$ 30,000	$ 30,000	Based on one line
7	Labor to operate	Labor Contract	1,500	hours	$ 68	$ 102,000	Based on 50 hours per week x 26 weeks plus 200 hours during winter
8	Disposal of Backwash	Disposal	655,200	gallons	$ 0.30	$ 196,560	97.5% efficiency 30 cents/gallon including hauling to Deep Well disposal
9	**Total Annual Expense, $/year**					**$ 510,000**	
10	**CMA #1B - Lifecycle Cost (2 years)**					**$ 3,756,000**	5% discount rate applied

Table 6
CMA #1B Cost Estimate - Water Treatment - Excavation and RO@100 gpm
Water Treatment Treatability Study
Bailly Generating Station

Item No.	Category	Element	Quantity	Unit	Unit Cost	Cost	Note & Cost Basis
Salvage Costs (estimated by vendors)							
1	Equipment	Equalization Tank (10,000 Gal)	3	EA	$ 8,400	$ 25,199	Estimate @ 35% of original cost
2	Equipment	GW Treatment EQ Pumps (100 gpm @ 45 psi)	2	EA	$ 1,644	$ 3,288	Estimate @ 35% of original cost
3	Equipment	RO Package	1	EA	$ 185,325	$ 185,325	Estimate @ 35% of original cost
6	Equipment	RO Feed Tank (5,500 Gal)	1	EA	$ 4,009	$ 4,009	Estimate @ 35% of original cost
7	Equipment	Low Pressure Feed Pump (200 gpm@ 45 psi)	2	EA	$ 1,829	$ 3,659	Estimate @ 35% of original cost
12	Equipment	Permeate Tank (6,000 Gal)	1	EA	$ 4,009	$ 4,009	Estimate @ 35% of original cost
13	Equipment	Reject Tank (10,000 Gal)	1	EA	$ 8,400	$ 8,400	Estimate @ 35% of original cost
14	Equipment	Permeate Transfer Pumps (100 gpm @ 45 psi)	2	EA	$ 1,644	$ 3,288	Estimate @ 35% of original cost
18	Equipment	Permeate Transfer Pumps (100 gpm @ 45 psi)	2	EA	$ 1,644	$ 3,288	Estimate @ 35% of original cost
CMA #1B - Total Salvage Value						**$ 240,000**	

Table 7
CMA #6A Cost Estimate - Water Treatment - Encapsulation and IX@10 gpm
Water Treatment Treatability Study
Bailly Generating Station

CMA #6A - Capital Cost							
Item No.	**Category**	**Element**	**Quantity**	**Unit**	**Unit Cost**	**Cost**	**Note & Cost Basis**
1	Equipment	Equalization Tank (2,500 Gal)	1	EA	$ 6,539	$ 6,539	Bailiff Tank, Freight is not included, 1 Tank used; if that tank leaks or goes down inexpensive replacements are available on
2	Equipment	Backwash Waste Tank (2,500 Gal)	1	EA	$ 6,539	$ 6,539	Bailiff Tank, Freight is not included, 1 Tank used; if that tank leaks or goes down inexpensive replacements are available on
3	Equipment	Effluent Tank (1,200 Gal)	1	EA	$ 2,838	$ 2,838	Bailiff Tank, Freight is not included, 1 Tank used; if that tank leaks or goes down inexpensive replacements are available on
4	Equipment	Cartridge Filters	2	EA	$ 3,496	$ 6,992	Protects IX, Suez, Freight is not included
5	Equipment	Ion Exchange Skid (Package) - Two (2) Contactors with Pneumatic Valves and Backwash Pumps	1	EA	$ 166,000	$ 166,000	Trussell Technologies San Diego, CA (recomm
6	Equipment	Hydrochloric Acid Pump	1	EA	$ 692	$ 692	Foust Marketing, Freight is not included
7	Equipment	50% Caustic Pump	1	EA	$ 1,101	$ 1,101	Foust Marketing, Freight is not included
8	Equipment	GW Treatment Feed Pumps (10 gpm gpm @ 45 psi)	2	EA	$ 6,361	$ 12,722	25 gpm @ 45 psi quote DXP, Freight is not included
9	Equipment	Effluent Transfer Pumps (10 gpm @ 45 psi)	2	EA	$ 6,361	$ 12,722	25 gpm @ 45 psi quote DXP, Freight is not included
10	Instrumentation	I&C Allowance	1	EA	$ 29,700	$ 29,700	This is raw cost of bubbled instruments not on vendor skids only.
11	Equipment	Backwash Pump	1	EA	Included in IX skid	$ -	Part of IX skid
12	Instrumentation	Instrument Installation Allowance	1	EA	$ 89,100	$ 89,100	3X Instrument Installation Allowance
13	Civil-Structural	Pump Pedestals	6	EA	$ 1,500	$ 9,000	Means
14	Civil-Structural	Treatment Building-Package	1	EA	$ 60,425	$ 60,425	Giles Incorporated Quote plus installation and HVAC allowance $27,000, building erection included
15	Civil-Structural	Site Preparation	1	LS	$ 27,500	$ 27,500	Means
16	Civil-Structural	EQ and BW Tanks Foundation	1	LS	Included in bldg	$ -	Tanks in building (included)

Table 7
CMA #6A Cost Estimate - Water Treatment - Encapsulation and IX@10 gpm
Water Treatment Treatability Study
Bailly Generating Station

Item No.	Category	Element	Quantity	Unit	Unit Cost	Cost	Note & Cost Basis
17	Civil-Structural	Building Foundation	1	LS	$ 39,253	$ 39,253	Based on 40 x 72 slab on grade, 18" with 3' deep engineered fill RS Means 2017 Facilities Cost Book (on line)
18	Civil-Structural	Backwash Waste Tank Foundation	1	LS	Included above	$ -	Included in Tank Foundation above
19	Civil-Structural	Effluent Tank Foundation	1	EA	Included above	$ -	Included in Tank Foundation above
20	Civil-Structural	Cartridge Filters Foundation	3	EA	Included above	$ -	Included in building foundation above
21	Electrical	Electrical Material, Labor, and Equipment	1	LS	$ 135,000	$ 135,000	AMD (AFW) based on one line, included utility service, transformer, duct bank to building panel, build panel and equipment wiring
22	Mechanical	All Piping	1	LS	$ 140,000	$ 140,000	Based on line list using PVC piping
23	Mechanical	Pumps Installation	1	LS	$ 30,400	$ 30,400	Based on RS means, 2017, 4 man crew and truck, 8 days
24	Mechanical	Install all major equipment	1	LS	$ 171,000	$ 171,000	Based on RS means, 2017, 4 man crew and truck, 45 days
25					**Subtotal Direct Cost**	**$ 948,000**	Items directly related to construction

Table 7
CMA #6A Cost Estimate - Water Treatment - Encapsulation and IX@10 gpm
Water Treatment Treatability Study
Bailly Generating Station

Item No.	Category	Element	Quantity	Unit	Unit Cost	Cost	Note & Cost Basis
CMA #6A - Indirect Capital Costs							
26	Freight	Freight	6%	Factor	$ 14,750.65	$ 14,751	AFW project guidance
27	Bond	Bonds for Subcontractors	2%	Factor	$ 18,960	$ 18,960	AFW project guidance
28	OH	Contractor Insurance	2%	Factor	$ 18,960	$ 18,960	AFW project guidance
29	OH	Contractor Field, Office, and OH Expenses	5	LS	$ 1,750	$ 8,750	GE Offices
30	Engineering	Engineering design	15%	Factor	$ 142,200	$ 142,200	FEL Guidance AFW
31	Procurement	Procurement/Management Support	5%		$ 47,400	$ 47,400	FEL Guidance AFW
32	Tax	Sales Tax (Equipment Only)	7%		$ 15,130.09	$ 15,130	Indiana Sales Tax
33	Construction	Field Supervisor	1,200		$ 110	$ 132,000	Job Superintendent
34	Construction	Office Admin	960		$ 55	$ 52,800	Clerk/Inventory/Invoice/Payables
35	Construction	Safety	640		$ 75	$ 48,000	Full Time Safety manager
36	Construction	OH Profit	14%		$ 127,980	$ 127,980	AFW project guidance; contractor OH&P
37	**Subtotal Indirect Cost**					**$ 627,000**	
39	Contingency	Contingency				$ -	A 20% contingency is included for the entire CMA cost.
40	**CMA #6A - Total Installed Cost**					**$ 1,575,000**	

Table 7
CMA #6A Cost Estimate - Water Treatment - Encapsulation and IX@10 gpm
Water Treatment Treatability Study
Bailly Generating Station

Item No.	Category	Element	Quantity	Unit	Unit Cost	Cost	Note & Cost Basis
CMA #6A - Operating Cost							
1	Chemical, $/year	50% Caustic Tote	1	EA	$ 1,548	$ 1,548	estimate based on flow
2	Chemical, $/year	93% Sulfuric Acid Tote	1	EA	$ 1,668	$ 1,668	estimate based on flow
3	Maintenance, $/year	Maintenance	1	LS	$ 47,250	$ 47,250	Engineering practices, weighted percent of capital cost (low in beginning of project), 3% of total installed cost
4	Electrical Operating Cost, $/year	Electrical Operating	653,496	kWh	$ 0.10	$ 65,350	Based on one line, 100 h.p. operating 24/7/365
5	Ion Exchange Resin, $/year	Material	1	LS	$ 25,000	$ 25,000	Allowance (DOW Conversation)
6	Labor to operate	Labor Contract	2,180	hours	$ 68	$ 148,240	Based on 40 hours per week x 52 weeks plus 100 hours emergency
7	Disposal of Backwash	Disposal	262,080	gallons	$ 0.30	$ 78,624	30 cents/gallon including hauling to Deep Well disposal
8	**Total Annual Expense, $/year**					**$ 368,000**	
9	**CMA #6A - Lifecycle Cost (30 years)**					**$ 7,232,000**	5% discount rate applied

Table 8
CMA #6B Cost Estimate - Water Treatment - Encapsulation and RO@10 gpm
Water Treatment Treatability Study
Bailly Generating Station

CMA #6B - Capital Cost							
Item No.	**Category**	**Element**	**Quantity**	**Unit**	**Unit Cost**	**Cost**	**Note & Cost Basis**
1	Equipment	Equalization Tank (2,500 Gal)	1	EA	$ 6,539	$ 6,539	Bailiff Tank, freight is not included
2	Equipment	GW Treatment EQ Pumps (10 gpm @ 45 psi)	2	EA	$ 6,361	$ 12,722	25 gpm @ 45 psi quote DXP, freight is not included
3	Equipment	RO Package	1	EA	$ 176,000	$ 176,000	H2O innovation Quote for package System
4	Equipment	Media Filter	2	EA	$ -	$ -	Included in the RO Package quote
5	Equipment	Media Filter Backwash System (Skidded)	1	EA	$ -	$ -	Included in the RO Package quote
6	Equipment	RO Feed Tank (55 Gal)	1	EA	$ 840	$ 840	75 Gal quote Baillif Tank, Freight is not included
7	Equipment	Low Pressure Feed Pump (20 gpm@ 45 psi)	2	EA	$ 6,361	$ 12,722	
8	Equipment	Cartridge Filters	2	EA	Included in the RO Package quote	$ -	Suez, Freight is not included
9	Equipment	RO Feed Pump (20 gpm @ 250 psi)	2	EA	Included in the RO Package quote	$ -	
10	Equipment	Primary RO Train	1	EA	Included in the RO Package quote	$ -	
11	Equipment	CIP System	1	EA	Included in the RO Package quote	$ -	
12	Equipment	Permeate Tank (1,200 Gal)	1	EA	$ 2,838	$ 2,838	
13	Equipment	Reject Tank (2,500 Gal)	1	EA	$ 6,539	$ 6,539	Bailiff Tank, Freight is not included
14	Equipment	Permeate Transfer Pumps (10 gpm @ 45 psi)	2	EA	$ 6,361	$ 12,722	DXP, Freight is included
15	Equipment	Hydrochloric Acid Pump	1	EA	$ 692	$ 692	Foust Marketing, freight is not included
16	Equipment	50% Caustic Pump	1	EA	$ 1,101	$ 1,101	Foust Marketing, freight is not included

Table 8
CMA #6B Cost Estimate - Water Treatment - Encapsulation and RO@10 gpm
Water Treatment Treatability Study
Bailly Generating Station

Item No.	Category	Element	Quantity	Unit	Unit Cost	Cost	Note & Cost Basis
17	Instrumentation	I&C Allowance	1	EA	$ 31,900	$ 31,900	This is raw cost of bubbled instruments not on vendor skids only.
18	Instrumentation	Instrument Installation Allowance	1	EA	$ 95,700	$ 95,700	3X I&C Allowance
19	Civil-Structural	Pump Pedestals	11	EA	$ 1,500	$ 16,500	RS Means 2017 facilities Cost Book (on line)
20	Civil-Structural	Treatment Building-Package	1	EA	$ 60,425	$ 60,425	Giles Incorporated Quote plus installation and HVAC allowance $27,000, building erection included
21	Civil-Structural	Site Preparation	1	LS	$ 27,500	$ 27,500	RS Means 2017 facilities Cost Book (on line)
22	Civil-Structural	EQ and BW Tanks Foundation	1	LS	$ 28,444	$ 28,444	Based on 30 x 40 slab on grade, 24" with 4' deep engineered fill RS Means 2017 Facilities Cost Book (on line)
23	Civil-Structural	Building Foundation	1	LS	$ 39,253	$ 39,253	Based on 40 x 72 slab on grade, 18" with 3' deep engineered fill RS Means 2017 Facilities Cost Book (on line)
24	Civil-Structural	Backwash Waste Tank Foundation	1	EA	$ -	$ -	Included in Tank Foundation above
25	Civil-Structural	Effluent Tank Foundation	1	EA	$ -	$ -	Included in Tank Foundation above
26	Civil-Structural	Cartridge Filters Foundation	3	EA	$ -	$ -	Included in building foundation above
23	Civil-Structural	Electrical Material, Labor, and Equipment	1	LS	$ 135,000	$ 135,000	AMD (AFW) based on one line, included utility service, transformer, duct bank to building panel, build panel and equipment wiring
24	Electrical	All Piping	1	EST	$ 140,000	$ 140,000	Based on line list using PVC piping
25	Mechanical	Pumps Installation	1	LS	$ 30,400	$ 30,400	Based on RS means, 2017, 4 man crew and truck, 10 days
26	Mechanical	Install all major equipment	1	LS	$ 228,000	$ 228,000	Based on RS means, 2017, 4 man crew and truck, 60 days
27					**Subtotal Direct Cost**	**$ 1,066,000**	

Table 8
CMA #6B Cost Estimate - Water Treatment - Encapsulation and RO@10 gpm
Water Treatment Treatability Study
Bailly Generating Station

Item No.	Category	Element	Quantity	Unit	Unit Cost	Cost	Note & Cost Basis
CMA #6B - Indirect Capital Cost							
28	Freight	Freight	6%	Factor	$ 15,876.88	$ 15,876.88	AFW project guidance
29	Bond	Bonds for Subcontractors	2%	Factor	$ 21,320	$ 21,320	AFW project guidance
30	OH	Contractor Insurance	2%	Factor	$ 21,320	$ 21,320	AFW project guidance
31	OH	Contractor Field, Office, and OH Expenses	5	LS	$ 1,750	$ 8,750	GE Offices
32	Engineering	Engineering design	15%	Factor	$ 159,900	$ 159,900	FEL Guidance AFW
33	Procurement	Procurement/Management Support	5%		$ 53,300	$ 53,300	FEL Guidance AFW
34	Tax	Sales Tax (Equipment Only)	7%		$ 16,290	$ 16,290	Indiana Sales Tax
35	Construction	Field Supervisor	1,200	HR	$ 110	$ 132,000	Job Superintendent
36	Construction	Office Admin	960	HR	$ 55	$ 52,800	Clerk/Inventory/Invoice/Payables
37	Construction	Safety	640	HR	$ 75	$ 48,000	Full time Safety manager
38	Construction	OH Profit	14%		$ 143,910	$ 143,910	AFW project guidance; contractor OH&P
39	**Subtotal Indirect Cost**					**$ 673,000**	
41	Contingency	Contingency				$ -	A 20% contingency is included for the entire CMA cost.
42	**CMA #6B - Total Installed Cost**					**$ 1,739,000**	

Table 8
CMA #6B Cost Estimate - Water Treatment - Encapsulation and RO@10 gpm
Water Treatment Treatability Study
Bailly Generating Station

Item No.	Category	Element	Quantity	Unit	Unit Cost	Cost	Note & Cost Basis
CMA #6B - Operating Cost							
1	Chemical, $/year	50% Caustic Tote	10	EA	$ 1,548	$ 15,480	
2	Chemical, $/year	93% Sulfuric Acid Tote	10	EA	$ 1,668	$ 16,680	
3	Maintenance, $/year	Maintenance	1	LS	$ 52,170	$ 52,170	3% of Total Installed Cost
4	Electrical Operating Cost, $/year	Electrical Operating	1,306,992	kWh	$ 0.10	$ 130,699	200 h.p., 365 days per year
5	PRO Membrane Cost , $/year	Material	1	LS	$ 12,500	$ 12,500	This is the allocation to replace every 5 years; so there is no costs if the RO lasts <5 years
6	Secondary RO	Material	1	LS	$ 30,000	$ 30,000	Based on one line
7	Labor to operate	Labor Contract	2,180	hours	$ 68	$ 148,240	Based on 40 hours per week x 52 weeks plus 100 hours emergency
8	Disposal of Backwash	Disposal	131,040	gallons	$ 0.30	$ 39,312	97.5% efficiency 30 cents/gallon including hauling to Deep Well disposal
9	**Total Annual Expense, $/year**					**$ 445,000**	
10	**CMA #6B - Lifecycle Cost (30 years)**					**$ 8,580,000**	5% discount rate applied

Attachment A

Process Flow Diagrams, Material Balance, and Equipment List

T-XXX1A & T-XXX1B & T-XXX1C EQUALIZATION TANKS (EACH)	P-XXX1A & P-XXX1B GW TREATMENT FEED PUMPS	C-XXX1A & C-XXX1B CARTRIDGE FILTERS	I-XXX1A CALCIUM ION EXCHANGE	I-XXX2A BORON ION EXCHANGE	P-XXX2A & P-XXX2B EFFLUENT TRANSFER PUMPS	T-XXX2A EFFLUENT TANK	T-XXX3A BACKWASH WASTE TANK	P-XXX3A BACKWASH PUMP
CAPACITY: 10,000 GAL	CAPACITY: 100 GPM @ 40 PSI	CAPACITY: 100 GPM	CAPACITY: 100 GPM	CAPACITY: 100 GPM	CAPACITY: 100 GPM @ 40 PSI	CAPACITY: 6,000 GAL	CAPACITY: 10,000 GAL	CAPACITY: TBD

GW PUMP(DIESEL)
CAPACITY: 200 GPM
@ 60 PSI

LEGEND:

- (2) MATERIAL BALANCE LOCATION
- (LIT) LEVEL INDICATING TRANSMITTER
- (PI) PRESSURE INDICATOR
- (AIT) ANALYZER TRANSMITTER
- (FIT) FLOW TRANSMITTER
- (FV) FLOW CONTROL VALVE
- FLOW CONTROL VALVE
- (FE) FLOW METER
- (FC) FLOW CONTROLLER
- (AI) ANALYZER INDICATOR
- (LI) LEVEL INDICATOR
- (LC) LEVEL CONTROLLER
- DRAIN OR VACUUM TRUCK
- ACTUATOR OR
- BUTTERFLY VALVE

ACID TOTE
ACID DOSING PUMP
CAUSTIC TOTE
CAUSTIC FEED PUMP
VENT
T-XXX1A/ T-XXX1B/ T-XXX1C
EQUALIZATION TANK
2x24" MANWAY
3 EQ TANKS: T-XXX1A, T-XXX1B, AND T-XXX1C
DEWATERING/ LEACHATE FLOW
GW PUMP
VACUUM TRUCK
P-XXX1A
GW TREATMENT FEED PUMPS
P-XXX1B
C-XXX1A
C-XXX1B
CARTRIDGE FILTERS
SERVICE IN
BACKWASH OUT
I-XXX1A
CALCIUM ION EXCHANGE
DRAIN
BACKWASH IN
SERVICE OUT
I-XXX2A
BORON ION EXCHANGE
BACKWASH OUT
T-XXX3A
BACKWASH WASTE TANK
EVAPORATION OR DEEP INJECTION WELL
VACCUM TRUCK
T-XXX2A
EFFLUENT TANK
BACKWASH PUMP
P-XXX3A
P-XXX2A
EFFLUENT TRANSFER PUMPS
P-XXX2B
DISCHARGE

NOTES:

GROUNDWATER (GW) PUMP MANUAL OR LEVEL CONTROL OF DEWATERING AREA.

FLOW IS SET BY PLC
i) DUAL TRANSFER PUMPS (LEAD-LAG)
ii) SINGLE FLOW METER + FLOW CONTROL VALVE (FCV)
iii) DUAL CARTRIDGE FILTER

NOTES:

NO.	REVISION	DATE	DRAWN	CHECKED	TA	HSE	APP'D	CLIENT
			/	/				
			/	/				
			/	/				
			/	/				
			/	/				
			/	/				
			/	/				
			/	/				

SEAL

amec foster wheeler

ENGINEER S.M.	DATE JAN 2018	SCALE N.T.S.
DRAWN P.R.V.	DATE JAN 2018	SHEET OF
CHECKED	DATE	JOB NO. 377882016
APPROVED	DATE	VPE NO.
CLIENT APPR	DATE	CLIENT
AMEC NO.		VERSION

NIPSCO BAILLY

PROCESS FLOW DIAGRAM GROUNDWATER TREATMENT - OPTION 1A FLOW = 100 GPM, 24 MONTHS

DRAWING NO. PFD-01A

REV.

T-XXX1A & T-XXX1B & T-XXX1C
EQUALIZATION TANKS (EACH)
CAPACITY: 10,000 GAL

P-XXX1A & P-XXX1B
EQUALIZATION PUMPS
CAPACITY: 100 GPM @ 40 PSI

C-XXX1A & C-XXX1B
MEDIA FILTERS
CAPACITY: 200 GPM

P-XXX2A & P-XXX2B
LOW PRESSURE RO FEED PUMPS
CAPACITY: 200 GPM @ 40 PSI

T-XXX2A
RO FEED TANK
CAPACITY: 5,500 GAL

T-XXX3A
PERMEATE TANK
CAPACITY: 6,000 GAL

T-XXX4A
REJECT TANK
CAPACITY: 10,000 GAL

P-XXX4A & P-XXX4B
PERMEATE TRANSFER PUMPS
CAPACITY: 100 GPM @ 40 PSI

T-XXX5A
CIP TANK
CAPACITY: 2000 GAL

P-XXX6A
CIP PUMP
CAPACITY: TBD

C-XXX3A
CARTRIDGE FILTER
CAPACITY: TBD

GW PUMP(DIESEL)
CAPACITY: 200 GPM
@ 60 PSI

C-XXX2A & C-XXX2B
CARTRIDGE FILTERS
CAPACITY: 200 GPM

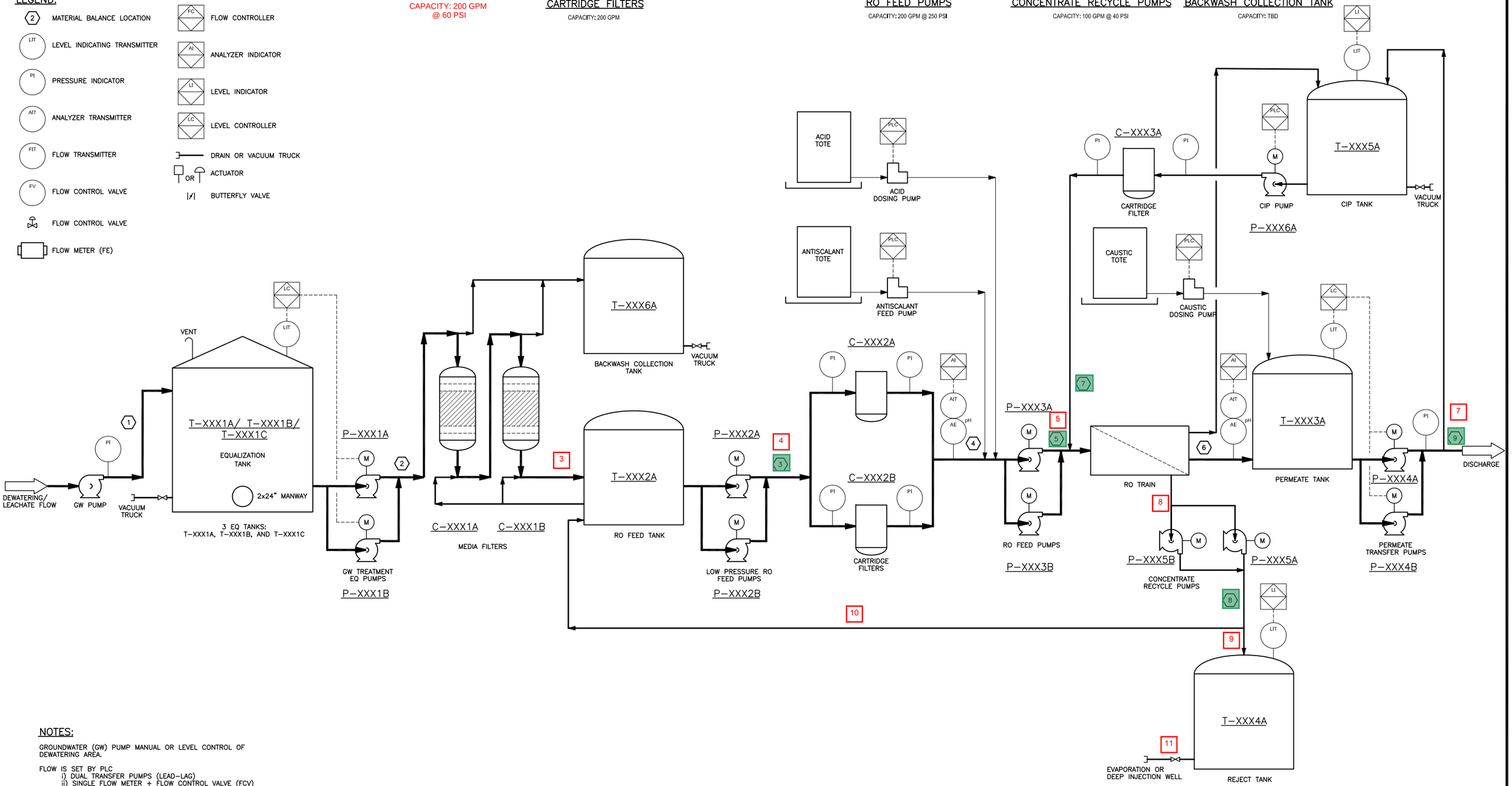
P-XXX3A & P-XXX3B
RO FEED PUMPS
CAPACITY: 200 GPM @ 250 PSI

P-XXX5A & P-XXX5B
CONCENTRATE RECYCLE PUMPS
CAPACITY: 100 GPM @ 40 PSI

T-XXX6A
BACKWASH COLLECTION TANK
CAPACITY: TBD

LEGEND:

- (2) MATERIAL BALANCE LOCATION
- LIT — LEVEL INDICATING TRANSMITTER
- PI — PRESSURE INDICATOR
- AIT — ANALYZER TRANSMITTER
- FIT — FLOW TRANSMITTER
- FV — FLOW CONTROL VALVE
- FLOW CONTROL VALVE
- FLOW METER (FE)
- FC — FLOW CONTROLLER
- AI — ANALYZER INDICATOR
- LI — LEVEL INDICATOR
- LC — LEVEL CONTROLLER
- DRAIN OR VACUUM TRUCK
- OR — ACTUATOR
- BUTTERFLY VALVE



NOTES:

GROUNDWATER (GW) PUMP MANUAL OR LEVEL CONTROL OF DEWATERING AREA.

FLOW IS SET BY PLC
- i) DUAL TRANSFER PUMPS (LEAD-LAG)
- ii) SINGLE FLOW METER + FLOW CONTROL VALVE (FCV)
- iii) DUAL CARTRIDGE FILTER

NOTES:

NO.	REVISION	DATE	DRAWN	CHECKED	TA	HSE	APP'D	CLIENT
			/	/				

SEAL

amec foster wheeler

ENGINEER	S.M.	DATE JAN 2018	SCALE N.T.S.
DRAWN	P.R.V.	DATE JAN 2018	SHEET OF
CHECKED		DATE	JOB NO. 377882016
APPROVED		DATE	VPE NO.
CLIENT APPR		DATE	CLIENT
AMEC NO.			VERSION

NIPSCO BAILLY

PROCESS FLOW DIAGRAM
GROUNDWATER TREATMENT - OPTION 1B
FLOW = 100 GPM, 24 MONTHS

DRAWING NO. PFD-01B

REV.

AFW Contract No.: 377882016
Doc. No.: 377882016 - Mass Balance
Date: 1/24/208
Revision

MATERIAL BALANCE

Bailly Groundwater Treatment-FEL-2

Chesterton,IN

Revision Index

REV	DATE	PREPARED BY	CHECKED BY	APPROVED BY	DESCRIPTION
A	1/25/2018	SM	JAC		Issued for Internal

amec foster wheeler

MASS BALANCE
OPTION #1A - ION EXCHANGE
(100 gpm , 2 years)

Unit No: NA
Unit Name: Option 1A
PFG No.
PFG Name
Train

	Stream ID	1	2	3	4	5	6	7	8	9	10	11
Description		Flow to EQ Tank	Feed to Cartridges	Feed to Calcium IX	Feed to Boron IX	Feed to Effluent Tank	Discharge	Backwash Flow To Calcium IX	Backwash Flow to Boron IX	Backwash out from Calcium IX to Backwash Waste Tank	Backwash out from Boron IX to Backwash Waste Tank	Backwash Waste Effluent
Flow (Design)	gpm	100	100	100	100	90	90	INT	INT	INT	INT	INT
Flow (Design)	gpd	144,000	144,000	144,000	144,000	129,600	129,600	7,200	7,200	7,200	7,200	14,400
ALUMINUM	ug/L	332	332	332	332	332	332	332	332			332
	lb/day	0	0	0	0	0	0	0	0			
ARSENIC	ug/L	154	154	154	74	37	37	37	37			1,210
	lb/day	0	0	0	0	0	0	0	0			
BORON	ug/L	5,523	5,523	5,523	5,523	442	442	442	442			51,257
	lb/day	7	7	7	7	7	1	1	1			
CADMIUM	ug/L	1	1	1	0	0	0	0	0			6
	lb/day	0	0	0	0	0	0	0	0			
CALCIUM METAL	ug/L	114,667	114,667	114,667	55,040	55,040	55,040	55,040	55,040			651,307
	lb/day	138	138	138	66	66	66	66	66			
CHROMIUM	ug/L	2	2	2	1	1	1	1	1			14
	lb/day	0	0	0	0	0	0	0	0			
COPPER	ug/L	4	4	4	2	2	2	2	2			24
	lb/day	0	0	0	0	0	0	0	0			
IRON	ug/L	653	653	653	314	314	314	314	314			3,711
	lb/day	1	1	1	0	0	0	0	0			
LEAD	ug/L	5	5	5	2	2	2	2	2			29
	lb/day	0	0	0	0	0	0	0	0			
MAGNESIUM	ug/L	23,333	23,333	23,333	11,667	11,667	11,667	11,667	11,667			128,333
	lb/day	28	28	28	14	14	14	14	14			
MANGANESE	ug/L	100	100	100	48	48	48	48	48			570
	lb/day	0	0	0	0	0	0	0	0			
MERCURY	ug/L	0	0	0	0	0	0	0	0			1
	lb/day	0	0	0	0	0	0	0	0			
MOLYBDENUM	ug/L	495	495	495	237	237	237	237	237			2,810
	lb/day	1	1	1	0	0	0	0	0			
POTASSIUM	ug/L	15,900	15,900	15,900	15,900	15,900	15,900	15,900	15,900			15,900
	lb/day	19	19	19	19	19	19	19	19			
SELENIUM	ug/L	35	35	35	17	17	17	17	17			197
	lb/day	0	0	0	0	0	0	0	0			
SILVER	ug/L	6	6	6	3	3	3	3	3			34
	lb/day	0	0	0	0	0	0	0	0			
SODIUM	ug/L	8,800	8,800	8,800	8,800	8,800	8,800	8,800	8,800			8,800
	lb/day	11	11	11	11	11	11	11	11			
ZINC	ug/L	19	19	19	19	19	19	19	19			19
	lb/day	0	0	0	0	0	0	0	0			
Sulfate	ug/L	71,333	71,333	71,333	71,333	71,333	71,333	71,333	71,333			71,333
	lb/day	86	86	86	86	86	86	86	86			
Total Organic Carbon (TOC)	ug/L	2,510	2,510	2,510	2,510	2,510	2,510	2,510	2,510			2,510
	lb/day	3	3	3	3	3	3	3	3			
Ammonia	ug/L	1,260	1,260	1,260	1,260	1,260	1,260	1,260	1,260			1,260
	lb/day	2	2	2	2	2	2	2	2			
Phosphorus	ug/L	89	89	89	89	89	89	89	89			89
	lb/day	0	0	0	0	0	0	0	0			
Total Suspended Solids (TSS)	ug/L	5,333	5,333	5,333	5,333	5,333	5,333	5,333	5,333			5,333
	lb/day	6	6	6	6	6	6	6	6			
Total Dissolved Solids (TDS) (Calculated)	ug/L	242,705	242,705	242,705	170,643	170,643	165,561	165,561	165,561			
	lb/day	291	291	291	205	205	199	199	199			
pH		8	8	8								

Notes :

1. Backwash flow is assumed 15% of flow
2. Calcium IX removal efficiency is assumed 52% based on DOW pilot study with Dowex Marathon Resin; resin required is estimated 6212.4 lbs/year
3. Boron IX removal efficiency is assumed 92% for Boron
4. Backwash is from effluent tank
5. Assumed the whole ion from IX resins is removed during backwash

amec foster wheeler

MASS BALANCE
OPTION #1B - RO
(100 gpm , 2 years)

Unit No: NA
Unit Name: Option 1B
PFG No.
PFG Name
Train

	EQ Tank	Media Filter				RO					
Assumptions for Flow Balance		**5%** Backwash				**95%** *Recovery*					
Assumptions for Mass Balance	**10%** TSS Removal	**50%** TSS Removal				**95%** *TDS Removal*	**100%** TSS Removal				

	Stream ID	1	2	3	4	5	6	7	8	9	10	11
Description		Flow to EQ Tank	Media Filters Feed from EQ Tank	RO Feed Tank Feed from Media Filters	Feed to Cartridges Filters from Media Filters	Feed To RO Train	*Permeate from RO to Permeate Tank*	*Discharge*	Concentrate from RO	Reject from RO to Reject Tank	Recycle from RO Train to RO Feed Tank	Soild Disposal from Reject Tank
Flow (Design)	gpm	100	95	95	95	95	*95*	*95*	5	TBD	TBD	TBD
Flow (Design)	gpd	144,000	136,800	136,800	136,800	136,800	*136,800*	*136,800*	6,840			
ALUMINUM	ug/L	332	332	332	332	332	*17*	*17*	316			
	lb/day	0	0		0	0	*0*	*0*				
ARSENIC	ug/L	154	154	154	154	154	*8*	*8*	147			
	lb/day	0	0	0	0	0	*0*	*0*				
BORON	ug/L	5,523	5,523	5,523	5,523	5,523	*276*	*276*	5,247			
	lb/day	7	7	7	7	7	*0*	*0*				
CADMIUM	ug/L	1	1	1	1	1	*0*	*0*	1			
	lb/day	0	0	0	0	0	*0*	*0*				
CALCIUM METAL	ug/L	114,667	114,667	114,667	114,667	114,667	*5,733*	*5,733*	108,933			
	lb/day	138	138	138	138	138	*7*	*7*				
CHROMIUM	ug/L	2	2	2	2	2	*0*	*0*	2			
	lb/day	0	0	0	0	0	*0*	*0*				
COPPER	ug/L	4	4	4	4	4	*0*	*0*	4			
	lb/day	0	0	0	0	0	*0*	*0*				
IRON	ug/L	653	653	653	653	653	*33*	*33*	621			
	lb/day	1	1	1	1	1	*0*	*0*				
LEAD	ug/L	5	5	5	5	5	*0*	*0*	5			
	lb/day	0	0	0	0	0	*0*	*0*				
MAGNESIUM	ug/L	23,333	23,333	23,333	23,333	23,333	*1,167*	*1,167*	22,167			
	lb/day	28	28	28	28	28	*0*	*0*				
MANGANESE	ug/L	100	100	100	100	100	*5*	*5*	95			
	lb/day	0	0	0	0	0	*0*	*0*				
MERCURY	ug/L	0	0	0	0	0	*0*	*0*	0			
	lb/day	0	0	0	0	0	*0*	*0*				
MOLYBDENUM	ug/L	495	495	495	495	495	*25*	*25*	470			
	lb/day	1	1	1	1	1	*0*	*0*				
POTASSIUM	ug/L	15,900	15,900	15,900	15,900	15,900	*795*	*795*	15,105			
	lb/day	19	19	19	19	19	*1*	*1*				
SELENIUM	ug/L	35	35	35	35	35	*2*	*2*	33			
	lb/day	0	0	0	0	0	*0*	*0*				
SILVER	ug/L	6	6	6	6	6	*0*	*0*	6			
	lb/day	0	0	0	0	0	*0*	*0*				
SODIUM	ug/L	8,800	8,800	8,800	8,800	8,800	*440*	*440*	8,360			
	lb/day	11	11	11	11	11	*1*	*1*				
ZINC	ug/L	19	19	19	19	19	*1*	*1*	18			
	lb/day	0	0	0	0	0		*0*				
Sulfate	ug/L	71,333	71,333	71,333	71,333	71,333	*3,567*	*3,567*	67,767			
	lb/day	86	86	86	86	86	*4*	*4*				
Total Organic Carbon (TOC)	ug/L	2,510	2,510	2,510	2,510	2,510	*126*	*126*	2,385			
	lb/day	3	3	3	3	3	*0*	*0*				
Ammonia	ug/L	1,260	1,260	1,260	1,260	1,260	*63*	*63*	1,197			
	lb/day	2	2	2	2	2	*0*	*0*				
Phosphorus	ug/L	89	89	89	89	89	*4*	*4*	85			
	lb/day	0	0	0	0	0	*0*	*0*				
Total Suspended Solids (TSS)	ug/L	5,333	4,800	2,400	2,400	2,400	*0*	*0*	2,280			
	lb/day	6	6	6	6	6	*0*	*0*				
Total Dissolved Solids (TDS) (Calculated)	ug/L	242,705	242,705	242,373	242,373	242,373	10,409	*10,409*	230,254			
	lb/day	291	291	291	291	291	12	*12*				
pH		8	8	8								

AFW Contract No.:
Doc. No.: 317882016 - EQUIPMENT LIST
Date: 1/24/208
Revision

EQUIPMENT LIST

Bailly Groundwater Treatment

Chesterton,IN

Revision Index

REV	DATE	PREPARED BY	CHECKED BY	APPROVED BY	DESCRIPTION
A	11/6/2017	SM	JAC	JAC	Issued for Internal Review

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EQUIPMENT LIST
OPTION #1A
ION EXCHANGE (100 gpm, 2 years)

Unit No.
Unit Name
PFG No.
PFG Name
Train

Item Number	Designation	P&ID	No. Reqd.	Equipment Type	Rated Capacity	HP/RPM All @ 60Hz	Input VAC/ph/Hz	Current	Design Conditions		Dimensions		Volume	Materials	Weight	Internals	Notes	Info Source
									Temperature	Pressure	Width x Length	Height						
									Min. / Max.	Max. / Normal								
								[Amps]	[°F]	[psi(g)]	[ft.]	[ft.]	[gallons]		[pounds]			
1	GW Pump		1	Disel Pumps	200 gpm									R4R DV80 3"x3" Pump			This would be provided by the dewatering contrcator who would supply the well point and the trash pump; it would pump only on days so it designed to fill the EQ pumps at 200 gpm so the treatment system can opertae 24/7 at 100 gpm; in winter it woukld be demobilized	rain for rent
2	Equalization Tank		3	Tank	10,000 gallons	N/A	N/A	N/A	-20/110	ATM	11'-10" OD	16'- 10"	10,000	HDPE Double wall tank	4,650/88,000		The basis of design is to hold 4 hours flow at 100 gpm (100*60*4 = 24,000 gallons) Bailiff Tanks, New Caney, TX	1
3	Transfer Pump from Equalization Tank to Treatment Units		2	Pumps	100 gpm @ 45 psi	7.5	460/3/60	12.2	40/100	ATM/40 psig	2'-6" X 1-0"	1'- 0"		Ductile Cast Iron	1,500		DXP pumps (Goulds equivalent), transfer from EQ storage to Treatment Units	2
4	Cartridge Filters		2	Filter	100 gpm	N/A	N/A	N/A	40/100				N/A	Stainless Steel	1,000		10 Micron, with removable basket/thimbles, 2 required to one can be taken off line for change out	3
5	pH analyzer (control pH feed to contacts) Spool Sections		1	Spool piece configured for pH control, acid/base addition	100 gpm				40/100					Stainless Steel	250		JMD, Aransas Pass, TX	4
6	Ion Exchange Skid (Package)-two (2) Contactors with Pneumatic Valves and Backwash Pumps		1		100 gpm (10 psig head loss)	5	460/3/60	8.1	40/100	40/25				Stainless Steel			Hungerford Vessels and Control System	5
7	93% Sulfuric Acid		1	Chemical metering pump	50 gpd	2/	460/3/60	N/A	40/100	ATM				Plastic			LMI	2
8	Hydrochloric Acid tote		1	Tote	275 gallons	N/A			40/100	ATM			275	HDPE or PE			Tote and tote-tainer from eagle	2
9	50% caustic Pump		1	Chemical metering pump	50 gpd	2/	120/1/60		40/100					Plastic			LMI	2
10	50% caustic Tote		1	Tote	275 gallons	N/A	N/A	N/A	40/100	ATM			275	HDPE or PE	9,500		Tote and tote-tainer from eagle	2
11	Effluent Storage Tank		1	Tank	6,000 gallons	N/A	N/A	N/A	-20/110	ATM	10'-0" OD	15'- 2"	6,000	HDPE Double wall tank	2,790/52,800		The basis of design is to hold 1 hour flow at 100 gpm (100*60*1 = 6,000 gallons) Bailiff Tanks, New Caney, TX	
12	Effluent Transfer Pumps		2	Pumps	100 gpm @ 45 psi	7.5	120/1/60	12.2	40/100	ATM/40 psig	2'-6" X 1-0"	1'- 0"		Cast iron			DXP pumps (Goulds equivalent), transfer from Effluent Storage to Wetlands Area	2
13	Backwash Storage Tank		1	Tank	10,000 gallons	N/A	N/A	N/A	-20/110	ATM	11'-10" OD	16'- 10"	10,000	HDPE Double wall tank	4,650/88,000		The basis of design is to hold 7 days backwash which will be trucked off, from Bailiff Tanks, New Caney, TX	
14	Treatment Building-Package		1	See Building SOW	30' x 40' x 14' high with vestibule (airlock), motor room, treatment room, concrete floor	N.A	460/3/60	TBD										

General Notes: Weights given are preliminary, and to be updated with information from Vendor. Weights given are for empty and under operating conditions, unless otherwise stated.

Revision Legend	Info Source Legend
Modified	1 Drawing
~~Removed~~	2 Budgetary Quote
Added	3 Approved Document

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EQUIPMENT LIST
OPTION #1B
RO (100 gpm,2 year)

Unit No.
Unit Name
PFG No.
PFG Name
Train

Item Number	Designation	P&ID	No. Reqd.	Equipment Type	Rated Capacity	HP/RPM All @ 60Hz	Input VAC/ph/Hz	Current	Design Conditions		Dimensions		Volume	Materials	Weight	Internals	Notes	Info Source
									Temperature Min. / Max.	Pressure Max. / Normal	Width x Length	Height						
								[Amps]	[°F]	[psi(g)]	[ft.]	[ft.]	[gallons]		[pounds]			
1	GW Pump		1	Disel Pumps	200 gpm @ 60 psi									R4R DVB0 3"x3" Pump			This would be provided by the dewatering contractor who would supply the well point and the trash pump; it would pump only on days so it deisgned to fill the EQ pumps at 200 gpm so the treatment system can operate 24/7 at 100 gpm, in winter it would be demobilized	rain for rent
2	Equalization Tank		3	Tank	10,000	N/A	N/A	N/A	-20/110	ATM	11'-10" OD	16'- 10"	10,000	HDPE Double wall tank	4,650/88,000		The basis of design is to hold 4 hours flow at 100 gpm (100*60*4 = 24,000 gallons) Bailiff Tanks, New Caney, TX	1
3	Transfer Pump from Equalization Tank to Treatment Units		2	Pumps	100 gpm @ 45 psi	7.5	460/3/60	12.2	40/100	ATM/40 psig	2'- 6" X 1- 0"	1'- 0"		Ductile Cast Iron	1,500		DXP pumps (Goulds equivalent), transfer from EQ storage to Treatment Units	2
4	Cartridge Filters		2	Filter	100 gpm	N/A	N/A	N/A	40/100				N/A	Stainless Steel	1,000		10 Micron, with removable basket/thimbles, 2 required to one can be taken off line for change out	3
5	pH analyzer (control pH feed to contacts) Spool Sections		1	Spool piece configured for pH control, acid/base addition	100 gpm				40/100					Stainless Steel	250		JMD, Aransas Pass, TX	4
6	Low Pressure RO Feed pump		2	Pumps	200 gpm @ 45 psi	10	460/3/60	16.2										
7	Concentrate Recycle Pump		2	Pumps	100 gpm @ 45 psi	7.5	460/3/60	12.2	40/100	ATM/40 psig	2'- 6" X 1- 0"	1'- 0"	0.0	Ductile Cast Iron	1500.0			
8	RO Train Membrane Vessels		1	Vessels	100 gpm		N/A		40/100	40/25				Stainless Steel			Vendor TBD	5
9	RO Feed Tank		1	Tank	6,000 Gal	N/A	N/A	N/A	-20/110	ATM	10'-0" OD	15'- 2"	6,000	HDPE Double wall tank	2,790/52,800			
10	RO Feed Pump		2	Pumps	200 gpm @ 250 psi	53	460/3/60		40/100	ATM/40 psig				Ductile Cast Iron			Check	
11	RO Membrane Cleaning Tank		1	Tanks	TBD	TBD									TBD			
12	RO Membrane CIP Pump		1	Pump	TBD	5		8.1										
13	Media Filter		2	Filter	200 gpm													
14	Backwash Collection Tank		1	Tank	TBD								TBD					
15	RO System CIP Cartridge Filter		1	Filter	TBD	TBD												
16	93% Sulfuric Acid Pump		1	Chemical metering pump	50 gpd	2/	120/1/60	N/A	40/100	ATM				Plastic			LMI	2
17	93% Sulfuric Acid Tote		1	Tote	275 gallons	N/A			40/100	ATM				HDPE or PE			Tote and tote-tainer from eagle	2
18	50% caustic Pump		1	Chemical metering pump	50 gpd	2/	120/1/60		40/100					Plastic			LMI	2
19	50% caustic Tote		1	Tote	275 gallons	N/A	N/A	N/A	40/100	ATM				HDPE or PE	9,500		Tote and tote-tainer from eagle	2
20	Antiscalant Pump		1	Chemical metering pump	50 gpd	2/	120/1/60	N/A	40/100	ATM				Plastic			LMI	2
21	Antiscalant Tote			Tote	275 gallons	N/A	N/A	N/A	40/100	ATM				HDPE or PE	9,500		Tote and tote-tainer from eagle	2
22	Permeate Storage Tank		1	Tank	6,000 gallons	N/A	N/A	N/A	-20/110	ATM	10'-0" OD	15'- 2"	6,000	HDPE Double wall tank	2,790/52,800		The basis of design is to hold 1 hour flow at 100 gpm (100*60*1 = 6,000 gallons) Bailiff Tanks, New Caney, TX	
23	Effluent Transfer Pumps		2	Pumps	100 gpm @ 45 psi	7.5	460/3/60	12.2	40/100	ATM/40 psig	2'-6" X 1-0"	1'- 0"		Cast iron			DXP pumps (Goulds equivalent), transfer from Effluent Storage to Wetlands Area	2
24	Reject Tanks		1	Tank	10,000 gallons	N/A	N/A	N/A	-20/110	ATM	11'-10" OD	16'- 10"	10,000	HDPE Double wall tank	TBD		The basis of design is to hold 7 days backwash which will be trucked off, from Bailiff Tanks, New Caney, TX	
25	Treatment Building-Package		1	See Building SOW	30' x 40' x 14' high with vestibule (airlock), motor room, treatment room, concrete floor	N/A	460/3/60	TBD										

General Notes: Weights given are preliminary, and to be updated with information from Vendor. Weights given are for empty and under operating conditions, unless otherwise stated.

Revision Legend	Info Source Legend	
Modified	1	Drawing
~~Removed~~	2	Budgetary Quote
Added	3	Approved Document

GW Pumps
CAPACITY: 20 GPM
@ 60 PSI

T-XXX1A EQUALIZATION TANK
CAPACITY: 2,500 GAL

P-XXX1A & P-XXX1B GW TREATMENT FEED PUMPS
CAPACITY: 10 GPM@40 PSI
25 GPM@ 45 PSI

C-XXX1A & C-XXX1B CARTRIDGE FILTERS
CAPACITY: 10 GPM

I-XXX1A CALCIUM ION EXCHANGE
CAPACITY: 10 GPM

I-XXX2A BORON ION EXCHANGE
CAPACITY: 10 GPM

P-XXX2A & P-XXX2B EFFLUENT TRANSFER PUMPS
CAPACITY: 10 GPM@40 PSI
25 GPM@ 45 PSI

T-XXX2A EFFLUENT TANK
CAPACITY: 1,200 GAL

T-XXX3A BACKWASH WASTE TANK
CAPACITY: 2,500 GAL

P-XXX3A BACKWASH PUMP
CAPACITY: TBD

LEGEND:

- (2) MATERIAL BALANCE LOCATION
- LIT — LEVEL INDICATING TRANSMITTER
- PI — PRESSURE INDICATOR
- AIT — ANALYZER TRANSMITTER
- FIT — FLOW TRANSMITTER
- FV — FLOW CONTROL VALVE
- FLOW CONTROL VALVE
- FE — FLOW METER
- FC — FLOW CONTROLLER
- AI — ANALYZER INDICATOR
- LI — LEVEL INDICATOR
- LC — LEVEL CONTROLLER
- DRAIN OR VACUUM TRUCK
- ACTUATOR OR
- BUTTERFLY VALVE

ACID TOTE
ACID DOSING PUMP
CAUSTIC TOTE
CAUSTIC FEED PUMP
VENT
T-XXX1A EQUALIZATION TANK
2x24" MANWAY
DEWATERING/ LEACHATE FLOW
GW PUMP
VACUUM TRUCK
P-XXX1A
GW TREATMENT FEED PUMPS
P-XXX1B
C-XXX1A
C-XXX1B
CARTRIDGE FILTERS
SERVICE IN
BACKWASH OUT
BACKWASH OUT
I-XXX1A
CALCIUM ION EXCHANGE
I-XXX2A
BORON ION EXCHANGE
DRAIN
DRAIN
BACKWASH IN
SERVICE OUT
BACKWASH IN
SERVICE OUT
T-XXX3A
BACKWASH WASTE TANK
EVAPORATION OR DEEP INJECTION WELL
VACCUM TRUCK
T-XXX2A
EFFLUENT TANK
BACKWASH PUMP
P-XXX3A
P-XXX2A
EFFLUENT TRANSFER PUMPS
P-XXX2B
DISCHARGE

NOTES:

GROUNDWATER (GW) PUMP MANUAL OR LEVEL CONTROL OF DEWATERING AREA.

FLOW IS SET BY PLC
i) DUAL TRANSFER PUMPS (LEAD-LAG)
ii) SINGLE FLOW METER + FLOW CONTROL VALVE (FCV)
iii) DUAL CARTRIDGE FILTER

NOTES:

NO.	REVISION	DATE	DRAWN	CHECKED	TA	HSE	APP'D	CLIENT
			/	/				

SEAL

amec foster wheeler

ENGINEER S.M.	DATE JAN 2018	SCALE N.T.S.
DRAWN P.R.V.	DATE JAN 2018	SHEET OF
CHECKED	DATE	JOB NO. 377882016
APPROVED	DATE	VPE NO.
CLIENT APPR	DATE	CLIENT
AMEC NO.		VERSION

NIPSCO BAILLY

PROCESS FLOW DIAGRAM
GROUNDWATER TREATMENT - OPTION 2A
FLOW = 10 GPM, 30 YEARS

DRAWING NO. PFD-02A
REV.

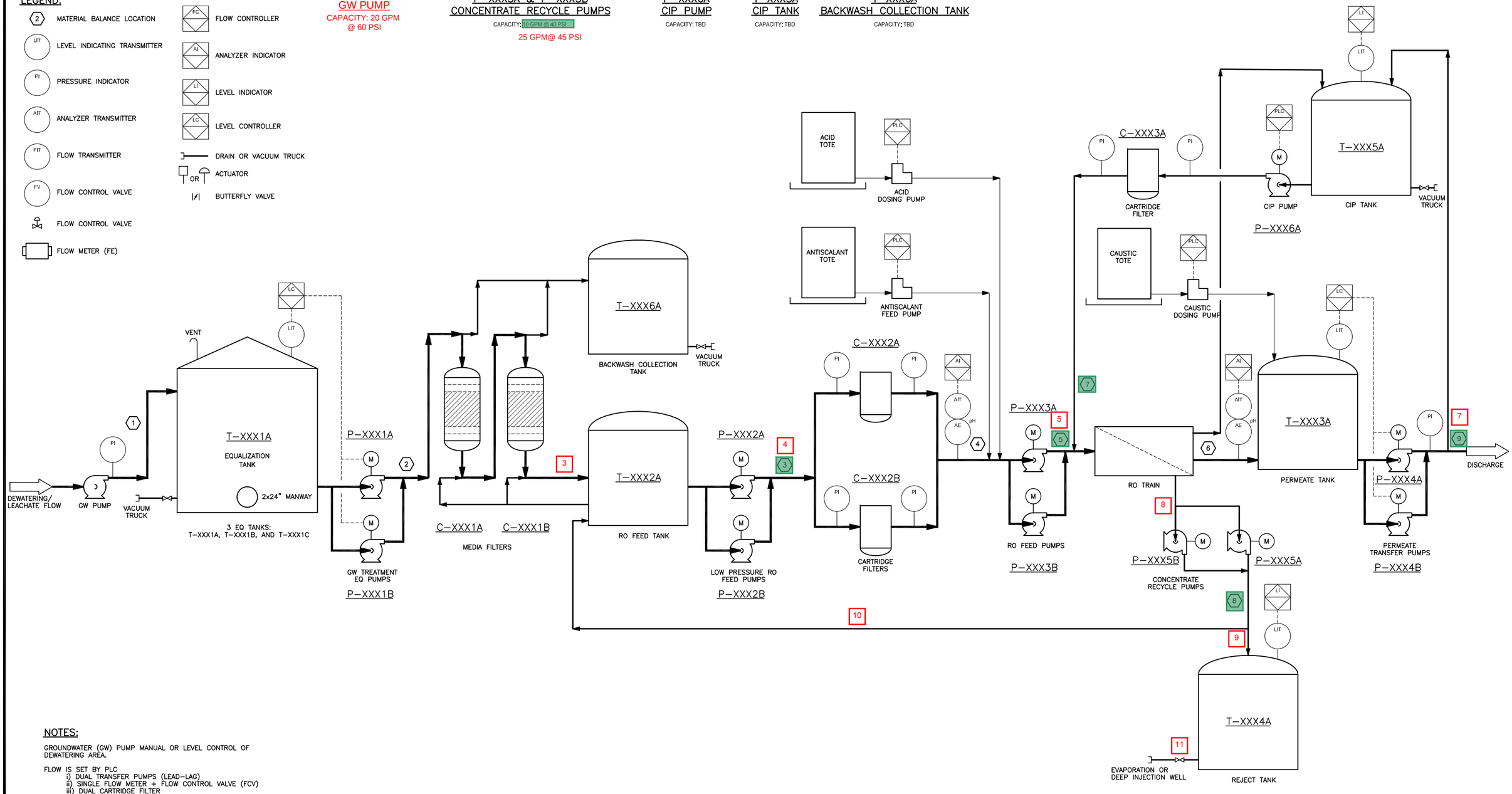
T-XXX1A EQUALIZATION TANK	P-XXX1A & P-XXX1B GW TREATMENT FEED PUMPS	C-XXX1A & C-XXX1B CARTRIDGE FILTERS	P-XXX3A & P-XXX3B RO FEED PUMPS	P-XXX2A & P-XXX2B LOW PRESSURE RO FEED PUMPS	C-XXX2A & C-XXX2B CARTRIDGE FILTERS	T-XXX2A RO FEED TANK	T-XXX3A PERMEATE TANK	T-XXX4A REJECT TANK	P-XXX4A & P-XXX4B PERMEATE TRANSFER PUMPS	C-XXX3A CARTRIDGE FILTER
CAPACITY: 2,500 GAL	CAPACITY: 10 GPM @ 40 PSI 25 GPM@ 45 PSI	CAPACITY: 20 GPM	CAPACITY: 20 GPM @ 250 PSI	CAPACITY: 20 GPM @ 40 PSI	CAPACITY: 20 GPM	CAPACITY: 55 GAL	CAPACITY: 1,200 GAL	CAPACITY: 2,500 GAL	CAPACITY: 10 GPM @ 40 PSI 25 GPM@ 45 PSI	CAPACITY: TBD

GW PUMP
CAPACITY: 20 GPM
@ 60 PSI

P-XXX5A & P-XXX5B CONCENTRATE RECYCLE PUMPS	P-XXX6A CIP PUMP	T-XXX5A CIP TANK	T-XXX6A BACKWASH COLLECTION TANK
CAPACITY: 10 GPM @ 40 PSI 25 GPM@ 45 PSI	CAPACITY: TBD	CAPACITY: TBD	CAPACITY: TBD

LEGEND:

- (2) MATERIAL BALANCE LOCATION
- LIT — LEVEL INDICATING TRANSMITTER
- PI — PRESSURE INDICATOR
- AIT — ANALYZER TRANSMITTER
- FIT — FLOW TRANSMITTER
- FV — FLOW CONTROL VALVE
- FLOW CONTROL VALVE
- FLOW METER (FE)
- FC — FLOW CONTROLLER
- AI — ANALYZER INDICATOR
- LI — LEVEL INDICATOR
- LC — LEVEL CONTROLLER
- DRAIN OR VACUUM TRUCK
- OR — ACTUATOR
- BUTTERFLY VALVE



NOTES:

GROUNDWATER (GW) PUMP MANUAL OR LEVEL CONTROL OF DEWATERING AREA.

FLOW IS SET BY PLC
- i) DUAL TRANSFER PUMPS (LEAD-LAG)
- ii) SINGLE FLOW METER + FLOW CONTROL VALVE (FCV)
- iii) DUAL CARTRIDGE FILTER

NOTES:

NO.	REVISION	DATE	DRAWN	CHECKED	TA	HSE	APP'D	CLIENT
			/	/				

SEAL

amec foster wheeler

ENGINEER S.M.	DATE JAN 2018	SCALE N.T.S.
DRAWN P.R.V.	DATE JAN 2018	SHEET OF
CHECKED	DATE	JOB NO. 377882016
APPROVED	DATE	VPE NO.
CLIENT APPR	DATE	CLIENT
AMEC NO.		VERSION

NIPSCO BAILLY

PROCESS FLOW DIAGRAM
GROUNDWATER TREATMENT – OPTION 2B
FLOW = 10 GPM, 30 YEARS

DRAWING NO. PFD-02B

REV.

AFW Contract No.: 377882016
Doc. No.: 377882016 - Mass Balance
Date: 1/24/208
Revision

MATERIAL BALANCE

Bailly Groundwater Treatment-FEL-2

Chesterton,IN

Revision Index

REV	DATE	PREPARED BY	CHECKED BY	APPROVED BY	DESCRIPTION
A	1/25/2018	SM	JAC		Issued for Internal

MASS BALANCE
OPTION #2A - ION EXCHANGE
(10 gpm , 30 years)

Unit No: NA
Unit Name: Option 2A
PFG No.
PFG Name
Train

Description	Stream ID	1 Flow to EQ Tank	2 Feed to Cartridges	3 Feed to Calcium IX	4 Feed to Boron IX	5 Feed to Effluent Tank	6 Discharge	7 Backwash Flow To Calcium IX	8 Backwash Flow to Boron IX	9 Backwash out from Calcium IX to Backwash Waste Tank	10 Backwash out from Boron IX to Backwash Waste Tank	11 Backwash Waste Effluent
Flow (Design)	gpm	10	10	10	10	9	9	INT	INT	INT	INT	INT
Flow (Design)	gpd	14,400	14,400	14,400	14,400	12,960	12,960	720	720	720	720	1,440
ALUMINUM	ug/L	332	332	332	332	332	332	332	332			332
	lb/day	0	0	0	0	0	0	0	0			
ARSENIC	ug/L	154	154	154	74	37	37	37	37			1,210
	lb/day	0	0	0	0	0	0	0	0			
BORON	ug/L	5,523	5,523	5,523	5,523	442	442	442	442			51,257
	lb/day	1	1	1	1	1	0	0	0			
CADMIUM	ug/L	1	1	1	0	0	0	0	0			6
	lb/day	0	0	0	0	0	0	0	0			
CALCIUM METAL	ug/L	114,667	114,667	114,667	55,040	55,040	55,040	55,040	55,040			651,307
	lb/day	14	14	14	7	7	7	7	7			
CHROMIUM	ug/L	2	2	2	1	1	1	1	1			14
	lb/day	0	0	0	0	0	0	0	0			
COPPER	ug/L	4	4	4	2	2	2	2	2			24
	lb/day	0	0	0	0	0	0	0	0			
IRON	ug/L	653	653	653	314	314	314	314	314			3,711
	lb/day	0	0	0	0	0	0	0	0			
LEAD	ug/L	5	5	5	2	2	2	2	2			29
	lb/day	0	0	0	0	0	0	0	0			
MAGNESIUM	ug/L	23,333	23,333	23,333	11,667	11,667	11,667	11,667	11,667			128,333
	lb/day	3	3	3	1	1	1	1	1			
MANGANESE	ug/L	100	100	100	48	48	48	48	48			570
	lb/day	0	0	0	0	0	0	0	0			
MERCURY	ug/L	0	0	0	0	0	0	0	0			1
	lb/day	0	0	0	0	0	0	0	0			
MOLYBDENUM	ug/L	495	495	495	237	237	237	237	237			2,810
	lb/day	0	0	0	0	0	0	0	0			
POTASSIUM	ug/L	15,900	15,900	15,900	15,900	15,900	15,900	15,900	15,900			15,900
	lb/day	2	2	2	2	2	2	2	2			
SELENIUM	ug/L	35	35	35	17	17	17	17	17			197
	lb/day	0	0	0	0	0	0	0	0			
SILVER	ug/L	6	6	6	3	3	3	3	3			34
	lb/day	0	0	0	0	0	0	0	0			
SODIUM	ug/L	8,800	8,800	8,800	8,800	8,800	8,800	8,800	8,800			8,800
	lb/day	1	1	1	1	1	1	1	1			
ZINC	ug/L	19	19	19	19	19	19	19	19			19
	lb/day	0	0	0	0	0	0	0	0			
Sulfate	ug/L	71,333	71,333	71,333	71,333	71,333	71,333	71,333	71,333			71,333
	lb/day	9	9	9	9	9	9	9	9			
Total Organic Carbon (TOC)	ug/L	2,510	2,510	2,510	2,510	2,510	2,510	2,510	2,510			2,510
	lb/day	0	0	0	0	0	0	0	0			
Ammonia	ug/L	1,260	1,260	1,260	1,260	1,260	1,260	1,260	1,260			1,260
	lb/day	0	0	0	0	0	0	0	0			
Phosphorus	ug/L	89	89	89	89	89	89	89	89			89
	lb/day	0	0	0	0	0	0	0	0			
Total Suspended Solids (TSS)	ug/L	5,333	5,333	5,333	5,333	5,333	5,333	5,333	5,333			5,333
	lb/day	1	1	1	1	1	1	1	1			
Total Dissolved Solids (TDS) (Calculated)	ug/L	242,705	242,705	242,705	170,643	170,643	165,561	165,561	165,561			
	lb/day	29	29	29	20	20	20	20	20			
pH		8	8	8								

Notes :

1. Backwash flow is assumed 15% of flow
2. Calcium IX removal efficiency is assumed 52% based on DOW pilot study with Dowex Marathon Resin; resin required is estimated 6212.4 lbs/year
3. Boron IX removal efficiency is assumed 92%
4. Backwash is from effluent tank
5. Assumed the whole ion from IX resins is removed during backwash

amec foster wheeler

MASS BALANCE
OPTION #2B - RO
(10 gpm , 30 years)

Unit No: NA
Unit Name: Option 1B
PFG No.
PFG Name
Train

	EQ Tank	Media Filter				RO					
Assumptions for Flow Balance		**5%** Backwash				**95%** *Recovery*					
Assumptions for Mass Balance	**10%** TSS Removal	**50%** TSS Removal				**95%** *TDS Removal*	**100%** TSS Removal				

	Stream ID	1	2	3	4	5	6	7	8	9	10	11
Description		Flow to EQ Tank	Media Filters Feed from EQ Tank	RO Feed Tank Feed from Media Filters	Feed to Cartridges Filters from Media Filters	Feed To RO Train	*Permeate from RO to Permeate Tank*	*Discharge*	Concentrate from RO	Reject from RO to Reject Tank	Recycle from RO Train to RO Feed Tank	Soild Disposal from Reject Tank
Flow (Design)	gpm	10	9.5	9.5	9.5	9.5	*9.5*	*9.5*	0	TBD	TBD	TBD
Flow (Design)	gpd	14,400	13,680	13,680	13,680	13,680	*13,680*	*13,680*	684			
ALUMINUM	ug/L	332	332	332	332	332	*17*	*17*	316			
	lb/day	0	0		0	0	*0*	*0*				
ARSENIC	ug/L	154	154	154	154	154	*8*	*8*	147			
	lb/day	0	0	0	0	0	*0*	*0*				
BORON	ug/L	5,523	5,523	5,523	5,523	5,523	*276*	*276*	5,247			
	lb/day	1	1	1	1	1	*0*	*0*				
CADMIUM	ug/L	1	1	1	1	1	*0*	*0*	1			
	lb/day	0	0	0	0	0	*0*	*0*				
CALCIUM METAL	ug/L	114,667	114,667	114,667	114,667	114,667	*5,733*	*5,733*	108,933			
	lb/day	14	14	14	14	14	*1*	*1*				
CHROMIUM	ug/L	2	2	2	2	2	*0*	*0*	2			
	lb/day	0	0	0	0	0	*0*	*0*				
COPPER	ug/L	4	4	4	4	4	*0*	*0*	4			
	lb/day	0	0	0	0	0	*0*	*0*				
IRON	ug/L	653	653	653	653	653	*33*	*33*	621			
	lb/day	0	0	0	0	0	*0*	*0*				
LEAD	ug/L	5	5	5	5	5	*0*	*0*	5			
	lb/day	0	0	0	0	0	*0*	*0*				
MAGNESIUM	ug/L	23,333	23,333	23,333	23,333	23,333	*1,167*	*1,167*	22,167			
	lb/day	3	3	3	3	3	*0*	*0*				
MANGANESE	ug/L	100	100	100	100	100	*5*	*5*	95			
	lb/day	0	0	0	0	0	*0*	*0*				
MERCURY	ug/L	0	0	0	0	0	*0*	*0*	0			
	lb/day	0	0	0	0	0	*0*	*0*				
MOLYBDENUM	ug/L	495	495	495	495	495	*25*	*25*	470			
	lb/day	0	0	0	0	0	*0*	*0*				
POTASSIUM	ug/L	15,900	15,900	15,900	15,900	15,900	*795*	*795*	15,105			
	lb/day	2	2	2	2	2	*0*	*0*				
SELENIUM	ug/L	35	35	35	35	35	*2*	*2*	33			
	lb/day	0	0	0	0	0	*0*	*0*				
SILVER	ug/L	6	6	6	6	6	*0*	*0*	6			
	lb/day	0	0	0	0	0	*0*	*0*				
SODIUM	ug/L	8,800	8,800	8,800	8,800	8,800	*440*	*440*	8,360			
	lb/day	1	1	1	1	1	*0*	*0*				
ZINC	ug/L	19	19	19	19	19	*1*	*1*	18			
	lb/day	0	0	0	0	0		*0*				
Sulfate	ug/L	71,333	71,333	71,333	71,333	71,333	*3,567*	*3,567*	67,767			
	lb/day	9	9	9	9	9	*0*	*0*				
Total Organic Carbon (TOC)	ug/L	2,510	2,510	2,510	2,510	2,510	*126*	*126*	2,385			
	lb/day	0	0	0	0	0	*0*	*0*				
Ammonia	ug/L	1,260	1,260	1,260	1,260	1,260	*63*	*63*	1,197			
	lb/day	0	0	0	0	0	*0*	*0*				
Phosphorus	ug/L	89	89	89	89	89	*4*	*4*	85			
	lb/day	0	0	0	0	0	*0*	*0*				
Total Suspended Solids (TSS)	ug/L	5,333	4,800	2,400	2,400	2,400	*0*	*0*	2,280			
	lb/day	1	1	1	1	1	*0*	*0*				
Total Dissolved Solids (TDS) (Calculated)	ug/L	242,705	242,705	242,373	242,373	242,373	10,409	*10,409*	230,254			
	lb/day	29	29	29	29	29	1	*1*				
pH		8	8	8								

AFW Contract No.:
Doc. No.: 317882016 - EQUIPMENT LIST
Date: 1/24/208
Revision

EQUIPMENT LIST

Bailly Groundwater Treatment

Chesterton,IN

Revision Index

REV	DATE	PREPARED BY	CHECKED BY	APPROVED BY	DESCRIPTION
A	11/6/2017	SM	JAC	JAC	Issued for Internal Review

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EQUIPMENT LIST
OPTION #2A
Ion Exchange (10 gpm,2 years)

Unit No.
Unit Name
PFG No.
PFG Name
Train

Item Number	Designation	P&ID	No. Reqd.	Equipment Type	Rated Capacity	HP/RPM All @ 60Hz	Input VAC/ph/Hz	Current	Design Conditions		Dimensions		Volume	Materials	Weight	Internals	Notes	Info Source
									Temperature	Pressure	Width x Length	Height						
									Min. / Max.	Max. / Normal								
								[Amps]	[°F]	[psi(g)]	[ft.]	[ft.]	[gallons]		[pounds]			
1	GW Pump		1	Pumps	20 gpm @ 60 psi	1.27	460/3/60	2.1						R4R DV80 3"x3" Pump			This would be provided by the dewatering contrcator who would supply the well point and the trash pump; it would pump only on days so it deisgned to fill the EQ pumps at 200 gpm so the treatment system can opertae 24/7 at 100 gpm; in winter it wouklld be demobilized	rain for rent
2	Equalization Tank		1	Tank	2,500 gallons	N/A	N/A	N/A	-20/110	ATM	8'-6" OD	8'- 4"	2,500	HDPE Double wall tank	1,160/21,950		The basis of design is to hold 4 hours flow at 10 gpm (100*60*4 = 2,400 gallons) Bailiff Tanks, New Caney, TX	1
3	Transfer Pump from Equalization Tank to Treatment Units		2	Pump	25 gpm @ 40 psi	5.00	460/3/60	8.1	40/100	ATM/40 psig				Ductile Cast Iron			DXP pumps (Goulds equivalent), transfer from EQ storage to Treatment Units	2
4	Cartridge Filters		2	Filter	10 gpm	N/A	N/A	N/A	40/100				N/A	Stainless Steel			10 Micron, with removable basket/thimbles, 2 required to one can be taken off line for change out	3
5	pH analyzer (control pH feed to contacts) Spool Sections		1	Spool piece configured for pH control, acid/base addition	10 gpm				40/100					Stainless Steel			JMD, Aransas Pass, TX	4
6	Ion Exchange Skid (Package)-two (2) Contactors with Pneumatic Valves and Backwash Pumps		1	Package unit containing skid, two 10000 gallon contactors, pneumatic valves and backwash pump	10 gpm (10 psig head loss)	5	460/3/60	8.1	40/100	40/25				Stainless Steel	TBD		Hungerford Vessels and Control System	5
7	93% Sulfuric Acid Pump		1	Chemical metering pump	5 gpd	2/	460/3/60	N/A	40/100	ATM				Plastic			LMI	2
8	Hydrochloric Acid tote		1	Tote	275 gallons	N/A		3	40/100	ATM			275	HSPE or PE			Tote and tote-tainer from eagle	2
9	50% caustic Pump		1	Chemical metering pump	5 gpd	2/	120/1/60		40/100					Plastic			LMI	2
10	50% caustic Tote		1	Tote	275 gallons	N/A	N/A	N/A	40/100	ATM			275	HDPE or PE			Tote and tote-tainer from eagle	2
11	Effluent Storage Tank		1	Tank	1,200 gallons	N/A	N/A	N/A	-20/110	ATM	7'-3" OD	8'- 0"	1,200	HDPE Double wall tank	558/10,566		The basis of design is to hold 1 hour flow at 10 gpm (10*60*1 = 600 gallons) Bailiff Tanks, New Caney, TX	
12	Effluent Transfer Pumps		2	Pumps	25 gpm @ 45 psi	5	120/1/60	8.1	40/100	ATM/40 psig				Cast iron			DXP pumps (Goulds equivalent), transfer from Effluent Storage to Wetlands Area	2
13	Backwash Storage Tank		1	Tank	2,500 gallons	N/A	N/A	N/A	-20/110	ATM	8'-6" OD	8'- 4"	2,500	HDPE Double wall tank	1,160/21,950		The basis of design is to hold 7 days backwash which will be trucked off, from Bailiff Tanks, New Caney, TX	
14	Treatment Building-Package		1	See Building SOW	30' x 40' x 14' high with vestibule (airlock), motor room, treatment room, concrete floor	N/A	460/3/60	TBD										

General Notes: Weights given are preliminary, and to be updated with information from Vendor. Weights given are for empty and under operating conditions, unless otherwise stated.

	Revision Legend			Info Source Legend														
	Modified		1	Drawing														
	~~Removed~~		2	Budgetary Quote														
	Added		3	Approved Document														

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EQUIPMENT LIST
OPTION #2B
ION EXCHANGE (10 gpm, 30 years)

Unit No.
Unit Name
PFG No.
PFG Name
Train

Item Number	Designation	P&ID	No. Reqd.	Equipment Type	Rated Capacity	HP/RPM All @ 60Hz	Input VAC/ph/Hz	Current	Design Conditions		Dimensions		Volume	Materials	Weight	Internals	Notes	Info Source
									Temperature	Pressure	Width x Length	Height						
									Min. / Max.	Max. / Normal								
								[Amps]	[°F]	[psi(g)]	[ft.]	[ft.]	[gallons]		[pounds]			
1	GW Pump		1	Pumps	20 gpm @ 60 psi	1.27	460/3/60	2.1						R4R DV80 3"x3" Pump			This would be provided by the dewatering contractor who would supply the well point and the trash pump. It would pump only on days so it deisgned to fill the EQ pumps at 200 gpm so the treatment system can opertae 24/7 at 100 gpm; in winter it would be demobilized	rain for rent
2	Equalization Tank		1	Tank	2,500 gallons	N/A	N/A	N/A	-20/110	ATM	8'-6" OD	8'- 4"	2,500	HDPE Double ~~wall~~ tank	1,160/21,950		The basis of design is to hold 4 hours flow at 10 gpm (100*60*4 = 2,400 gallons) Balliff Tanks, New Caney, TX	1
3	Transfer Pump from Equalization Tank to Treatment Units		2	Pump	25 gpm @ 45 psi	5	460/3/60	8.1	40/100	ATM/40 psig				Ductile Cast Iron			DXP pumps (Goulds equivalent), transfer from EQ storage to Treatment Units	2
4	Cartridge Filters		2	Filter	20 gpm	N/A	N/A	N/A	40/100				N/A	Stainless Steel			10 Micron, with removable basket/thimbles, 2 required to one can be taken off line for change out	3
5	pH analyzer (control pH feed to contacts) Spool Sections		1	Spool piece configured for pH control, acid/base addition	10 gpm				40/100					Stainless Steel			JMD, Aransas Pass, TX	4
6	Low Pressure RO Feed pump		2	Pumps	25 gpm @ 45 psi	5	460/3/60	8.1										
7	Concentrate Recycle Pump		2	Pumps	25 gpm @ 45 psi	5	460/3/60	8.1										
8	RO Train Membrane Vessels		1	Vessels	10 gpm		N/A		40/100	40/25				Stainless Steel			Vendor TBD	5
9	RO Feed Tank		1	Tank	75 Gal	N/A	N/A	N/A			2'-7" OD	4'- 2"	75	HDPE Double ~~wall~~ tank				
10	RO Feed Pump		2	Pumps	20 gpm @ 250 psi	5	460/3/60		40/100	ATM/40 psig				Ductile Cast Iron				
11	RO Membrane Cleaning Tank		1	Tanks	TBD													
12	RO Membrane CIP Pump		1	Pumps		5		8.1										
13	Media Filter		2	Filter	20 gpm													
14	Media Filter Backwash Collection Tank		1	Tank	TBD								TBD					
15	RO System CIP Cartridge Filter		1	Filter	TBD	TBD												
16	Hydrochloric Acid Pump		1	Chemical metering pump	5 gpd	2/	120/1/60	N/A	40/100	ATM				Plastic			LMI	2
17	93% Sulfuric Acid tote		1	Tote	275 gallons	N/A	N/A		40/100	ATM				HSPE or PE			Tote and tote-tainer from eagle	2
18	50% caustic Pump		1	Chemical metering pump	5 gpd	2/	120/1/60		40/100					Plastic			LMI	2
19	50% caustic Tote		1	Tote	275 gallons	N/A	N/A	N/A	40/100	ATM				HDPE or PE	9,500		Tote and tote-tainer from eagle	2
20	Antiscalant Pump		1	Chemical metering pump	5 gpd	2/	120/1/60	N/A	40/100	ATM				Plastic			LMI	2
21	Antiscalant Tote			Tote	275 gallons	N/A	N/A	N/A	40/100	ATM				HDPE or PE			Tote and tote-tainer from eagle	2
22	Permeate Storage Tank		1	Tank	1,200 gallons	N/A	N/A	N/A	0	ATM	7'-3" OD	8'- 0"	1,200	HDPE Double ~~wall~~ tank	558/10,566		The basis of design is to hold 1 hour flow at 10 gpm (10*60*1 = 600 gallons) Balliff Tanks, New Caney, TX	
23	Reject Tank		1	Tank	2,500 gallons	N/A	N/A	N/A	-20/110	ATM	8'-6" OD	8'- 4"	2,500	HDPE Double ~~wall~~ tank	0		The basis of design is to hold 7 days backwash which wil be trucked off, from Balliff Tanks, New Caney, TX	
24	Effluent Transfer Pumps		2	Pumps	25 gpm @ 45 psi	5	460/3/60	8.1	40/100	ATM/40 psig				Cast iron			DXP pumps (Goulds equivalent), transfer from Effluent Storage to Wetlands Area	2
25	Treatment Building-Package		1	See Building SOW	30' x 40' x 14' high with vestibule (airlock), motor room, treatment room, concrete floor	N/A	460/3/60	TBD		40/20				Ductile Cast Iron				

General Notes: Weights given are preliminary, and to be updated with information from Vendor. Weights given are for empty and under operating conditions, unless otherwise stated.

Revision Legend	Info Source Legend
Modified	1 Drawing
~~Removed~~	2 Budgetary Quote
Added	3 Approved Document

Attachment B

Equipment Data and Cost Quotes

GE Power & Water
Water & Process Technologies

Fact Sheet

Hytrex*

Depth Cartridge Filters

Figure 1 : Hytrex Depth Cartridge Filters

Description and Use

The purity and reliability of Hytrex* cartridge filters (Figure 1) ensure consistent results, time after time. Thermally bonded micro fibers create a strong secure cartridge that traps particles throughout its depth. Hytrex combines efficiency, long life and purity to create a high performance depth filter.

- Pure polypropylene construction
- Fast rinse-up in high purity applications
- Meets the requirement of the FDA Title 21 of the Code of Federal Regulations 174.5 and relevant subparts of 177
- Wide chemical compatibility
- Automated packaging for a clean finished product
- NSF Standard 42 certified

Typical Applications

- High Purity Chemicals
- Bottled Water
- Pre-treatment for Reverse Osmosis
- Oil & Gas
- Electronics

Consistent Performance

Patented, continuous process assures consistent product performance. Lot-to-lot, order-to-order, strict quality control assures repeatability. Figures 2 and 3 give greater detail of the high flow rate at low pressure drop for the various sizes of Hytrex filters.

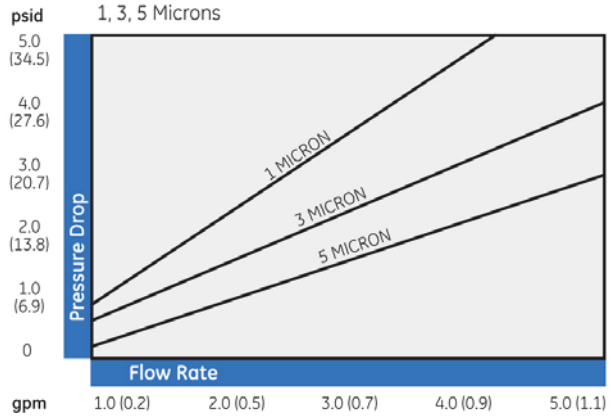

Figure 2: High Flow Rate at Low Pressure Drop[1]

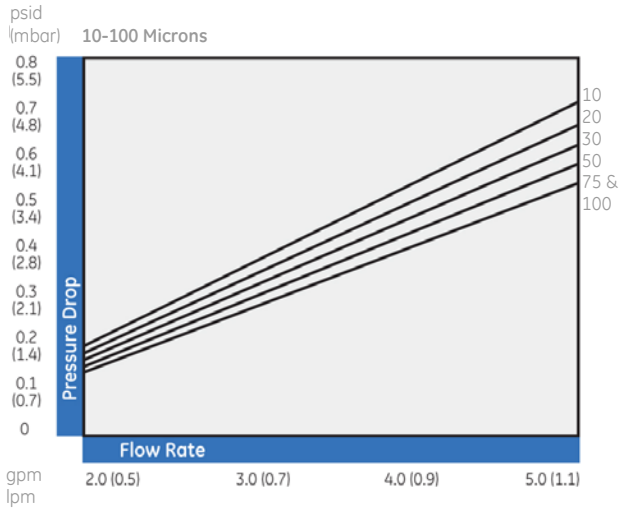

Figure 3: High Flow Rate at Low Pressure Drop[1]

[1] Data based on 10" length filter with clean water.

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Operating Pressure & Temperature

- Maximum operating differential pressure: 35 psid @ 100°F (38°C)
- Maximum operating temperature: 160°F (71°C) @ 15 psid (103.4 kPa)

High Dirt Holding Capacity

- True-graded density captures particles throughout entire filter depth
- High dirt-holding capacity means longer life and fewer changeouts which translates to money saved
- Lower density at the surface of the filter with progressively higher density toward the center
- No surface blinding, which reduces flow and increases filter changeouts

Wide Range of Lengths & Adapters

- Standard lengths fit most housings—custom lengths can also be provided
- Wide range of polypropylene end-adapters including gaskets, extended cores and
- GE patented self-seal polypropylene springs
- If required, specify FDA-compliant sealing materials and end adapters
- Table 1 details specific ordering information.

Material and FDA Compliance

Hytrex cartridge filters are made from thermally-welded blown microfibers of polypropylene. GE certifies that the resin used for manufacturing the filter media of this product meets the requirements of the Food and Drug Administration (FDA) Title 21 of the Code of Federal Regulations (CFR) 174.5 and relevant subparts of 177. If required, specify FDA-compliant sealing materials and end adapters.

Important Notice To User

The following is made in lieu of all other warranties expressed or implied. Manufacturer's and Seller's only obligation shall be to issue credit against the purchase or replacement of the product proved to be defective in material or workmanship. Neither Manufacturer nor Seller shall be liable for any injury, loss or damage, direct or indirect, special or consequential, arising out of the use of, misuse, or the inability to use such product. The information contained herein is based on technical data and tests which we believe to be reliable and is intended for use by persons having technical skill at their discretion and risk. Since conditions of use are outside GE control, we can assume no liability whatsoever for results obtained or damages incurred through the application of the data presented. This information is not intended as a license to operate under, or a recommendation to infringe upon, any patent of GE or others covering any material or use. The foregoing may not be altered except by a written agreement signed by officers of the Manufacturer.

Table 1: Ordering Information

If you are ordering Hytrex filters with standard ends (with no adapter on either end), select one designation from each of the first three columns. Your Product Order Number will look like this: GX05-29 ¼. If you are ordering Hytrex with one or more end adapters, select designations from all applicable columns. Your Product Order Number will look like this: GX05-29 ¼ WP or GX05-29 ¼ XX.

GX	05	29 ¼	Y	Y	P
Type	**Micron Rating**	**Cartridge Length**	**End #1 Adapter**	**End #2 Adapter**	**Gasket Material**
GX ID = 1 inch (2.5 cm) OD = 2.5 inch (6.4 cm)	01 = 1 µm 03 = 3 µm[4] 05 = 5 µm 10 = 10 µm 20 = 20 µm 30 = 30 µm 50 = 50 µm 75 = 75 µm 100 = 100 µm	4 7/8 inch (12.4 cm) 9 ¾ inch (24.8 cm) 9 ⅞ inch (25.1 cm) 10 inch (25.4 cm) 19 ½ inch (49.5 cm) 20 inch (50.8 cm) 29 ¼ inch (74.3 cm) 30 inch (76 cm) 40 inch (102 cm) 50 inch (127 cm)	Y = 1 inch (2.54 cm) Open End Gasket L = Extended Core E = 222 O-Ring X = Standard Hytrex Plain End (No Gasket)	Y = 1 inch (2.54 cm) Open End Gasket K = Self Seal Spring H = Fin S = Solid End X = Standard Hytrex Plain End (No Gasket)	P = Santoprene[2] (Gasket Only) **O-Rings** S = Silicone E = EPDM V = Viton[3] B = BUNA

[2] Santoprene is licensed to Advanced Elastomer Systems, L.P. [3] Viton is a registered trademark of DuPont.

GE
Water & Process Technologies

Fact Sheet

Stainless Steel 7-Round HX Cartridge Filter Housings

Figure 1: 7-Round HX Cartridge Filter Housings**

**Shown with optional clamp on stand and pressure gauges.

Cartridge Filter Housings

GE Water & Process Technologies Stainless Steel 7-Round Filter Housings (Figure 1) combine superior versatility with maximum value to meet the demands of a variety of applications. Each 7-round housing accommodates seven cartridge filters in 20-, 30-, 40- or 50-inch lengths (51, 76, 102, or 127 cm), and up to 2.75-inches (7 cm) in diameter. The innovative housings accept filters with a wide variety of end adapters. In addition, the V-band closure design simplifies cartridge filter replacement.

General Properties

Table 1: Features and Benefits

Stainless Steel Construction	Proven corrosion resistance and strength. Operating pressure to 150 psig (10.3 bar) at 200° F (93° C).
Side Inlet and Bottom Outlet	Side inlet is located below the level of the filters, providing non-impinging flow. The bottom outlet allows the housing to be drained completely and reduces the installation space required.
Universal Cup and Post Sealing	Provides lower seal for cartridge filters with open-end knife-edge type, 222 O-ring, or 120 O-ring end adapters.
Hold-Down Plate	Provides upper seal for cartridge filters with patented Hytrex* self seal spring, open-end knife-edge seal (when used with optional stainless steel cup and spring adapters).
V-Clamp Closure	Quick and easy cartridge filter replacement reduces labor costs and downtime.
Clamp-On Stainless Steel Stand	An optional floor mounting stand allows adjustment of the housing height and the level of the inlet and outlet. Height can be adjusted so that the outlet is lower than floor level.
Tungsten Inert Gas (TIG) Welding	All TIG welding is done at GE factories for the highest quality control.

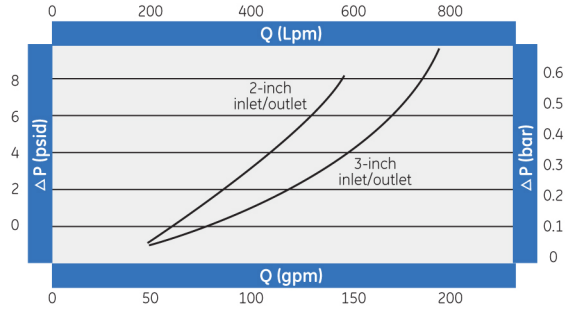

Figure 2: Pressure Drop vs. Flow Rate (Empty Housing)

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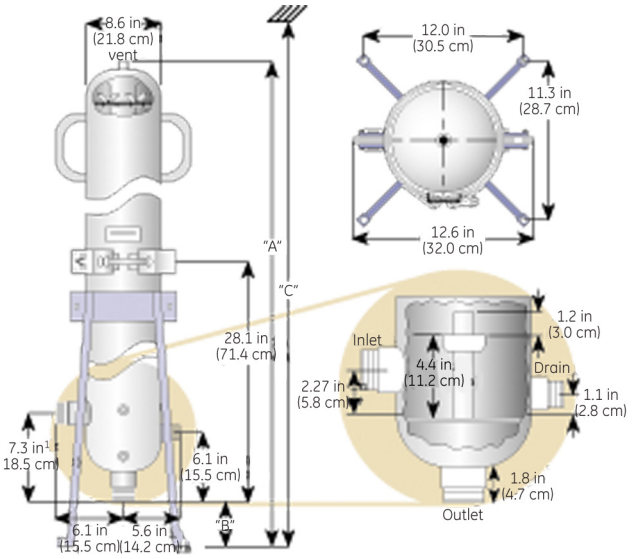
+86 (0) 411-8366-6489

FS1156EN 0606

Table 2: Specifications

Liquid Pressure Rating	150 psig @ 200˚ F (10.3 bar @ 93˚ C)
Housing Material	316 Stainless Steel
Inlet/Outlet Connections	2-inch (5.1 cm) MNPT standard [3" (7.62 cm) optional]; Victaulic and flanges optional
Pre- and Post-Filter Gauge Ports	1/4-inch (0.6 cm) FNPT ports for inlet and outlet pressure gauges
Upstream Vent Port	1/4-inch (0.6 cm) FNPT
Drain Port	1/2-inch (1.3 cm) MNPT
O-Ring Material	Buna-N Standard; EPDM, Silicone, Viton[2] and Teflon[2] optional
Cartridge Lengths	20-, 30-, 40-, or 50-inch filters (51, 76, 102, or 127 cm)
Finish	Satin Finish
Handles	Handles included on 30-, 40-, and 50-inch (76, 102, or 127 cm) housing domes

[2]Viton and Teflon are trademarks of DuPont



B: Bottom of outlet can be as high as 10 inches (25.4 cm) above the floor or as low as 7.5 inches (19.0 cm) below the floor if mounted over a trench.
[1]8.4 inch (21.3 cm) with flange connection.

Figure 3: Housing Specifications

Table 3: Housing Specifications

Model	Flow Capacity[3]		Weight		"A" Length[3]		"C" Overall height required for cartridge removal[4] inch (cm)	
	gpm	(Lpm)	lb	(kg)	inch	(cm)		
HX720-_____-316-A	to 70	(265)	64	(29)	40	(102)	54	(137)
HX730-_____-316-A	to 105	(397)	72	(33)	50	(127)	68	(173)
HX740-_____-316-A	to 140	(530)	81	(37)	60	(152)	88	(224)
HX750-_____-316-A	to 175	(662)	90	(41)	70	(178)	108	(274)

[3]Flow rate is dependent upon cartridge filter selection, fluid properties, and maximum acceptable pressure drop.
[4]Based on B = 5 inches (12.7 cm) on dimensional drawing (this dimension is adjustable). Add 1 inch for housings with flanged ports.

Table 4: Ordering Information – Sample: HX740-2.0T-316-A-222

Hytrex Filter Housing	Number of Cartridges per Housing		Cartridge Length	Inlet/Outlet Size	Port Type		Housing Material 316SS		V-Band Clamp Closure
HX	7	-				-	316	-	A
			20-inch	2.0-inch	V=Victaulic (optional)				
			30-inch	3.0-inch	T=MNPT (standard)				
			40-inch		F=Flange (optional)				

Accessories: Clamp-on legs, cup and spring assemblies (for double-open-end cartridges), pressure gauges, and threaded or victaulic flanges are ordered separately.

ISO 9001 registered

Customer Price Sheet

Customer	Amec Foster Wheeler	Size / Active Stages	1x1.5x8 PWA-LF / 1
Item number	002	Pump speed	3560 rpm
Customer reference		Quote number	Somayeh (Amec)

Totals

Grand Total	$ 6,361	Lead Time Total	8-10 weeks Weeks, ARAD
Pump Total	$ 6,069		
Motor Total	$ 292		

Pump

Qty	Description	Average Unit Price	Extended Price
1	*1x1.5x8 PWA-LF*	*$ 6,069*	*$ 6,069*
	Pump		
	Configuration Type: Complete Configured Pump		
	Liquid End		
	Delivery Time: Delivery Time (Weeks)		
	Materials of Construction: Carbon Steel ASTM A216 Casing with 316L SS Impeller		
	Casing Gasket Material: Aramid Fiber with EPDM Binder		
	Impeller O-Ring Material: Teflon		
	Flanges		
	Suction and Discharge Flange Rating: ANSI 150 LB		
	Suction and Discharge Flange Facing: ANSI RF		
	Flange Options		
	Suction and discharge boss only		
	Casing Connections		
	Casing Drain Piping: None		
	Casing Drain Options: Boss only		
	Seal Chamber / Stuffing Box		
	Seal Chamber Type: Taper bore		
	Power Frame		
	Power Frame: Group 1		
	Shaft Configuration: Solid shaft (no sleeve)		
	Shaft Material: 316L SS		
	Lubrication: Flinger Disk Lubrication		
	Oil Seals: Labyrinth Oil Seals-ISOMAG, Bronze/SS Inboard, Bronze/ Bronze Outboard		
	Thrust Bearing: Double row thrust bearing		
	Power Frame Optional Features		
	Frame cooler access tapped and plugged		
	Magnetic bearing frame drain plug		
	Oil fill connection		
	Sight glass / Oiler connection		
	Pure / Purge Oil mist tapped and plugged		
	Stuffing Box Sealing		
	Seal Type: Cartridge single		
	Seal: John Crane 1.375", 5610V, Carbon vs. Silicon Carbide, EPDM elastomer, 316 SS metal parts		
	Seal Flush Plan - Primary		
	Primary Seal Flush Plan: None		
	Seal Flush Plan - Secondary		
	Secondary Seal Flush Plan: None		
	Baseplate		
	Group: Structural channel steel ANSI/ASME B73.1M 1991 dimensions		
	Baseplate Features		

Pump

Qty	Description	Average Unit Price	Extended Price
	Anchor bolt holes, ANSI/ASME B73.1M		
	Coupling		
	Service Factor: 1.25		
	Fit: AGMA Class 1 clearance fit		
	Model: Martin QuadraFlex EM 6SC35 W/6H 1 HUBS and 6EM Element spacer coupling		
	Coupling Guard: Carbon steel		
	Surface Preparation and Paint		
	Baseplate Preparation		
	Sand blasted to white out		
	Baseplate Paint		
	Epoxy, primer base, 1 coat, 3 mils DFT per coat		
	Pump Paint		
	Epoxy, 1 coat, 4-5 mils DFT		
	Quality Assurance		
	NDE Material Testing		
	Shaft Testing		
	CMTR's		
	Inspection, Shipment Preparation, and Packaging		
	Packaging: Domestic		
	Packaging Duration: Standard packaging for up to 6 mos. storage		
	Flange Protection: Plastic		
	Documentation		
	Standard Documentation Portfolio		
	Portfolio Contents		
	Pump CDS Curve		
	Pump General Arrangement Drawing		
	Pump Cross Section Drawing with generic parts listing (in IOM)		
	Spare Parts		
	Recommended Spare Parts		
	Start-up and 1 year		
	Maintenance Kit		
	Pump Reliability and Control and Monitoring		
	Pump Reliability and Control and Monitoring		
	Enclosure: NEMA 1		

Motor

Qty	Description	Average Unit Price	Extended Price
1	**Pump**	$ 292	$ 292
	Driver		
	Type: Electric Motor		
	Driver Supplied By: Pump Manufacturer		
	Driver Mounted By: Pump Manufacturer		
	Electric Motor Type: NEMA		
	Insulation Class: Class F		
	Electric Motor: TECO, MAX-E1, 3600 RPM, 5 HP, TEFC SD, 184T		

Optional Adders

Qty	Description	Unit Price	Extended Price
	Casing and Cover Hydrostatic Test		
1	Component hydrotest	$ 41	$ 41
1	Non-witnessed, assembled Casing and Cover	$ 277	$ 277
	Performance with Vibration Test		
1	Non-witnessed	$ 526	$ 526

Optional Adders

Qty	Description	Unit Price	Extended Price
	Start-up and 1 year		
1	Spare Mechanical Seal	$ 938	$ 938
	Normal Maintenance-2year and longer		
1	Repair Kit	$ 210	$ 210
1	Impeller	$ 815	$ 815
	NEMA 1 Combination Starter		
1	Nema 1, 5HP, Cmb. Starter, 8A, w/EOL, MMS Disc, & HOA	$ 405	$ 405
1	Nema 1, 5HP, Cmb. Starter, 10A, w/EOL, MMS Disc, & HOA	$ 438	$ 438

Pump Performance Datasheet

Customer	: Amec Foster Wheeler	Quote number	: Somayeh (Amec)
Customer reference	:	Size and model	: 1x1.5x8 PWA-LF
Item number	: 002	Stages	: 1
Service	:	Based on curve number	: 1x1.5x8PWA-LF
Quantity	: 1	Date last saved	: 26 Jan 2018 10:40 AM

Operating Conditions

Flow, rated	: 25.00 USgpm
Differential head / pressure, rated (requested)	: 45.00 psi
Differential head / pressure, rated (actual)	: 45.89 psi
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 3560 rpm
Impeller diameter, rated	: 5.00 in
Impeller diameter, maximum	: 8.00 in
Impeller diameter, minimum	: 4.50 in
Efficiency	: 19.07 %
NPSH required / margin required	: 4.32 / 0.00 ft
Ns (imp. eye flow) / Nss (imp. eye flow)	: 292 / 3,747 US Units
MCSF	: 2.17 USgpm
Head, maximum, rated diameter	: 55.07 psi
Head rise to shutoff	: 20.91 %
Flow, best eff. point	: 24.56 USgpm
Flow ratio, rated / BEP	: 101.77 %
Diameter ratio (rated / max)	: 62.50 %
Head ratio (rated dia / max dia)	: 29.01 %
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Hydrocarbon
Additional liquid description	:
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

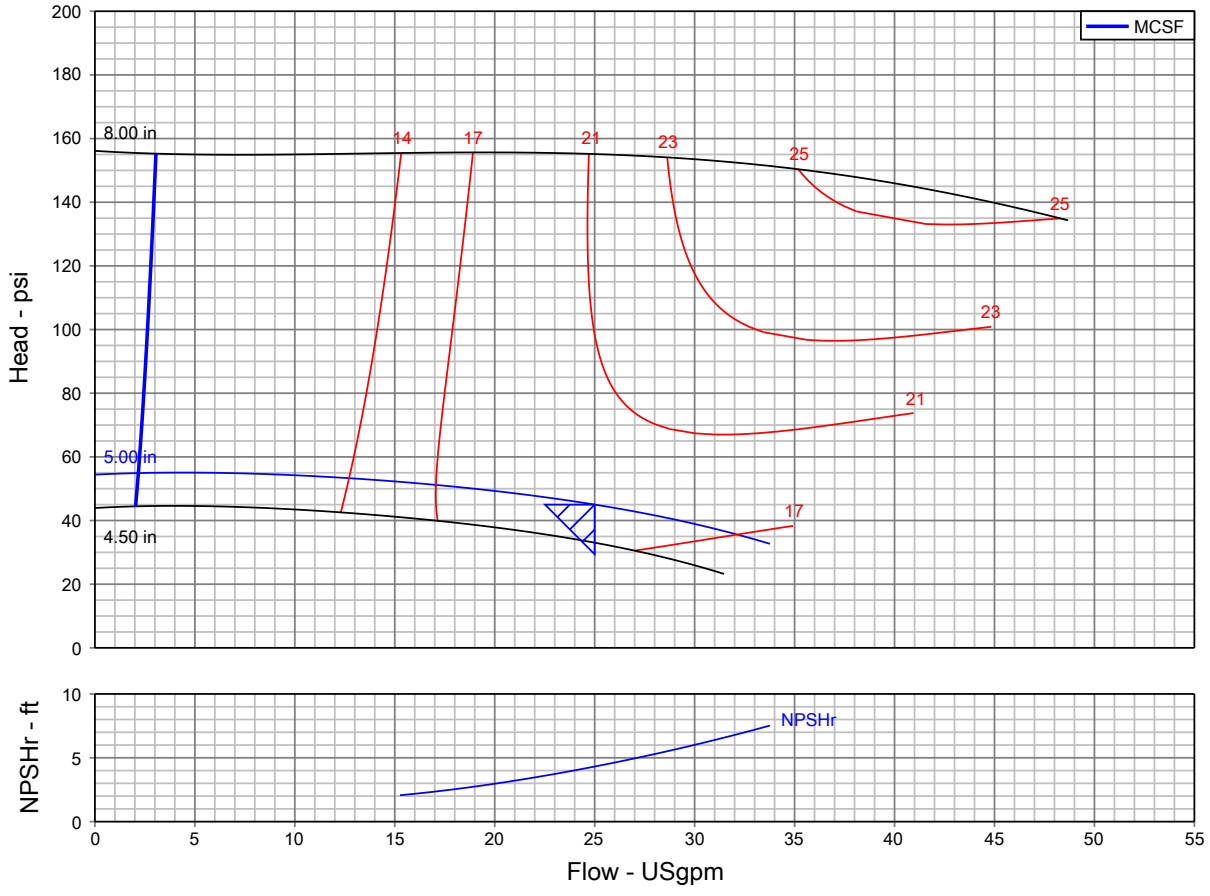
Material selected	: Carbon Steel / 316L SS

Pressure Data

Maximum working pressure	: 55.07 psi.g
Maximum allowable working pressure	: 285.0 psi.g
Maximum allowable suction pressure	: 100.0 psi.g
Hydrostatic test pressure	: 428.0 psi.g

Driver & Power Data (@Max density)

Driver sizing specification	: API 610 / ISO 13709
Margin over specification	: 0.00 %
Service factor	: 1.15
Power, hydraulic	: 0.66 hp
Power, rated	: 3.44 hp
Power, maximum, rated diameter	: 4.01 hp
Minimum recommended motor rating	: 5.00 hp / 3.73 kW
Motor Voltage	: 460 V



Construction Datasheet

Customer	: Amec Foster Wheeler	Quote Number	: Somayeh (Amec)
Customer reference	:	Pump size	: 1x1.5x8 PWA-LF
Item number	: 002	Stages	: 1
Service	: -	Speed	: 3560 rpm
Quantity of pumps	: 1	Date last saved	: 26 Jan 2018 10:40 AM

Construction

Nozzle	Size	Rating (DIN)	Face	Pos'n
Suction	1.5	ANSI 150 LB	ANSI RF	End
Discharge	1	ANSI 150 LB	ANSI RF	Top

Casing mounting	: Foot
Casing split	: Radial
Impeller type	: Open
Rotation (view from cplg)	: CW

Materials

Casing	: Carbon Steel ASTM A216
Impeller	: 316L SS
Shaft	: 316L SS

Shaft

Diameter at Coupling	: 0.875
Diameter Between Bearings	: 1.50 in
Span Between Bearing Centers	: 4.13 in
Span Between Bearing and Impeller	: 6.13 in
Shaft Deflection (L3 / D4)	: 64

Bearings and Lubrication

Power Frame	: Group 1
Radial	: 6207
Thrust	: 3306
Lubrication	: Flinger Disk Lubrication

Baseplate, Coupling and Guard

Baseplate Type	: Structural channel steel
Baseplate No.	: DXP B139.18
Baseplate material	: Structural channel steel
Coupling manufacturer	: Martin
Coupling type	: EM 6SC35
Coupling rating [hp/100rpm]	: 0.6
Spacer Length [DBSE]	: 3.5
Service Factor	: 1.25
Coupling Guard Material	: Carbon steel

Weights (Approximate)

Pump	: 115.0 lb
Baseplate	: 124.0 lb
Motor	: 145.0 lb
Total	: 384.0 lb

Driver Description

Manufacturer	: TECO
Power	: 5 hp
Service Factor	: 1.15
Pump Speed	: 3560 rpm
Orientation / Mounting	: Horizontal
Driver type	: Electric Motor
Frame	: 184T
Enclosure	: TEFC SD
Volts / Phase / Hz	: 460 V / 3 phase / 60 Hz
Insulation class	: Class F
Motor supplied by	: Pump Manufacturer
Motor mounted by	: Pump Manufacturer

Seal, Gland and Piping

Sealing Type	: Cartridge single
Seal size	: 1.375 in
Manufacturer	: John Crane
Stuffing Box Type	: Taper bore
Gland material	: 316SS
Flush	: Tapped and plugged
Vent	: Tapped and plugged
Drain	: Tapped and plugged
Primary seal flush plan	: None
Primary seal flush material	: -
Secondary seal flush plan	: None
Secondary seal flush material	None

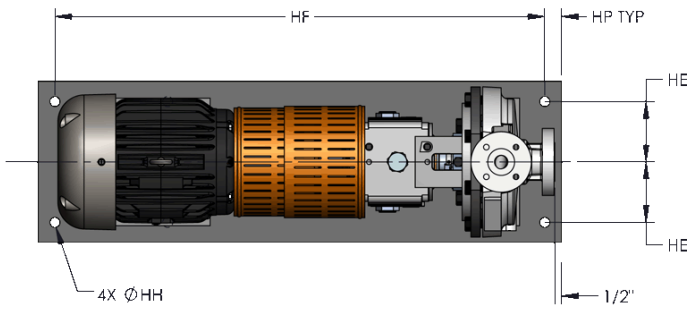
Testing

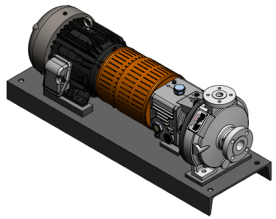
Hydrostatic	: Component hydrotest
Performance	: Non-witnessed

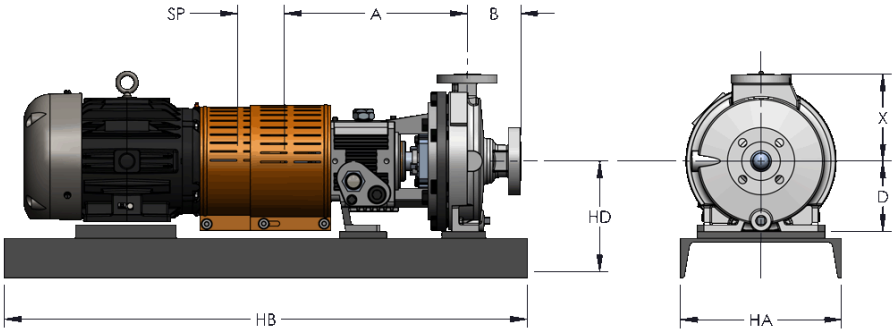
Material certification type	Impeller	Casing	Shaft
Material certification required?	No	No	Yes

Inspection Required for Connection Welds	: No
Inspection Required for Castings	: No

General Arrangement







Dimensions in inches (mm)

HA	HB	HD	HE	HF	HH	HP	A	B	D	SP	X
12.00	39.00	9.06	4.50	36.50	0.75	1.25	13.50	4.00	5.25	3.75	6.50

Flange Note: Discharge flange bolting is threaded, 0.50", 13 UNC

Pump Description				
Model	PWA-LF			
Size	1x1.5x8 PWA-LF			
Capacity	25.00 USgpm	Differential Head	45.00 psi	
Liquid Specific Gravity	1.000 SG	Pump Material	Carbon Steel / 316L SS	

Nozzle	Size	Rating	Face	Rotation (view from cplg)
Suction	1.5	ANSI 150 LB	ANSI RF	
Discharge	1	ANSI 150 LB	ANSI RF	CW

Power Frame	Group 1
Lubrication	Flinger Disk Lubrication
Stuffing Box Type	Taper bore
Casing Drain	Boss only
Flange Tapping	None

Driver Description					
Manufacturer	TECO				
Voltage(VAC)	460	Phase	3	Cycles(HZ)	60
Power	5 hp	Speed	3560 rpm		
Frame	184T	Enclosure	TEFC SD		
Service Factor	1.15	Insulation	Class F		

Auxiliary Equipment Description	
Coupling Manufacturer & Size	Martin EM 6SC35
Coupling Guard Material	Carbon steel
Baseplate Type	Structural channel steel
Baseplate No.	DXP B139.18
Sealing Type	Cartridge single
Mechanical Seal	John Crane 1.375", 5610V, Carbon vs. Silicon Carbide, EPDM elastomer, 316 SS metal parts

Weights (Approximate)	
Pump	115.0 lb
Baseplate	124.0 lb
Motor	145.0 lb
Total	384.0 lb

PumpWorks INDUSTRIAL	Customer	Amec Foster Wheeler		
	Customer Ref			
Not to be used for construction unless certified by manufacturer	Item Number	002	Quantity	1
	Manufacturer's Quote #		Somayeh (Amec)	

Terms & Conditions

I. CONDITIONS

(a) No terms and conditions contained in any order placed with DXP ENTERPRISES, INC. , herein referred to as "Company", other than those stated herein shall be binding on Company.

(b) All orders are subject to acceptance by an officer of Company.

II. PRICES

PRICES All prices quoted herein will be subject to the prices in effect at time of shipment.

III. TERMS OF PAYMENT

(a) On all orders UNDER $100,000 regardless of manufacturing schedule, and those orders OVER $100,000 with a manufacturing schedules less than ninety (90) days: NET cash thirty (30) days after shipment or notification that shipment is ready to be made. These terms apply to partial as well as complete shipments.

(b) On all orders OVER $100,000 with a manufacturing schedule in excess of 90 days:
15% - upon submittal of initial drawing for approval
50% - 30 days after submittal of initial drawings for approval
35% - when unit is ready for shipment (* All changes or additions will be invoiced at this time.)

(c) All orders subject to approval of credit.

IV. STANDARD WARRANTY

(a) The Company warrants its machinery, so far as the same is of its own manufacture, against defects in material and workmanship under normal use and service for which the equipment was designed for a period of one year after date of acceptance but not later than eighteen (18) months from date of shipment. The Company will warrant components or parts not manufactured by it to the same extent that the respective manufacture warrants such equipment and material.

(b) This warranty does not obligate the Company to bear the cost of labor or transportation charges in connection with the replacement or repair of defective parts without approval by an officer of the Company prior to the time repairs are made. The obligation under this warranty may be limited to the repair or replacement of parts f.o.b. its factory provided that upon inspection at such point they shall be determined by the Company to have been defective in material or workmanship.

(c) If the Company can agree that circumstances require the replacement or repair of defective parts on the jobsite, after a Company representative has determined that a warranty situation does exist, and that no revisions or alterations have been made to the equipment by others, the Company representative will implement the required repairs on an eight-hour straight time basis only.

(d) Acceptance of the material from a common carrier constitutes a waiver of any claim against the Company for delay or damages in transit.

V. SHIPMENT

(a) Shipment quoted is effective as of proposal date and will be confirmed upon receipt of order, subject to availability of materials and production space. The Company shall not be held responsible for delays due to causes beyond the Company's control such as strikes, riots, carrier delays, etc.

(b) Should significant manufacturing changes or additions be made by the Purchaser after production has begun, shipping commitments may be extended at the Company's discretion.

VI. CANCELLATION

This contract cannot be canceled without the mutual agreement between the Purchaser and Company. If such cancellation is agreed upon, Purchaser agrees to pay immediately, all cancellation charges.

VII. TAXES

The Purchaser shall pay to the Company, in addition to the purchase price, the amount of all Sales, Use, Privilege, Occupation, Excise, or other taxes, Federal, State, local or foreign which the Company is required to pay in connection with furnishing goods or services to the Purchaser.

VIII. INSTALLATION

Equipment shall be transported, installed and connected at Purchaser's risk and expense. The Company will furnish a service representative to assist in initial installation and start-up. This service will be invoiced separately at our current published rates plus living and traveling expenses.

Customer Price Sheet

Customer	Amec Foster Wheeler	Size / Active Stages	1x1.5x6 PWA / 1
Item number	001	Pump speed	3500 rpm
Customer reference		Quote number	Somayeh (Amec)

Totals

Grand Total	$ 4,697	Lead Time Total	8-10 weeks Weeks, ARAD
Pump Total	$ 4,302		
Motor Total	$ 395		

Pump

Qty	Description	Average Unit Price	Extended Price
1	*1x1.5x6 PWA*	*$ 4,302*	*$ 4,302*
	Pump		
	Configuration Type: Complete Configured Pump		
	Liquid End		
	Delivery Time: Delivery Time (Weeks)		
	Materials of Construction: Carbon Steel ASTM A216		
	Casing Gasket Material: Aramid Fiber with EPDM Binder		
	Impeller O-Ring Material: Teflon		
	Flanges		
	Suction and Discharge Flange Rating: ANSI 150 LB		
	Suction and Discharge Flange Facing: ANSI FF		
	Flange Options		
	Suction and discharge boss only		
	Casing Connections		
	Casing Drain Piping: None		
	Casing Drain Options: Boss only		
	Seal Chamber / Stuffing Box		
	Seal Chamber Type: Taper bore		
	Power Frame		
	Power Frame: Group 1		
	Shaft Configuration: Solid shaft (no sleeve)		
	Shaft Material: 316L SS		
	Lubrication: Flinger Disk Lubrication		
	Oil Seals: Labyrinth Oil Seals-ISOMAG, Bronze/SS Inboard, Bronze/ Bronze Outboard		
	Thrust Bearing: Double row thrust bearing		
	Power Frame Optional Features		
	Frame cooler access tapped and plugged		
	Magnetic bearing frame drain plug		
	Oil fill connection		
	Sight glass / Oiler connection		
	Pure / Purge Oil mist tapped and plugged		
	Stuffing Box Sealing		
	Seal Type: Cartridge single		
	Seal: John Crane 1.375", 5610V, Carbon vs. Silicon Carbide, EPDM elastomer, 316 SS metal parts		
	Seal Flush Plan - Primary		
	Primary Seal Flush Plan: None		
	Seal Flush Plan - Secondary		
	Secondary Seal Flush Plan: None		
	Baseplate		
	Group: Structural channel steel ANSI/ASME B73.1M 1991 dimensions		
	Baseplate Features		
	Anchor bolt holes, ANSI/ASME B73.1M		

Pump

Qty	Description	Average Unit Price	Extended Price
	Coupling		
	Service Factor: 1.25		
	Fit: AGMA Class 1 clearance fit		
	Model: Martin QuadraFlex EM 6SC35 W/6H 1 HUBS and 6EM Element spacer coupling		
	Coupling Guard: Carbon steel		
	Surface Preparation and Paint		
	Baseplate Preparation		
	Sand blasted to white out		
	Baseplate Paint		
	Epoxy, primer base, 1 coat, 3 mils DFT per coat		
	Pump Paint		
	Epoxy, 1 coat, 4-5 mils DFT		
	Quality Assurance		
	NDE Material Testing		
	Shaft Testing		
	CMTR's		
	Inspection, Shipment Preparation, and Packaging		
	Packaging: Domestic		
	Packaging Duration: Standard packaging for up to 6 mos. storage		
	Flange Protection: Plastic		
	Documentation		
	Standard Documentation Portfolio		
	Portfolio Contents		
	Pump CDS Curve		
	Pump General Arrangement Drawing		
	Pump Cross Section Drawing with generic parts listing (in IOM)		
	Spare Parts		
	Recommended Spare Parts		
	Start-up and 1 year		
	Maintenance Kit		
	Pump Reliability and Control and Monitoring		
	Pump Reliability and Control and Monitoring		
	Enclosure: NEMA 1		

Motor

Qty	Description	Average Unit Price	Extended Price
1	**Pump**	$ 395	$ 395
	Driver		
	Type: Electric Motor		
	Driver Supplied By: Pump Manufacturer		
	Driver Mounted By: Pump Manufacturer		
	Electric Motor Type: NEMA		
	Insulation Class: Class F		
	Electric Motor: TECO, MAX-E1, 3600 RPM, 7.5 HP, TEFC SD, 213T		

Optional Adders

Qty	Description	Unit Price	Extended Price
	Casing and Cover Hydrostatic Test		
1	Component hydrotest	$ 41	$ 41
1	Non-witnessed, assembled Casing and Cover	$ 277	$ 277
	Performance with Vibration Test		
1	Non-witnessed	$ 526	$ 526
	Start-up and 1 year		

Optional Adders

Qty	Description	Unit Price	Extended Price
1	Spare Mechanical Seal	$ 875	$ 875
	Normal Maintenance-2year and longer		
1	Repair Kit	$ 210	$ 210
1	Impeller	$ 312	$ 312
	NEMA 1 Combination Starter		
1	Nema 1, 7.5HP, Cmb. Starter, 13A, w/EOL, MMS Disc, & HOA	$ 438	$ 438
	NEMA 1 VFD		
1	EquipmentSaver™ NEMA 1,VFD, 7.5HP, 480V, 3PH, 5.5kW, 50/60Hz, 0-120Hz	$ 585	$ 585
	Enclosed NEMA 1 Line Reactors- 3 & 5%		
1	3%, 7.5HP, 480V, Enclosed Type 1 Line Reactor	$ 721	$ 721
1	5%, 7.5HP, 480V, Enclosed Type 1 Line Reactor	$ 863	$ 863
	Enclosed NEMA 1 Output Reactors & Filters		
1	7.5HP, 480V,UL Type 1 Enclosed Output Reactor	$ 794	$ 794
1	7.5HP, 480V, V1K, KLC Series Output Filter, Nema 1 Encl.	$ 1,317	$ 1,317

Pump Performance Datasheet

Customer	: Amec Foster Wheeler	Quote number	: Somayeh (Amec)
Customer reference	:	Size and model	: 1x1.5x6 PWA
Item number	: 001	Stages	: 1
Service	:	Based on curve number	: 1x1.5x6PWA
Quantity	: 1	Date last saved	: 25 Jan 2018 3:08 PM

Operating Conditions

Flow, rated	: 100.0 USgpm
Differential head / pressure, rated (requested)	: 45.00 psi
Differential head / pressure, rated (actual)	: 46.05 psi
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 3500 rpm
Impeller diameter, rated	: 5.38 in
Impeller diameter, maximum	: 6.06 in
Impeller diameter, minimum	: 3.50 in
Efficiency	: 60.67 %
NPSH required / margin required	: 6.71 / 0.00 ft
Ns (imp. eye flow) / Nss (imp. eye flow)	: 883 / 8,464 US Units
MCSF	: 8.84 USgpm
Head, maximum, rated diameter	: 56.79 psi
Head rise to shutoff	: 25.95 %
Flow, best eff. point	: 94.69 USgpm
Flow ratio, rated / BEP	: 105.61 %
Diameter ratio (rated / max)	: 88.65 %
Head ratio (rated dia / max dia)	: 77.84 %
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Hydrocarbon
Additional liquid description	:
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

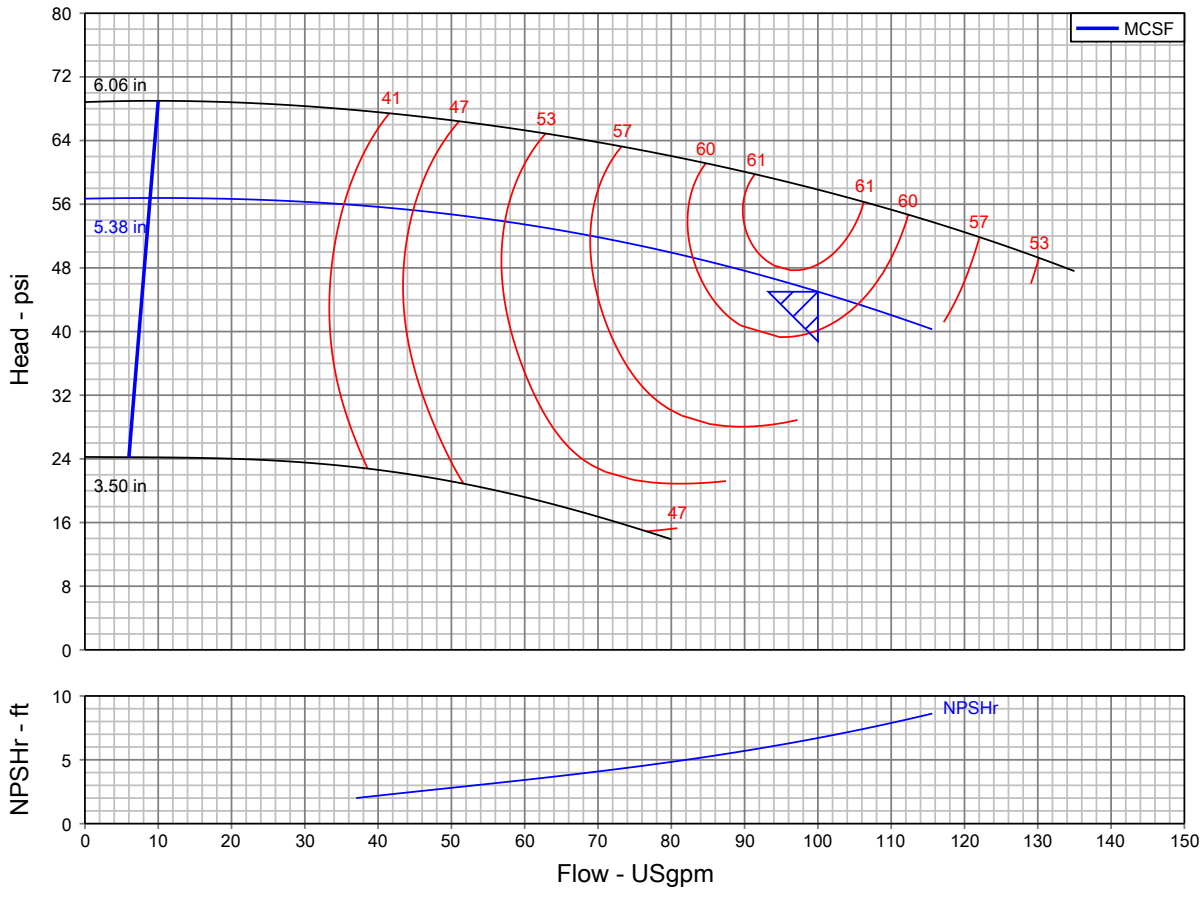
Material selected	: Carbon Steel

Pressure Data

Maximum working pressure	: 56.79 psi.g
Maximum allowable working pressure	: 285.0 psi.g
Maximum allowable suction pressure	: 100.0 psi.g
Hydrostatic test pressure	: 428.0 psi.g

Driver & Power Data (@Max density)

Driver sizing specification	: API 610 / ISO 13709
Margin over specification	: 0.00 %
Service factor	: 1.15
Power, hydraulic	: 2.63 hp
Power, rated	: 4.33 hp
Power, maximum, rated diameter	: 4.74 hp
Minimum recommended motor rating	: 7.50 hp / 5.59 kW
Motor Voltage	: 460 V



Construction Datasheet

Customer	: Amec Foster Wheeler	Quote Number	: Somayeh (Amec)
Customer reference	:	Pump size	: 1x1.5x6 PWA
Item number	: 001	Stages	: 1
Service	: -	Speed	: 3500 rpm
Quantity of pumps	: 1	Date last saved	: 25 Jan 2018 3:08 PM

Construction

Nozzle	Size	Rating (DIN)	Face	Pos'n
Suction	1.5	ANSI 150 LB	ANSI FF	End
Discharge	1	ANSI 150 LB	ANSI FF	Top

Casing mounting	: Foot
Casing split	: Radial
Impeller type	: Open
Rotation (view from cplg)	: CW

Materials

Casing	: Carbon Steel ASTM A216
Impeller	: Carbon Steel ASTM A216
Shaft	: 316L SS

Shaft

Diameter at Coupling	: 0.875
Diameter Between Bearings	: 1.50 in
Span Between Bearing Centers	: 4.13 in
Span Between Bearing and Impeller	: 6.13 in
Shaft Deflection (L3 / D4)	: 64

Bearings and Lubrication

Power Frame	: Group 1
Radial	: 6207
Thrust	: 3306
Lubrication	: Flinger Disk Lubrication

Baseplate, Coupling and Guard

Baseplate Type	: Structural channel steel
Baseplate No.	: DXP B148.21
Baseplate material	: Structural channel steel
Coupling manufacturer	: Martin
Coupling type	: EM 6SC35
Coupling rating [hp/100rpm]	: 0.6
Spacer Length [DBSE]	: 3.5
Service Factor	: 1.25
Coupling Guard Material	: Carbon steel

Weights (Approximate)

Pump	: 110.0 lb
Baseplate	: 222.0 lb
Motor	: 200.0 lb
Total	: 532.0 lb

Driver Description

Manufacturer	: TECO
Power	: 7.5 hp
Service Factor	: 1.15
Pump Speed	: 3500 rpm
Orientation / Mounting	: Horizontal
Driver type	: Electric Motor
Frame	: 213T
Enclosure	: TEFC SD
Volts / Phase / Hz	: 460 V / 3 phase / 60 Hz
Insulation class	: Class F
Motor supplied by	: Pump Manufacturer
Motor mounted by	: Pump Manufacturer

Seal, Gland and Piping

Sealing Type	: Cartridge single
Seal size	: 1.375 in
Manufacturer	: John Crane
Stuffing Box Type	: Taper bore
Gland material	: 316SS
Flush	: Tapped and plugged
Vent	: Tapped and plugged
Drain	: Tapped and plugged
Primary seal flush plan	: None
Primary seal flush material	: -
Secondary seal flush plan	: None
Secondary seal flush material	None

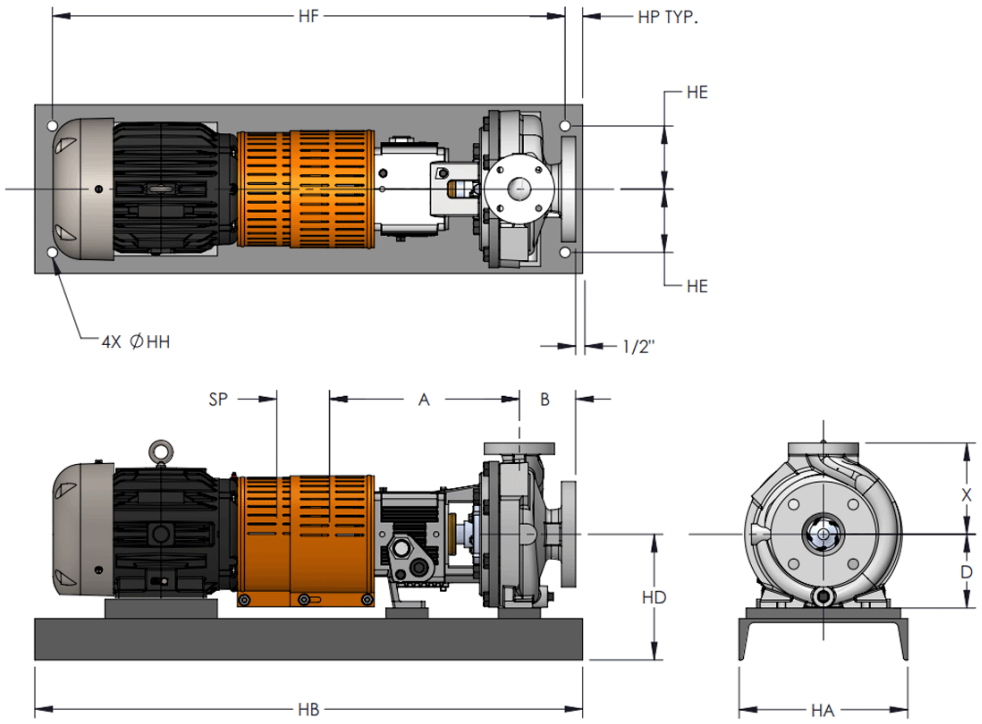
Testing

Hydrostatic	: Component hydrotest
Performance	: Non-witnessed

Material certification type	Impeller	Casing	Shaft
Material certification required?	No	No	Yes

Inspection Required for Connection Welds	: No
Inspection Required for Castings	: No

General Arrangement



Dimensions in inches (mm)

HA	HB	HD	HE	HF	HH	HP	A	B	D	SP	X
15.00	48.00	10.38	6.00	45.50	0.75	1.25	13.50	4.00	5.25	3.75	6.50

- -

Pump Description				
Model	PWA			
Size	1x1.5x6 PWA			
Capacity	100.0 USgpm	Differential Head	45.00 psi	
Liquid Specific Gravity	1.000 SG	Pump Material	Carbon Steel	
Nozzle	Size	Rating	Face	Rotation (view from cplg)
Suction	1.5	ANSI 150 LB	ANSI FF	
Discharge	1	ANSI 150 LB	ANSI FF	CW
Power Frame	Group 1			
Lubrication	Flinger Disk Lubrication			
Stuffing Box Type	Taper bore			
Casing Drain	Boss only			
Flange Tapping	None			

Driver Description					
Manufacturer	TECO				
Voltage(VAC)	460	Phase	3	Cycles(HZ)	60
Power	7.5 hp	Speed	3500 rpm		
Frame	213T	Enclosure	TEFC SD		
Service Factor	1.15	Insulation	Class F		

Auxiliary Equipment Description	
Coupling Manufacturer & Size	Martin EM 6SC35
Coupling Guard Material	Carbon steel
Baseplate Type	Structural channel steel
Baseplate No.	DXP B148.21
Sealing Type	Cartridge single
Mechanical Seal	John Crane 1.375", 5610V, Carbon vs. Silicon Carbide, EPDM elastomer, 316 SS metal parts

Weights (Approximate)	
Pump	110.0 lb
Baseplate	222.0 lb
Motor	200.0 lb
Total	532.0 lb

PumpWorks INDUSTRIAL	Customer	Amec Foster Wheeler		
	Customer Ref			
Not to be used for construction unless certified by manufacturer	Item Number	001	Quantity	1
	Manufacturer's Quote #		Somayeh (Amec)	

Terms & Conditions

I. CONDITIONS

(a) No terms and conditions contained in any order placed with DXP ENTERPRISES, INC. , herein referred to as "Company", other than those stated herein shall be binding on Company.

(b) All orders are subject to acceptance by an officer of Company.

II. PRICES

PRICES All prices quoted herein will be subject to the prices in effect at time of shipment.

III. TERMS OF PAYMENT

(a) On all orders UNDER $100,000 regardless of manufacturing schedule, and those orders OVER $100,000 with a manufacturing schedules less than ninety (90) days: NET cash thirty (30) days after shipment or notification that shipment is ready to be made. These terms apply to partial as well as complete shipments.

(b) On all orders OVER $100,000 with a manufacturing schedule in excess of 90 days:
15% - upon submittal of initial drawing for approval
50% - 30 days after submittal of initial drawings for approval
35% - when unit is ready for shipment (* All changes or additions will be invoiced at this time.)

(c) All orders subject to approval of credit.

IV. STANDARD WARRANTY

(a) The Company warrants its machinery, so far as the same is of its own manufacture, against defects in material and workmanship under normal use and service for which the equipment was designed for a period of one year after date of acceptance but not later than eighteen (18) months from date of shipment. The Company will warrant components or parts not manufactured by it to the same extent that the respective manufacture warrants such equipment and material.

(b) This warranty does not obligate the Company to bear the cost of labor or transportation charges in connection with the replacement or repair of defective parts without approval by an officer of the Company prior to the time repairs are made. The obligation under this warranty may be limited to the repair or replacement of parts f.o.b. its factory provided that upon inspection at such point they shall be determined by the Company to have been defective in material or workmanship.

(c) If the Company can agree that circumstances require the replacement or repair of defective parts on the jobsite, after a Company representative has determined that a warranty situation does exist, and that no revisions or alterations have been made to the equipment by others, the Company representative will implement the required repairs on an eight-hour straight time basis only.

(d) Acceptance of the material from a common carrier constitutes a waiver of any claim against the Company for delay or damages in transit.

V. SHIPMENT

(a) Shipment quoted is effective as of proposal date and will be confirmed upon receipt of order, subject to availability of materials and production space. The Company shall not be held responsible for delays due to causes beyond the Company's control such as strikes, riots, carrier delays, etc.

(b) Should significant manufacturing changes or additions be made by the Purchaser after production has begun, shipping commitments may be extended at the Company's discretion.

VI. CANCELLATION

This contract cannot be canceled without the mutual agreement between the Purchaser and Company. If such cancellation is agreed upon, Purchaser agrees to pay immediately, all cancellation charges.

VII. TAXES

The Purchaser shall pay to the Company, in addition to the purchase price, the amount of all Sales, Use, Privilege, Occupation, Excise, or other taxes, Federal, State, local or foreign which the Company is required to pay in connection with furnishing goods or services to the Purchaser.

VIII. INSTALLATION

Equipment shall be transported, installed and connected at Purchaser's risk and expense. The Company will furnish a service representative to assist in initial installation and start-up. This service will be invoiced separately at our current published rates plus living and traveling expenses.

Customer Price Sheet

Customer	Amec Foster Wheeler	Size / Active Stages	3x3x13 PWA-SP / 1
Item number	003	Pump speed	1780 rpm
Customer reference		Quote number	Somayeh (Amec)

Totals

Grand Total	$ 12,147	Lead Time Total	8-10 weeks Weeks, ARAD
Pump Total	$ 11,452		
Motor Total	$ 695		

Pump

Qty	Description	Average Unit Price	Extended Price
1	*3x3x13 PWA-SP*	*$ 11,452*	*$ 11,452*
	Pump		
	Configuration Type: Complete Configured Pump		
	Liquid End		
	Delivery Time: Delivery Time (Weeks)		
	Materials of Construction: Carbon Steel ASTM A216		
	Casing Gasket Material: Aramid Fiber with EPDM Binder		
	Impeller O-Ring Material: Teflon		
	Flanges		
	Suction and Discharge Flange Rating: ANSI 150 LB		
	Suction and Discharge Flange Facing: ANSI FF		
	Flange Options		
	Suction and discharge boss only		
	Casing Connections		
	Casing Connections: Casing filler drilled, tapped and plugged (1.5" NPT)		
	Casing Drain Options		
	Casing Drain drilled, tapped and plugged (1.5"NPT)		
	Seal Chamber / Stuffing Box		
	Seal Chamber Type: Taper bore		
	Power Frame		
	Power Frame: Group 2		
	Power Frame Group Override: Configured per EPOD		
	Shaft Configuration: Solid shaft (no sleeve)		
	Shaft Material: 316L SS		
	Lubrication: Flinger Disk Lubrication		
	Oil Seals: Labyrinth Oil Seals-ISOMAG, Bronze/SS Inboard, Bronze/ Bronze Outboard		
	Thrust Bearing: Double row thrust bearing		
	Power Frame Optional Features		
	Frame cooler access tapped and plugged		
	Magnetic bearing frame drain plug		
	Oil fill connection		
	Sight glass / Oiler connection		
	Pure / Purge Oil mist tapped and plugged		
	Stuffing Box Sealing		
	Seal Type: Cartridge single		
	Seal: John Crane 1.750", 5610V, Carbon vs. Silicon Carbide, EPDM elastomer, 316 SS metal parts		
	Seal Flush Plan - Primary		
	Primary Seal Flush Plan: None		
	Seal Flush Plan - Secondary		
	Secondary Seal Flush Plan: None		
	Baseplate		
	Group: Structural channel steel ANSI/ASME B73.1M 1991 dimensions		

Pump

Qty	Description	Average Unit Price	Extended Price
	Baseplate Features		
	Anchor bolt holes, ANSI/ASME B73.1M		
	Coupling		
	Service Factor: 1.25		
	Fit: AGMA Class 1 clearance fit		
	Model: Martin QuadraFlex EM 8SC35 W/8H 1-1/8 HUBS and 8EM Element spacer coupling		
	Coupling Guard: Carbon steel		
	Surface Preparation and Paint		
	Baseplate Preparation		
	Sand blasted to white out		
	Baseplate Paint		
	Epoxy, primer base, 1 coat, 3 mils DFT per coat		
	Pump Paint		
	Epoxy, 1 coat, 4-5 mils DFT		
	Quality Assurance		
	NDE Material Testing		
	Shaft Testing		
	CMTR's		
	Inspection, Shipment Preparation, and Packaging		
	Packaging: Domestic		
	Packaging Duration: Standard packaging for up to 6 mos. storage		
	Flange Protection: Plastic		
	Documentation		
	Standard Documentation Portfolio		
	Spare Parts		
	Recommended Spare Parts		
	Start-up and 1 year		
	Maintenance Kit		
	Pump Reliability and Control and Monitoring		
	Pump Reliability and Control and Monitoring		
	Enclosure: NEMA 1		

Motor

Qty	Description	Average Unit Price	Extended Price
1	**Pump**	$ 695	$ 695
	Driver		
	Type: Electric Motor		
	Driver Supplied By: Pump Manufacturer		
	Driver Mounted By: Pump Manufacturer		
	Electric Motor Type: NEMA		
	Insulation Class: Class F		
	Electric Motor: Baldor Reliance, ECP, 1800 RPM, 20 HP, TEFC SD, 256T		

Optional Adders

Qty	Description	Unit Price	Extended Price
	Casing and Cover Hydrostatic Test		
1	Component hydrotest	$ 309	$ 309
1	Non-witnessed, assembled Casing and Cover	$ 308	$ 308
	Performance with Vibration Test		
1	Non-witnessed	$ 823	$ 823
	Start-up and 1 year		
1	Spare Mechanical Seal	$ 875	$ 875
	Normal Maintenance-2year and longer		

Optional Adders

Qty	Description	Unit Price	Extended Price
1	Repair Kit	$ 427	$ 427
1	Impeller	$ 1,019	$ 1,019
	NEMA 1 Combination Starter		
1	Nema 1, 20HP, Cmb. Starter, 32A, w/EOL, MMS Disc, & HOA	$ 471	$ 471
	NEMA 1 VFD		
1	EquipmentSaver™ NEMA 1,VFD, 20HP, 480V, 3PH, 15kW, 50/60Hz, 0-120Hz	$ 979	$ 979
	Enclosed NEMA 1 Line Reactors- 3 & 5%		
1	3%, 20HP, 480V, Enclosed Type 1 Line Reactor	$ 905	$ 905
1	5%, 20HP, 480V, Enclosed Type 1 Line Reactor	$ 1,051	$ 1,051
	Enclosed NEMA 1 Output Reactors & Filters		
1	20HP, 480V,UL Type 1 Enclosed Output Reactor	$ 967	$ 967
1	20HP, 480V, V1K, KLC Series Output Filter, Nema 1 Encl.	$ 1,545	$ 1,545

Pump Performance Datasheet

Customer	: Amec Foster Wheeler	Quote number	: Somayeh (Amec)
Customer reference	:	Size and model	: 3x3x13 PWA-SP
Item number	: 003	Stages	: 1
Service	:	Based on curve number	: 3x3x13PWA-SP
Quantity	: 1	Date last saved	: 02 Feb 2018 10:10 AM

Operating Conditions

Flow, rated	: 200.0 USgpm
Differential head / pressure, rated (requested)	: 60.00 psi
Differential head / pressure, rated (actual)	: 60.10 psi
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 1780 rpm
Impeller diameter, rated	: 12.88 in
Impeller diameter, maximum	: 13.00 in
Impeller diameter, minimum	: 10.00 in
Efficiency	: 44.04 %
NPSH required / margin required	: 5.39 / 0.00 ft
Ns (imp. eye flow) / Nss (imp. eye flow)	: 870 / 4,792 US Units
MCSF	: 64.69 USgpm
Head, maximum, rated diameter	: 66.74 psi
Head rise to shutoff	: 11.23 %
Flow, best eff. point	: 312.0 USgpm
Flow ratio, rated / BEP	: 64.11 %
Diameter ratio (rated / max)	: 99.04 %
Head ratio (rated dia / max dia)	: 97.62 %
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Hydrocarbon
Additional liquid description	:
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

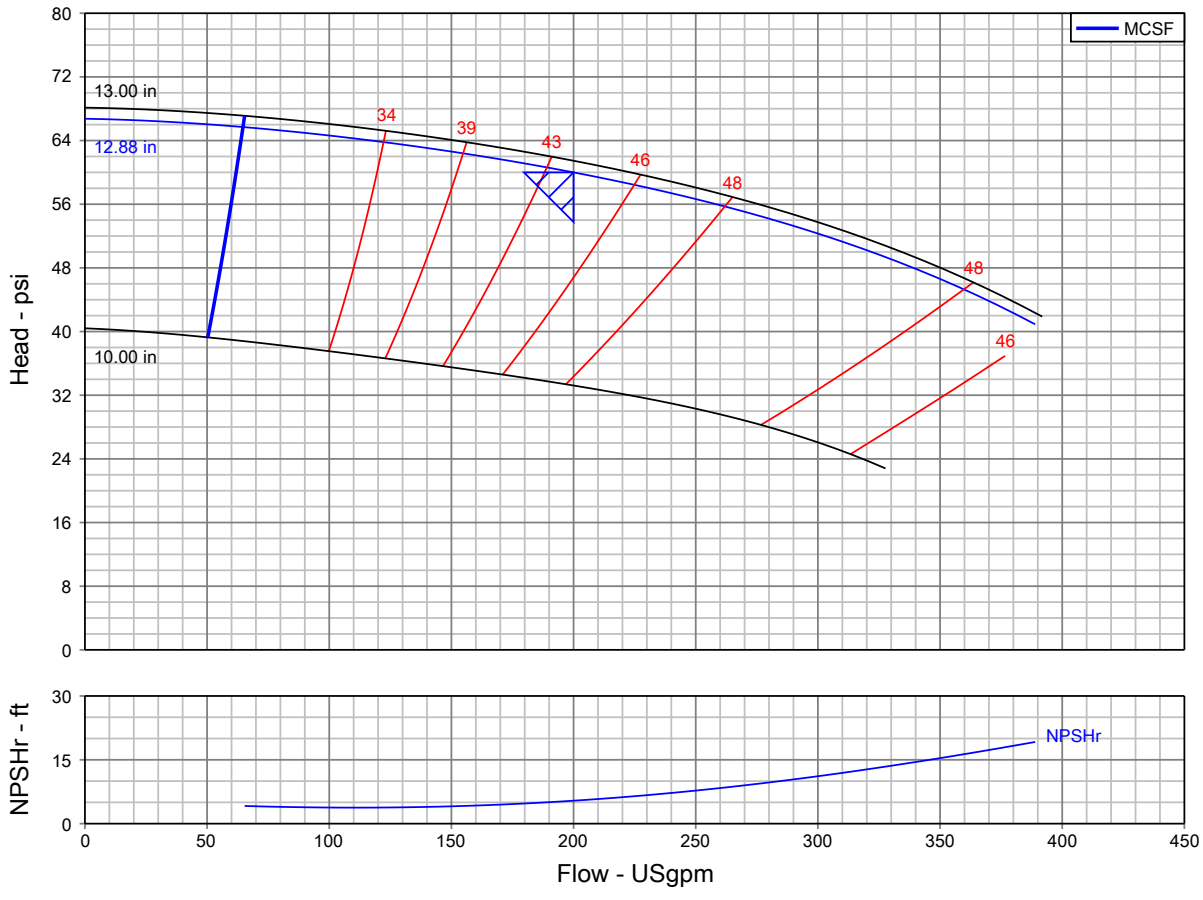
Material selected	: Carbon Steel

Pressure Data

Maximum working pressure	: 66.74 psi.g
Maximum allowable working pressure	: 285.0 psi.g
Maximum allowable suction pressure	: 100.0 psi.g
Hydrostatic test pressure	: 428.0 psi.g

Driver & Power Data (@Max density)

Driver sizing specification	: API 610 / ISO 13709
Margin over specification	: 0.00 %
Service factor	: 1.15
Power, hydraulic	: 7.00 hp
Power, rated	: 15.90 hp
Power, maximum, rated diameter	: 20.05 hp
Minimum recommended motor rating	: 20.00 hp / 14.91 kW
Motor Voltage	: 460 V



Construction Datasheet

Customer	: Amec Foster Wheeler	Quote Number	: Somayeh (Amec)
Customer reference	:	Pump size	: 3x3x13 PWA-SP
Item number	: 003	Stages	: 1
Service	: -	Speed	: 1780 rpm
Quantity of pumps	: 1	Date last saved	: 02 Feb 2018 10:10 AM

Construction

Nozzle	Size	Rating (DIN)	Face	Pos'n
Suction	3	ANSI 150 LB	ANSI FF	End
Discharge	3	ANSI 150 LB	ANSI FF	Top

Casing mounting	: Foot
Casing split	: Radial
Impeller type	: Open
Rotation (view from cplg)	: CW

Materials

Casing	: Carbon Steel ASTM A216
Impeller	: Carbon Steel ASTM A216
Shaft	: 316L SS

Shaft

Diameter at Coupling	: 1.125
Diameter Between Bearings	: 2.13 in
Span Between Bearing Centers	: 6.75 in
Span Between Bearing and Impeller	: 8.38 in
Shaft Deflection (L3 / D4)	: 63

Bearings and Lubrication

Power Frame	: Group 2
Radial	: 6309
Thrust	: 3309
Lubrication	: Flinger Disk Lubrication

Baseplate, Coupling and Guard

Baseplate Type	: Structural channel steel
Baseplate No.	: DXP BSP266.25
Baseplate material	: Structural channel steel
Coupling manufacturer	: Martin
Coupling type	: EM 8SC35
Coupling rating [hp/100rpm]	: 1.4
Spacer Length [DBSE]	: 3.5
Service Factor	: 1.25
Coupling Guard Material	: Carbon steel

Weights (Approximate)

Pump	: 400.0 lb
Baseplate	: 322.0 lb
Motor	: 340.0 lb
Total	: 1,062.0 lb

Driver Description

Manufacturer	: Baldor Reliance
Power	: 20 hp
Service Factor	: 1.15
Pump Speed	: 1780 rpm
Orientation / Mounting	: Horizontal
Driver type	: Electric Motor
Frame	: 256T
Enclosure	: TEFC SD
Volts / Phase / Hz	: 460 V / 3 phase / 60 Hz
Insulation class	: Class F
Motor supplied by	: Pump Manufacturer
Motor mounted by	: Pump Manufacturer

Seal, Gland and Piping

Sealing Type	: Cartridge single
Seal size	: 1.75 in
Manufacturer	: John Crane
Stuffing Box Type	: Taper bore
Gland material	: 316SS
Flush	: Tapped and plugged
Vent	: Tapped and plugged
Drain	: Tapped and plugged
Primary seal flush plan	: None
Primary seal flush material	: -
Secondary seal flush plan	: None
Secondary seal flush material	None

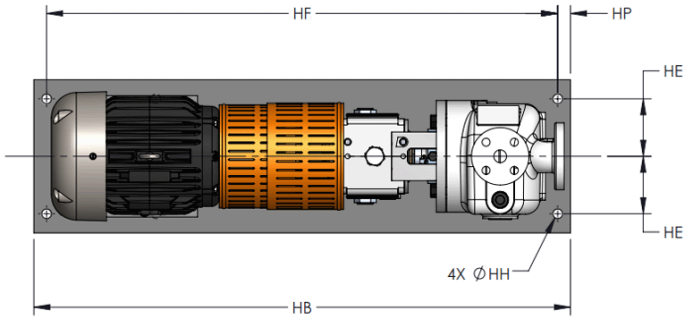
Testing

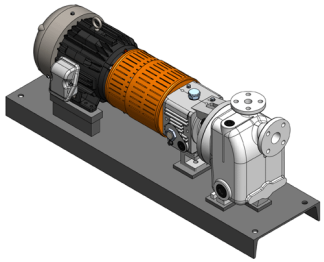
Hydrostatic	: Component hydrotest
Performance	: Non-witnessed

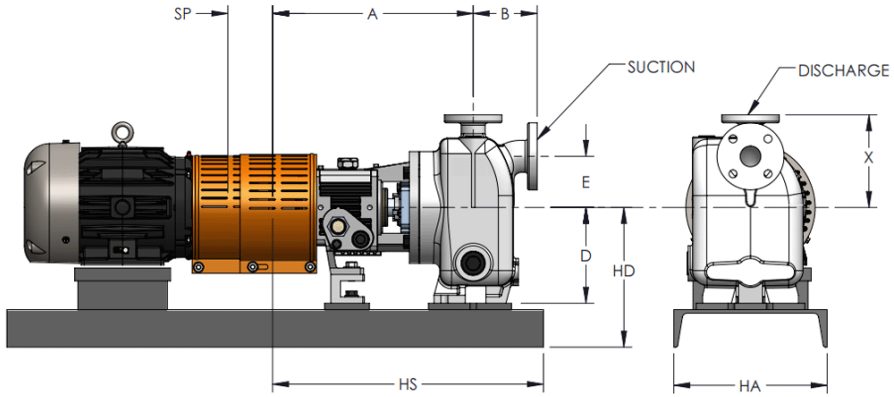
Material certification type	Impeller	Casing	Shaft
Material certification required?	No	No	Yes

Inspection Required for Connection Welds	: No
Inspection Required for Castings	: No

General Arrangement







Dimensions in inches (mm)

HA	HB	HD	HE	HF	HH	HP	HS	A	B	C	D	E	SP	X
18.00	66.00	15.08	7.50	63.50	1.00	1.25	34.00	22.63	6.75	4.63	10.00	6.00	3.75	11.50

Pump Description				
Model	PWA-SP			
Size	3x3x13 PWA-SP			
Capacity	200.0 USgpm	Differential Head	60.00 psi	
Liquid Specific Gravity	1.000 SG	Pump Material	Carbon Steel	

Nozzle	Size	Rating	Face	Rotation (view from cplg)
Suction	3	ANSI 150 LB	ANSI FF	
Discharge	3	ANSI 150 LB	ANSI FF	CW

Power Frame	Group 2
Lubrication	Flinger Disk Lubrication
Stuffing Box Type	Taper bore
Casing Drain	1.5" NPT
Flange Tapping	None

Driver Description					
Manufacturer	Baldor Reliance				
Voltage(VAC)	460	Phase	3	Cycles(HZ)	60
Power	20 hp	Speed	1780 rpm		
Frame	256T	Enclosure	TEFC SD		
Service Factor	1.15	Insulation	Class F		

Auxiliary Equipment Description	
Coupling Manufacturer & Size	Martin EM 8SC35
Coupling Guard Material	Carbon steel
Baseplate Type	Structural channel steel
Baseplate No.	DXP BSP266.25
Sealing Type	Cartridge single
Mechanical Seal	John Crane 1.750", 5610V, Carbon vs. Silicon Carbide, EPDM elastomer, 316 SS metal parts

Weights (Approximate)	
Pump	400.0 lb
Baseplate	322.0 lb
Motor	340.0 lb
Total	1,062.0 lb

PumpWorks INDUSTRIAL	Customer	Amec Foster Wheeler		
	Customer Ref			
Not to be used for construction unless certified by manufacturer	Item Number	003	Quantity	1
	Manufacturer's Quote #		Somayeh (Amec)	

Customer Price Sheet

Customer	Amec Foster Wheeler	Size / Active Stages	2x3x6 PWA / 1
Item number	004	Pump speed	3500 rpm
Customer reference		Quote number	Somayeh (Amec)

Totals

Grand Total	$ 5,227	Lead Time Total	8-10 weeks Weeks, ARAD
Pump Total	$ 4,783		
Motor Total	$ 444		

Pump

Qty	Description	Average Unit Price	Extended Price
1	*2x3x6 PWA*	*$ 4,783*	*$ 4,783*
	Pump		
	Configuration Type: Complete Configured Pump		
	Liquid End		
	Delivery Time: Delivery Time (Weeks)		
	Materials of Construction: Carbon Steel ASTM A216		
	Casing Gasket Material: Aramid Fiber with EPDM Binder		
	Impeller O-Ring Material: Teflon		
	Flanges		
	Suction and Discharge Flange Rating: ANSI 150 LB		
	Suction and Discharge Flange Facing: ANSI FF		
	Flange Options		
	Suction and discharge boss only		
	Casing Connections		
	Casing Drain Piping: None		
	Casing Drain Options: Boss only		
	Seal Chamber / Stuffing Box		
	Seal Chamber Type: Taper bore		
	Power Frame		
	Power Frame: Group 1		
	Shaft Configuration: Solid shaft (no sleeve)		
	Shaft Material: 316L SS		
	Lubrication: Flinger Disk Lubrication		
	Oil Seals: Labyrinth Oil Seals-ISOMAG, Bronze/SS Inboard, Bronze/ Bronze Outboard		
	Thrust Bearing: Double row thrust bearing		
	Power Frame Optional Features		
	Frame cooler access tapped and plugged		
	Magnetic bearing frame drain plug		
	Oil fill connection		
	Sight glass / Oiler connection		
	Pure / Purge Oil mist tapped and plugged		
	Stuffing Box Sealing		
	Seal Type: Cartridge single		
	Seal: John Crane 1.375", 5610V, Carbon vs. Silicon Carbide, EPDM elastomer, 316 SS metal parts		
	Seal Flush Plan - Primary		
	Primary Seal Flush Plan: None		
	Seal Flush Plan - Secondary		
	Secondary Seal Flush Plan: None		
	Baseplate		
	Group: Structural channel steel ANSI/ASME B73.1M 1991 dimensions		
	Baseplate Features		
	Anchor bolt holes, ANSI/ASME B73.1M		

Pump

Qty	Description	Average Unit Price	Extended Price
	Coupling		
	Service Factor: 1.25		
	Fit: AGMA Class 1 clearance fit		
	Model: Martin QuadraFlex EM 6SC35 W/6H 1 HUBS and 6EM Element spacer coupling		
	Coupling Guard: Carbon steel		
	Surface Preparation and Paint		
	Baseplate Preparation		
	Sand blasted to white out		
	Baseplate Paint		
	Epoxy, primer base, 1 coat, 3 mils DFT per coat		
	Pump Paint		
	Epoxy, 1 coat, 4-5 mils DFT		
	Quality Assurance		
	NDE Material Testing		
	Shaft Testing		
	CMTR's		
	Inspection, Shipment Preparation, and Packaging		
	Packaging: Domestic		
	Packaging Duration: Standard packaging for up to 6 mos. storage		
	Flange Protection: Plastic		
	Documentation		
	Standard Documentation Portfolio		
	Portfolio Contents		
	Pump CDS Curve		
	Pump General Arrangement Drawing		
	Pump Cross Section Drawing with generic parts listing (in IOM)		
	Spare Parts		
	Recommended Spare Parts		
	Start-up and 1 year		
	Maintenance Kit		
	Pump Reliability and Control and Monitoring		
	Pump Reliability and Control and Monitoring		
	Enclosure: NEMA 1		

Motor

Qty	Description	Average Unit Price	Extended Price
1	**Pump**	$ 444	$ 444
	Driver		
	Type: Electric Motor		
	Driver Supplied By: Pump Manufacturer		
	Driver Mounted By: Pump Manufacturer		
	Electric Motor Type: NEMA		
	Insulation Class: Class F		
	Electric Motor: Baldor Reliance, ECP, 3600 RPM, 10 HP, TEFC SD, 215T		

Optional Adders

Qty	Description	Unit Price	Extended Price
	Casing and Cover Hydrostatic Test		
1	Component hydrotest	$ 309	$ 309
1	Non-witnessed, assembled Casing and Cover	$ 308	$ 308
	Performance with Vibration Test		
1	Non-witnessed	$ 823	$ 823
	Start-up and 1 year		

Optional Adders

Qty	Description	Unit Price	Extended Price
1	Spare Mechanical Seal	$ 875	$ 875
	Normal Maintenance-2year and longer		
1	Repair Kit	$ 210	$ 210
1	Impeller	$ 422	$ 422

Pump Performance Datasheet

Customer	: Amec Foster Wheeler	Quote number	: Somayeh (Amec)
Customer reference	:	Size and model	: 2x3x6 PWA
Item number	: 004	Stages	: 1
Service	:	Based on curve number	: 2x3x6PWA
Quantity	: 1	Date last saved	: 02 Feb 2018 10:12 AM

Operating Conditions

Flow, rated	: 200.0 USgpm
Differential head / pressure, rated (requested)	: 40.00 psi
Differential head / pressure, rated (actual)	: 41.59 psi
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 3500 rpm
Impeller diameter, rated	: 5.19 in
Impeller diameter, maximum	: 6.06 in
Impeller diameter, minimum	: 4.00 in
Efficiency	: 66.87 %
NPSH required / margin required	: 10.20 / 0.00 ft
Ns (imp. eye flow) / Nss (imp. eye flow)	: 1,453 / 8,192 US Units
MCSF	: 33.65 USgpm
Head, maximum, rated diameter	: 46.02 psi
Head rise to shutoff	: 14.99 %
Flow, best eff. point	: 254.8 USgpm
Flow ratio, rated / BEP	: 78.48 %
Diameter ratio (rated / max)	: 85.57 %
Head ratio (rated dia / max dia)	: 58.78 %
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Hydrocarbon
Additional liquid description	:
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

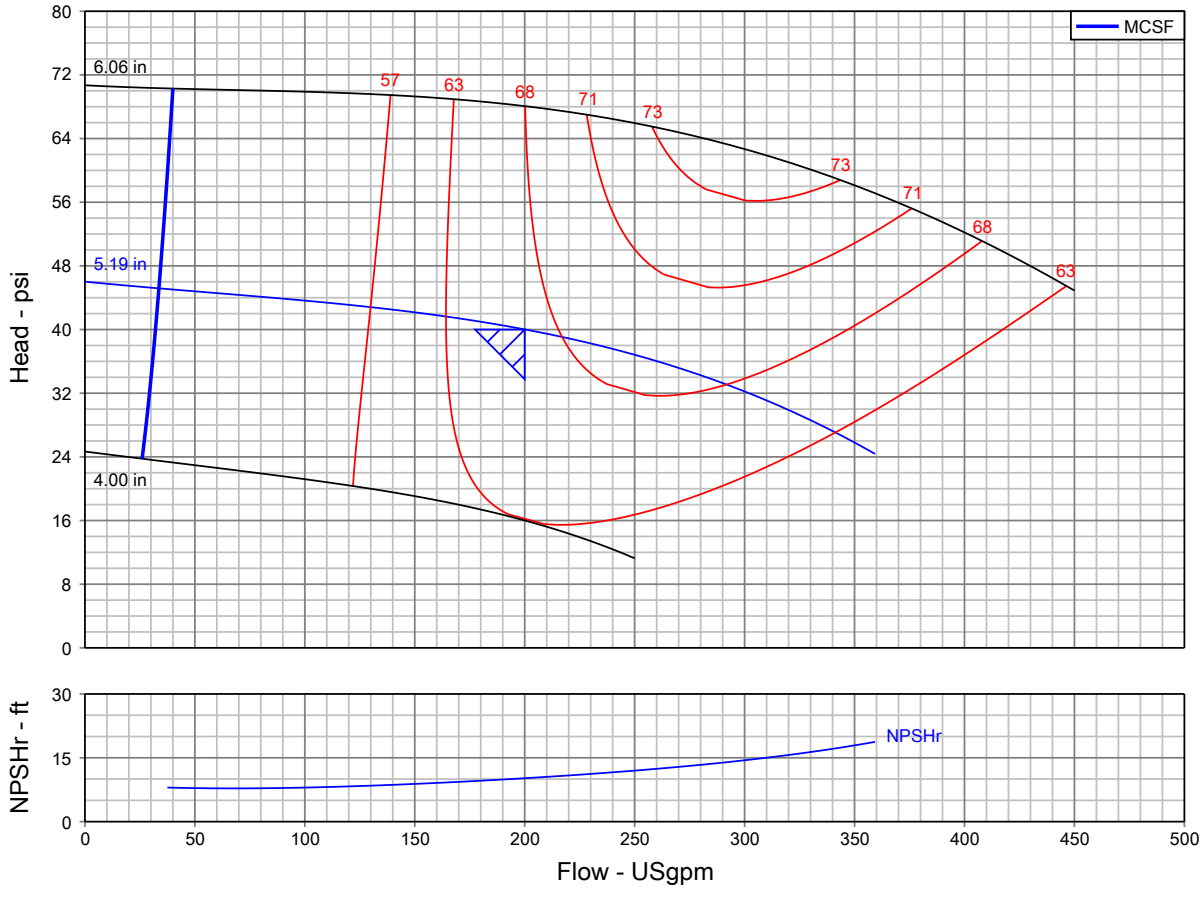
Material selected	: Carbon Steel

Pressure Data

Maximum working pressure	: 46.02 psi.g
Maximum allowable working pressure	: 285.0 psi.g
Maximum allowable suction pressure	: 100.0 psi.g
Hydrostatic test pressure	: 428.0 psi.g

Driver & Power Data (@Max density)

Driver sizing specification	: API 610 / ISO 13709
Margin over specification	: 0.00 %
Service factor	: 1.15
Power, hydraulic	: 4.67 hp
Power, rated	: 6.98 hp
Power, maximum, rated diameter	: 8.56 hp
Minimum recommended motor rating	: 10.00 hp / 7.46 kW
Motor Voltage	: 460 V



Construction Datasheet

Customer	: Amec Foster Wheeler	Quote Number	: Somayeh (Amec)
Customer reference	:	Pump size	: 2x3x6 PWA
Item number	: 004	Stages	: 1
Service	: -	Speed	: 3500 rpm
Quantity of pumps	: 1	Date last saved	: 02 Feb 2018 10:12 AM

Construction

Nozzle	Size	Rating (DIN)	Face	Pos'n
Suction	3	ANSI 150 LB	ANSI FF	End
Discharge	2	ANSI 150 LB	ANSI FF	Top

Casing mounting	: Foot
Casing split	: Radial
Impeller type	: Open
Rotation (view from cplg)	: CW

Materials

Casing	: Carbon Steel ASTM A216
Impeller	: Carbon Steel ASTM A216
Shaft	: 316L SS

Shaft

Diameter at Coupling	: 0.875
Diameter Between Bearings	: 1.50 in
Span Between Bearing Centers	: 4.13 in
Span Between Bearing and Impeller	: 6.13 in
Shaft Deflection (L3 / D4)	: 64

Bearings and Lubrication

Power Frame	: Group 1
Radial	: 6207
Thrust	: 3306
Lubrication	: Flinger Disk Lubrication

Baseplate, Coupling and Guard

Baseplate Type	: Structural channel steel
Baseplate No.	: DXP B148.21
Baseplate material	: Structural channel steel
Coupling manufacturer	: Martin
Coupling type	: EM 6SC35
Coupling rating [hp/100rpm]	: 0.6
Spacer Length [DBSE]	: 3.5
Service Factor	: 1.25
Coupling Guard Material	: Carbon steel

Weights (Approximate)

Pump	: 125.0 lb
Baseplate	: 222.0 lb
Motor	: 165.0 lb
Total	: 512.0 lb

Driver Description

Manufacturer	: Baldor Reliance
Power	: 10 hp
Service Factor	: 1.15
Pump Speed	: 3500 rpm
Orientation / Mounting	: Horizontal
Driver type	: Electric Motor
Frame	: 215T
Enclosure	: TEFC SD
Volts / Phase / Hz	: 460 V / 3 phase / 60 Hz
Insulation class	: Class F
Motor supplied by	: Pump Manufacturer
Motor mounted by	: Pump Manufacturer

Seal, Gland and Piping

Sealing Type	: Cartridge single
Seal size	: 1.375 in
Manufacturer	: John Crane
Stuffing Box Type	: Taper bore
Gland material	: 316SS
Flush	: Tapped and plugged
Vent	: Tapped and plugged
Drain	: Tapped and plugged
Primary seal flush plan	: None
Primary seal flush material	: -
Secondary seal flush plan	: None
Secondary seal flush material	None

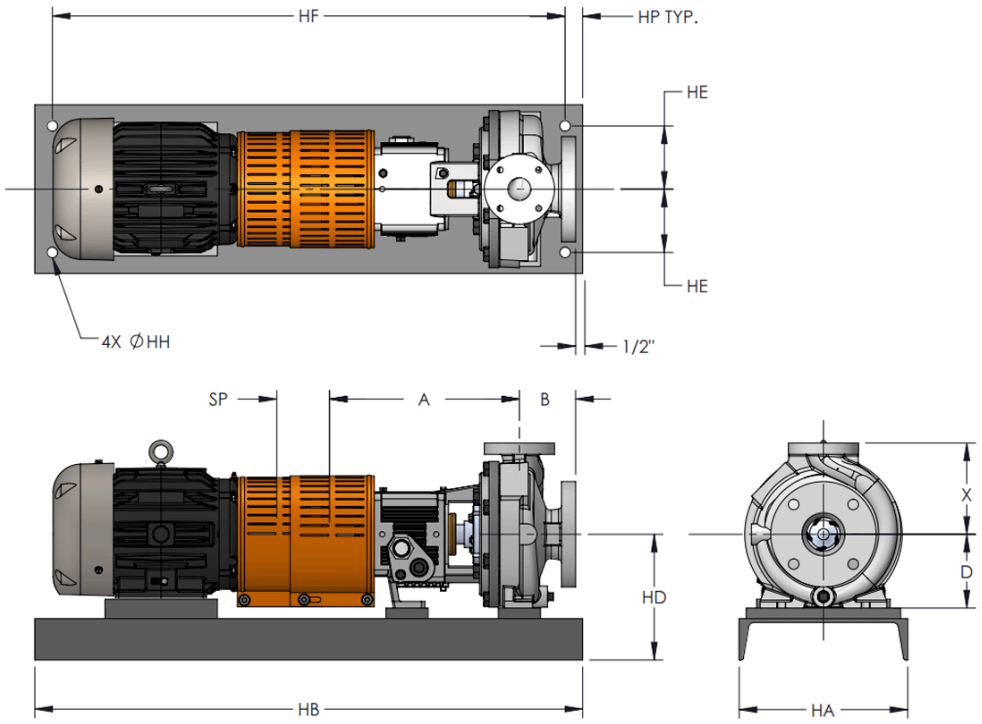
Testing

Hydrostatic	: Component hydrotest
Performance	: Non-witnessed

Material certification type	Impeller	Casing	Shaft
Material certification required?	No	No	Yes

Inspection Required for Connection Welds	: No
Inspection Required for Castings	: No

General Arrangement



Dimensions in inches (mm)

HA	HB	HD	HE	HF	HH	HP	A	B	D	SP	X
15.00	48.00	10.38	6.00	45.50	0.75	1.25	13.50	4.00	5.25	3.75	6.50

- -

Pump Description				
Model	PWA			
Size	2x3x6 PWA			
Capacity	200.0 USgpm	Differential Head	40.00 psi	
Liquid Specific Gravity	1.000 SG	Pump Material	Carbon Steel	
Nozzle	Size	Rating	Face	Rotation (view from cplg)
Suction	3	ANSI 150 LB	ANSI FF	
Discharge	2	ANSI 150 LB	ANSI FF	CW
Power Frame	Group 1			
Lubrication	Flinger Disk Lubrication			
Stuffing Box Type	Taper bore			
Casing Drain	Boss only			
Flange Tapping	None			

Driver Description					
Manufacturer	Baldor Reliance				
Voltage(VAC)	460	Phase	3	Cycles(HZ)	60
Power	10 hp	Speed	3500 rpm		
Frame	215T	Enclosure	TEFC SD		
Service Factor	1.15	Insulation	Class F		

Auxiliary Equipment Description	
Coupling Manufacturer & Size	Martin EM 6SC35
Coupling Guard Material	Carbon steel
Baseplate Type	Structural channel steel
Baseplate No.	DXP B148.21
Sealing Type	Cartridge single
Mechanical Seal	John Crane 1.375", 5610V, Carbon vs. Silicon Carbide, EPDM elastomer, 316 SS metal parts

Weights (Approximate)	
Pump	125.0 lb
Baseplate	222.0 lb
Motor	165.0 lb
Total	512.0 lb

PumpWorks INDUSTRIAL	Customer	Amec Foster Wheeler		
	Customer Ref			
Not to be used for construction unless certified by manufacturer	Item Number	004	Quantity	1
	Manufacturer's Quote #		Somayeh (Amec)	

Terms & Conditions

I. CONDITIONS

(a) No terms and conditions contained in any order placed with DXP ENTERPRISES, INC. , herein referred to as "Company", other than those stated herein shall be binding on Company.

(b) All orders are subject to acceptance by an officer of Company.

II. PRICES All prices quoted herein will be subject to the prices in effect at time of shipment.

III. TERMS OF PAYMENT

(a) On all orders UNDER $100,000 regardless of manufacturing schedule, and those orders OVER $100,000 with a manufacturing schedules less than ninety (90) days: NET cash thirty (30) days after shipment or notification that shipment is ready to be made. These terms apply to partial as well as complete shipments.

(b) On all orders OVER $100,000 with a manufacturing schedule in excess of 90 days:
15% - upon submittal of initial drawing for approval
50% - 30 days after submittal of initial drawings for approval
35% - when unit is ready for shipment (* All changes or additions will be invoiced at this time.)

(c) All orders subject to approval of credit.

IV. STANDARD WARRANTY

(a) The Company warrants its machinery, so far as the same is of its own manufacture, against defects in material and workmanship under normal use and service for which the equipment was designed for a period of one year after date of acceptance but not later than eighteen (18) months from date of shipment. The Company will warrant components or parts not manufactured by it to the same extent that the respective manufacture warrants such equipment and material.

(b) This warranty does not obligate the Company to bear the cost of labor or transportation charges in connection with the replacement or repair of defective parts without approval by an officer of the Company prior to the time repairs are made. The obligation under this warranty may be limited to the repair or replacement of parts f.o.b. its factory provided that upon inspection at such point they shall be determined by the Company to have been defective in material or workmanship.

(c) If the Company can agree that circumstances require the replacement or repair of defective parts on the jobsite, after a Company representative has determined that a warranty situation does exist, and that no revisions or alterations have been made to the equipment by others, the Company representative will implement the required repairs on an eight-hour straight time basis only.

(d) Acceptance of the material from a common carrier constitutes a waiver of any claim against the Company for delay or damages in transit.

V. SHIPMENT

(a) Shipment quoted is effective as of proposal date and will be confirmed upon receipt of order, subject to availability of materials and production space. The Company shall not be held responsible for delays due to causes beyond the Company's control such as strikes, riots, carrier delays, etc.

(b) Should significant manufacturing changes or additions be made by the Purchaser after production has begun, shipping commitments may be extended at the Company's discretion.

VI. CANCELLATION

This contract cannot be canceled without the mutual agreement between the Purchaser and Company. If such cancellation is agreed upon, Purchaser agrees to pay immediately, all cancellation charges.

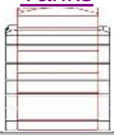
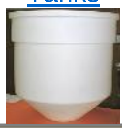
VII. TAXES

The Purchaser shall pay to the Company, in addition to the purchase price, the amount of all Sales, Use, Privilege, Occupation, Excise, or other taxes, Federal, State, local or foreign which the Company is required to pay in connection with furnishing goods or services to the Purchaser.

VIII. INSTALLATION

Equipment shall be transported, installed and connected at Purchaser's risk and expense. The Company will furnish a service representative to assist in initial installation and start-up. This service will be invoiced separately at our current published rates plus living and traveling expenses.

[illegible] [illegible]

Vertical Tanks 	Double Wall Tanks 	Horizontal Tanks 	Containment Tanks 	Cone Bottom Tanks 	Rectangular Tanks 	Open Top Tanks 
Open-Top Cone Bottom Tanks 	Water Tanks 	Pickup Truck Tanks 	PCO Storage Tanks 	PVDF "Kynar" Tanks		

1

add to cart

$23999.00

10000 gallon Double Wall tank.
-- 142" Diameter x 202" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.9 specific gravity (15.8 pounds per gallon).
-- Weight - 4650 pounds.
-- 16" Lid
-- This tank ships from: TX.
-- Item number: VTBDC10000-142-1.9
Click for Drawing - VTBDC10000-142

1

add to cart

$21999.00

10000 gallon Double Wall tank.
-- 142" Diameter x 202" Height
.
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.5 specific gravity (12.5 pounds per gallon).
-- Weight - 4250 pounds.

-- 16" Lid
-- This tank ships from: TX.
-- Item number: VTBDC10000-142-1.5
Click for Drawing - VTBDC10000-142

1
add to cart

$11455.00

6000 gallon Double Wall tank.
-- 120" Diameter x 182" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.9 specific gravity (15.8 pounds per gallon).
-- Weight - pounds.
-- 16" Lid
-- This tank ships from: TX.
-- Item number: VTBDC06000-120-1.9
Click for Drawing - VTBDC06000-120

1
add to cart

$10199.00

6000 gallon Double Wall tank.
-- 120" Diameter x 182" Height
.
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.5 specific gravity (12.5 pounds per gallon).
-- Weight - pounds.
-- 16" Lid
-- This tank ships from: TX.
-- Item number: VTBDC06000-120-1.5
Click for Drawing - VTBDC06000-120

5000 gallon Double Wall tank.

1
add to cart
$9999.00

-- 120" Diameter x 152" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.9 specific gravity (15.8 pounds per gallon).
-- Weight - pounds.
-- 16" Lid
-- This tank ships from: TX.
-- Item number: VTBDC05000-120-1.9
Click for Drawing - VTBDC05000-120

5000 gallon Double Wall tank.
-- 120" Diameter x 152" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.5 specific gravity (12.5 pounds per gallon).
-- Weight - pounds.
-- 16" Lid
-- This tank ships from: TX.
-- Item number: VTBDC05000-120-1.5
Click for Drawing - VTBDC05000-120

1
add to cart
$8999.00

4200 gallon Double Wall tank.
-- 120" Diameter x 131" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.9 specific gravity (15.8 pounds per gallon).
-- Weight - pounds.
-- 16" Lid

1
add to cart
$9849.00

1
add to cart
$6990.00

-- This tank ships from: TX.
-- Item number: VTBDC04200-120
Click for Drawing - VTBDC04200-120

3000 gallon Completely Encapsulated Double Wall tank.
-- 102" Diameter x 131" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.9 specific gravity (15.8 pounds per gallon).
-- Weight - pounds.
-- 16" Lid
-- This tank ships from: TX.
-- Item number: VTBDC03000-102
Click for Drawing - VTBDC03000-102

2500 gallon Double Wall tank.
-- 102" Diameter x 100" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.9 specific gravity (15.8 pounds per gallon).
-- Weight - pounds.
-- 16" Lid
-- This tank ships from: TX.
-- Item number: VTBDC02500-102
Click for Drawing - VTBDC02500-102

1
add to cart
$6539.00

2000 gallon Completely

1
add to cart
$6349.00

Encapsulated Double Wall tank.
-- 102" Diameter x 93" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.9 specific gravity (15.8 pounds per gallon).
-- Weight - pounds.
-- 16" Lid
-- This tank ships from: TX.
-- Item number: VTBDC02000-102
Click for Drawing - VTBDC02000-102

1
add to cart
$3710.00

1550 gallon Double Wall tank.
-- 95" Diameter x 124" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.9 specific gravity (15.8 pounds per gallon).
-- Weight - pounds.
-- 16" Lid
-- This tank ships from: TX.
-- Item number: VTBDC01550-6487
Click for Drawing - VTBDC01550-6495

1
add to cart
$2838.00

1200 gallon Double Wall tank.
-- 87" Diameter x 96" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.9 specific gravity (15.8 pounds per gallon).

-- Weight - pounds.
-- 16" Lid
-- This tank ships from: TX.
-- Item number: VTBDC01200-87
Click for Drawing - VTBDC01200-87

1
add to cart
$1760.00

700 gallon Double Wall tank.
-- 60" Diameter x 98" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.9 specific gravity (15.8 pounds per gallon).
-- Weight - 410 pounds.
-- 8" Lid
-- This tank ships from: TX.
-- Item number: VTBDC00700-60
Click for Drawing - VTBDC00700-60

1
add to cart
$1630.00

550 gallon Double Wall tank.
-- 48" Diameter x 98" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.9 specific gravity (15.8 pounds per gallon).
-- Weight - pounds.
-- 8" Cap
-- This tank ships from: TX.
-- Item number: VTBDC00550-48
Click for Drawing - VTBDC00550-48

1
add to cart
$1331.00

300 gallon Double Wall tank.
-- 48" Diameter x 79" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.9 specific gravity (15.8 pounds per gallon).
-- Weight - pounds.
-- 8" Cap
-- This tank ships from: TX.
-- Item number: VTBDC00300-48
Click for Drawing - VTBDC00300-48

1
add to cart
$1205.00

265 gallon Double Wall tank.
-- 35" Diameter x 91" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.9 specific gravity (15.8 pounds per gallon).
-- Weight - pounds.
-- 8" Cap
-- This tank ships from: TX.
-- Item number: VTBDC00265-35
Click for Drawing - VTBDC00265-35

1
add to cart
$1203.00

250 gallon Double Wall tank.
-- 35" Diameter x 86" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.9 specific gravity (15.8 pounds per gallon).

-- Weight - pounds.
-- 8" Cap
-- This tank ships from: TX.
-- Item number: VTBDC00250-35
Click for Drawing - VTBDC00250-35

1
add to cart
$1140.00

200 gallon Totally Encapsulated Double Wall tank.
-- 35" Diameter x 78" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.9 specific gravity (15.8 pounds per gallon).
-- Weight - pounds.
-- 8" Cap
-- This tank ships from: TX.
-- Item number: VTBDC00200-35
Click for Drawing - VTBDC00200-35

1
add to cart
$907.00

120 gallon Double Wall tank.
-- 32" Diameter x 54" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.9 specific gravity (15.8 pounds per gallon).
-- Weight - pounds.
-- 8" Cap
-- This tank ships from: TX.
-- Item number: VTBDC00120-32
Click for Drawing - VTBDC00120-32

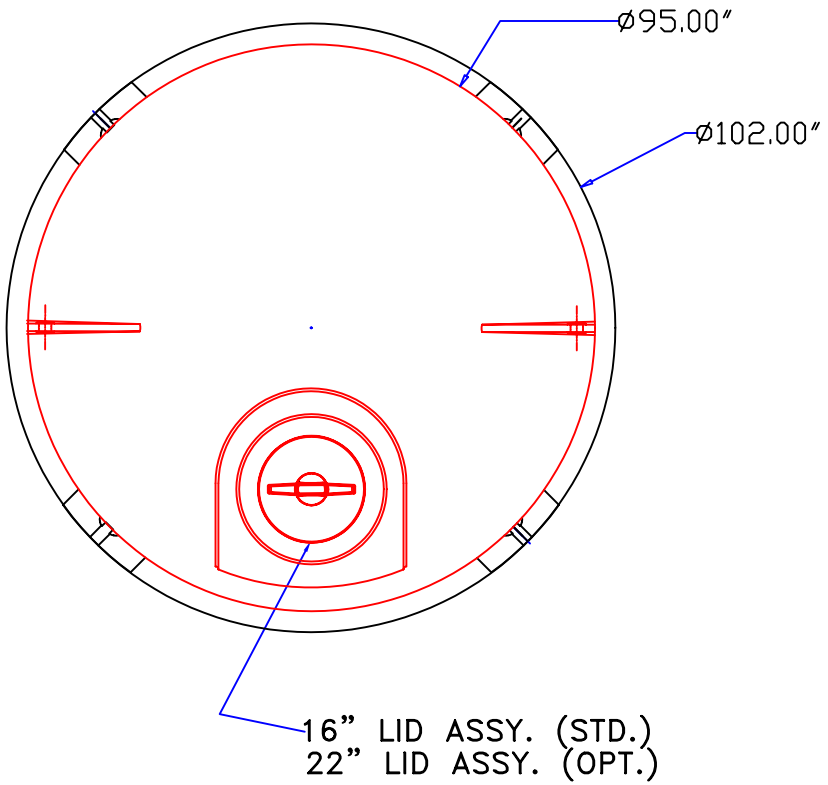
1

add to cart

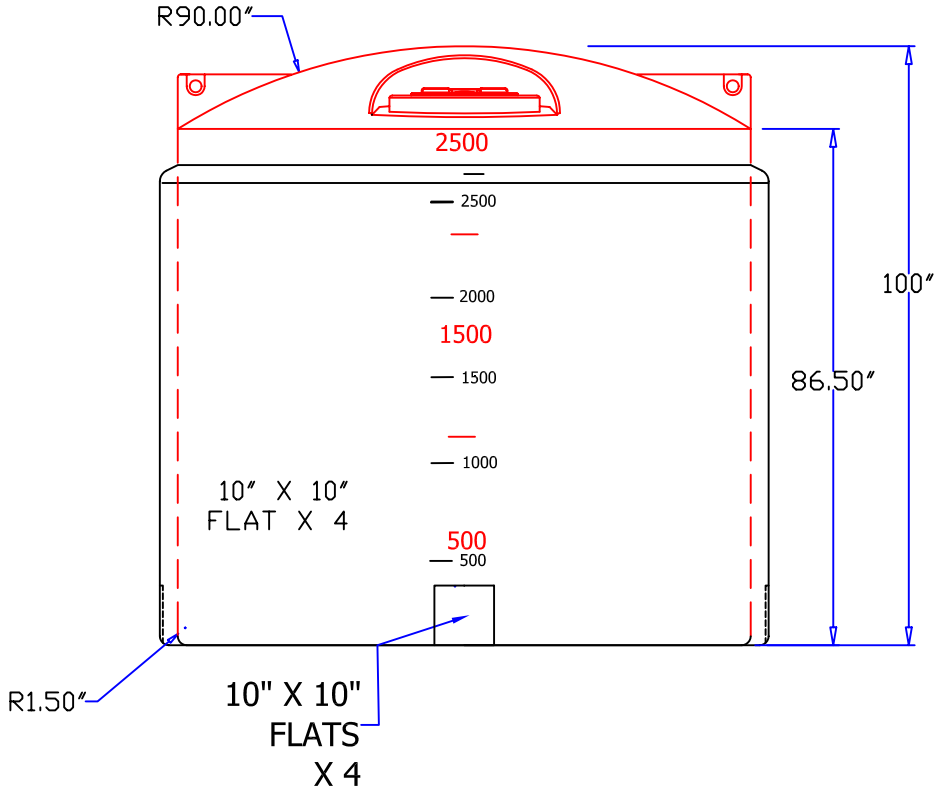
$840.00

75 gallon Double Wall tank.
-- 31" Diameter x 50" Height
-- Molded from FDA approved High Density Polyethylene (HDPE).
-- Rated for storage of liquids up to 1.9 specific gravity (15.8 pounds per gallon).
-- Weight - pounds.
-- 5" Cap
-- This tank ships from: TX.
-- Item number: VTBDC00075-31
Click for Drawing - VTBDC00075-31

TOP VIEW



SIDE VIEW



REV	DESCRIPTION	DATE	APPRD

ALL DIMENSIONS ARE IN DECIMAL INCHES
TOLERANCES UNLESS OTHERWISE SPECIFIED
± .5% @ 68° F

DRAWN / DATE
MPS/9/24/01

APPRD. / DATE

THIRD ANGLE PROJECTION
ANSI 14.5M

MATERIAL / SHOT WEIGHT	
HDPE	LBS.

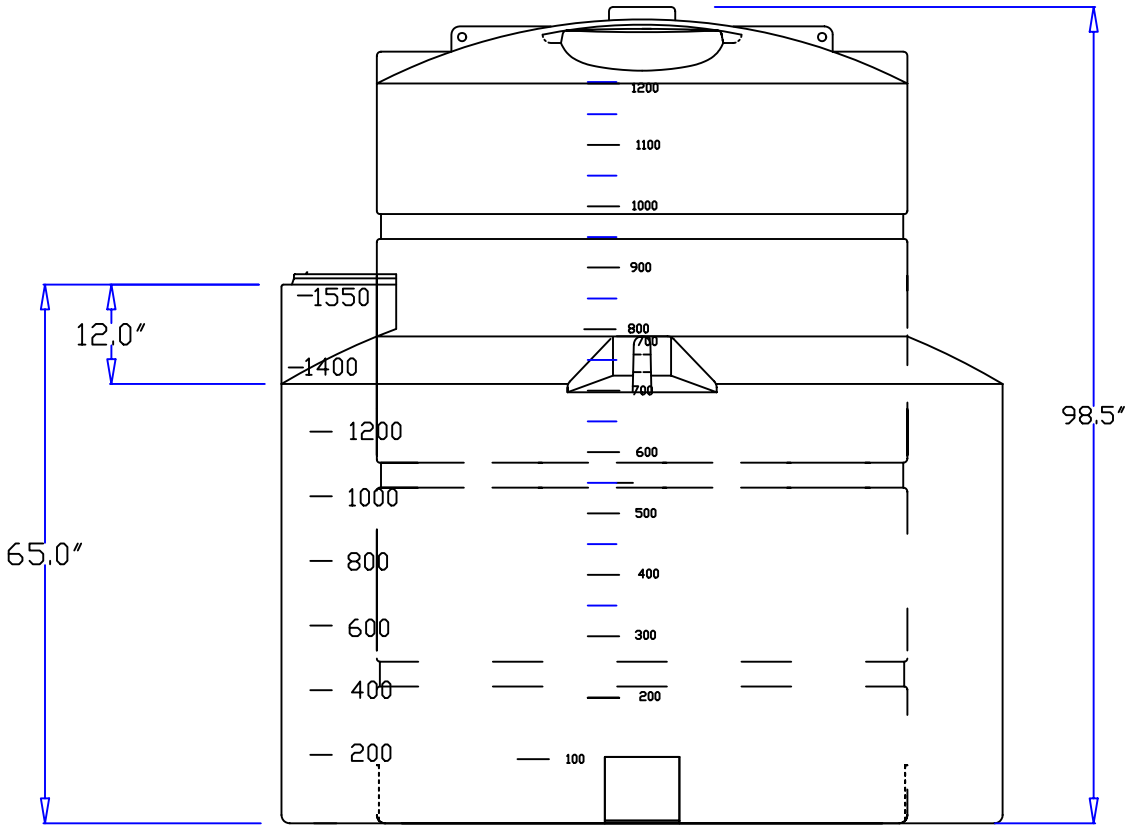
NOTES:

BAILIFF ENTERPRISES, INC.
8423 AIRLINE DRIVE, HOUSTON, TEXAS 77037
PHONE (281) 447-5372 FAX (281) 999-1223

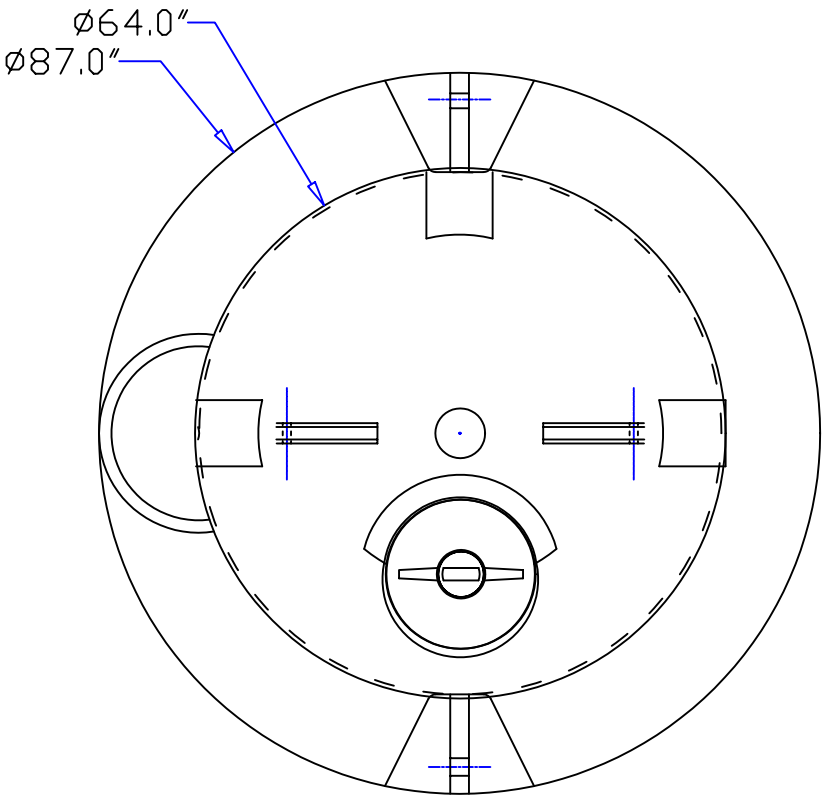
CLIENT / DESCRIPTION
2500-102 DUAL CONTAINMENT VERTICAL TANK

SCALE	PART NO.
N.S.	2500/4200 V

SIDE VIEW



PLAN VIEW



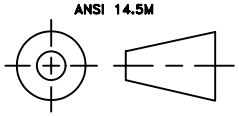
REV	DESCRIPTION	DATE	APPRD

ALL DIMENSIONS ARE IN DECIMAL INCHES
TOLERANCES UNLESS OTHERWISE SPECIFIED
± .5% @ 68° F

DRAWN / DATE
MSYKES/1/7/01

APPRD. / DATE

THIRD ANGLE PROJECTION
ANSI 14.5M



MATERIAL / SHOT WEIGHT	
HDPE	550 LBS.

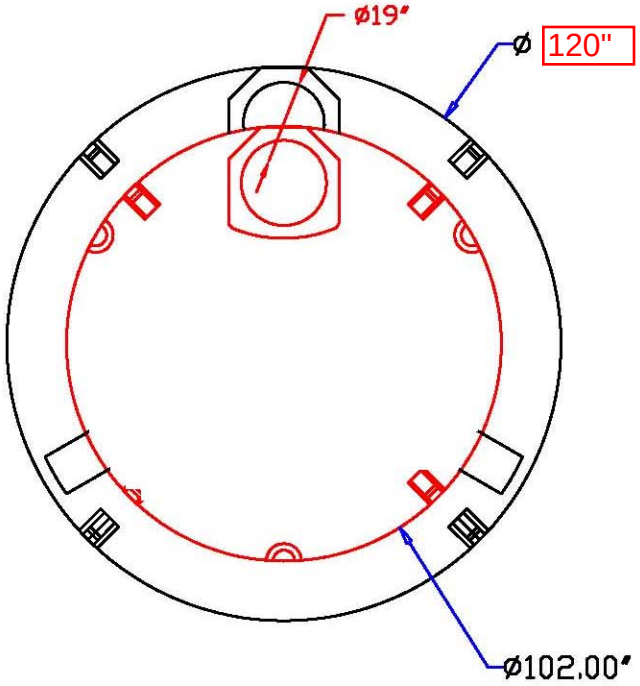
NOTES:
HRP-111

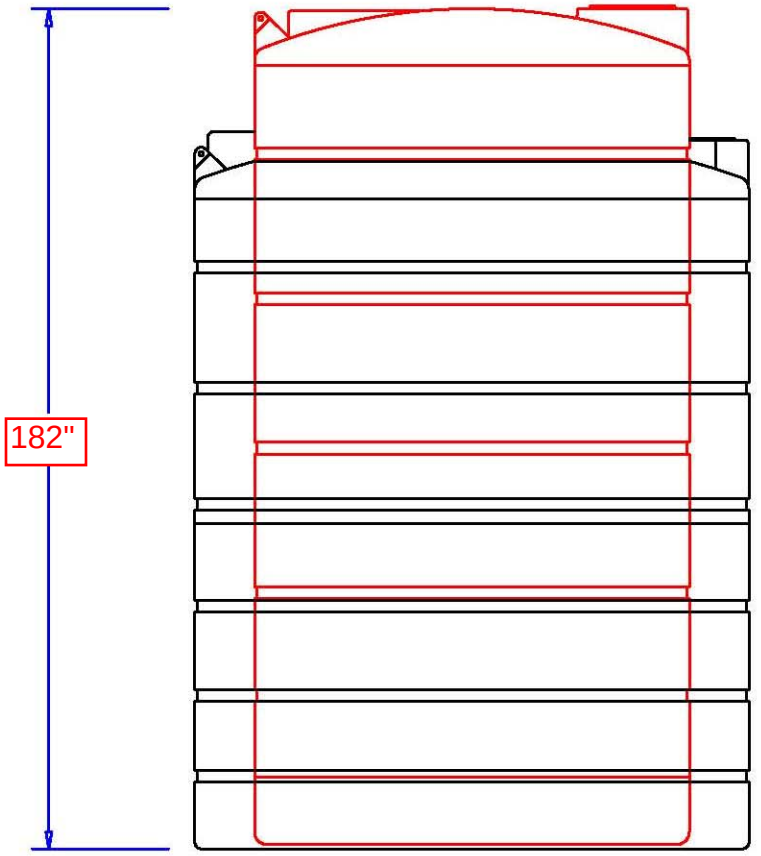
BAILIFF ENTERPRISES, INC.
8423 AIRLINE DRIVE, HOUSTON, TEXAS 77037
PHONE (281) 447-5372 FAX (281) 999-1223

CLIENT / DESCRIPTION
1200 VERTICAL DUAL CONTAINMENT

SCALE N.S.

PART NO. VTBDC1200-64-87





REV	DESCRIPTION	DATE	APPRD

DRAWN / DATE

APPRD. / DATE

MATERIAL / SHOT WEIGHT

HDPE	LBS.

ALL DIMENSIONS ARE IN DECIMAL INCHES
TOLERANCES UNLESS OTHERWISE SPECIFIED
± .5% ● 68° F

THIRD ANGLE PROJECTION
ANSI 14.5M

NOTES:

BAILIFF ENTERPRISES, INC.
8423 AIRLINE DRIVE, HOUSTON, TEXAS 77037
PHONE (281) 447-5372 FAX (281) 999-1223

CLIENT / DESCRIPTION

VTBDC6000-102-120

SCALE N.S.

PART NO

From: Jason Longer <jasonl@skyhawkchemicals.com>
Sent: Wednesday, January 24, 2018 10:49 AM
To: Milani, Somayeh
Subject: RE: Tote Quotes

Hello Milani,

I am still working on the antiscalant. Below is my pricing for the caustic soda and sulfuric acid. We are generally pretty low on these products but, freight really hikes the price up here.

Caustic Soda 50%
Packaging: 3500 lbs. IBC Tote
Quantity: 1 tote
Pricing: Delivered to 46304 Chesterton, IN $0.44/lbs.
Terms: Open Account 30 days with Skyhawk credit approval or prepayment for prompt shipment
Lead time: 2 days estimated
Validity: Pricing and availability subject to reconfirmation

Sulfuric Acid 93% (H2SO4)
Packaging: 3500 lbs. IBC Tote
Quantity: 1 tote
Pricing: Delivered to 46304 Chesterton, IN $0.403/lbs.
Terms: Open Account 30 days with Skyhawk credit approval or prepayment for prompt shipment
Lead time: 2 days estimated
Validity: Pricing and availability subject to reconfirmation

Thank you,
Jason Longer
Skyhawk Chemicals Inc.
713-737-5455

From: Milani, Somayeh [mailto:somayeh.milani@woodplc.com]
Sent: Tuesday, January 23, 2018 4:01 PM
To: Jason Longer <jasonl@skyhawkchemicals.com>
Subject: Tote Quotes

Hi Jason,

I am working on a remedial project in Indiana in which we are trying to conduct the remediation on a CCR land field. Would you please quote me on the following items:

1. 275 gallons tote , 50% caustic

2. 275 gallons tote, 93% H2SO4
3. 275 gallons tote, antiscalatant

Would you also please provide me with the shipping cost to 46 Bailly Station Rd, Chesterton, IN 46304
Also, would you please send the SDS as well ?

Thanks
Somi

Somayeh Milani,Ph.D.
Civil Environmental Engineer
Environment & Infrastructure Americas
Amec Foster Wheeler
585 N. Dairy Ashford, Houston, TX 77079, USA
D +01 713-929-8034 M +01 765-543-4444
somayeh.milani@amecfw.com amecfw.com

APPROVED maureen.simon
09/11/2015

GILES INCORPORATED

P.o. Box 390
Artesia, NM 88211-0390
Office # (505) 748-2142
Fax # (505) 748-2142
NM License # 81259

12456

AMEC Environment & Infrastructure, Inc
8519 Jefferson, NE
Albuquerque, NM 87113
Attn: Dan Kwiecinski

July 16, 2015

C01220666 56

INVOICE
NAVAJO SECONDARY R.O. PROJECT

Item	Cost Type	Current Value	% Complete	Value Complete	Balance
Mobilize	L & M	8,017	100%	8,017	0
R.O. Reject	L & M	45,175	100%	45,175	0
2' Water Supply	L & M	15,800	0	0	15,800
6" Primary Reject	L & M	8,560	0	0	8,560
Secondary Reject	L & M	8,390	0	0	8,390
Secondary Permeate	L & M	12,660	0	0	12,660
Sanitary Sewer	L & M	6,955	0	0	6,955
2" Air Supply	L & M	15,140	0	0	15,140
Vault	L & M	10,380	0	0	10,380
Buried Elect	L & M	45,723	0	0	45,723
Site Work & Prep	L & M	70,041	50%	35,021	35,020
Structural Concrete	L & M	114,200	0	0	114,200
Metal Bldg	Mat'l	33,425	0	0	33,425
	Labor	33,425	0	0	33,425

Item	Cost Type	Current Value	% Complete	Value Complete	Balance
TOTAL DIRECTS		427,891	20.7%	88,213	339,678
TOTAL INDIRECTS		89,388	20.7%	18,503	70,885
GRAND TOTAL		512,279		106,716	410,563

Total Work complete as of July 1, 2015: $ 106,716.00

TOTAL THIS INVOICE: **$ 106,716.00**

Thank You,

Thomas S. Giles
Giles Incorporated
NM #81259

Accepted by,

AMEC

GILES INCORPORATED

P.o. Box 390
Artesia, NM 88211-0390
Office # (505) 748-2142
Fax # (505) 748-2142
NM License # 81259

AMEC Environment & Infrastructure, Inc
8519 Jefferson, NE
Albuquerque, NM 87113
Attn: Dan Kwiecinski

July 16, 2015

NAVAJO SECONDARY R.O. PROJECT
SCHEDULE OF VALUES

Item	Cost Type	Value	C.O.	C.O.	C.O.	Current Value
Mobilize	L & M	8,017				8,017
R.O. Reject	L & M	37,145	#1- 8,030			45,175
2' Water Supply	L & M	15,800				15,800
6" Primary Reject	L & M	8,560				8,560
Secondary Reject	L & M	8,390				8,390
Secondary Permeate	L & M	12,660				12,660
Sanitary Sewer	L & M	6,955				6,955
2" Air Supply	L & M	15,140				15,140
Vault	L & M	10,380				10,380
Buried Elect	L & M	45,723				45,723
Site Work & Prep	L & M	57,391	#1- 12,650			70,041
Structural Concrete	L & M	114,200				114,200
Metal Bldg	Mat'l	33,425				33,425
	Labor	33,425				33,425
TOTAL DIRECTS		407,211	20,680			427,891
TOTAL INDIRECTS		89,388				89,388
GRAND TOTAL		496,599	20,680			517,279

ADSORBSIA™ As600 Titanium Based Media

A titanium oxide adsorbent for the removal of arsenic, lead, and other heavy metals

Typical Physical and Chemical Properties

Product Type		Granulated Titanium oxide media
Particle size range	Micron (Mesh)	250-1180 (16-60)
On 1180 Micron (16 mesh)	%	<10
Through 250 micron (60 mesh)	%	<10
Moisture Content	%	<10
Bulk Density	g/L (Lb/ft3)	640 (40)
Specific surface area	m^2/g	250
	cc/g	0.39

Typical Properties and Applications

ADSORBSIA™ As600 media is an easy to use granular titanium oxide with strong affinity for arsenic, lead and other heavy metals. This distinct media is designed for non-regenerative applications. The inherently high adsorptive capacity of Dow's titanium oxide based technology has been formulated into a mechanically stable granulation suitable for use in a broad range of potable water applications. Because it is based on titanium, ADSORBSIA As600 does not support bacterial growth as will iron based media.

When exhausted, it is removed from the vessel and replaced with new media. Spent media from arsenic loading tests have been shown to pass the U.S. Environmental Protection Agency's TCLP extraction protocol as well as both the WET and TTLC tests for California. ADSORBSIA As600 media is NSF/ANSI 61 certified.

Recommended Operating Conditions

Flow Direction	Down Flow
Minimum Bed Depth	61 cm (24 in)
Backwash Rate	7 -12m/h (3-5 gpm/ft^2)
Backwash Volume	5-10 BV
Service Rate	12-17 m/h (5-7 gpm/ft^2)
Empty Bed Contact Time (EBCT)	3.0 min.
Maximum Feed Temperature	65°C (150°F)

Figure 1. Backwash expansion data.

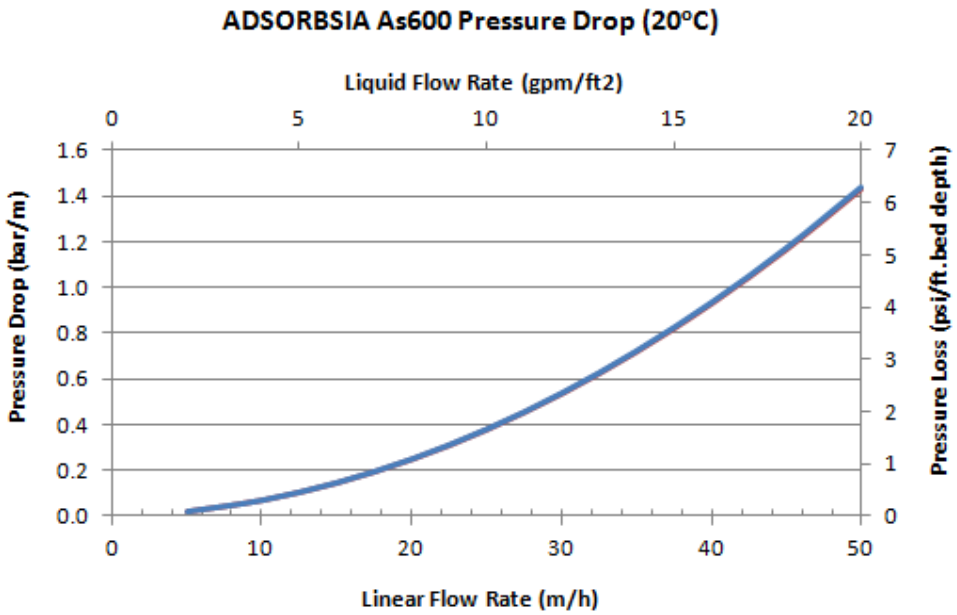
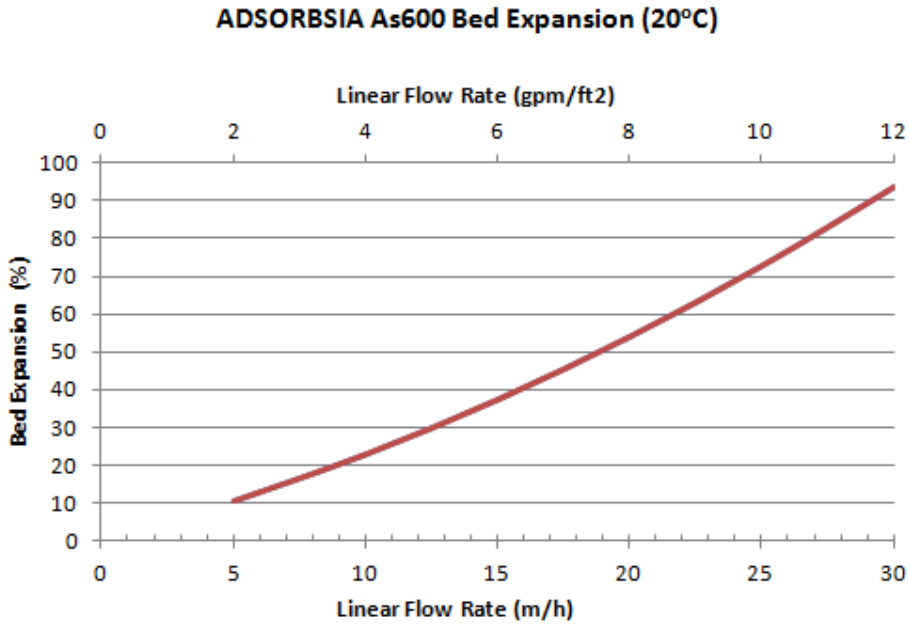


Figure 2. Pressure drop as a function of feed rate.



Note: This product may be subject to drinking water application restrictions in some countries; please check the application status before use and sale.

Handling Precautions

Before using this product, consult the Material Safety Data Sheet (MSDS)/Safety Data Sheet (SDS) for details on product hazards, recommended handling precautions and product storage.

Storage

Store products in tightly closed original containers at temperatures recommended on the product label.

Disposal Considerations

Dispose in accordance with all local, state (provincial) and federal regulations. Empty containers may contain hazardous residues. This material and its container must be disposed in a safe and legal manner.

It is the user's responsibility to verify that treatment and disposal procedures comply with local, state (provincial) and federal regulations. Contact your Dow Water and Process Solutions Technical Representative for more information.

Product Stewardship

Dow has a fundamental concern for all who make, distribute, and use its products, and for the environment in which we live. This concern is the basis for our product stewardship philosophy by which we assess the safety, health, and environmental information on our products and then take appropriate steps to protect employee and public health and our environment. The success of our product stewardship program rests with each and every individual involved with Dow products - from the initial concept and research, to manufacture, use, sale, disposal, and recycle of each product.

Customer Notice

Dow strongly encourages its customers to review both their manufacturing processes and their applications of Dow products from the standpoint of human health and environmental quality to ensure that Dow products are not used in ways for which they are not intended or tested. Dow personnel are available to answer your questions and to provide reasonable technical support. Dow product literature, including safety data sheets, should be consulted prior to use of Dow products. Current safety data sheets are available from Dow.

DOW™ Ion Exchange Resins
For more information about DOW™ resins, call the Dow Water & Process Solutions business:
North America: 1-800-447-4369
Latin America: (+55) 11-5188-9222
Europe: 800 3 694 6367
Italy: 800 783 825
South Africa: 0800 99 5078
Pacific: +800 7776 7776
China: +800 889 0789
www.dowwaterandprocess.com

AMBERSEP™ GT74

Industrial Grade Complexing Resin

Introduction

AMBERSEP GT74 is a weakly acidic cation exchange resin with very pronounced selectivity for certain metal ions, e.g. rhodium, copper, silver, cadmium and lead. AMBERSEP GT74 has been developed for the removal of Hg from different solutions and gaseous streams and can be regenerated very efficiently with hydrochloric acid.

The selectivity sequence is :
Hg > Ag > Cu > Pb > Cd > Ni > Co > Fe > Ca > Na

AMBERSEP GT74 is insoluble in common solvents and stable over the entire pH range. Oxidizing media should be avoided. The special properties of AMBERSEP GT74 can be useful for problems where removal of metal ions Cu, Ag, Pb, Cd is desired. Applications may be found in different fields of chemical technology such as waste water treatment, recovery of solutions and metals in the plating industry, recovery of catalysts and removal of interfering ions in hydrometallurgy.

Properties

Matrix	Macroporous styrene copolymer
Functional groups	Thiol
Physical form	Beads
Ionic form as shipped	H
Total exchange capacity	≥ 1.30 eq/L (SH form)
Moisture holding capacity	48 to 55 % (H form)
Shipping weight	785 g/L (49.0 lb/ft^3)
Particle size	
Harmonic mean size	0.450 - 0.700 mm
Uniformity coefficient	≤ 1.8
Fines content	< 0.425 mm : 12 % max
Coarse beads	> 0.850 mm : 15 % max

Suggested Operating Conditions

Maximum operating temperature	60°C (140 °F)
Minimum bed depth	1 m (39 inches)
Service flow rate	10 BV/h (1.25 gpm/ft^3)
Regenerant	Concentrated hydrochloric acid
Rinse requirements	2 to 3 BV* (15 to 22.5 gal/ft^3)
Backwash flow rate	About 12 m/h (5 gpm/ft^2)with water at 20°C (68 °F)

** 1 BV (Bed Volume) = 1 m^3 solution per m^3 resin*

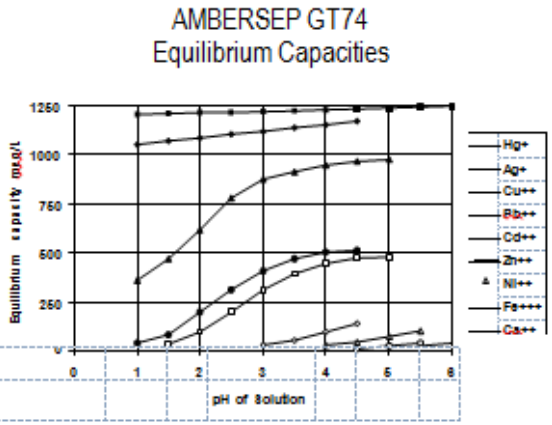
Selectivity

The high selectivity of AMBERSEP GT74 for certain metals is shown in the graph below as a function of pH. All data were determined in a normal solution of $NaNO_3$. The resin has a pronounced preference for copper, lead and cadmium ions, which are removed in considerable quantities, even from solutions containing only 1 meq/L of metal and a large excess of Na^+ ions. The data indicate the possibility of selective separation of these metals.

The solution passes a column of AMBERSEP GT74 at a flow rate of 15 m/h (6gpm/ft^2). The effluent contains less than 0.01 ppm Pb. After passage of 700 bed volumes of the solution the effluent composition was still unchanged.

Influent composition

• Pb^{++}	6 ppm
• Sb^{+++}	0.3 ppm
• Na^{+}	100 ppm
• pH	2.5



For more information about DOW™ resins, call the Dow Water & Process Solutions business:
North America: 1-800-447-4369
Latin America: (+55) 11-5188-9222
Europe: +800-3-694-6367
Italy: +800-783-825
South Africa: +0800 99 5078
Pacific: +8007776 7776
China: +400 889-0789
http://www.dowwaterandprocess.com

BORON REMOVAL PROJECT

Water & Process Solutions

AMEC Foster Wheeler

Scenario 1 - 60 gpm

Boron Tool Version 2.8.9

PROJECT DATA

Date of project	24 Jul 2015			
Data prepared by	Bill Carlin			
Feed water	Ground Water			
	Boron inlet	7.2	mg/L as B	
	Temperature	12	°C	
Treated water	Boron outlet <	0.5	mg/L as B	
	Boron outlet <	0.5	mg/L as B (final blended water)	
Total Flow rate :	86,400	gal/day		
Production time per day	24	hours per day	for 365 days per year	
=	60	gpm	31,536 kgal/year	
	0.00	gpm	No by-pass	
Treated through resins	**60**	**gpm**	**86,400**	**gal/day**

SYSTEM DESCRIPTION

There will be :	1	Column(s) on loading at [gpm]	60
	1	Column(s) in regeneration	
Total number of columns	2		
Each column contains :	**36**	**ft3 of AMBERLITE IRA743**	
Total resin volume :	71	ft3	

FOR ONE COLUMN

			COMMENTS
Service time (loading)	24	hours	**2 columns in service, one in regen. or stand-by**
Regeneration time	2.8	hours	
Total cycle time	27	hours	
Service flow rate	60	gpm	
Net throughput	86400	gal = 324 BV	
Specific flow rate	13.5	BV/h	
Linear flow (velocity)	8.5	gpm/ft2	
Boron removal capacity	2.38	g/L resin as B	
Resin bed depth	5.0	ft	
Internal column diameter	3.0	ft	
Approximate pressure drop*	6.9	psi @ 20°C	* Resin bed only

REGENERATION SUMMARY

Acid type	HCl	@ 32 %
Acid regenerant level	2.5	lb/ft3 resin
Total acid per regeneration	89	lb as 100%
Acid per final kgal produced	1.0	lb per kgal
NaOH level	1.5	lb/ft3 resin
NaOH per regeneration	53	lb as 100%
NaOH per final m3 produced	0.6	lb per kgal
Total regeneration time	171	minutes
Water consumption per cycle	2344	gal
Water consumed per kgal produced	27	gal per kgal
Waste produced per cycle	2177	gal
Percent waste / net production	2.5	%

Suggested regeneration procedure shown on page 2

BORON REMOVAL PROJECT

Water & Process Solutions

AMEC Foster Wheeler

Scenario 1 - 60 gpm

SUGGESTED REGENERATION PROCEDURE

Backwash water (optional)	30	minutes	**RO or soft water**
Backwash flow rate	13	gpm	for about 80% bed expansion at 15°C
Backwash water volume	390	gal	
Acid injection	**HCl**	@ 32 % as supplied	
Acid concentration	5	%	
Flow rate	13	gpm	
Volume	400	gal	
Dilution water for 32% HCl	180	gal	
Time	30	minutes	
Rinse (acid displacement)	2	BV	
Flow rate	13	gpm	
Volume	533	gal	
Time	40	minutes	
Caustic injection	NaOH	@ 50 % as supplied	
NaOH concentration	2.0	%	
Flow rate	13	gpm	
Volume	320	gal	
Dilution water* for 50% NaOH	307	gal	*Soft water or RO permeate
Time	24	minutes	
Rinse (caustic displacement)	2	BV	
Flow rate	13	gpm	
Volume	533	gal	
Time	40	minutes	
Final rinse with feed water			
Flow rate	60	gpm	
Volume	400	gal	**(can be recycled)**
Time	7	minutes	
Total regeneration time	**171**	minutes	

VOLUME AND COMPOSITION OF WASTE

Waste volume per cycle	**2177**	**gal (not including final rinse)**		61.1 BV = 2.5 %
Acid consumption per cycle	89	lb HCl	(as 100%)	89 lb/day
Caustic consumption per cycle	53	lb NaOH	(as 100%)	53 lb/day
Boron load per cycle	5.2	lb B		5.2 lb/day
Estimated boron-rich fraction	533	gal		2 BV
Boron in this fraction	1.16	g/L as B		
Number of cycles per day	1.00	At full flow with 0% by-pass for whole system		
Waste volume per day	**2,177**	**gal (not including final rinse) for whole system**		

BORON REMOVAL PROJECT

Water & Process Solutions

AMEC Foster Wheeler

Scenario 2 - 100 gpm

Boron Tool Version 2.8.9

PROJECT DATA

Date of project	24 Jul 2015			
Data prepared by	Bill Carlin			
Feed water	Ground Water			
	Boron inlet	27.0	mg/L as B	
	Temperature	12.5	°C	
Treated water	Boron outlet <	0.5	mg/L as B	
	Boron outlet <	0.5	mg/L as B (final blended water)	
Total Flow rate :	144,000	gal/day		
Production time per day	24	hours per day	for 365 days per year	
=	100	gpm	52,560	kgal/year
	0.00	gpm	No by-pass	
Treated through resins	**100**	**gpm**	**144,000**	**gal/day**

SYSTEM DESCRIPTION

There will be :	1	Column(s) on loading at [gpm]	100
	1	Column(s) in regeneration	
Total number of columns	2		
Each column contains :	**80**	**ft3 of AMBERLITE IRA743**	
Total resin volume :	160	ft3	

FOR ONE COLUMN

			COMMENTS
Service time (loading)	10	hours	**2 columns in service, one in regen. or stand-by**
Regeneration time	2.9	hours	
Total cycle time	13	hours	
Service flow rate	100	gpm	
Net throughput	60000	gal = 100 BV	
Specific flow rate	10.0	BV/h	
Linear flow (velocity)	6.3	gpm/ft2	
Boron removal capacity	2.73	g/L resin as B	
Resin bed depth	5.0	ft	
Internal column diameter	4.5	ft	
Approximate pressure drop*	5.1	psi @ 20°C	* Resin bed only

REGENERATION SUMMARY

Acid type	HCl	@ 32 %
Acid regenerant level	2.5	lb/ft3 resin
Total acid per regeneration	200	lb as 100%
Acid per final kgal produced	3.3	lb per kgal
NaOH level	1.5	lb/ft3 resin
NaOH per regeneration	120	lb as 100%
NaOH per final m3 produced	2.0	lb per kgal
Total regeneration time	173	minutes
Water consumption per cycle	5274	gal
Water consumed per kgal produced	88	gal per kgal
Waste produced per cycle	4898	gal
Percent waste / net production	8.2	%

Suggested regeneration procedure shown on page 2

BORON REMOVAL PROJECT

Water & Process Solutions

AMEC Foster Wheeler

Scenario 2 - 100 gpm

SUGGESTED REGENERATION PROCEDURE

Backwash water (optional)	30	minutes	**RO or soft water**
Backwash flow rate	29	gpm	for about 80% bed expansion at 15°C
Backwash water volume	878	gal	
Acid injection	**HCl**	@ 32 % as supplied	
Acid concentration	5	%	
Flow rate	30	gpm	
Volume	900	gal	
Dilution water for 32% HCl	405	gal	
Time	30	minutes	
Rinse (acid displacement)	2	BV	
Flow rate	30	gpm	
Volume	1200	gal	
Time	40	minutes	
Caustic injection	NaOH	@ 50 % as supplied	
NaOH concentration	2.0	%	
Flow rate	30	gpm	
Volume	720	gal	
Dilution water* for 50% NaOH	691	gal	*Soft water or RO permeate
Time	24	minutes	
Rinse (caustic displacement)	2	BV	
Flow rate	30	gpm	
Volume	1200	gal	
Time	40	minutes	
Final rinse with feed water			
Flow rate	100	gpm	
Volume	900	gal	**(can be recycled)**
Time	9	minutes	
Total regeneration time	**173**	minutes	

VOLUME AND COMPOSITION OF WASTE

Waste volume per cycle	**4898**	**gal (not including final rinse)**		61.1 BV = 8.2 %
Acid consumption per cycle	200	lb HCl	(as 100%)	481 lb/day
Caustic consumption per cycle	120	lb NaOH	(as 100%)	288 lb/day
Boron load per cycle	13.5	lb B		32.4 lb/day
Estimated boron-rich fraction	1200	gal		2 BV
Boron in this fraction	1.35	g/L as B		
Number of cycles per day	2.40	At full flow with 0% by-pass for whole system		
Waste volume per day	**11,756**	**gal (not including final rinse) for whole system**		

BORON REMOVAL PROJECT

Water & Process Solutions

AMEC Foster Wheeler

Scenario 3 - 5 gpm

Boron Tool Version 2.8.9

PROJECT DATA

Date of project	24 Jul 2015			
Data prepared by	Bill Carlin			
Feed water	Ground Water			
	Boron inlet	21.6	mg/L as B	
	Temperature	12.5	°C	
Treated water	Boron outlet <	0.5	mg/L as B	
	Boron outlet <	0.5	mg/L as B (final blended water)	
Total Flow rate :	7,200	gal/day		
Production time per day	24	hours per day	for 365 days per year	
=	5	gpm	2,628	kgal/year
	0.00	gpm	No by-pass	
Treated through resins	**5**	**gpm**	**7,200**	**gal/day**

SYSTEM DESCRIPTION

There will be :	1	Column(s) on loading at [gpm]	5
	1	Column(s) in regeneration	
Total number of columns	2		
Each column contains :	**8**	**ft3 of AMBERLITE IRA743**	
Total resin volume :	16	ft3	

FOR ONE COLUMN

			COMMENTS
Service time (loading)	32	hours	**2 columns in service, one in regen. or stand-by**
Regeneration time	3.0	hours	
Total cycle time	35	hours	
Service flow rate	5	gpm	
Net throughput	9600	gal = 160 BV	
Specific flow rate	5.0	BV/h	
Linear flow (velocity)	2.8	gpm/ft2	
Boron removal capacity	3.55	g/L resin as B	
Resin bed depth	4.5	ft	
Internal column diameter	1.5	ft	
Approximate pressure drop*	2.1	psi @ 20°C	* Resin bed only

REGENERATION SUMMARY

Acid type	HCl	@ 32 %
Acid regenerant level	2.5	lb/ft3 resin
Total acid per regeneration	20	lb as 100%
Acid per final kgal produced	2.1	lb per kgal
NaOH level	1.5	lb/ft3 resin
NaOH per regeneration	12	lb as 100%
NaOH per final m3 produced	1.3	lb per kgal
Total regeneration time	182	minutes
Water consumption per cycle	537	gal
Water consumed per kgal produced	56	gal per kgal
Waste produced per cycle	500	gal
Percent waste / net production	5.2	%

Suggested regeneration procedure shown on page 2

BORON REMOVAL PROJECT

Water & Process Solutions

AMEC Foster Wheeler

Scenario 3 - 5 gpm

SUGGESTED REGENERATION PROCEDURE

Backwash water (optional)	30	minutes	**RO or soft water**
Backwash flow rate	3	gpm	for about 80% bed expansion at 15°C
Backwash water volume	98	gal	
Acid injection	**HCl**	@ 32 % as supplied	
Acid concentration	5	%	
Flow rate	3	gpm	
Volume	90	gal	
Dilution water for 32% HCl	41	gal	
Time	30	minutes	
Rinse (acid displacement)	2	BV	
Flow rate	3	gpm	
Volume	120	gal	
Time	40	minutes	
Caustic injection	NaOH	@ 50 % as supplied	
NaOH concentration	2.0	%	
Flow rate	3	gpm	
Volume	72	gal	
Dilution water* for 50% NaOH	69	gal	*Soft water or RO permeate
Time	24	minutes	
Rinse (caustic displacement)	2	BV	
Flow rate	3	gpm	
Volume	120	gal	
Time	40	minutes	
Final rinse with feed water			
Flow rate	5	gpm	
Volume	90	gal	**(can be recycled)**
Time	18	minutes	
Total regeneration time	**182**	minutes	

VOLUME AND COMPOSITION OF WASTE

Waste volume per cycle	**500**	**gal (not including final rinse)**		62.3 BV = 5.2 %
Acid consumption per cycle	20	lb HCl	(as 100%)	15 lb/day
Caustic consumption per cycle	12	lb NaOH	(as 100%)	9 lb/day
Boron load per cycle	1.7	lb B		1.3 lb/day
Estimated boron-rich fraction	120	gal		2 BV
Boron in this fraction	1.73	g/L as B		
Number of cycles per day	0.75	At full flow with 0% by-pass for whole system		
Waste volume per day	**375**	**gal (not including final rinse) for whole system**		

Boron removal
Recirculation of caustic soda

Application of the Dow patent US 200810237123 A1

Introduction: the problem

The process of removing boric acid from water with a boron-selective ion exchange resin such as Amberlite PWA10, Amberlite IRA743 or Dowex BSR involves a regeneration in two steps: first elution of the boric acid from the resin using a strong acid such as sulphuric or hydrochloric acid, second conversion of the resin to its free base form using caustic soda.

Experience has shown that when the caustic soda is injected slowly into the resin bed at a concentration of about 2.5 %, the conversion of the functional groups in the resin bed is inhomogeneous, some areas being totally converted to the free amine and ammonium forms with adsorption of additional OH^- ions in the converted zone, other areas remaining largely protonated, i.e. in the salt form created by the acid regeneration step, as shown in figure 1.

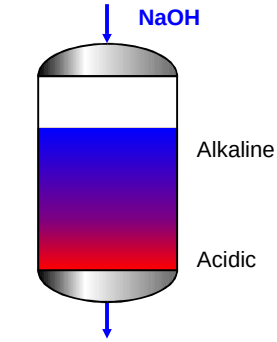


Figure 1

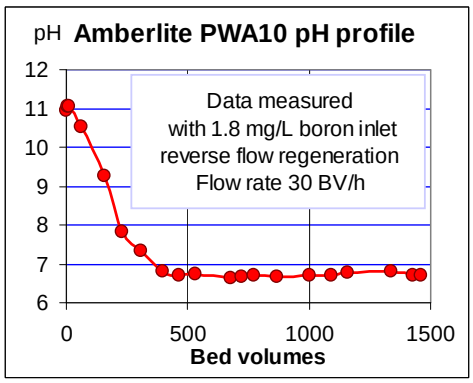


Figure 2

As a result, at the beginning of the following exhaustion run, the OH^- ions adsorbed in the upper resin layers of the bed find their way in the treated water and cause a high pH value at the beginning of the run; the pH then progressively goes down to reach neutrality, as shown in figure 2. This fluctuation of pH value is a serious disadvantage of the ion exchange process.

The solution

To obtain a more homogeneous conversion of the resin to the free base form, it was found that the injection process of the caustic soda had to be modified: instead of passing the caustic slowly through the bed, it is re-circulated at a high speed, so that the OH^- ions do not convert totally the upper layers of the bed at once, but are distributed throughout the bed and cause a progressive, homogeneous conversion to take place, as shown in figure 3. In essence, we are doing a controlled batch regeneration in a column. We run the recirculation quickly so we overrun the kinetic response of the resin neutralisation reaction. Hence, we partially neutralise the bed throughout.

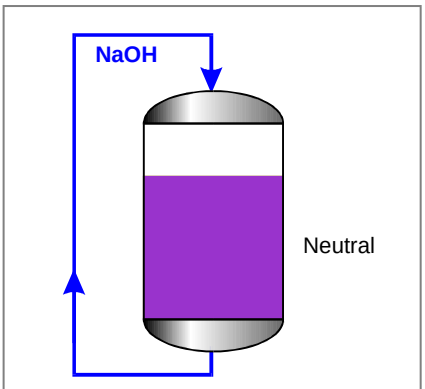


Figure 3

Implementation

Acid

In the regeneration process, the first step, which is the elution of boron by destruction of the complex with the resin, is unchanged: it requires about 1 eq acid per litre of resin, i.e. 50 g H_2SO_4 or 35 g HCl. As the regeneration reaction is relatively slow, sufficient contact time must be taken into account, a reasonable value being about 40 minutes injection time. The volume of acid is about one bed volume, which means sulphuric acid is diluted to a 5 % solution and hydrochloric acid to 3.5 %.

Caustic soda

Instead of passing 28 g NaOH per litre resin at 2.5 % concentration slowly through the bed, we circulate a smaller quantity of caustic soda (18 g NaOH at 2 % concentration) quickly. There are two options:

1. Upflow recirculation with fluidisation of the bed

The resin bed is fluidised to a low degree of expansion (25 to 30 %) by the upflow recirculation stream. The corresponding linear velocity is about 2 m/h at 20 °C. In the fluidised bed, exchange is not immediate and the caustic solution is immediately distributed through the whole bed instead of contacting first the upper layer of the bed. This option is shown in figure 4. Recycling is continued for a period of one hour.

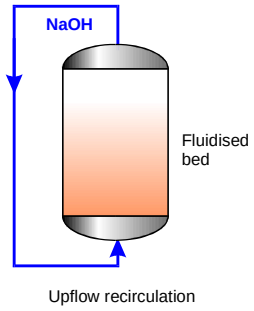


Figure 4

2. Fast recirculation downflow

Recirculation must be done as fast as the pressure drop permits, which means using a flow rate at least equal to the service flow rate, at 25 to 30 BV/h*. The caustic may have to be added progressively. The volume of caustic solution is usually around one bed volume, and must be recycled through an appropriate small tank. See figure 5. The recirculation time is one hour as for option 1.

We also found out that a partial neutralisation of the resin bed was more effective in terms of operating capacity than a complete neutralisation. Therefore the overall quantity of caustic soda can be reduced.

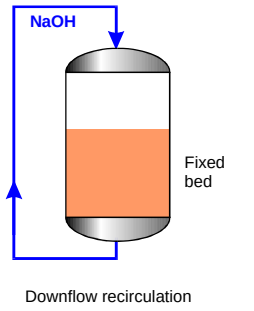


Figure 5

* 1 BV/h = 1 bed volume per hour = 1 m^3 solution per m^3 resin per hour.

Result

The new pH profile is shown with a blue curve in figure 6: with the recirculation procedure, the pH value drops now immediately at the very beginning of the run, down to values acceptable for drinking water.

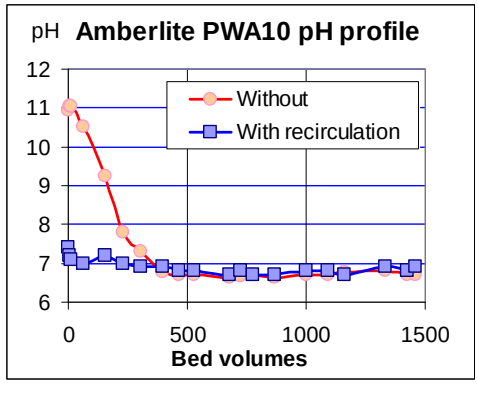


Figure 6

License

This regeneration process includes proprietary Dow information along with patents pending in many jurisdictions. Therefore a license is necessary to implement the procedure. Information about the terms of licensing is available from Dow Water and Process Solutions.

BORON REMOVAL SYSTEM - DOW CALCULATIONS

Discussions on Sept 29 w/ Bob Kimball on how the full scale process would be sized
Piloting needs to be based on the contraints for the full production unit
Decided on 3 vessels of 250 cf each Boron Selective resin with two on line at all times and the third in regeneration and coming back into service as soon as it is regenerated

Full Flow	100,000	bpd								
Flow rate to treat	92,000	bpd	3,864,000	gpd	14,606	m3/day				Pilot flow ra
			161,000	gph	608.58	m3/hr	608,580	l/hr		
			2,683	gpm	10.14	m3/min	10,143	l/min		
Boron in feed	1.4	ppm (mg/L) Borate			0.05	ppm treatment target so blending is not possible				
	14	g borate/min			96.4%	Removal requirement				
	852	g borate/hr								
	24	hours/day of service								
	20,448	g boron/day				Resin demand per day				
						Loading limit	flow limit			
DOWEX BSR-1 loading capacity	2.25	g/l of resin	50	BV/hr	9,088	12,172	l resin	Pretty good case		
**Conservative values used	2.75	g/l of resin	25	BV/hr	7,436	24,343	l resin	Also a good case		
Based on low levels of B leakage										
Resin capacity will be avarage of	2.5	g B/l of resin at	25.86	to	38.80	BV/hr				
	341	L of resin per hour	90	gal per hour						
	12	cf of resin per hour	289	cf per day						
Control beds based on gallons throughput of	250	cf resin	7,075	liters	1,872	gal media	17,688	g Boron capacity		
	340.80	l resin demand per hour	20.8	hrs of service per bed						
	3,342,309	gal water treated per bed								
Assume we could put a totalizer on each bed and run until they hit their limit and take the bed off line for regeneration										
Propose system	250.0	cf beds	3	total beds	894	gpm/bed	25.86	BV/hr	17.80	gpm/ft2
			2	in service at all times	1,342	gpm/bed	38.80	BV/hr	26.71	gpm/ft2
Bed dimension check	250	2,075 gal of resin	8.00	ft diameter	4.0	r	50.24	ft2 X area		
then	5.0	ft deep beds								
	3	bed system	2	beds in service while the other is in regeneration						
Total installed resin	750	ft3	21,225	liters	5,615	gallons				
Resin cost		$25.00 $/liter			$708	$/cf				
		$530,625 $ installed			life of 3 to 7		3	years		
							$176,875			
Equipment cost	to be provided by system mfgr									
Operating cost	2	BV of 7% per regeneration cycle								
Acid regenerant per cycle	3,743	gal of	7.00%	or	262.04	gal of	100.00%	acid		
Base pH neutralization	15	lbs of caustic at 95% rinse efficiency rate								
Waste volume estimate per cycle	3,743	gallons of concentrated Boron/acid per cycle								
	7,487	gallons of rinse water for recycle or rcovery								
	3,743	gallons of pH neutralization rinse water for discharge								

System could be modified to be a zero water discharge operation

NONE

Chain of Custody Form

Company / Project Name/Address/Phone:
Bailly Generating Station, Indiana

Company Contact / Project Manager:
John Christiansen, 713-851-1641, john.christiansen@amec.com

Sampled By (Printed and Written Signature): Casey Richards Casey Richards

Sample Identification	**Matrix (Aq/S)**	Sample Volume	Sample Type: Comp/Grab	No. of containers	Analysis requested	Date/Time Sampled
MW-119[1]	AQ	65mL[2]	Comp	9	Filtered Boron[3]	5-3-17
MW-119 Blank[1]	AQ	65mL[2]	Comp	1	Filtered Boron[3]	5-3-17

Relinquished By (signature): Casey Richards — Date/Time: May 23, 2017 4:00 PM

Received By (signature): Auburn — Date/Time:

[1]Original 3 gallon sample was preserved with 15mL of HCl per 3 gallons of water.

[2]Cliff- Please see the following information provided by the Dow lab regarding the sample. This sample was originally collected by Amec Foster Wheeler (May 3, 2017), and sent to Dow labs for the following tests:

DOWEX MARATHON C Na for the removal of the cations
DOWEX MARATHON A Cl for removal of the anions
ADSORBDSIA As600 – a one-time-use chelating media for removal of heavy metals

Dow shipped the samples to Amec Foster Wheeler on May 18/19, 2017. Dow expects that the shipping will allow for equilibration of the ions of interest with the media. Dow preparation of the water samples: Dow decanted 3 gallons of sampled water into 65 ml glass bottles with 10 g or 1 g or 0.1 g of media. Once media are added, add 50 mLs of each solution to the bottles. Please remember to also include a blank (no media) for the lab to use as a reference. This should mean you have 10 bottles. Labeling should match sample to the right media at the right resin dose. If it doesn't please call me (Casey Richards) at 512-970-1076.

[3]One the samples arrive at the lab, decant/filter off the media and test the water for filtered boron.

Attachment C

Instrument, Tank, and Pumps Cost Data

amec foster wheeler	**HDPE Double Wall Tank**				
	Bailiff Enterprises (http://www.plasticstoragetanks.com/)				
Component	10,000 Gallon	6,000 Gallon	2500 Gallon	1,200 Gallon	1,200 Gallon
Material	High Density Polyethylene (HDPE)	High Density Polyethylene (HDPE)	High Density Polyethylene (HDPE)	High Density Polyethylene (HDPE)	High Density Polyethylene (HDPE)
Volume (gallon)	10,000	6,000	2,500	1,200	75
Diameter (inches)	11'-10" OD	10'-0" OD	11'-10" OD	7'-3" OD	2'-7" OD
Height (inches)	16'- 10"	15'- 2"	16'- 10"	8'- 0"	4'- 2"
Cost	**$ 23,999.00**	**$ 11,455.00**	**$ 6,539.00**	**$ 2,838.00**	**$ 840.00**

	Skyhawk Chemicals Inc. Jason Longer <jasonl@skyhawkchemicals.com>	
	50% Caustic	93% Sulfuric Acid
Tote Volume (gal)	275	275
Tote Volume (ft3)	36.85	36.85
Specefic Gravity	1.53	1.8
Density	95.47	112.32
Mass of Tote	3518.14	4138.99
Cost per lbs.	$ 0.44	$ 0.40
Cost Per 275 Gallon Tote (Includes shipping)	**$ 1,547.98**	**$ 1,668.01**

amec foster wheeler	Evoqua Water Technologies http://www.evoqua.com/en
	antiscalant
Tote Volume (gal)	272
Tote Volume (ft3)	36.42
Specefic Gravity	1.1
Density	68.64
Mass of Tote	2500
Cost per lbs.	
Cost Per 272 Gallon Tote (No shipping cost)	**3,392.86**

amec foster wheeler	**Cartidge Filter**

Suez
Larry Padgett
Padgett, Lawrence <lawrence.padgett@suez.com>

10 gpm			100 gpm		
Component	Unit	Unit Cost	Component	Unit	Unit Cost
20” polypro (Housing)	EA	$ 90.00	HX0740-2.0T-316-A,PKG (Housing)	EA	$ 2,855.00
GX10-20 filter	Case of 20	$ 5.20	GX10-40 filter	Case of 20	$ 11.50
			Accessory kit (adjustable stand, springs, cup, vent valve)		$ 629

amec foster wheeler	**Metering Pump**			
	Foust Marketing, Inc. Bryan Foust 281-296-2500 bryan@foustmarketing.com			
Item Number	Description	List Price	Multiplier	**Net Price**
LPK5SA-PTC3-500 ANTISCALANT	SERIES E+ 115 FPP/TFE/CDBL.50T 50 GPD @ 150 PSI	$1,295.00	0.85	**$1,100.75**
LPA2SA-PTCJ-500 ANTISCALANT	SERIES E+ 115 FPP/TFE/CDBL.38T 6 GPD @ 150 PSI	$729.00	0.85	**$619.65**
LPK5SA-PTC3-500 CAUSTIC	SERIES E+ 115 FPP/TFE/CDBL.50T 50 GPD @ 150 PSI	$1,295.00	0.85	**$1,100.75**
LPA2SA-PTCJ-500 CAUSTIC	SERIES E+ 115 FPP/TFE/CDBL.38T 6 GPD @ 150 PSI	$729.00	0.85	**$619.65**
LPK5SA-KTC3-500 H2SO4	SERIES E+ 115 PVD/TFE/CDBL.50T	$1,358.00	0.85	**$1,154.30**
LPA2SA-KTCJ-500 H2SO4	SERIES E+ 115 PVD/TFE/CDBL.38T	$814.00	0.85	**$691.90**

amec foster wheeler	**Pumps**		
	DXP		
Component	Brian Seay DXP Enterprises, Inc. Cell: 713-614-1458		
Model	ANSI Pumps	ANSI Pumps	ANSI Pumps
Quantity	1	1	1
Pump Capacity	100 gpm @ 40 psi	25 gpm @ 40 psi	200 gpm @ 40 psi
Pump Speed	3500 rpm	3560 rpm	3500 rpm
HP	7.5	5	7
Pump Cost	$ 4,302	$ 6,069	$ 4,783
Motor	$ 395	$ 292	$ 444
Total Cost Estimate	**$ 4,697**	**$ 6,361**	**$ 5,227**

NAVAJO SECONDARY R.O. PROJECT
SCHEDULE OF VALUES

Item	Cost Type	Value	C.O.	C.O.	C.O.	Current Value
Mobilize	L & M	8,017				8,017
R.O. Reject	L & M	37,145	#1- 8,030			45,175
2' Water Supply	L & M	15,800				15,800
6" Primary Reject	L & M	8,560				8,560
Secondary Reject	L & M	8,390				8,390
Secondary Permeate	L & M	12,660				12,660
Sanitary Sewer	L & M	6,955				6,955
2" Air Supply	L & M	15,140				15,140
Vault	L & M	10,380				10,380
Buried Elect	L & M	45,723				45,723
Site Work & Prep	L & M	57,391	#1- 12,650			70,041
Structural Concrete	L & M	114,200				114,200
Metal Bldg	Mat'l	33,425				33,425
	Labor	33,425				33,425
TOTAL DIRECTS		407,211	20,680			427,891
TOTAL INDIRECTS		89,388				89,388
GRAND TOTAL		496,599	20,680			517,279

INSTRUMENT COST ESTIMATE, OPTION 1A

GROUNDWATER TREATMENT PROJECT, FEL-2

BAILLY GENERATING STATION

INSTRUMENT TAG NUMBER	P&ID NUMBER	INSTRUMENT TYPE	DESCRIPTION	EQUIPMENT TAG NUMBER	I/O TYPE	CONTROL SYSTEM	COST ESTIMATE	MANUFACTURER	MODEL NUMBER	REMARKS
PI-GWPUMP		PRESSURE INDICATOR	GW PUMP DISCHARGE PRESSURE	---	NONE	N/A	$ 200.00			
LIT-XXX1A		LEVEL TRANSMITTER	EQUALIZATION TANK 'A' LEVEL	T-XXX1A	AI	PLC	$ 4,500.00			RADAR LEVEL TRANSMITTER
LIT-XXX1B		LEVEL TRANSMITTER	EQUALIZATION TANK 'B' LEVEL	T-XXX1B	AI	PLC	$ 4,500.00			RADAR LEVEL TRANSMITTER
LIT-XXX1C		LEVEL TRANSMITTER	EQUALIZATION TANK 'C' LEVEL	T-XXX1C	AI	PLC	$ 4,500.00			RADAR LEVEL TRANSMITTER
PI-XXX1A		PRESSURE INDICATOR	GW TREATMENT FEED PUMPS DISCHARGE PRESSURE	P-XXX1A/B	NONE	N/A	$ 200.00			
FE/FIT-XXX1		FLOW METER AND TRANSMITTER	GW TREATMENT FEED PUMPS FLOW RATE	---	AI	PLC	$ 6,000.00			MAGNETIC FLOW METER AND TRANSMITTER
FY-XXX1		VALVE POSITIONER	GW TREATMENT FEED PUMPS FLOW CONTROL	---	AO	PLC	N/A			POSITIONER, INCLUDED WITH CONTROL VALVE
FV-XXX1		FLOW CONTROL VALVE	GW TREATMENT FEED PUMPS FLOW CONTROL	---	NONE	N/A	$ 4,000.00			
PI-XXX1AA		PRESSURE INDICATOR	CARTRIDGE FILTER 'A' INLET PRESSURE	C-XXX1A	NONE	N/A	$ 200.00			
PI-XXX1AB		PRESSURE INDICATOR	CARTRIDGE FILTER 'A' OUTLET PRESSURE	C-XXX1A	NONE	N/A	$ 200.00			
PI-XXX1BA		PRESSURE INDICATOR	CARTRIDGE FILTER 'B' INLET PRESSURE	C-XXX1B	NONE	N/A	$ 200.00			
PI-XXX1BB		PRESSURE INDICATOR	CARTRIDGE FILTER 'B' OUTLET PRESSURE	C-XXX1B	NONE	N/A	$ 200.00			
AE/AIT-XXX1A		pH ANALYZER	INLET GW pH	I-XXX1A	AI	PLC	$ 2,800.00			PH ANALYZER AND TRANSMITTER
AE/AIT-XXX2A		pH ANALYZER	GW pH AFTER Ca ION EXCHANGE	I-XXX2A	AI	PLC	$ 2,800.00			PH ANALYZER AND TRANSMITTER
LIT-XXX2A		LEVEL TRANSMITTER	EFFLUENT TANK LEVEL	T-XXX2A	AI	PLC	$ 4,000.00			RADAR LEVEL TRANSMITTER
LIT-XXX3A		LEVEL TRANSMITTER	BACKWASH TANK LEVEL	T-XXX3A	AI	PLC	$ 4,500.00			RADAR LEVEL TRANSMITTER
PI-XXX2A		PRESSURE INDICATOR	EFFLUENT TRANSFER PUMPS DISCHARGE PRESSURE	P-XXX2A/B	NONE	N/A	$ 200.00			
PI-XXX3A		PRESSURE INDICATOR	BACKWASH PUMP DISCHARGE PRESSURE	P-XXX3A	NONE	N/A	$ 200.00			

TOTAL REAL INSTRUMENT COUNT		
RAW TOTAL	**UNCERTAINTY**	**RAW TOTAL + 50%**
25	50%	38

TOTAL COST	$ 39,200.00

INSTRUMENT COST ESTIMATE, OPTION 1B

GROUNDWATER TREATMENT PROJECT, FEL-2

BAILLY GENERATING STATION

INSTRUMENT TAG NUMBER	P&ID NUMBER	INSTRUMENT TYPE	DESCRIPTION	EQUIPMENT TAG NUMBER	I/O TYPE	CONTROL SYSTEM	COST ESTIMATE	MANUFACTURER	MODEL NUMBER	REMARKS
PI-GWPUMP		PRESSURE INDICATOR	GW PUMP DISCHARGE PRESSURE	---	NONE	N/A	$ 200.00			
LIT-XXX1A		LEVEL TRANSMITTER	EQUALIZATION TANK 'A' LEVEL	T-XXX1A	AI	PLC	$ 4,500.00			RADAR LEVEL TRANSMITTER
LIT-XXX1B		LEVEL TRANSMITTER	EQUALIZATION TANK 'B' LEVEL	T-XXX1B	AI	PLC	$ 4,500.00			RADAR LEVEL TRANSMITTER
LIT-XXX1C		LEVEL TRANSMITTER	EQUALIZATION TANK 'C' LEVEL	T-XXX1C	AI	PLC	$ 4,500.00			RADAR LEVEL TRANSMITTER
PI-XXX1A		PRESSURE INDICATOR	GW TREATMENT FEED PUMPS DISCHARGE PRESSURE	P-XXX1A/B	NONE	N/A	$ 200.00			
FE/FIT-XXX1		FLOW METER AND TRANSMITTER	GW TREATMENT FEED PUMPS FLOW RATE	---	AI	PLC	$ 6,000.00			MAGNETIC FLOW METER AND TRANSMITTER
FY-XXX1		VALVE POSITIONER	GW TREATMENT FEED PUMPS FLOW CONTROL	---	AO	PLC	N/A			POSITIONER, INCLUDED WITH CONTROL VALVE
FV-XXX1		FLOW CONTROL VALVE	GW TREATMENT FEED PUMPS FLOW CONTROL	---	NONE	N/A	$ 4,000.00			
PI-XXX1AA		PRESSURE INDICATOR	MEDIA FILTER 'A' INLET PRESSURE	C-XXX1A	NONE	N/A	$ 200.00			
PI-XXX1AB		PRESSURE INDICATOR	MEDIA FILTER 'A' OUTLET PRESSURE	C-XXX1A	NONE	N/A	$ 200.00			
PI-XXX1BA		PRESSURE INDICATOR	MEDIA FILTER 'B' INLET PRESSURE	C-XXX1B	NONE	N/A	$ 200.00			
PI-XXX1BB		PRESSURE INDICATOR	MEDIA FILTER 'B' OUTLET PRESSURE	C-XXX1B	NONE	N/A	$ 200.00			
PI-XXX2A		PRESSURE INDICATOR	LOW PRESSURE RO FEED PUMPS DISCHARGE	P-XXX2A/B	NONE	N/A	$ 200.00			
PI-XXX2AA		PRESSURE INDICATOR	CARTRIDGE FILTER 'A' INLET PRESSURE	C-XXX1A	NONE	N/A	$ 200.00			
PI-XXX2AB		PRESSURE INDICATOR	CARTRIDGE FILTER 'A' OUTLET PRESSURE	C-XXX1A	NONE	N/A	$ 200.00			
PI-XXX2BA		PRESSURE INDICATOR	CARTRIDGE FILTER 'B' INLET PRESSURE	C-XXX1B	NONE	N/A	$ 200.00			
PI-XXX2BB		PRESSURE INDICATOR	CARTRIDGE FILTER 'B' OUTLET PRESSURE	C-XXX1B	NONE	N/A	$ 200.00			
AE/AIT-XXX1A		pH ANALYZER	INLET GW pH	I-XXX1A	AI	PLC	$ 2,800.00			PH ANALYZER AND TRANSMITTER
LIT-XXX3A		LEVEL TRANSMITTER	PERMEATE TANK LEVEL	T-XXX3A	AI	PLC	$ 4,000.00			RADAR LEVEL TRANSMITTER
LIT-XXX4A		LEVEL TRANSMITTER	REJECT TANK LEVEL	T-XXX4A	AI	PLC	$ 4,000.00			RADAR LEVEL TRANSMITTER
LIT-XXX5A		LEVEL TRANSMITTER	CIP TANK LEVEL	T-XXX5A	AI	PLC	$ 4,000.00			RADAR LEVEL TRANSMITTER
PI-XXX3A		PRESSURE INDICATOR	RO FEED PUMPS DISCHARGE PRESSURE	P-XXX3A/B	NONE	N/A	$ 200.00			
PI-XXX4A		PRESSURE INDICATOR	PERMEATE TRANSFER PUMPS DISCHARGE PRESSURE	P-XXX4A/B	NONE	N/A	$ 200.00			

TOTAL REAL INSTRUMENT COUNT		
RAW TOTAL	**UNCERTAINTY**	**RAW TOTAL + 50%**
23	50%	35

INSTRUMENT COST ESTIMATE, OPTION 1B

GROUNDWATER TREATMENT PROJECT, FEL-2

BAILLY GENERATING STATION

INSTRUMENT TAG NUMBER	P&ID NUMBER	INSTRUMENT TYPE	DESCRIPTION	EQUIPMENT TAG NUMBER	I/O TYPE	CONTROL SYSTEM	COST ESTIMATE	MANUFACTURER	MODEL NUMBER	REMARKS

TOTAL COST	$ 40,900.00

INSTRUMENT COST ESTIMATE, OPTION 2A

GROUNDWATER TREATMENT PROJECT, FEL-2

BAILLY GENERATING STATION

INSTRUMENT TAG NUMBER	P&ID NUMBER	INSTRUMENT TYPE	DESCRIPTION	EQUIPMENT TAG NUMBER	I/O TYPE	CONTROL SYSTEM	COST ESTIMATE	MANUFACTURER	MODEL NUMBER	REMARKS
PI-GWPUMP		PRESSURE INDICATOR	GW PUMP DISCHARGE PRESSURE	---	NONE	N/A	$ 200.00			
LIT-XXX1A		LEVEL TRANSMITTER	EQUALIZATION TANK 'A' LEVEL	T-XXX1A	AI	PLC	$ 4,500.00			RADAR LEVEL TRANSMITTER
PI-XXX1A		PRESSURE INDICATOR	GW TREATMENT FEED PUMPS DISCHARGE PRESSURE	P-XXX1A/B	NONE	N/A	$ 200.00			
FE/FIT-XXX1		FLOW METER AND TRANSMITTER	GW TREATMENT FEED PUMPS FLOW RATE	---	AI	PLC	$ 6,000.00			MAGNETIC FLOW METER AND TRANSMITTER
FY-XXX1		VALVE POSITIONER	GW TREATMENT FEED PUMPS FLOW CONTROL	---	AO	PLC	N/A			POSITIONER, INCLUDED WITH CONTROL VALVE
FV-XXX1		FLOW CONTROL VALVE	GW TREATMENT FEED PUMPS FLOW CONTROL	---	NONE	N/A	$ 4,000.00			
PI-XXX1AA		PRESSURE INDICATOR	CARTRIDGE FILTER 'A' INLET PRESSURE	C-XXX1A	NONE	N/A	$ 200.00			
PI-XXX1AB		PRESSURE INDICATOR	CARTRIDGE FILTER 'A' OUTLET PRESSURE	C-XXX1A	NONE	N/A	$ 200.00			
PI-XXX1BA		PRESSURE INDICATOR	CARTRIDGE FILTER 'B' INLET PRESSURE	C-XXX1B	NONE	N/A	$ 200.00			
PI-XXX1BB		PRESSURE INDICATOR	CARTRIDGE FILTER 'B' OUTLET PRESSURE	C-XXX1B	NONE	N/A	$ 200.00			
AE/AIT-XXX1A		pH ANALYZER	INLET GW pH	I-XXX1A	AI	PLC	$ 2,800.00			PH ANALYZER AND TRANSMITTER
AE/AIT-XXX2A		pH ANALYZER	GW pH AFTER Ca ION EXCHANGE	I-XXX2A	AI	PLC	$ 2,800.00			PH ANALYZER AND TRANSMITTER
LIT-XXX2A		LEVEL TRANSMITTER	EFFLUENT TANK LEVEL	T-XXX2A	AI	PLC	$ 4,000.00			RADAR LEVEL TRANSMITTER
LIT-XXX3A		LEVEL TRANSMITTER	BACKWASH TANK LEVEL	T-XXX3A	AI	PLC	$ 4,000.00			RADAR LEVEL TRANSMITTER
PI-XXX2A		PRESSURE INDICATOR	EFFLUENT TRANSFER PUMPS DISCHARGE PRESSURE	P-XXX2A/B	NONE	N/A	$ 200.00			
PI-XXX3A		PRESSURE INDICATOR	BACKWASH PUMP DISCHARGE PRESSURE	P-XXX3A	NONE	N/A	$ 200.00			

TOTAL REAL INSTRUMENT COUNT		
RAW TOTAL	**UNCERTAINTY**	**RAW TOTAL + 50%**
23	50%	35

TOTAL COST	$ 29,700.00

INSTRUMENT COST ESTIMATE, OPTION 2B

GROUNDWATER TREATMENT PROJECT, FEL-2

BAILLY GENERATING STATION

INSTRUMENT TAG NUMBER	P&ID NUMBER	INSTRUMENT TYPE	DESCRIPTION	EQUIPMENT TAG NUMBER	I/O TYPE	CONTROL SYSTEM	COST ESTIMATE	MANUFACTURER	MODEL NUMBER	REMARKS
PI-GWPUMP		PRESSURE INDICATOR	GW PUMP DISCHARGE PRESSURE	---	NONE	N/A	$ 200.00			
LIT-XXX1A		LEVEL TRANSMITTER	EQUALIZATION TANK 'A' LEVEL	T-XXX1A	AI	PLC	$ 4,500.00			RADAR LEVEL TRANSMITTER
PI-XXX1A		PRESSURE INDICATOR	GW TREATMENT FEED PUMPS DISCHARGE PRESSURE	P-XXX1A/B	NONE	N/A	$ 200.00			
FE/FIT-XXX1		FLOW METER AND TRANSMITTER	GW TREATMENT FEED PUMPS FLOW RATE	---	AI	PLC	$ 6,000.00			MAGNETIC FLOW METER AND TRANSMITTER
FY-XXX1		VALVE POSITIONER	GW TREATMENT FEED PUMPS FLOW CONTROL	---	AO	PLC	NA			POSITIONER, INCLUDED WITH CONTROL VALVE
FV-XXX1		FLOW CONTROL VALVE	GW TREATMENT FEED PUMPS FLOW CONTROL	---	NONE	N/A	$ 4,000.00			
PI-XXX1AA		PRESSURE INDICATOR	MEDIA FILTER 'A' INLET PRESSURE	C-XXX1A	NONE	N/A	$ 200.00			
PI-XXX1AB		PRESSURE INDICATOR	MEDIA FILTER 'A' OUTLET PRESSURE	C-XXX1A	NONE	N/A	$ 200.00			
PI-XXX1BA		PRESSURE INDICATOR	MEDIA FILTER 'B' INLET PRESSURE	C-XXX1B	NONE	N/A	$ 200.00			
PI-XXX1BB		PRESSURE INDICATOR	MEDIA FILTER 'B' OUTLET PRESSURE	C-XXX1B	NONE	N/A	$ 200.00			
PI-XXX2A		PRESSURE INDICATOR	LOW PRESSURE RO FEED PUMPS DISCHARGE	P-XXX2A/B	NONE	N/A	$ 200.00			
PI-XXX2AA		PRESSURE INDICATOR	CARTRIDGE FILTER 'A' INLET PRESSURE	C-XXX1A	NONE	N/A	$ 200.00			
PI-XXX2AB		PRESSURE INDICATOR	CARTRIDGE FILTER 'A' OUTLET PRESSURE	C-XXX1A	NONE	N/A	$ 200.00			
PI-XXX2BA		PRESSURE INDICATOR	CARTRIDGE FILTER 'B' INLET PRESSURE	C-XXX1B	NONE	N/A	$ 200.00			
PI-XXX2BB		PRESSURE INDICATOR	CARTRIDGE FILTER 'B' OUTLET PRESSURE	C-XXX1B	NONE	N/A	$ 200.00			
AE/AIT-XXX1A		pH ANALYZER	INLET GW pH	I-XXX1A	AI	PLC	$ 2,800.00			PH ANALYZER AND TRANSMITTER
LIT-XXX3A		LEVEL TRANSMITTER	PERMEATE TANK LEVEL	T-XXX3A	AI	PLC	$ 4,000.00			RADAR LEVEL TRANSMITTER
LIT-XXX4A		LEVEL TRANSMITTER	REJECT TANK LEVEL	T-XXX4A	AI	PLC	$ 4,000.00			RADAR LEVEL TRANSMITTER
LIT-XXX5A		LEVEL TRANSMITTER	CIP TANK LEVEL	T-XXX5A	AI	PLC	$ 4,000.00			RADAR LEVEL TRANSMITTER
PI-XXX3A		PRESSURE INDICATOR	RO FEED PUMPS DISCHARGE PRESSURE	P-XXX3A/B	NONE	N/A	$ 200.00			
PI-XXX4A		PRESSURE INDICATOR	PERMEATE TRANSFER PUMPS DISCHARGE PRESSURE	P-XXX4A/B	NONE	N/A	$ 200.00			

TOTAL REAL INSTRUMENT COUNT		
RAW TOTAL	UNCERTAINTY	RAW TOTAL + 50%
21	50%	32

TOTAL COST	$ 31,900.00