HEADWORKS AND PRIMARY TREATMENT OPTIONS STUDY

FOR THE CITY OF TRAVERSE CITY REGIONAL WASTEWATER TREATMENT PLANT

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CITY of TRAVERSE CITY MICHIGAN



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SECTION 1.0 — INTRODUCTION

1.1 SCOPE

This report provides an evaluation of the headworks and primary treatment at the Traverse City Regional Wastewater Treatment Plant (TCRWWTP). The Primary Influent Distribution Piping is in severely distressed condition and requires corrective action as it is reportedly on the verge of failure and has already exhibited leaks that have been arrested but almost caused disastrous flooding of the lower level of the TCRWWTP. This Options Study considers several alternatives for improvements of the Headworks as well as the primary treatment system including interim repairs, a totally different primary treatment option, and proceeding with an expedited complete replacement of the header pipe at the conclusion of the study.

1.2 BACKGROUND

Currently, raw sewage enters the TCRWWTP through four force mains which flow into the influent channel of the Preliminary Treatment Building. The influent channel directs the wastewater through a Rotary (Lakeside Rotamat) Semi-Fine Screen (3/8-inch +/- openings). The screened wastewater then flows by gravity through two 24-inch pipes to the two separate grit removal systems (East and West). The influent wastewater flow is measured through two 24-inch Parshall Flumes located upstream of both grit tanks each with a range of 0–10 MGD. The design capacity of the WWTP is 8.5 MGD with a peak flow capacity of 17 MGD.

If the flow is in excess of the rotary screen's capacity, it can overflow a slide gate and proceed through a bypass channel that is equipped with a manually cleaned coarse bar screen with 1-inch openings. Since it is a manually cleaned screen it can become blinded rather quickly and result in problematic overflows of both of the channels or bypassing around the rotary screen since the rotary screen has points of overflow that are below the top of the channel walls. It has been indicated that equipping the overflow channel with a fine screen mechanism would be desirable.

Grit removal is achieved using two 18' x18' square Detritor Style grit chambers (East and West Grit Tanks). The effluent from the West Grit Tank then flows through three cast iron sluice gates to the Primary Settling Tanks: one 24-inch diameter sluice gate/pipe and one 18-inch diameter sluice gate/pipe to the North Primary Settling Tanks (Numbered 1 thru 4 in this report for clarity – See below) and one 24-inch diameter sluice gate/pipe to the South Primary Settling Tanks (5 thru 8). The effluent from the East Grit Tank flows through one 24-inch diameter sluice gate/pipe to the South Primary Settling Tanks and through one 24-inch diameter sluice gate/pipe to the North Primary Settling Tanks. The existing gates from each grit tank are nearly inoperable and the TCRWWTP is unable to isolate flows downstream of each grit chamber.

The eight rectangular Primary Settling Tanks (each 66.5 feet long) are used to remove suspended solids and organics via gravity settling. In this report, the tanks are labeled Numbers 1 through 8 from North to South for clarity. Tanks 3, 4, 5 & 6 are the original Primary Settling Tanks and located closest to the center plant walkway (original plant axis) are each 14 feet wide and was originally constructed in the 1930s. The newer tanks, 1, 2, 7 & 8 are each 16-ft wide and were constructed in the 1950s. The primary setting tank effluent discharges via overflow weirs and then flows to the Secondary Influent Screw pumps which then lifts the flow to the secondary biological process. The primary settling tanks are entirely covered with fiberglass covers supported by fiberglass beams that are anchored to the concrete walls with mild steel hardware that has indications of severe corrosion.

The sludge that settles to the bottom of the primary settling tanks is collected using chain and flight sludge removal mechanisms. Reportedly there is some grit carryover from the grit tanks that ends up in the primary sludge and has accumulated in the digesters.

Most of the influent pipe between the grit tanks and both sets of Primary Settling Tanks is spiral welded steel pipe. This pipe also has several points of connection that were completed using bolted flexible connections (BFC's or "Dresser Couplings"), some are exposed but most were buried. The buried BFC's were likely coated with an asphaltic material prior to burying. A significant section of this piping adjacent to the south primary settling tanks has since ended up under the Sludge Thickening Building and is thus not easily accessible for any maintenance or repairs.

The section of these 24-inch pipes from the buried section outside of the south and north ends of the pipe gallery to the 18-inch pipe inside is a high point and not vented. At these locations, air tends to accumulate in this piping at the headspace. In wastewater, this air gap allows hydrogen sulfide to off-gas and collect in the pipe headspace. Bacteria in the biofilm of the pipe oxidize hydrogen sulfide to form corrosive acids (typically sulfuric acid) which causes crown corrosion at the top of the metal pipe. Visual inspection of this steel pipe exterior at the south end of the gallery indicates severe corrosion and exposed holes. Also, the noticeable sound of the pipe "gulping" was present at the south end of the pipe gallery indicating that the trapped bubble at the larger diameter section of buried pipe outside was periodically being released into the pipe within the building. In addition, at the pipe gallery sump pump discharge pipe connection, a severe leak developed previously. This leak almost resulted in a catastrophic failure of the entire pipe system but was averted by the TCRWWTP maintenance personnel. At the north end of the pipe gallery any accumulated air in the pipe can also relieve itself through the 24-inch pipe section that connects to the West Grit tank provided that the sluice gate at the west grit tank is totally open. However, there could still be small sections of air pockets since pipes are never perfectly level and bubbles in level pipes move very slowly so acids could still accumulate at the top of the pipe.

It is likely that most of the primary influent piping is totally submerged given that the pipe centerline is typically at centerline elevation 112.0 (from the East Grit) or 113.0 (from the West Grit) at the point where it leaves the grit tanks and then rises up to centerline elevation 113.0 for tanks 1, 2, 7 & 8. The older tanks (3,4,5 & 6) are all at a lower centerline elevation, 111.50. Given that the water surface elevation in the primary settling tanks is usually always at or above the weir elevation of 116.0, the pipes should be submerged except at the location in the south pipe gallery entrance where the pipe transitions from 24 to 18-inch diameter where the top air (or offgas generated within the pipe) gets trapped. As mentioned above, the air at the north end is not totally trapped since it can relieve itself to the north grit tank which is relatively close to this location. Installing vents at the north and south ends of the pipe gallery would help serve to eliminate any potential gas bubble buildup.

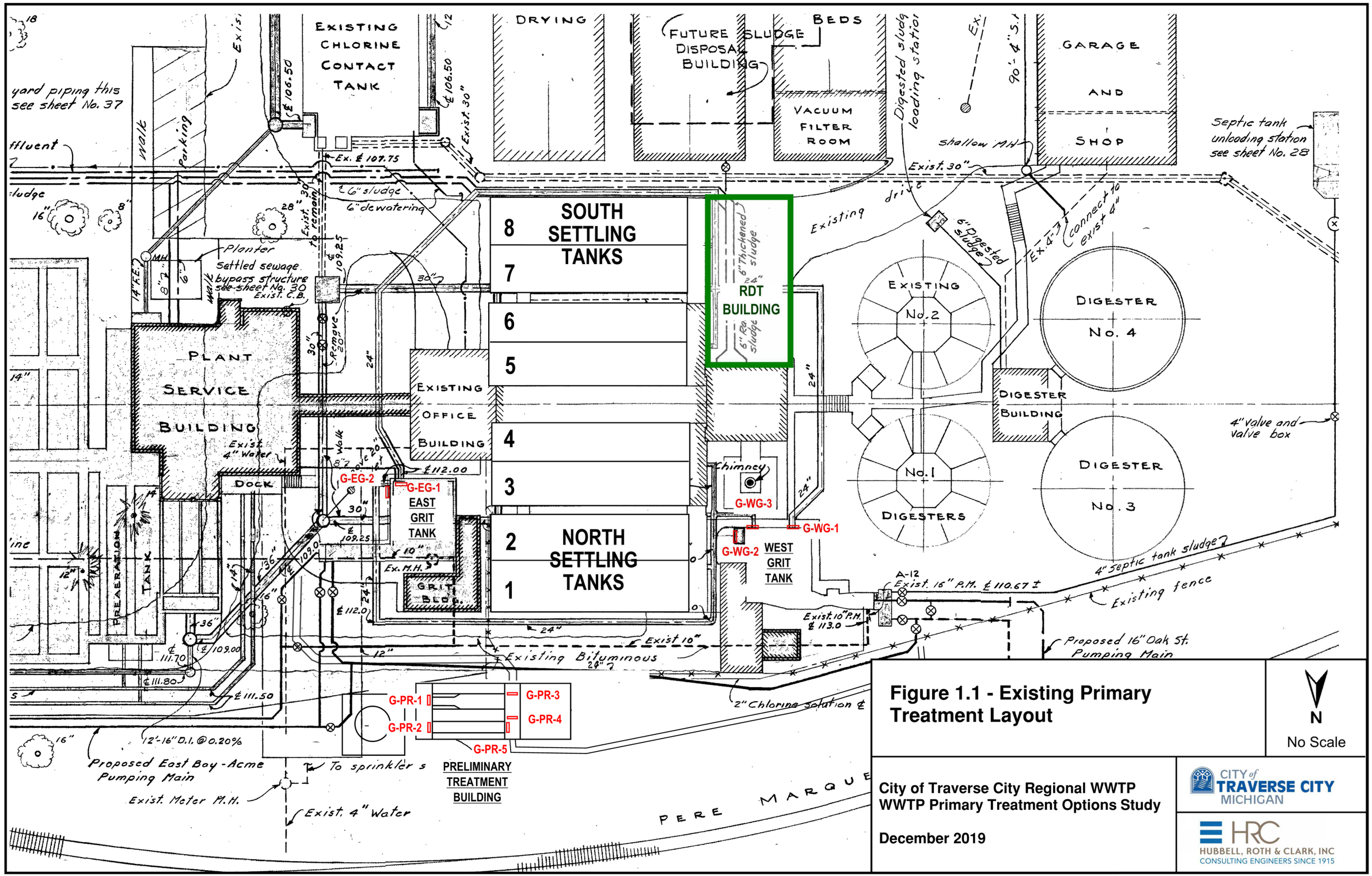

Figure 1.1 - Existing Primary Treatment Layout

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City of Traverse City Regional WWTP
WWTP Primary Treatment Options Study

December 2019

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SECTION 2.0 — HEADWORKS AND PRELIMINARY TREATMENT

2.1 BACKGROUND

The Headworks or Preliminary Treatment provides preliminary treatment of the wastewater before other treatment processes, mainly screening and grit removal. The screening system at the TCRWWTP currently consists of two screening channels that each provide screening of the wastewater before subsequent treatment. The removed screenings are compacted and deposited into a dumpster for landfill disposal.

The primary screen channel has a ROTAMAT (proprietary tipped rotary cylindrical screen) installed inside of a 6-feet 3-inch wide channel that is provided with approximately 3/8" openings. When flow exceeds the capacity of the ROTAMAT, it overflows into a bypass channel. This channel is equipped with a manually raked bar screen with 1-inch wide openings. Since the screen in the bypass channel is manually cleaned, it very easily becomes blinded, and then its capacity is exceeded. Plant staff have indicated that it would be desirable to also install a mechanically cleaned screen in the bypass channel so that when high flows are experienced, all of the wastewater flow can be screened.

The primary ROTAMAT screen has a limited capacity since it is tipped and therefore the entire space of the channel is not utilized for screen media and therefore it would be also desirable to replace this screen with something with a greater capacity although this need may not be as urgent. The options for replacement of this screen include a fixed bar rack mechanically clean bar screen or a band screen where the screen media travels through the waste and the flow passes through both sides of the traveling band screen after turning a right angle. The 6-feet 3-inch wide section of this channel would easily accommodate either a traveling band screen or a fixed bar rake mechanically cleaned screen.

The bypass channel is narrower at 3.5 feet wide and probably would not easily accommodate a band screen but could accommodate a fixed bar rack mechanically raked screen.

If a new mechanically cleaned screen were to be installed at the headworks building, a washer-compactor would also need to be installed downstream of the unit and would provide for the washing and compacting of the screenings as well as conveying them to the same dumpster as the current ROTAMAT screen.

In addition, it has been noted by plant staff that the flow rate to each of the grit processes (east and west) is often exceeded during times of high flow. It would be desirable to regulate the flow to either of the east and west grit removal processes so that the grit removal efficiency is not impaired from the higher flows. This can be accomplished through the installation of a mechanical motorized gate operator on the slide gate downstream of the screen processes. By installing a motorized actuator on either or both of the slide gates downstream of the screens and upstream of each of the grit removal processes, the flow rate can be regulated to a set maximum flow rate as measured at the Parshall flume upstream of either grit tank or to control the flow rate to a set maximum or to split the flow rate to a preset, desired percentage of the total. This would involve the installation of gate operators on both of the gates at the downstream end of the channel after screening and upstream of each grit removal tank.

2.2 PRELIMINARY SCREENING ALTERNATIVES

2.2.1 Alternative S1 - Mechanically Raked Bar Screen in Bypass Channel, Band Screen in Primary Channel

This alternative would include the installation of a mechanically raked bar screen on a fixed bar rack in the current bypass channel and the installation of motorized gate actuators to regulate the flow to the grit removal processes downstream similar to Alternative S1 and the installation of a mechanical traveling band screen in the current primary channel.

The Opinion of Probable Project Cost for this alternative is $1,739,000. There would likely be minimal changes in Operation Cost since the additional periodic operation of the bypass channel screen would likely be offset by fewer problems resulting from bypassing of excess flows with lower levels of screenings as well as the cost of labor of tending to the manual screen bypass. This alternative would address the need for mechanical screening of all flows. The overall screen capacity during high plant flows would also be increased since the band screen has a higher capacity than the Rotamat.

2.2.2 Alternative S2 - Mechanically Raked Bar Screen in both Bypass Channel and Primary Channels

This alternative would include the installation of a 3/8" mechanically raked bar screen on a fixed bar rack in the current bypass channel similar to Alternative S1. In addition, the existing Rotamat screen would be replaced with a fixed bar rack mechanically cleaned screen.

The Opinion of Probable Project Cost for this alternative is $1,662,000. There would likely be minimal changes in Operation Cost since the additional periodic operation of the bypass channel screen would likely be offset by fewer problems resulting from bypassing of excess flows with lower levels of screenings as well as the cost of labor of tending to the manual screen bypass. This alternative would address the need for mechanical screening of all flows. The overall screen capacity during high plant flows would also be increased since the mechanically cleaned bar screen has a higher capacity than the Rotamat.

2.3 GRIT REMOVAL ALTERNATIVES

The existing Detritor Grit Removal Tanks are both very old (approaching 90 and 70 years old respectively). As such, their component parts have been rebuilt extensively and several of the isolation gates are in need of replacement. This process relies on very simple flow-thru hydraulic settling technology and does not provide reliable grit removal at higher flow rates. New, more efficient grit removal processes such as stacked trays are more effective at reducing the flow energy and balancing the settling velocities so that grit removal is more efficient. This hydraulic grit removal system uses vortex flow and stacked trays to settle grit over a large surface area and provides higher grit removal efficiencies compared to other systems such as aerated grit, forced vortex, or the Detritor style technology. This increased grit removal improves the downstream processes as well as the sludge digestion and storage issues associated with excessive grit such as wear on equipment and increased tank cleaning frequency. At this stage of considering a major upgrade of the front of the treatment plant it is prudent to consider a more efficient grit removal process such as the head cell tank arrangement which is essentially a stacked tray configuration that reduces the settling distance so that grit removal efficiency is enhanced. Considering this, there are essentially two options for grit removal for consideration at the TCRWWTP:

2.3.1 Alternative G1 - Rehabilitate the Existing Grit Removal Treatment Process (Detritors)

This option assumes the two existing Detritor grit removal tanks continued to be used. The existing tanks would be rehabilitated, and new covers would be installed. The mechanisms and grit classifiers would be replaced to match the existing. Additional building repairs are also included in this estimate. The two existing flumes are also old and should be replaced or modified to ensure their accuracy. The Project Cost for Alternative G1 is $900,000.

A concern has been expressed over the lack of adequate flow control to the Grit removal since there is currently no means to limit the flow to one grit tank versus the other. This could be rectified by installing a motor actuator on the channel gates downstream of the primary screen channel. If the actuator were set to limit the flow to one of the grit systems, the other channel could be used for the excess flow. Specific programming would be required to control the actuator to perform one of the following functions:

- Limit the flow to either of the grit tanks based on the measured flow at the influent primary flumes
- Split the flow based on a desired percentage flow split (i.e. 50-50, 60-40, etc.).

Since the plant normally operates the flow to the plant with all the flow going to one or the other grit tank, having this control might improve grit removal since lower flows could be directed to both tanks easier.

The Project Cost for this item is included in the alternatives. The additional annual operation and maintenance costs would be minimal in comparison to the benefits obtained from improved grit removal. This item would address the need for regulation of flows to the grit removal process downstream.

2.3.2 Alternative G2 - Replace the Existing Grit Removal Using Stacked Tray System

This alternative assumes the grit system would be replaced with two stacked tray grit removal units (Hydro HeadCell). For this evaluation, two 9' diameter stacked tray systems would be installed in grit removal tanks. A grit classifier/washer would be installed in a new building adjacent to the tanks for final grit disposal to achieve greater than 95% grit removal with less and 5% volatile solids. The building would be equipped with foul air odor control and connected to the existing odor control system. Flow splitting to each grit tank would be achieved using a splitter box and flow metering using a Parshall flumes.

The Project Cost for Alternative G2 is $4,820,000.

SECTION 3.0 — PRIMARY TREATMENT

3.1 BACKGROUND

Primary treatment in wastewater treatment is most commonly completed through conventional sedimentation using rectangular or circular settling tanks. This treatment typically achieves a removal of total solids (30 to 50%) and BOD (25 to 30%) prior to biological treatment. However, this total solids and BOD separation can also be completed using primary solids separation equipment with rotating belt fine mesh sieves. The existing primary settling tanks have exhibited a variety of problems resulting from the corrosion of the primary influent piping between the grit tanks and the primary settling tanks. These pipes were constructed using spiral-welded steel pipe which was prevalent in the 1970s and early 1980s. Generally, steel pipe is appropriate for wastewater conveyance if it is kept submerged in all areas. Since the existing primary influent piping has several size changes plus changes in elevation there are areas where air pockets accumulate and are not be easily relieved. One of these is at the south end of the south pipe gallery where the pipe size changed from 24-inch to 18-inch. It was observed during the plant walk through that there was a noticeable (audible) gulping of air at this location. A similar condition exists at the north end of the North Primary pipe gallery but, at this location, the 24-inch piping continues around to the west and the air pocket can be relieved into the West Grit tank provided that the 24-inch sluice gate from this tank is open entirely. Figure 3-1 shows the approximate extent of primary influent piping replacements and proposed replacement procedure.

The existing settling tanks are also covered with insulated fiberglass panels. Since the covers had minor leaks, the insulation has become water-logged thus making the covers extremely heavy and with freeze-thaw action working on them, they are likely all ruined and in need of replacement. In addition, the covers are supported by fiberglass beams connected to the walls using painted steel supports which are now all corroding. The covers and connecting hardware are all likely in need of replacement except that perhaps the support beams may possibly be salvaged except that there is reportedly spider cracking present on some of these beams, which may require that they too be replaced.

Recognizing that the settling tank equipment may also need replacement, one alternative that may exist would be to replace the settling tank equipment including scum troughs, influent piping covers, connecting hardware and optionally cover support beams and perform the recommended concrete rehabilitation of the portions of the concrete tank that are showing distress.

If the existing tanks are utilized in their current configuration, the existing primary influent conveyance lines will need to be replaced since they have indicated signs of distress due to internal corrosion and have already had significant leakage at the area where the primary gallery sump pump discharges into the line. A hydraulic analysis was prepared for the existing piping arrangement which includes several parallel paths of 18 and 24-inch piping. These parallel paths are likely problematic in that, when the flow divides, there may be grit settling in the lesser used path which does not easily get re-suspended. A check of the hydraulic level during our site visit indicated that there may be evidence of grit settling in the line between the East Grit Tanks and the primary settling tanks since the hydraulic losses seemed slightly higher than what would exist in a clean pipe condition. When the primary influent lines are to be replaced, it is recommended that these parallel paths be eliminated to the greatest extent possible. The proposed layout of primary influent piping completely eliminates the parallel paths so that there would only be two paths each from the East and West Grit Tanks – One to the North and One to the South set of Primary

Tanks from each grit tank. This elimination of redundant, hydraulically unequal paths would help to minimize the potential for grit settling in the lines. Note that the proposed line size would need to be one to two sizes larger where the parallel lines are eliminated so that the effect on hydraulic capacity would be negligible. The primary influent lines can be replaced concurrently with the installation of new isolation gates at the Grit Tank effluent. The specific procedure to allow for this replacement is discussed in detail in the following sections of this report.

An alternative to conventional primary settling would be to install mechanical primary solids separation equipment for primary treatment to replace the primary settling tanks and to reduce the dependence on long lengths of underground primary influent piping and also reduce the need for extensive equipment replacement of the plastic chain and flight settling tank equipment. Mechanical treatment alternatives to primary settling were evaluated as part of earlier drafts of this report. These alternatives were fairly capital cost intensive and would likely be operationally more demanding. Accordingly, it was agreed between the City and its Operations Consultant, Jacobs, not to pursue mechanical treatment alternatives any further.

3.1.1 Primary Tank Structural Analysis

HRC completed a structural inspection as part of an effort to provide a more conclusive and definitive course of action relative to options for the rehabilitation of the existing Primary Tanks or replacement with of new tanks. The inspection was completed using visual and non-destructive inspection methods of the tanks in October 2020. In addition, concrete compressive strength testing and petrographic analysis of core samples were taken, the locations of which were determined based on the structural inspection observations. The inspection report and reports on the concrete evaluation including the compressive strength testing and petrographic analysis are included in Appendix C.

Based on the observations, the structural conditions of the concrete in Tanks 1S and 3N are sound. Deterioration of the beams spanning the tanks supporting the covers was observed. Deterioration was also observed of the concrete along the top slab and walls near the grit tanks. Minor to moderate structural repairs are recommended to extend the service life of the tanks. These recommended repairs include:

- Protective coating and surface repairs to the primary tanks and pipe gallery walls to address cracking and spalling
- Reconstructions of the scum troughs
- Repairs to the walls and beams

Together with the results and conclusions of the compressive strength tests and petrographic analyses of the cores taken as part of the study scope, HRC recommends that the Primary Tanks are good candidates for reuse provided the service and exposure types are not changed significantly from current conditions.

3.2 PRIMARY SETTLING ALTERNATIVES

Several alternatives were evaluated to address the immediate issues with Primary Treatment at the TCRWWTP. Considering all of the above factors, two primary settling alternatives are presented for consideration as described below.

3.2.1 Alternative P1 - Upgrade Existing Primary Settling Tanks and Influent Piping

This alternative includes the complete replacement of the four dual chain and flight primary settling tanks including drive mechanisms, chains, flights scrapers and scum trough actuators, replacement of critical primary influent

distribution piping -- mainly in the primary pipe gallery and just beyond the wall to facilitate removal of all parallel pipe paths and the installation of all twelve 12-inch influent valves, three redundant 24-inch knife gate valves (all except the path from West Grit to North Primary since it is so short), cleaning of 24-inch piping between the East Grit Tank and the South Primary Settling Tanks and the installation of slide gates at the location of four of the inoperable sluice gates downstream of both grit tanks (the fifth one – 18-inch from West Grit Tank would be removed and this pipe abandoned). Odor control treatment of the foul air from the revised tanks would still be required similar to existing practices.

The Opinion of Probable Project Cost for this alternative is $3,550,000 and could be combined with either Headworks Alternative S1 or S2 and Grit Removal Alternatives G1 or G2. It is worth noting that the replacement of the primary treatment settling tank mechanisms could possibly be deferred if their replacement is not urgent as the replacement of the influent piping and gates is much more urgent.

3.2.2 Alternative P2 – New Circular Primary Settling Tanks

This alternative includes two new circular settling tanks that would be installed to provide similar capacity as the existing rectangular units. Operations staff at the facility have indicated that circular settling tank mechanisms are easier to maintain, and this is consistent with industry practices. With only two tanks there would be only two mechanisms versus the current four collector mechanisms and significantly fewer moving parts since there would be no chains and flights. Settling rates using two 70 feet diameter units would be approximately the same as the as the existing 8 rectangular tanks as the settling area is 7,702 SF and the proposed settling area would be 7,693 SF. For this alternative, the circular tanks would be installed at approximately the same hydraulic grade line and within the footprint of the existing rectangular tanks. The settled water from the circular primary tanks would then flow to the existing fine band screens and Primary Effluent screw pumps to be lifted up to the secondary treatment process. Each of the circular primary treatment tanks could be paired with one of either the east or west grit tanks (either the existing or new ones) with flow control occurring upstream of these tanks in accordance with paragraph 2.5 above. Doing so would equally distribute the hydraulic capacity between the two primary settling tanks. Covering the circular tanks for odor containment would be more challenging but still feasible. Odor control treatment of the foul air would also still be required similar to existing practices.

The Opinion of Probable Project Cost for this alternative is $6,340,000 and could be combined with Headworks Alternative S1 or S2 and Grit Removal Alternative G1 or G2.

3.3 PRIMARY EFFLUENT PUMPING ALTERNATIVES

Currently the TCRWWTP utilizes screw pumps to lift the Primary Effluent up to the level required for secondary biological treatment. Alternatives that would change the level of the front of the TCRWWTP were investigated as part of this study with the intent of eliminating the need for pumping of the primary effluent but the Capital Cost of these alternatives were very expensive and the impacts of raising the front end of the plant would have far reaching impacts on several upstream pumping stations that pump to this plant. Accordingly, continued primary effluent pumping has been determined to be a more cost-effective long-term alternative. There are basically two alternatives for continued primary effluent pumping, using new screw centrifugal immersible/submersible pumps or rehabilitating or replacing the existing screw pumps.

3.3.1 Alternative PE1 – Primary Effluent Pumping Using Submersible Pumps

Primary Effluent currently flows through one of two existing fine mesh opening band screens and then into one of four screw pumps for pumping to the secondary treatment process. These screw pump bays could be reconfigured to accept a submersible pump that can operate at the low levels. Alternative PE1 would include a Hidrostal™ screw centrifugal pump with pre-rotation basin installed in each bay along with a discharge pipe that would extend up to the level of the existing discharge channel. This type of pump can routinely operate at very low suction levels similar to the existing screw pumps and would fit fairly nicely into the existing screw pump bays with a slight alteration of the floor in each bay.

The Opinion of Probable Project Cost for this alternative is $1,717,000. The approximate layout of this alternative is shown in Figure 3-2.

3.3.2 Alternative PE2 – Primary Effluent Pumping Using Existing Screw Pumps

Alternative PE2 includes replacement of the existing screw pumps in kind. In addition, replacement of some of the concrete on the discharge channels with sulfide resistant concrete is recommended due to the extensive corrosion which has been experienced in this area due to the sulfide release and eventual hydrochloric acid deposition on the wall, which has seriously degraded the existing concrete.

The Opinion of Probable Project Cost for this alternative is $2,711,000.

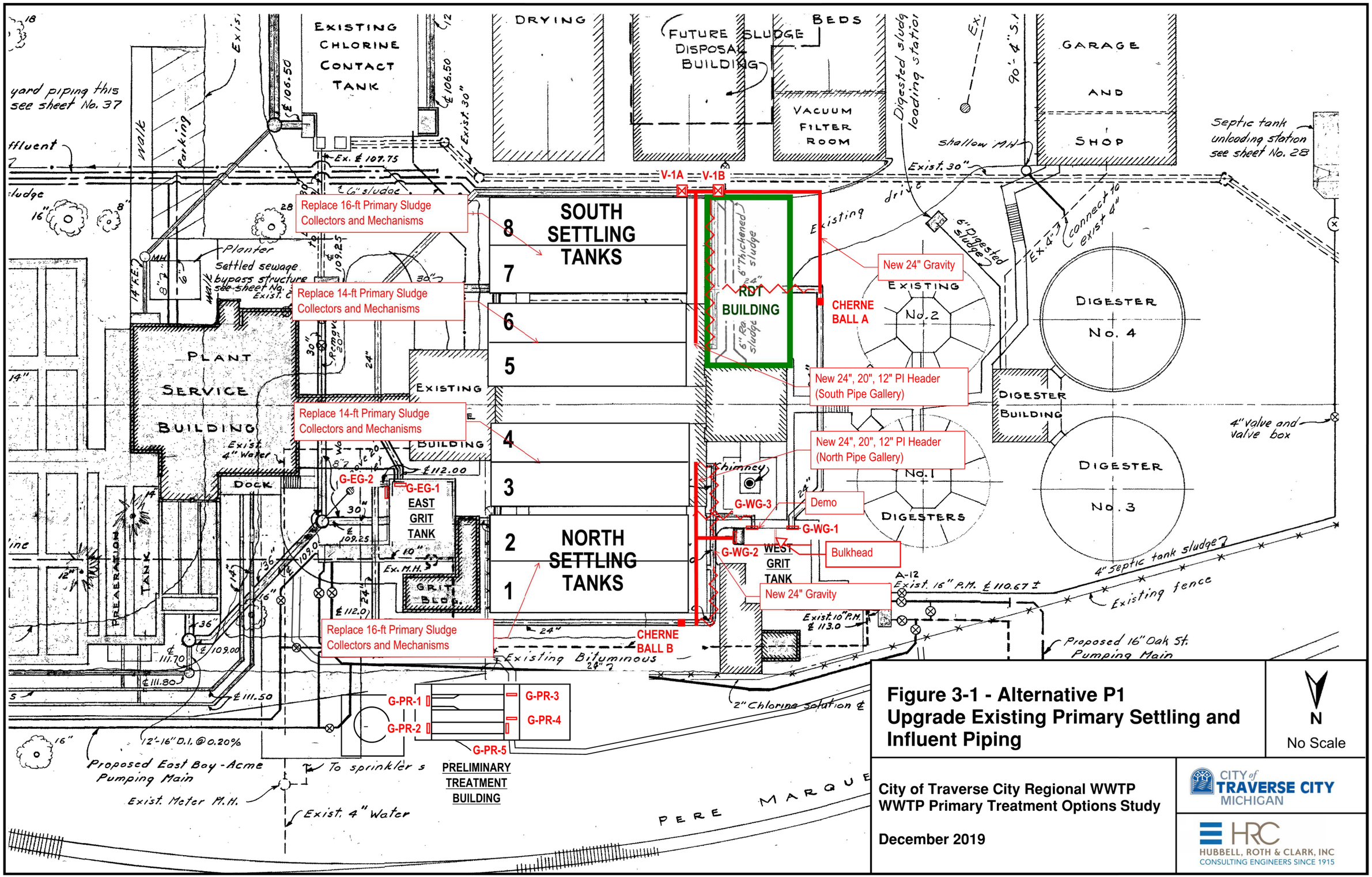

Figure 3-1 - Alternative P1 Upgrade Existing Primary Settling and Influent Piping

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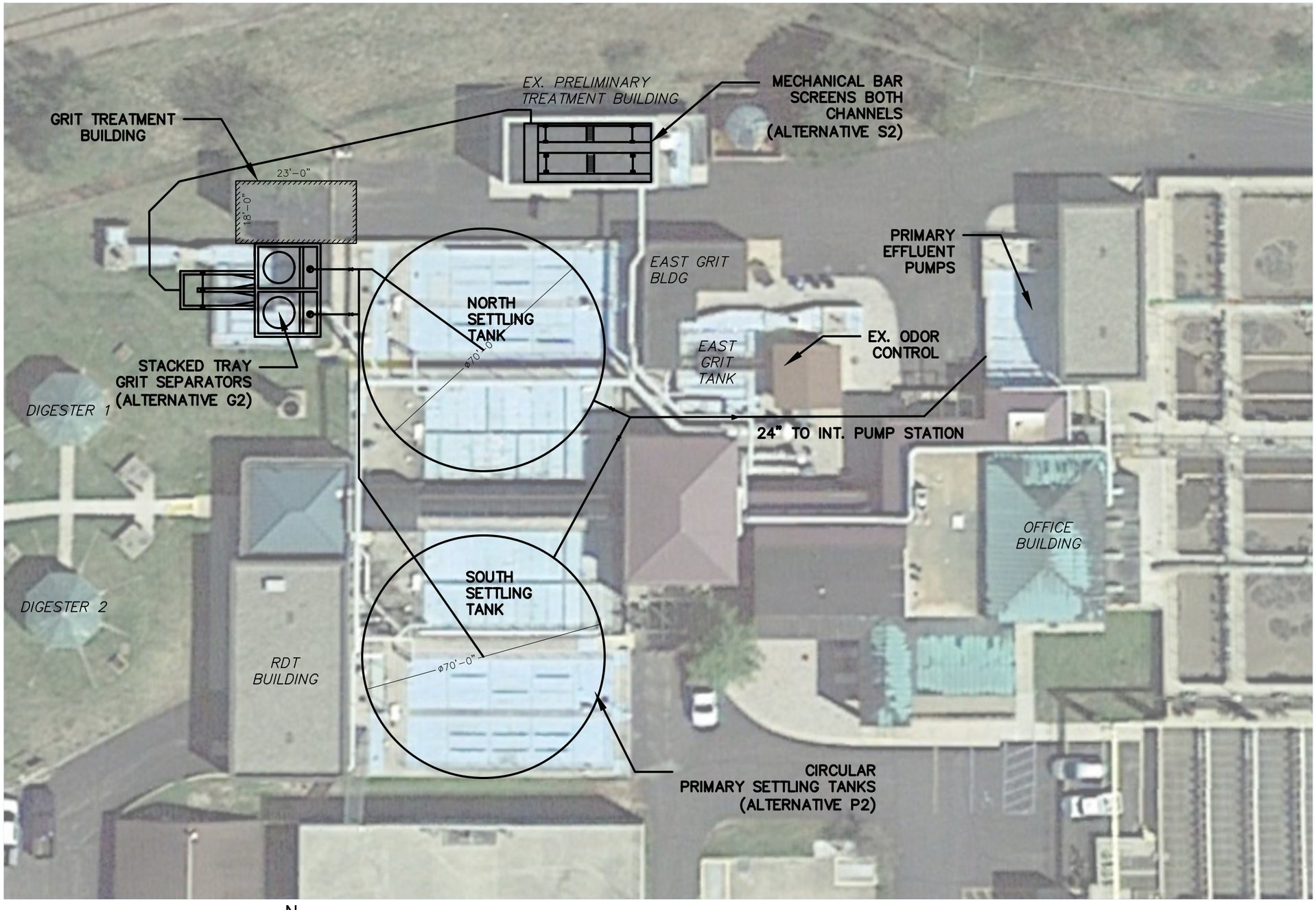

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REGIONAL WWTP

HEADWORKS AND PRIMARY OPTIONS STUDY

ALTERNATIVE S2/M2/P2
CIRCULAR PRIMARY TANKS
NEW SCREENS/GRIT REMOVAL

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SECTION 4.0 — ALTERNATIVE EVALUATION

To get a reasonable comparison of alternatives for Preliminary and Primary Treatment, the improvement alternatives suggested for both Preliminary and Primary Treatment were compared between each equivalent alternative so that a complete Capital and Operating Cost impact could be determined and compared.

The Opinion of Probable Project Cost for the lowest present worth (PW) alternatives is shown in Table 4-1 below along with a proportional amount of Annual Operation & Maintenance (O&M) cost for each. This comparison included various differential components such as an allowance for the HV costs based on the relative volumes of the additional building volumes that would need to be ventilated and heated on an annual basis, the cost of dealing with grit carryover from the existing grit removal process as opposed to improved grit removal from a more efficient process, the relative cost of screenings removal versus improved screenings equipment, as well as the relative cost of operation of rectangular settling equipment versus circular clarifier equipment. A Present Worth factor was applied to the relative Annual O&M cost (3.5% at 20 years) in each case to determine a 20-year Present Worth of the O&M costs to develop an Equivalent Present Worth Cost for each of the alternatives being considered. This provides a baseline economic comparison upon which each of these alternative combinations was compared. The table below summarizes the results of this economic comparison.

Table 4-1 – Present Worth Comparison of Alternatives

DESCRIPTION	PROJECT AMOUNT	ANNUAL O&M [4]	20 YEAR PW OF O&M [1.]	TOTAL PW
Preliminary Screening				
Alternative S1 - Mech. Fine Bar Screen in Bypass Ch, Band Screen in Exist Ch.	$1,739,000	$202,368	$2,876,137	$4,429,137
Alternative S2 - Mech. Fine Bar Screen in Both Channels	$1,662,000	$202,368	$2,876,137	**$4,360,137**
Grit Removal				
Alternative G1 - Ex. Grit Removal [3]	$900,000	$270,471	$6,094,039	$6,994,039
Alternative G2 - New Grit Removal	$4,820,000	$42,909	$609,838	**$5,429,838**
Primary Settling				
Alternative P1 - Primary Settling and Influent Piping/Valves Replacements[2]	$3,550,000	$63,932	$3,408,631	$6,958,631
Alternative P2 - Two new 70' diam circular Primary Settling Tanks	$6,340,000	$12,416	$176,463	**$6,516,463**
Primary Effluent Pump				
Alternative PE1 - New Submersible Primary Effluent Pumps	$1,717,000	$49,724	$706,698	**$2,423,698**
Alternative PE2 - Rehab Exist Primary Effluent Screw Pumps	$2,711,000	$180,843	$2,570,207	$5,281,207

1. Assumes 3.5% Interest Rate over 20 years.
2. Alternative P1 annual O&M includes the future tank replacements as a percentage of the future cost.
3. Alternative G1 annual O&M includes future tank replacements – West Grit Tank in 20 years and East Grit Tank in 40 years*
4. A portion of the total O&M Cost most relevant to each alternative and utilized for comparison of the alternatives.

The most cost-effective alternative for preliminary screening is Alternative S2, for two new mechanical fine bar screens. Improved flow splitting before the grit removal is also recommended to equally distribute the flow to each grit removal unit.

The rehabilitation of the existing grit tanks would also require their eventual complete replacement. New, more efficient, stacked tray grit removal would provide significantly less wear on downstream equipment. Accordingly, the life cycle cost (20-year present worth) of Alternative G1 is $6,994,039 versus $5,429,838 for Alternative G2. Therefore, Alternative G2 would provide a more cost-effective solution for the long-term grit removal at the TCRWWTP.

Re-using the existing primary settling tanks represents the lowest capital cost and based on the structural analysis, the existing primary sludge tanks are in sound condition if concrete repairs are completed. However, given their age, the tanks would likely need to be replaced in the next 40 to 60 years. Alternative P2, replacement of the existing primary settling tanks with circular tanks, provides a lower 20-year present worth mainly due to the lower estimated O&M costs and the anticipated replacement cost of the existing tanks (one pair in 40 years and one pair in 60 years). The O&M and potential safety risks of continuing to work in the crowded primary piping gallery (both very difficult to quantify) also contribute to recommending replacement of the primary tanks at this time.

Preliminary Effluent Pumping Alternative PE1 using new submersible pumps in the existing screw pump bays represents the most cost-effective alternative versus continued reliance on the screw pumps.

SECTION 5.0 — RECOMMENDATIONS

Addressing the Primary Influent Distribution Piping remains one of the more urgent focus needs of the facility. The estimated cost of this replacement is $1M if completed independently in advance of the recommended project alternatives. If this replacement is completed prior to the implementation of new circular primary tanks it would only be functional temporarily or at least until new tanks are available for use and thus would not be a wise investment if new tanks are pursued.

Improvements to the Headworks and Primary Treatment are necessary to improve the reliability of treatment and address the system deficiencies. The total estimated project cost of these recommended alternatives is $14,177,000 and is summarized in Table 5-1.

Table 5-1 – Summary of Recommended Headworks and Primary Treatment Projects

Project Component	Estimated Cost [1]
Alternative S2 - Mech. Fine Bar Screen in Both Channels	$1,662,000
Alternative G2 - New Grit Removal	$4,820,000
Alternative P2 - Two new 70' diam Circular Primary Settling Tanks	$6,340,000
Alternative PE1 - New Submersible Primary Effluent Pumps	$1,717,000
Total	**$14,539,000**

Notes:

1. Rounded Values, includes 20% contingency and 20% engineering and administrative. 2020 Pricing.

The specific formulation of project improvements warrants additional discussion with the City leaders and Operations Staff before the development of a specific capital improvement project. These projects would address the Preliminary and Primary Treatment needs of the facility as well as other needs such as building improvements, odor control, corridor piping, yard piping, and other site work. Additionally, we recommend completing site visits to similar installations for the proposed equipment and processes so that City and plant operations staff can gain a full concurrence in the specific equipment selection.

Appendix A — Cost Opinion Breakdowns

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1925 Breton Road SE, Suite 100; Grand Rapids, MI 49506 Telephone: (616) 454-4286

PROJECT: **Traverse City Regional WWTP Primary Treatment Options Study** DATE: **10/8/2020**

LOCATION: **Traverse City, Michigan** PROJECT NO. **20190115**

BASIS FOR ESTIMATE: [X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL ESTIMATOR: **DJB**

WORK: **Project Cost Summary** CHECKED BY: **DJB**

CURRENT ENR:

ITEM NO.	DESCRIPTION	PROJECT AMOUNT	ANNUAL O&M **	20 YEAR PW OF O&M ***	TOTAL PW AMOUNT
1	**Headworks Alternatives**				
2	Alternative S1 - Mech. Fine Bar Screen in Bypass Ch, Band Screen in Exist Ch.	$1,739,000	$202,368	$2,876,137	$4,615,137
3	Alternative S2 - Mech. Fine Bar Screen in Both Channels	**$1,662,000**	$202,368	$2,876,137	**$4,538,137**
4	**Lowest Cost Headworks Alternative - Alternative S2**	**$1,662,000**			
5					
6	**Grit Removal Alternatives**				
7	Alt. G1 - Ex. Grit Removal (incl tank replacements - West, 20 yrs and East, 40 yrs)*	$900,000	$270,471	$6,094,039	$6,994,039
8	Alternative G2 - New Grit Removal	**$4,820,000**	$42,909	$609,838	**$5,429,838**
9	**Lowest Cost Grit Removal Alternative - Alternative G2**	**$4,820,000**			
10					
11	**Primary Treatment Alternatives**				
12	Alternative P1 - Primary Settling and Influent Piping/Valves Replacements*	$3,550,000	$63,932	$3,408,631	$6,958,631
13	Alternative P2 - Two new 70' diam circular Primary Settling Tanks	**$6,340,000**	$12,416	$176,463	**$6,516,463**
14	**Lowest Cost Primary Treatment Alternative - Alternative P2**	**$6,340,000**			
15					
16					
17	**Primary Effluent Pump Alternatives**				
18	Alternative PE1 - New Submersible Primary Effluent Pumps	**$1,717,000**	$49,724	$706,698	**$2,423,698**
19	Alternative PE2 - Rehab Exist Primary Effluent Screw Pumps	$2,711,000	$180,843	$2,570,207	$5,281,207
20	**Lowest Cost PE Pump Alt. - Alternative PE1**	**$1,717,000**			**$2,423,698**
21					
22	**Total Projected Project Cost**	**$14,539,000**			
23					
24					
25					
26					
27					
28					
29	* Note that the 20 Year Present Worth of O&M of P1 includes tank replacements (One pair in 40 and another pair in 60 yrs)				
30	** This is a portion of the O&M Cost most relevant to each Alternative and utilized for comparison of the aLternatives				
31	*** Using 3.5% Interest Rate over 20 years				
32					
33					
34					

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PROJECT: **Traverse City Regional WWTP Primary Treatment Options Study** DATE: **9/18/2020**

LOCATION: **Traverse City, Michigan** PROJECT NO. **20190115**

BASIS FOR ESTIMATE: [X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL ESTIMATOR: **DIU**

WORK: **Alternative S1 - Mech. Fine Bar Screen in Bypass Ch, Band Screen in Exist Ch.** CHECKED BY: **DJB**

CURRENT ENR:

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	42-inch wide Mechanically Raked Fine Bar screen and wash/compact	1	EA	$427,500	$427,500
2	Demo Exist Manual Screen	1	LS	$12,000	$12,000
3	Conveyance Duct to Dumpster	10	LF	$800	$8,000
4	Grating modifications	24	SF	$125	$3,000
5	Handrail Additions	12	LF	$120	$1,440
6	Concrete Rehab Allowance	20	SF	$100	$2,000
7	72-inch wide Channel - Band screen and washer/compactor	1	EA	$513,000	$513,000
8	Demo Exist Rotamat Screen	1	LS	$20,000	$20,000
9	Conveyance Duct to Dumpster	8	LF	$800	$6,400
10	Slide Gate Actuators for Grit Flow Control	2	EA	$18,500	$37,000
11	Controls Modifications and Programming	1	LS	$20,000	$20,000
12					
13	Misc Metal	1	%	$11,000	$11,000
14	Misc Mechanical	1	%	$11,000	$11,000
15	Misc Painting	1	%	$11,000	$11,000
16	Electrical Allowance	15	%	$158,000	$158,000
	Construction Subtotal				**$1,242,000**
	Engineering, Legal, Administrative and Contingencies	40	%		$497,000
	TOTAL PROJECT COST				**$1,739,000**

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PROJECT: **Traverse City Regional WWTP Primary Treatment Options Study** DATE: **9/18/2020**

LOCATION: **Traverse City, Michigan** PROJECT NO. **20190115**

BASIS FOR ESTIMATE: [X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL ESTIMATOR: **DIU**

WORK: **Alternative S2 - Mech. Fine Bar Screen in Both Channels** CHECKED BY: **DJB**

CURRENT ENR:

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	42-inch wide Mechanically Raked Fine Bar screen and wash/compact	1	EA	$427,500	$427,500
2	Demo Exist Manual Screen	1	LS	$12,000	$12,000
3	Conveyance Duct to Dumpster	10	LF	$800	$8,000
4	grating modifications	24	SF	$125	$3,000
5	handrail additions	12	LF	$120	$1,440
6	Concrete Rehab Allowance	20	SF	$100	$2,000
7	72-inch wide Channel - Mech Fine Bar screen and washer/compactor	1	EA	$465,500	$465,500
8	Demo Exist Rotamat Screen	1	LS	$20,000	$20,000
9	Conveyance Duct to Dumpster	8	LF	$800	$6,400
10	Slide Gate Actuators for Grit Flow Control	2	EA	$18,500	$37,000
11	Controls Modifications and Programming	1	LS	$20,000	$20,000
12					
13	Misc Metal	1	%	$11,000	$11,000
14	Misc Mechanical	1	%	$11,000	$11,000
15	Misc Painting	1	%	$11,000	$11,000
16	Electrical Allowance	15	%	$151,000	$151,000
	Construction Subtotal				**$1,187,000**
	Engineering, Legal, Administrative and Contingencies	40	%		$475,000
	TOTAL PROJECT COST				**$1,662,000**

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PROJECT: **Traverse City Regional WWTP Primary Treatment Options Study** DATE: **10/8/2020**

LOCATION: **Traverse City, Michigan** PROJECT NO. **20190115**

BASIS FOR ESTIMATE: [X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL ESTIMATOR: **DJB**

WORK: **Alternative G1 Rehab Exist Grit Removal Tanks** CHECKED BY: **DJB**

CURRENT ENR:

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	Replace 24-inch Slide Gates	4	EA	$19,500	$78,000
2	Clean 24-inch pipe from West Grit Tank to South Primary Tanks	1	LS	$6,700	$6,700
3	New Grit Detritor Mechs	2	EA	$80,000	$160,000
4	New Classifiers	2	EA	$100,000	$200,000
5	Misc Building Repairs	1	LS	$30,000	$30,000
6	New Tank Covers	800	SF	$80	$64,000
7					
8	Misc Metal	1.0	%	$6,000	$6,000
9	Misc Mechanical (Pl HVAC)	0.5	%	$3,000	$3,000
10	Painting	1.5	%	$9,000	$9,000
11	Electrical	15	%	$81,000	$81,000
	Construction Subtotal				**$638,000**
	Engineering, Legal, Administrative and Contingencies	40	%		$256,000
	TOTAL PROJECT COST				**$900,000**

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PROJECT: **Traverse City Regional WWTP Primary Treatment Options Study**

LOCATION: **Traverse City, Michigan**

BASIS FOR ESTIMATE: [X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL

WORK: **Alternative G2 - New Grit Removal**

DATE: **9/18/2020**

PROJECT NO. **20190115**

ESTIMATOR: **DJB**

CHECKED BY: **DJB**

CURRENT ENR:

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	Demo Old West Detritor	1	LS	$35,000	$35,000
2	Concrete Floors and Footings on Grade	126	CY	$800	$101,096
3	Concrete Walls	243	CY	$1,000	$242,667
4	Concrete Oper Floor & Struts	99	LS	$1,200	$118,933
5	Superstructure	2,172	SF	$250	$543,000
6	Grit Weirs/Baffles	24	LF	$100	$2,400
7	Isolation Slide Gates	7	EA	$32,000	$224,000
8	Tank Covers	1,008	SF	$80	$80,640
9	Soil or Flowable Fill Below and Around Channels	506	CY	$75	$37,949
10	FRP Foul Air Ductwork (just in this building)	102	LF	$200	$20,400
11	FRP Foul Air Registers and Grilles	1	LS	$20,000	$20,000
12	Site Improvements (Minor)	1	LS	$50,000	$50,000
13	Excavation and Backfill	400	CY	$200	$80,000
14					
15	Influent 24 Valves	6	EA	$12,000	$72,000
16	24" RS Extension/Revisions	200	LF	$250	$50,000
17	Influent Meters (s)	2	EA	$36,000	$72,000
18	Influent Sampler and piping	1	EA	$20,000	$20,000
19	Grit Tank Equipment Package	1	LS	$967,500	$967,500
20					
21	Handrails	46	LF	$150	$6,900
22	Stairs	25	VLF	$1,500	$36,750
23					
24	Misc Metal	2	%	$56,000	$56,000
25	Misc Mechanical (Pl HVAC)	5	%	$140,000	$140,000
26	Painting	1.5	%	$42,000	$42,000
27	Electrical	15	%	$418,000	$418,000
	Construction Subtotal				**$3,438,000**
	Engineering, Legal, Administrative and Contingencies	40	%		$1,376,000
	TOTAL PROJECT COST				**$4,820,000**

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PROJECT: **Traverse City Regional WWTP Primary Treatment Options Study**
LOCATION: **Traverse City, Michigan**
BASIS FOR ESTIMATE: [X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL
WORK: **Alternative P1 - Primary Settling and Influent Piping/Valve Replacements**

DATE: **9/18/2020**
PROJECT NO. **20190115**
ESTIMATOR: **DIU**
CHECKED BY: **DJB**
CURRENT ENR:

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	Replace 24-inch Slide Gates	4	EA	$19,500	$78,000
2	Chain and Flight in 14-ft Settling Tanks (3,4 and 5,6)	2	EA	$145,500	$291,000
3	Chain and Flight in 16-ft Settling Tanks (1,2 and 7,8)	2	EA	$151,500	$303,000
4	Primary Influent Header Replacement (See breakdown, other sheet)	1	LS	$587,000	$587,000
5	12-inch Knife Gate Valves	4	EA	$21,400	$85,600
6	10-inch Knife Gate Valves	8	EA	$16,000	$128,000
7	Clean 24-inch pipe from West Grit Tank to South Primary Tanks	1	LS	$6,700	$6,700
8	Cover Replacements	6,886	SF	$80	$550,880
9	Beam Support Connector Replacements	108	EA	$1,500	$162,000
10	Clarifier concrete repairs	2,880	SF	$25	$72,000
11					
12					
13					
14	Misc Metal	2	%	$46,000	$46,000
15	Misc Mechanical	5	%	$114,000	$114,000
16	Misc Painting	3	%	$68,000	$68,000
17	Electrical	15	%	$340,000	$340,000
	Construction Subtotal				**$2,833,000**
	Engineering, Legal, Administrative and Contingencies	25	%		$709,000
	TOTAL PROJECT COST				**$3,550,000**

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PROJECT: **Traverse City Regional WWTP Primary Treatment Options Study**

LOCATION: **Traverse City, Michigan**

BASIS FOR ESTIMATE: [X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL

WORK: **Primary Influent Header Piping Replacements**

Completed with P1

DATE: **9/18/2020**

PROJECT NO. **20190115**

ESTIMATOR: **DIU**

CHECKED BY: **DJB**

CURRENT ENR:

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	15 foot long Flg-Flg 24-inch SS Header with two (2) 12" Flg Nozzles	4	EA	$25,100	$100,400
2	20 foot long Flg-PE 20-inch x 12-inch SS Header with 18" vertical offset 20x24	2	EA	$26,700	$53,400
3	18-inch steel bulkheads (exposed)	5	EA	$3,300	$16,500
4	Core concrete walls in gallery for 24 inch pipe	3	EA	$5,800	$17,400
5	Buried 24-inch DIP or SS piping (from West Grit to SPS)	90	LF	$800	$72,000
6	Buried SS piping (from West Grit to North PS)	8	LF	$1,700	$13,600
7	Buried 24-inch 90 bends	2	EA	$10,000	$20,000
8	Buried 24-inch tees	1	EA	$20,000	$20,000
9	Buried 24-inch knife gates with manhole structure	2	EA	$60,100	$120,200
10	24-inch knife gate in gallery (North end)	1	EA	$37,600	$37,600
11	24-inch BFCs for buried connections	4	EA	$10,000	$40,000
12	24-inch steel bulkheads (buried)	2	EA	$5,000	$10,000
13	18-inch steel bulkheads (buried)	1	EA	$4,200	$4,200
14	4-inch vent piping thru ceiling	2	EA	$6,700	$13,400
15	4-inch sump pump discharge connection with valve	1	EA	$10,900	$10,900
16	Clean 24-inch pipe from S Primary to East Grit Tank and NP to W Grit	1	LS	$10,000	$10,000
17	24-inch SS F x PE connectors at North and South Ends of Gallery	2	EA	$13,400	$26,800
	Construction Subtotal				**$587,000**
	TOTAL CONSTRUCTION COST				**$587,000**

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PROJECT: **Traverse City Regional WWTP Primary Treatment Options Study**
LOCATION: **Traverse City, Michigan**
BASIS FOR ESTIMATE: [X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL
WORK: **Primary Influent Header Piping Replacements**
Completed Independent of Other Projects

DATE: **9/18/2020**
PROJECT NO. **20190115**
ESTIMATOR: **DIU**
CHECKED BY: **DJB**
CURRENT ENR:

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	15 foot long Flg-Flg 24-inch SS Header with two (2) 12" Flg Nozzles	4	EA	$25,100	$100,400
2	20 foot long Flg-PE 20-inch x 12-inch SS Header with 18" vertical offset 20x24	2	EA	$26,700	$53,400
3	18-inch steel bulkheads (exposed)	5	EA	$3,300	$16,500
4	Core concrete walls in gallery for 24 inch pipe	3	EA	$5,800	$17,400
5	Buried 24-inch DIP or SS piping (from West Grit to SPS)	90	LF	$800	$72,000
6	Buried SS piping (from West Grit to North PS)	8	LF	$1,700	$13,600
7	Buried 24-inch 90 bends	2	EA	$10,000	$20,000
8	Buried 24-inch tees	1	EA	$20,000	$20,000
9	Buried 24-inch knife gates with manhole structure	2	EA	$60,100	$120,200
10	24-inch knife gate in gallery (North end)	1	EA	$37,600	$37,600
11	24-inch BFCs for buried connections	4	EA	$10,000	$40,000
12	24-inch steel bulkheads (buried)	2	EA	$5,000	$10,000
13	18-inch steel bulkheads (buried)	1	EA	$4,200	$4,200
14	4-inch vent piping thru ceiling	2	EA	$6,700	$13,400
15	4-inch sump pump discharge connection with valve	1	EA	$10,900	$10,900
16	Clean 24-inch pipe from S Primary to East Grit Tank and NP to W Grit	1	LS	$10,000	$10,000
17	24-inch SS F x PE connectors at North and South Ends of Gallery	2	EA	$13,400	$26,800
18	Replace 24-inch Slide Gates	4	EA	$19,500	$78,000
19	12-inch Knife Gate Valves	4	EA	21400	$85,600
20	10-inch Knife Gate Valves	8	EA	16000	$128,000
21	Clean 24-inch pipe from West Grit Tank to South Primary Tanks	1	LS	6700	$6,700
	Construction Subtotal				**$885,000**
	Contingency	10	%	$885,000	$88,500
	TOTAL CONSTRUCTION COST				**$974,000**

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PROJECT: **Traverse City Regional WWTP Primary Treatment Options Study**
LOCATION: **Traverse City, Michigan**
BASIS FOR ESTIMATE: [X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL
WORK: **Alternative P2 - Two new 70' diam circular Primary Settling Tanks**

DATE: **9/18/2020**
PROJECT NO. **20190115**
ESTIMATOR: **DJB**
CHECKED BY: **DJB**
CURRENT ENR:

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	Floor Fill	2133	CY	$100	$213,333
2	Concrete Floor	372	CY	$800	$297,719
3	Concrete Walls	228	CY	$1,000	$227,941
4	Concrete Weirs Struts	98	LS	$1,200	$117,227
5	12-inch Knife Gate Valves	4	EA	$21,400	$85,600
6	Weirs/Baffles	440	LF	$100	$43,960
7	Concrete Wall Demo (Partial)	344	CY	$400	$137,600
8	Covers	7,693	SF	$80	$615,440
9	Collection Mechanisms	2	EA	$288,000	$576,000
10	30-inch Influent / Effluent Piping	400	LF	$350	$140,000
11	Handrails	879	LF	$150	$131,880
12	Stairs	40	VLF	$1,500	$60,000
13	Relocating PE Screens and Channels	1	LS	$1,000,000	$1,000,000
14	Misc Metal	2	%	$73,000	$73,000
15	Misc Mechanical	5	%	$183,000	$183,000
16	Misc Painting	2	%	$73,000	$73,000
17	Electrical	15	%	$548,000	$548,000
	Construction Subtotal				**$4,524,000**
	Engineering, Legal, Administrative and Contingencies	40	%		$1,810,000
	TOTAL PROJECT COST				**$6,340,000**

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PROJECT: **Traverse City Regional WWTP Primary Treatment Options Study**

LOCATION: **Traverse City, Michigan**

BASIS FOR ESTIMATE: [X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL

WORK: **Alternative PE1 - New Submersible Primary Effluent Pumps**

DATE: **9/18/2020**

PROJECT NO. **20190115**

ESTIMATOR: **DIU**

CHECKED BY: **DJB**

CURRENT ENR:

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	Submersible Pump Package with Prerostal Basin	3	EA	$222,400	$667,200
2	Concrete Core for Basin Install	3	EA	$4,000	$12,000
3	Concrete Grout around Basin and Base Elbow Install	33	CY	$2,000	$66,667
4	Discharge Piping 24-inch	48	LF	$300	$14,400
5	Pump VFDs	3	EA	$60,000	$180,000
6	Control Panel and Programming	1	LS	$70,000	$70,000
7					
8	Misc Metal	3	%	$31,000	$31,000
9	Misc Mechanical	2	%	$21,000	$21,000
10	Misc Painting	1	%	$11,000	$11,000
11	Misc. Electrical	15	%	$152,000	$152,000
12	**Construction Subtotal**				**$1,226,000**
13					
14	Engineering, Legal, Administrative and Contingencies	40	%		$491,000
	TOTAL PROJECT COST				**$1,717,000**

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PROJECT:	**Traverse City Regional WWTP Primary Treatment Options Study**	DATE:	**9/18/2020**
LOCATION:	**Traverse City, Michigan**	PROJECT NO.	**20190115**
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	ESTIMATOR:	**DIU**
WORK:	**Alternative PE2 - Rehab Exist Primary Effluent Screw Pumps**	CHECKED BY:	**DJB**
		CURRENT ENR:	

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	New Screw Pumps	2	EA	$750,000	$1,500,000
2	Demo and regrout Channels	2	EA	$50,000	$100,000
3					
4					
5	Misc Metal	3	%	$48,000	$48,000
6	Misc Mechanical	2	%	$32,000	$32,000
7	Misc Painting	1	%	$16,000	$16,000
8	Misc. Electrical	15	%	$240,000	$240,000
9	**Construction Subtotal**				**$1,936,000**
10					
11	Engineering, Legal, Administrative and Contingencies	40	%		$775,000
	TOTAL PROJECT COST				**$2,711,000**

Appendix B — Vendor Backup Materials

Full-Range Flexibility and Maximum Capture with Thru-Bar™ Cleaning; Adapts Automatically to Wide Variations in Debris

FlexRake® FPFS

Thru-Bar™ Cleaning
Fine Screen

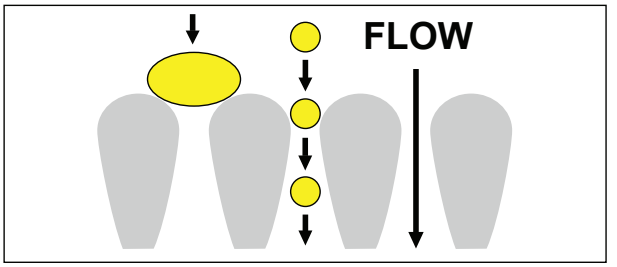
Simple front-cleaning, front-return Duperon® FlexRake® technology. Utilizes stainless steel teardrop shaped bars with 1/4 inch, 3/8 inch or 1/2 inch openings.

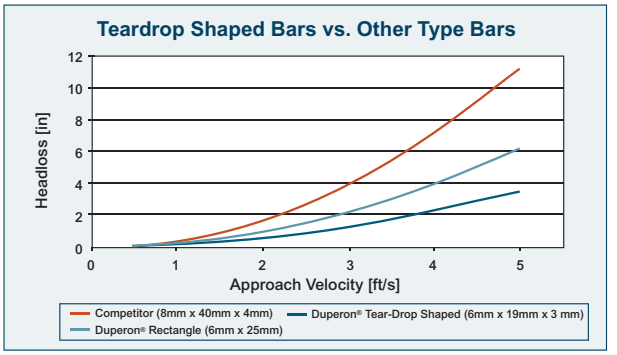
- No Lower Sprockets, Bearings or Tracks to Foul or Jam
- Adapts to Debris Variations; Full-Range Flexibility
- High Capture Thru-Bar™ Stainless Steel Scrapers
- Low Horsepower, Energy Efficient Drive System
- Teardrop Shaped Bars Most Efficient in the Market
- Five-Year Warranty for Wastewater Applications

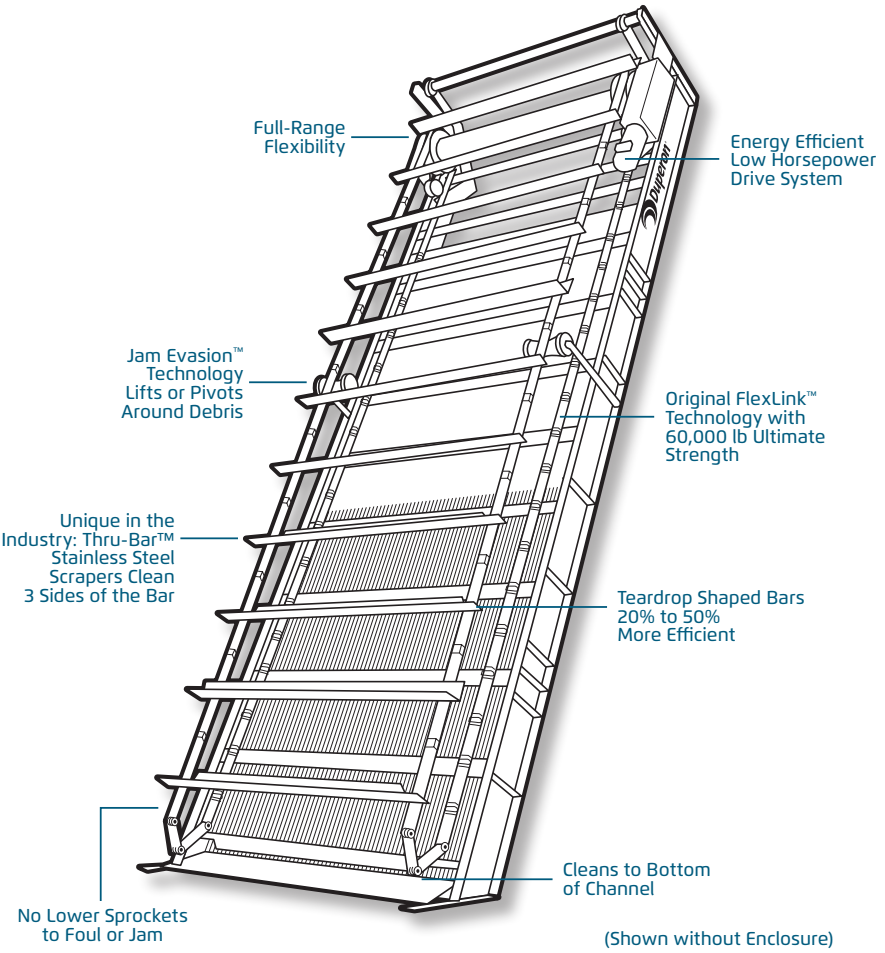
Duperon | ADAPTIVE TECHNOLOGY™

The Duperon® FlexRake® FPFS

TEARDROP SHAPED BARS ARE THE MOST EFFICIENT BARS IN THE INDUSTRY







TYPICAL APPLICATIONS

Wastewater, combined sewer overflows and prison applications. Also used in pulp/paper mills, raw water intakes and other applications where debris is highly variable or difficult to capture.

UNIT WIDTH

- 2 feet to 12 feet
- Single Strand FlexRake® configuration available for channel widths of 18 inches to 24 inches

UNIT LENGTH

10 feet to 100 feet

ANGLE OF INSTALLATION

Vertical to 45 degrees

STANDARD MATERIALS OF CONSTRUCTION

- Standard: 304 Stainless Steel
- Available in: 316 Stainless Steel

BAR OPENING

1/4 inch, 3/8 inch and 1/2 inch

STANDARD SCRAPER SPACING

Every 2nd link (21 inches)

SCRAPER CONFIGURATION

- 3:1 UHMW-PE staging scraper/stainless steel Thru-Bar™ teeth ratio

TYPICAL MOTOR

1/2 HP, 1 PH/3 PH explosion-proof inverter-duty motor

STANDARD OPERATING SPEED

- 0.5 RPM
- Can be increased to 2.2 RPM in high flow conditions
- 1 discharge/minute on low; 4 discharges/minute on high
- Scrapers move 28 inches/minute

SHIPPING DATA

Ships fully assembled or can be provided in modular form.

STANDARD CONTROLS OPTIONS

Base packages range from simple start/stop to sophisticated automation. Motor overload protection provided. Contact Duperon® for further details and assistance in selecting the perfect package for your site.

OPERATION OPTIONS

- Continuous/Manual
- Automatic with timer, float, SCADA, differential/high level sensing options with I/O as needed

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3340/7/18/1M

MILLENNIAL PLATFORM

LOWEST COST OF OWNERSHIP

WASHING COMPACTING

WASHER COMPACTOR

Positive Displacement, Dual-Auger System

Self-Regulating Compaction Provides a Reliable, No-Hassle Way to Reduce Landfill Costs

Robustly simple, high-efficiency, non-batching process machine that cleans and compacts screenings up to 4 inches. Standard discharge lengths up to 20 feet.

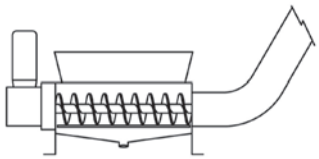
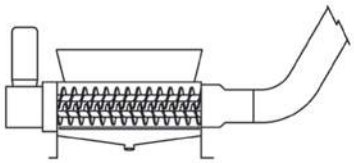
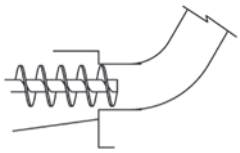
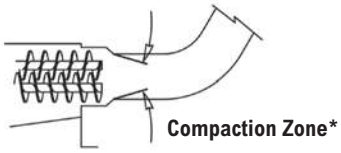
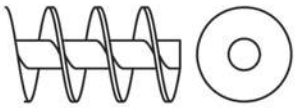
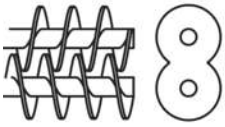
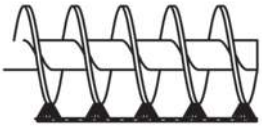
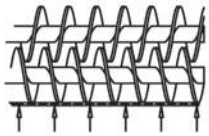
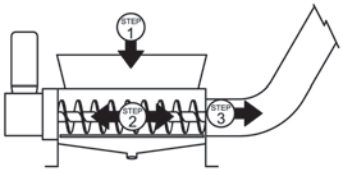
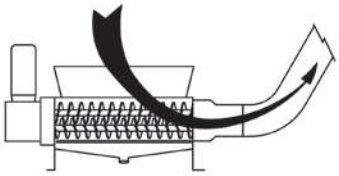
- Consistent Compaction Regardless of Debris Size or Volume (Using Proprietary Compaction Zone*)
- Positive Displacement: What Goes In, Comes Out
- Up To 84% Volume Reduction, Up To 60% Dry Solids
- Processes Non-Standard Wastewater Debris (Rocks, Clothing, Concrete, Metal) up to 4 inches
- Self-Centering Dual Augers Prevent Debris Wrapping
- Housing Geometry Controls Potential for “Slip Flow” When Handling Grease, Septage and Similar Debris
- Non-Clogging Flood Wash Port: Ideal For Non-Potable Water

*Patent Pending

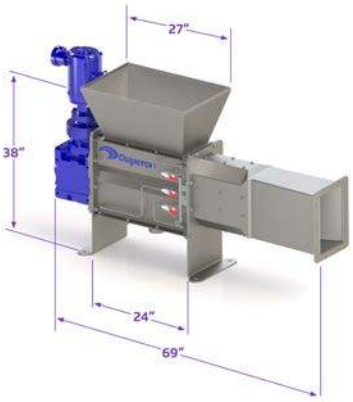
Duperon® ADAPTIVE TECHNOLOGY™

PRELIMINARY LIQUIDS/SOLIDS SEPARATION SYSTEMS

THE DUPERON® WASHER COMPACTOR VS. OTHER MANUFACTURERS

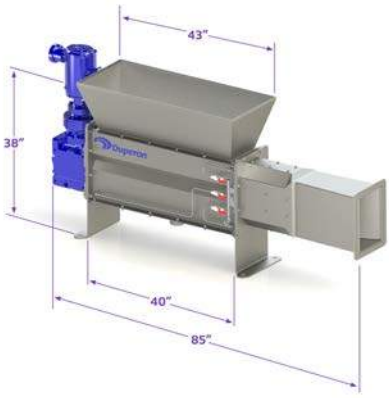
OTHER WASHER COMPACTORS	DUPERON® WASHER COMPACTOR
	
Fixed Reduction Compaction	**Controlled Reduction**
	
Dependent on friction, debris volume and type	Depends on mechanical device that controls compaction regardless of size & volume
RESULT: inconsistent dry solids	**RESULT:** consistent dry solids
Single Screw	**Dual Auger**
	
Debris falls & if it can move along the flight, it is dragged forward	Positive displacement (like meat grinder) counter rotation
Prone to sticking & then rotating w/auger (not driving forward) OR wrapping & overflowing hopper, churning, slipflow	Flights prevent wrapping and slipflow (The flight of one auger continuously interrupts the debris wrapping on the other auger)
	Two small augers = less HP, more energy efficient, stretches and stresses debris without chopping or grinding
RESULT: overflowing or wrapped debris not driven forward	**RESULT:** what goes in must go out
BRUSHES	**STRAINER – No Brushes**
	
High maintenance & inconsistent performance	Self-cleaning strainer as a result of maintained auger contact
Expensive, potentially labor intensive, requires replacement of parts	Non-clogging, durable & non-wearing
BATCHING	**CONTINUOUS FLOW NON-BATCHING**
	
Debris is stored in hopper during batch cycle	Continuous screen operation
Can have odor issues	Immediate processing of debris for low odor
	Low HP = Low energy requirement
AGITATION	**SATURATE – WRING**
Large motor/gearbox & batch times	Consistent high-pressure throughout system
Complexity of controls	Wash ports – flood vs. high maintenance fine spray nozzles
Maintenance, energy, storage & possible overflow	Wash ports located prior to compaction so debris is not forced into nozzle openings
	No Splashing

DUPERON® WASHER COMPACTOR CONFIGURATIONS AND APPLICATIONS



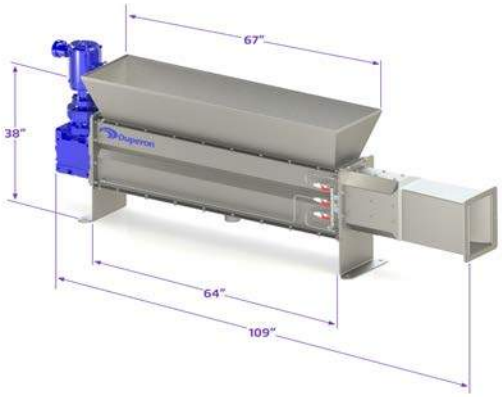
WC BODY 1

- ¾ HP Motor typical
- For bar screens up to 2' wide
- Ideal for FlexRake® Low Flow units
- Generally for flows less than 15MGD



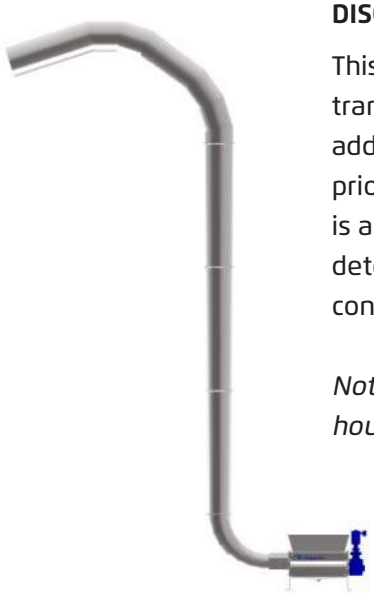
WC BODY 2

- ¾, 3, 5 HP motors
- For bar screens 2' to 6' wide
- Flows up to 60 MGD
- 3 and 5 HP conveyor-fed and Industrial applications



WC BODY 3

- ¾, 3, 5 HP motors
- For bar screens 5' to 10' wide
- Flows up to 100 MGD
- 3 and 5 HP conveyor-fed and Industrial applications



DISCHARGE EXTENSION OPTION

This option is available for the Duperon® Washer Compactor and can transport debris up to 40 feet in any direction, eliminating the need for additional motorized conveyance systems. With debris being compressed prior to the discharge chute, extended transport distance and elevation is achieved with little or no resistance and is unaffected by extended detention times. It contains no moving parts to fail and can operate continually if required.

Note: Screenings compaction is achieved without the use of a compaction housing in this configuration.

WATER

- Utilizes filtered effluent or municipal water
- Washer consumes 3-10 gallons per minute
- Requires 40 PSI-60 PSI
- Drain connection 3" NPT
- Supply connection 1/2" NPT

UTILITY

- 120/240 volt, single phase
- 240/480 volt, three phase (0.6 kW/2.3 kW/3.8kW)

DRIVE

3/4 HP, 3 HP, 5 HP inverter duty motors available

MATERIALS OF CONSTRUCTION

- 304 SSTL or 316 SSTL
- SSTL spur gears (17 - 4 PH)
- Self-lubricating main auger bearings

TYPICAL PERFORMANCE

- 30% - 60% dry solids
- 60% - 70% weight reduction
- Significantly decreases odor and fecal content

CAPACITY

Available from: 30 ft^3/hour to 150 ft^3/hour

MAINTENANCE

Five years: Recommended gearbox service

DUPERON® WASHER COMPACTOR ACCESSORIES

BAGGER: The Bagger System attaches to the discharge chute for applications where bag dispensing and odor control are required. Included is a 100 meter length of continuous feed bags.

SPECIFICATIONS:
LATCH AND HOLDER: 304 SS or 316 SSTL
BAG: 1.3 mil Polyethylene
BAG SIZE: 22" Diameter x 295 ft. length

DROP SLEEVE: This flexible Drop Sleeve is an economical way to direct and contain downward debris discharge. Also used where waste container hauling may cause damage to metal discharge chutes.

SPECIFICATIONS:
LATCH AND HOLDER: 304 SS/316 SSTL
SLEEVE: Heavy Duty Urethane Canvas

ACCESS CHUTE: In applications that involve periodic inspection of discharging solids, the Access Chute with inspection panel is available in modular segments, installed as needed in the discharge chute system.

SPECIFICATIONS:
CHUTE: 14 ga. 304/316 SSTL
FLANGES: 1/4"
DRAW TYPE LATCHES:Hinged and Latched or Latched Both Sides

CASTER ASSEMBLY: Optional casters allow for flexible placement of the Washer Compactor and simple movement of the unit.

SPECIFICATIONS:
CASTERS: Urethane Wheels, 304/316 SSTL
FRAME: 2x2x1/4 Tubular, 304/316
LOCKING CASTERS
EXPLOSION PROOF ELEC. DISCONNECT

HEAT BLANKET: The Compaction Zone and discharge chute can be thermally protected from cold temperatures with the addition of the Heat Blanket with integral heat trace.

SPECIFICATIONS:
EXPLOSION PROOF HEAT TRACE SYSTEM
(All connections NEMA 7/9)
10 W/FT = 600 w max., 120V
HARD CONTACT THERMOSTAT (NEMA 7/9)
INSULATED BLANKET: All Weather Teflon

Duperon® PRELIMINARY LIQUIDS/SOLIDS SEPARATION SYSTEMS ADAPTIVE TECHNOLOGY™

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2032/1/17/0M

Duperon ADAPTIVE TECHNOLOGY™
Let's Build a System that Works for You™

Date: September 26, 2019
Project: Traverse City, MI
Number: P10342

HYDRAULIC CALCULATIONS

Notes: 8.5 MGD Peak Flow, 3.5' wide channel, 0.375" bar openings, 3' upstream water level, 25% blinding

INPUT: Channel Physics

Flow in MGD		8.50	MGD
Upstream water level	*	3.00	ft
Channel width		3.50	ft
Channel depth		5.00	ft
Degree of blinding		25%	

INPUT: Screen Physics

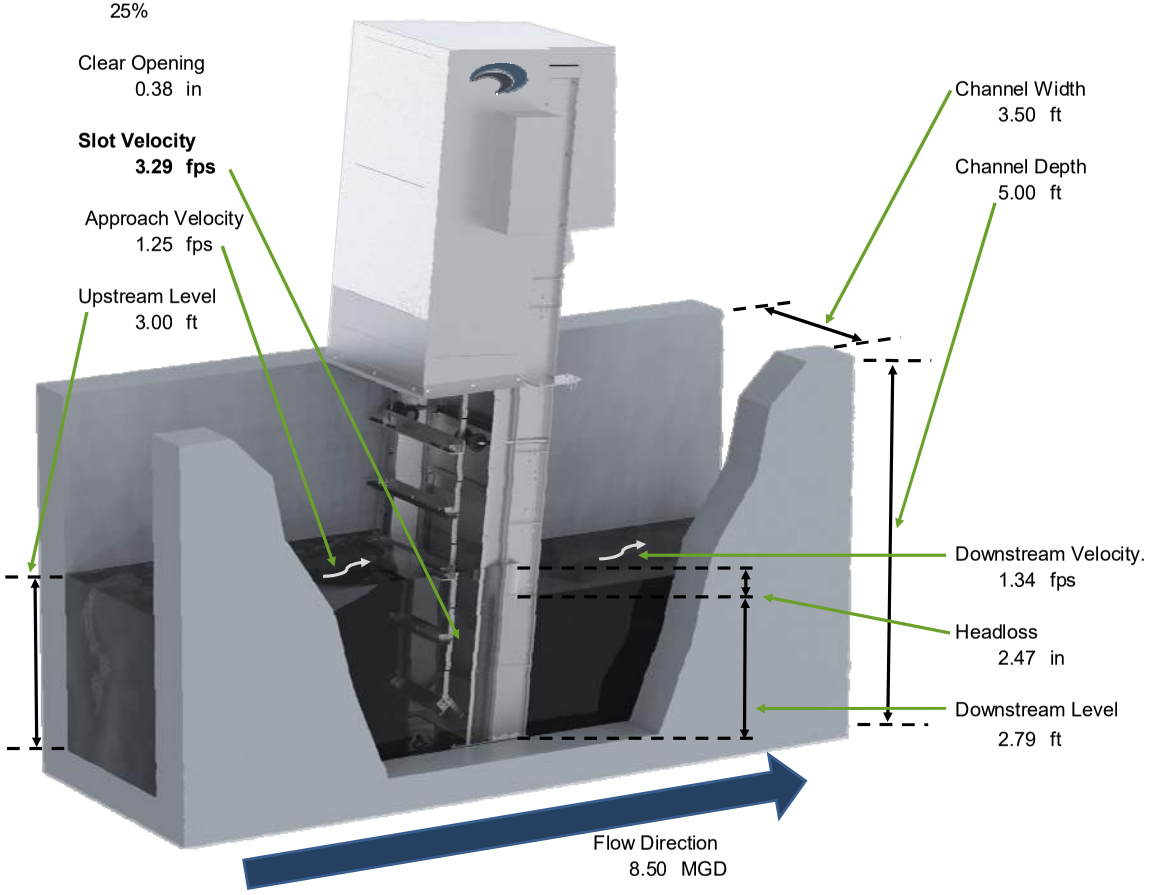
Clear Opening		0.38	in
Bar thickness		0.25	in
Thickness of side fab and closeout (2)		0.58	ft

Calculations

Side fab & closeout area	1.74	sft
Flow area between side fab & closeouts	8.76	sft
Number of bars	55.00	ea
Flow area taken up by bars	3.44	sft
Total Channel flow without screen	10.50	sft
Flow area after screen area and blinding taken out	3.99	sft
Approach Velocity	1.25	fps
Slot Velocity	3.29	fps
Downstream Velocity	1.34	fps
Downstream Depth	2.79	ft
Head Loss	2.47	in

Bernoulli Calculations

Velocity thru bar screen	3.29	fps
Velocity upstream of bar screen	1.25	fps
Gravitational acceleration (constant)	32.20	ft/s^2
Frictional coefficient (constant)	1.43	c
Headloss	0.21	ft
Headloss	2.47	inches



These calculations are an estimation based upon the information available. Flow channel hydraulics are highly dependent on water levels and the degree of blinding. The calculations above are a snapshot of only one condition. To fully analyze the hydraulics please contact your local Duperon representative.
Duperon recommends a minimum of 1.00 ft water depth when the unit is in operation to keep the SSTL FlexLinks lubricated and ensure an optimal amount of screening area.
Duperon recommends using Water Environment Federation (WEF) & "10 States" standards as design guidelines:
Approach velocity should be greater than 1.25 ft/s to prevent settling. Slot velocities should be less than 4 ft/s to prevent forcing material thru openings.

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Duperon ADAPTIVE TECHNOLOGY™
Let's Build a System that Works for You™

Date: September 26, 2019
Project: Traverse City, MI
Number: P10342

HYDRAULIC CALCULATIONS

Notes: 8.5 MGD Peak Flow, 6.25' wide channel, 0.375" bar openings, 1.7' upstream water level, 25% blinding

INPUT: Channel Physics

Flow in MGD		8.50	MGD
Upstream water level	*	1.70	ft
Channel width		6.25	ft
Channel depth		5.00	ft
Degree of blinding		25%	

INPUT: Screen Physics

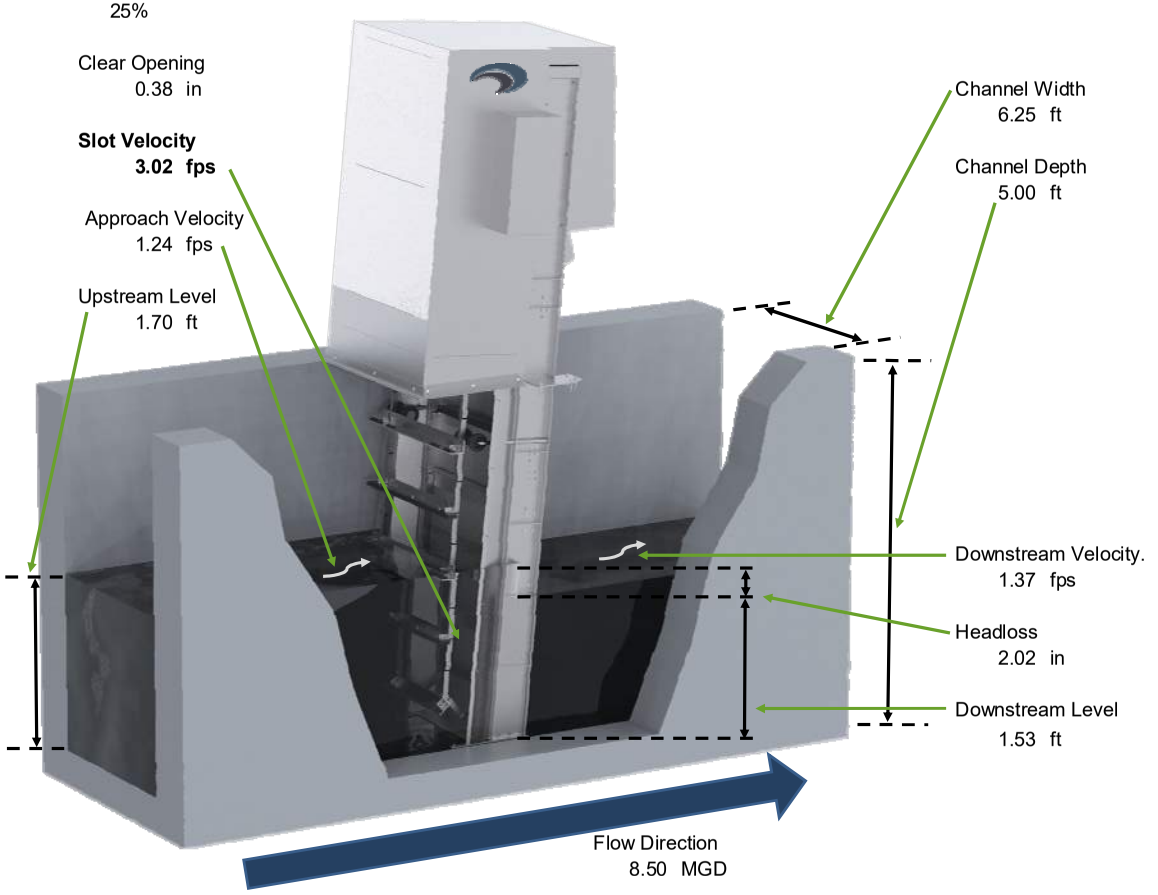
Clear Opening		0.38	in
Bar thickness		0.25	in
Thickness of side fab and closeout (2)		0.58	ft

Calculations

Side fab & closeout area	0.99	sft
Flow area between side fab & closeouts	9.64	sft
Number of bars	108.00	ea
Flow area taken up by bars	3.83	sft
Total Channel flow without screen	10.63	sft
Flow area after screen area and blinding taken out	4.36	sft
Approach Velocity	1.24	fps
Slot Velocity	3.02	fps
Downstream Velocity	1.37	fps
Downstream Depth	1.53	ft
Head Loss	2.02	in

Bernoulli Calculations

Velocity thru bar screen	3.02	fps
Velocity upstream of bar screen	1.24	fps
Gravitational acceleration (constant)	32.20	ft/s^2
Frictional coefficient (constant)	1.43	c
Headloss	0.17	ft
Headloss	2.02	inches



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Duperon® ADAPTIVE TECHNOLOGY™
PRELIMINARY LIQUIDS/SOLIDS SEPARATION SYSTEMS

Date: September 26, 2019

Project: Traverse City WWTP, MI (3.5 ft wide channel) **Proposal Number:** 10342

BUDGET EQUIPMENT SCOPE

To: Traverse City, MI

From: **Your Duperon® Team**
David Herald
Lead Sales Project Manager
(989) 754-8800
dherald@duperon.com

Rep: Jay Vermilye
Dubois Cooper Associates
(248) 935-4456
jvermilye@duboiscooper.com

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Regional Sales Manager
(989) 754-8800
saiken@duperon.com

Duperon® ADAPTIVE TECHNOLOGY™
PRELIMINARY LIQUIDS/SOLIDS SEPARATION SYSTEMS

Date: September 26, 2019

Project: Traverse City WWTP, MI (3.5 ft wide channel) **Proposal Number:** 10342

BUDGET EQUIPMENT SCOPE

Thank you for considering Duperon® system solutions for your project. We appreciate the opportunity to provide you with a Budget Equipment Scope. Please do not hesitate to contact your Duperon® Team with any questions as we work with you through the design process and ensure a successful project.

Equipment Scope

SCREENS:

QTY	UNIT	DESCRIPTION		
1	EA	**Duperon® FlexRake® - Front Clean Front-Return**		
		Model:	FPFS - Full Penetration, Fine Screen	
Notes: Based on 3.5' wide x 5' tall channel.		Enclosure (& Material):	Fully Enclosed (304)	
		Nom Width x Length:	3.5 x 13	Feet
		Clear Opening Size:	0.375 in	
		Angle of Installation:	30	Deg. from Vertical
		Material Construction:	304	SSTL

Screenings Processing

QTY	UNIT	DESCRIPTION		
1	EA		**Duperon® Washer Compactor**	
		Model:	WC3.A2.5	
Notes:		Appx Footprint:	2 ft wide x 9 ft long	
		Motor HP:	0.75 HP	
		Chute Allowance:	10 ft long w/ 1 bend (customizable)	
		Material Construction:	304	SSTL

CONTROLS

QTY	UNIT			
1	EA	**Main Control Panel:**	**1 - FPFS / 1 - WC**	
		Power:	480V/3ph/60hz	
Notes: 1 Main Panel		Panel Rating:	NEMA 4X	
		PLC/Relay Based:	Relay	
		Screen Instrumentation:	(2) Transducers w/ HydroRanger	
		2 Local Pushbutton Station(s):	Three Button (E-Stop/Run/Jog Rev)	

TECH/FREIGHT

QTY	UNIT	DESCRIPTION		
1	LOT	**On-Site Technical Assistance**		
		Number of Trips:	1	Trip(s)
		Days On-Site per Trip:	2	8-hour man-day(s)
1	LOT	**Freight**		
		FOB Factory, Full Freight Allowed		

Clarifications:

- This is not a fully designed project; pricing may be affected by scope change/project development
- Operational, structural, wind, or seismic calculations are not included
- Scope is based on models and assumptions widely utilized in the industry
- Scope does not convey an offer to sell; installation and taxes are not included
- **For reference only:** Standard Delivery Schedule: Submittals 4-6 week from PO - Delivery 8-12 weeks from approval

BUDGET PRICING: **$220,000.00**

Duperon® ADAPTIVE TECHNOLOGY™
PRELIMINARY LIQUIDS/SOLIDS SEPARATION SYSTEMS

Date: September 26, 2019

Project: Traverse City WWTP, MI (3.5 ft wide channel) **Proposal Number:** 10342

OPTIONAL EQUIPMENT AND ACCESSORIES

Thank you for considering Duperon® system solutions for your project. We appreciate the opportunity to provide you with a Budget Equipment Scope. Please do not hesitate to contact your Duperon® Team with any questions as we work with you through the design process and ensure a successful project.

Optional Accessories

Bar Screen Deadplate Heat Pad
24" x 24" heat pad (power by others)
Thermostat

ADD PRICE (EA): $3,000

Bar Screen Deadplate Heat Pad
12" x 12" heat pad (power by others)
Thermostat

ADD PRICE (EA): $1,800

Washer Compactor Elephant Drop Sleeve
Solid canvas flexible tube
10 ft overall length
Attaches directly to discharge chute

ADD PRICE (EA): $1,575

Washer Compactor Heat Trace & Blanket Kit
Required in applications where freezing temperature are possible
Teflon heat blanket (weather-proof) construction
Thermostat (NEXA 4X) with remote probe for temperature reading
Components are CLASS I DIVISION I rated

ADD PRICE (EA): $5,000

Washer Compactor Bagging System
Longofill cassette holder - SSTL & ABS plastic
Longopac PE continuous bagger cassette, 295 ft (90 m)

ADD PRICE (EA): $3,400

Duperon® ADAPTIVE TECHNOLOGY™
PRELIMINARY LIQUIDS/SOLIDS SEPARATION SYSTEMS

Date: September 26, 2019

Project: Traverse City WWTP, MI (6.25 ft wide channel) **Proposal Number:** 10342 R1

BUDGET EQUIPMENT SCOPE

To: Traverse City, MI

From: **Your Duperon® Team**
David Herald
Lead Sales Project Manager
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Duperon® ADAPTIVE TECHNOLOGY™
PRELIMINARY LIQUIDS/SOLIDS SEPARATION SYSTEMS

Date: September 26, 2019

Project: Traverse City WWTP, MI (6.25 ft wide channel) **Proposal Number:** 10342 R1

BUDGET EQUIPMENT SCOPE

Thank you for considering Duperon® system solutions for your project. We appreciate the opportunity to provide you with a Budget Equipment Scope. Please do not hesitate to contact your Duperon® Team with any questions as we work with you through the design process and ensure a successful project.

Equipment Scope

SCREENS:

QTY	UNIT	DESCRIPTION		
1	EA	**Duperon® FlexRake® - Front Clean Front-Return**		
		Model:	FPFS - Full Penetration, Fine Screen	
Notes: Based on 6.25' wide x 5' tall channel.		Enclosure (& Material):	Fully Enclosed (304)	
		Nom Width x Length:	6.25 x 13	Feet
		Clear Opening Size:	0.375 in	
		Angle of Installation:	30	Deg. from Vertical
		Material Construction:	304	SSTL

Screenings Processing

QTY	UNIT	DESCRIPTION		
1	EA		**Duperon® Washer Compactor**	
		Model:	WC3.A3.5	
Notes:		Appx Footprint:	2 ft wide x 10 ft long	
		Motor HP:	0.75 HP	
		Chute Allowance:	10 ft long w/ 1 bend (customizable)	
		Material Construction:	304	SSTL

CONTROLS

QTY	UNIT		
1	EA	**Main Control Panel:**	**1 - FPFS / 1 - WC**
		Power:	480V/3ph/60hz
Notes: 1 Main Panel		Panel Rating:	NEMA 4X
		PLC/Relay Based:	Relay
		Screen Instrumentation:	(2) Transducers w/ HydroRanger
		2 Local Pushbutton Station(s):	Three Button (E-Stop/Run/Jog Rev)

TECH/FREIGHT

QTY	UNIT	DESCRIPTION		
1	LOT	**On-Site Technical Assistance**		
		Number of Trips:	1	Trip(s)
		Days On-Site per Trip:	2	8-hour man-day(s)
1	LOT	**Freight**		
		FOB Factory, Full Freight Allowed		

Clarifications:

- This is not a fully designed project; pricing may be affected by scope change/project development
- Operational, structural, wind, or seismic calculations are not included
- Scope is based on models and assumptions widely utilized in the industry
- Scope does not convey an offer to sell; installation and taxes are not included
- **For reference only:** Standard Delivery Schedule: Submittals 4-6 week from PO - Delivery 8-12 weeks from approval

BUDGET PRICING: **$240,000.00**

Duperon® ADAPTIVE TECHNOLOGY™
PRELIMINARY LIQUIDS/SOLIDS SEPARATION SYSTEMS

Date: September 26, 2019

Project: Traverse City WWTP, MI (6.25 ft wide channel) **Proposal Number:** 10342 R1

OPTIONAL EQUIPMENT AND ACCESSORIES

Thank you for considering Duperon® system solutions for your project. We appreciate the opportunity to provide you with a Budget Equipment Scope. Please do not hesitate to contact your Duperon® Team with any questions as we work with you through the design process and ensure a successful project.

Optional Accessories

Bar Screen Deadplate Heat Pad
24" x 24" heat pad (power by others)
Thermostat

ADD PRICE (EA): $3,000

Bar Screen Deadplate Heat Pad
12" x 12" heat pad (power by others)
Thermostat

ADD PRICE (EA): $1,800

Washer Compactor Elephant Drop Sleeve
Solid canvas flexible tube
10 ft overall length
Attaches directly to discharge chute

ADD PRICE (EA): $1,575

Washer Compactor Heat Trace & Blanket Kit
Required in applications where freezing temperature are possible
Teflon heat blanket (weather-proof) construction
Thermostat (NEXA 4X) with remote probe for temperature reading
Components are CLASS I DIVISION I rated

ADD PRICE (EA): $5,000

Washer Compactor Bagging System
Longofill cassette holder - SSTL & ABS plastic
Longopac PE continuous bagger cassette, 295 ft (90 m)

ADD PRICE (EA): $3,400

Budget Proposal

Project:
Traverse City WWTP

Equipment:
FSM Multirake Bar Screen Model HUR1500 x 75/6
FSM Screenings Wash Press Model SPW 300-1300

Represented By:
Peterson and Matz, Inc.
Michael Wright
Phone: 248-476-3204
Email: michael.wright@petersonandmatz.com

Regional Sales Manager:
Enviro-Care
Chris Kincaid
Phone: 224-302-0309
Email: ckincaid@enviro-care.com

Project No.: WEC219343
October 7, 2019

Enviro-Care
A WAMGROUP® Company
1570 St. Paul Avenue - Gurnee IL 60031
P: 815.636.8306
F: 847.672.7968
www.enviro-care.com

ITEM: "A" – One (1) FSM Multirake Bar Screen
Model HUR1500 x 75/6

BASIS OF DESIGN (EACH)

Application:	Municipal Wastewater
Peak Flow:	18.0 MGD
Screen Bar Opening:	1/4 inch (6 mm)
Angle of Screen:	75 degrees from horizontal
Channel Width:	6.0 feet
Channel Depth:	5.0 feet
Downstream Water Level:	26.8 inches @ Peak Flow**
Headloss:	6.1 inches @ Peak Flow with 0% blinding
	10.5 inches @ Peak Flow with 20% blinding
Discharge Height:	4.0 feet (above top of channel)

***Downstream water level is crucial to properly size a screen and to calculate the headloss through the screen. The downstream water level used for the screen sizing and headloss calculations assumes that a 24 inch Parshall Flume will be located downstream of the screen. If this is incorrect, please advise Enviro-Care of what will be controlling the downstream water level and the headloss calculations will be revised.*

MULTIRAKE BAR SCREEN (EACH)

- Frame constructed from type 304 stainless steel.
- Barfield with continuous tapered bars from type 304 stainless steel.
- Guide rails constructed from type 304 stainless steel.
- Rake assemblies entirely constructed from type 304 stainless steel.
- Dead plate constructed from type 304 stainless steel.
- Stainless steel screen drive roller chain from 304 stainless steel with PA6 rollers, bushings, and pins from 304 stainless steel.
- Stainless steel roller chain and screen rake elements driven by two (2) drive shaft mounted 304 stainless steel sprockets.
- Drive shaft from solid 304 stainless steel.

- Lower rotating guide sprockets from type 304 stainless steel with ceramic collar bonded to the stub shaft with fiber reinforced PTFE self-lubricating bushing.
- Lower stub shafts from solid 304 stainless steel.
- Discharge chute constructed from type 304 stainless steel.
- Replaceable polyethylene wiper mounted to pivoting 304 stainless steel support arm.
- Screen electric drive motor, 2.0 HP TEFC, 1760 rpm suitable for 230/460/3/60 supplied with gear reducer mounted directly onto screen drive shaft.
- Neoprene side seals with type 304 stainless steel backing plates prevent bypass of material around the screen unit.
- Screen covers above the top of channel from type 304 stainless steel.
- Shop surface preparation, stainless steel full dip passivation and painting as required.

HARDWARE (EACH)

- Assembly fasteners from type 304 stainless steel.
- Anchor rods from type 304 stainless steel.

CONTROL PANEL AND INSTRUMENTATION (EACH)

- One (1) NEMA 4X type 304 stainless steel wall mount main control panel suitable for 480/3/60 electrical supply. Control panel shall contain the following control devices for operation of the bar screen.
    1. Main disconnect with through door interlock handle.
    2. Control transformer 480/120.
    3. Branch circuit protection.
    4. Screen motor starter (IEC), reversing with overload.
    5. Load monitor for screen motor overtorque/overload protection
    6. Emergency stop pushbutton.
    7. HOA switch for each motor.
    8. Hour meter for each motor.
    9. Run indicating lights.
    10. Alarm lights indicating overcurrent and starter overload.
    11. Alarm reset pushbutton.
    12. Programmable control relay for screen control logic functions.
    13. Run and alarm auxiliary contacts.
    14. UL Label.

- One (1) NEMA 4X local Emergency Stop pushbutton control station complete.
- One (1) Ultrasonic Level Controller: A 120V differential level controller shall be provided in a windowed NEMA 4X polycarbonate enclosure suitable for wall mounting, to receive and interpret a 4-20mA scaled signal from a upstream and downstream transducers. The controller shall have 5 internal relays and provide an LCD display.
- Two (2) Ultrasonic level transducers shall be provided with type 304 stainless steel mounting brackets and expansion anchors. Each sensor shall have an ETFE housing with an integral sensor to provide compensation for acoustic variations due to temperature. Each sensor shall have a range of 1-33 ft and be supplied with a 33 ft integral cable. Sensor shall be suitable for installation in a Class I, Division 1, Group D area.

SPARE PARTS (TOTAL)

- None.

FIELD SERVICE (TOTAL)

- Site service of one (1) trip for a total of two (2) days for installation inspection, startup and operator training.

CLARIFICATIONS/COMMENTS

- None.

OPTIONAL ITEMS

- None.

NOTE: ANY ITEM NOT LISTED ABOVE TO BE FURNISHED BY OTHERS.

EXCLUSIONS

Taxes, electrical wiring, conduit or electrical equipment, piping, valves, or fittings, shimming material, lubricating oil or grease, shop or field painting, field welding, erection, hoist or lifting apparatus, detail shop fabrication drawings, performance testing, unloading, storage, concrete work, civil design, grating, platforms, stairs, hand railing, dumpster (except as specifically noted).

This proposal section has been reviewed for accuracy and is approved for issue:
By: Beth Emmelot Date: October 7, 2019

ITEM: "B" - One (1) FSM Screenings Wash Press Model SPW 300-1300

BASIS OF DESIGN (EACH)

Application:	Municipal Headworks
Screenings Capacity:	177 ft3/hr
Inlet Opening:	1300 mm (51.2 inches)
Screw Diameter:	300 mm (11.81 inches)
Discharged Material Dry Solids:	>40%
Volume Reduction:	60 – 85%
Weight Reduction:	60 – 85%
Fecal Reduction:	90% (<20 mg/g BOD5)
Wash Water:	16 gpm @ 20-40 psi

SCREENINGS COMPACTOR (EACH)

- Screenings washer and compactor from type 304 stainless steel.
- Discharge chute an inlet hopper and spray header – 304 stainless steel.
- Screw auger with torque tube and nylon brushes fitted to screw flights to clean drainage trough perforations – shaft from high tensile steel with flights from Hardox 400.
- Axial thrust bearing with stainless steel body.
- Wear bars from Hardox® 400 alloy steel.
- 6 mm perforated curved drainage section from type 304 stainless steel.
- Drainage collection pan with 4 inch diameter outlet connection and 1 inch NPT flush water connection from type 304 stainless steel.
- Wash water piping from type 304 stainless steel.
- Inlet and outlet flanges from type 304 stainless steel.
- Discharge piping with 45 degree elbows from type 304 stainless steel.
- Washer/compactor electric drive motor 5.0 HP TEFC 1760 rpm suitable for 460/3/60 supply with gear reducer mounted directly onto auger drive shaft.
- Support legs, stand and frame from type 304 stainless steel.
- Anchor bolts from type 304 stainless steel.
- Fasteners from type 304 stainless steel.
- Shop surface preparation, stainless steel full dip passivation and painting as required.

CONTROL PANEL AND INSTRUMENTATION (EACH)

- The following control devices will be added to the screen control panel for operation of the screenings wash press.
    1. Branch circuit protection.
    2. Compactor motor starter (IEC) with overloads.
    3. Load monitor for compactor motor overtorque/overload protection.
    4. HOA switch for motor.
    5. Open-Close-Auto switch for washer compactor wash water solenoid valve.
    6. Hour meter for each motor.
    7. Run indicating lights.
    8. Alarm lights indicating overcurrent and starter overload.
    9. Run and alarm auxiliary contacts.

- One (1) NEMA 4X brass body wash water solenoid valve.

SPARE PARTS (TOTAL)

- None.

FIELD SERVICE (TOTAL)

- Provided with screen start-up services.

CLARIFICATIONS/COMMENTS

- None.

OPTIONAL ITEMS

- None.

NOTE: ANY ITEM NOT LISTED ABOVE TO BE FURNISHED BY OTHERS.

EXCLUSIONS

Taxes, electrical wiring, conduit or electrical equipment, piping, valves, or fittings, shimming material, lubricating oil or grease, shop or field painting, field welding, erection, hoist or lifting apparatus, detail shop fabrication drawings, performance testing, unloading, storage, concrete work, civil design, grating, platforms, stairs, hand railing, dumpster (except as specifically noted).

This proposal section has been reviewed for accuracy and is approved for issue:
By: Beth Emmelot Date: October 7, 2019

BUDGET

Item	Equipment	Budget Price
A	One (1) FSM Multirake Bar Screen Model HUR1500 x 75/6	$ 176,000
B	One (1) FSM Screenings Wash Press Model SPW 300-1300	$ 81,500

Validity:
Prices are valid for a period of 30 days from the date of this proposal.

Warranty Statement and Term:
Enviro-Care Company, Inc. warrants the supplied equipment to the original end user against defects in workmanship or material under normal use and service in compliance with the original design specifications and the maintenance requirements and instructions as found in the Operations & Maintenance Manual. All Enviro-Care supplied equipment is warranted for 12 months from date of start-up or 18 months from date of shipment, whichever occurs first.

Warranty Exclusions:
This warranty does not cover costs for standard and/or scheduled maintenance performed, nor does it cover consumables and Enviro-Care parts that, by virtue of their operation, require replacement through normal wear (aka: Wear Parts), unless a defect in material or workmanship can be determined by Enviro-Care. Wear parts are defined as brushes, rollers, spray nozzles, drum seals and other items specifically identified in the Operations & Maintenance Manual.

Warranty Coverage:
Enviro-Care's liability is limited to the supply or repair of defective parts returned, freight prepaid by buyer to a location specified by Enviro-Care. Repaired or replacement parts will be shipped to buyer prepaid via standard ground freight. Express or expedited shipments will be at the expense of the buyer.

Exclusions and Exceptions:
This Warranty excludes damage or wear to equipment caused by misapplication of product, improper maintenance, accident, abuse, unauthorized alteration or repair, Acts of God, or installation or operation that is non-compliant with Enviro-Care installation and operations instructions.

Limited Liability:
Enviro-Care shall not under any circumstances be liable for any incidental or consequential damages arising from loss, damage to property, personal injury or other damage or losses owing to the failure of Enviro-Care's equipment. The liability of Enviro-Care Company, Inc. is limited as set forth above within the time period set forth above.

Term: 15% with Submittal Approval
80% Net 30 Days after Shipment
5% Net 30 days after Startup. Startup not to exceed 180 days from equipment delivery.

Taxes: No sales or use taxes have been included in our pricing.

Freight: Prices quoted are F.O. B. shipping point with freight allowed to a readily accessible location nearest jobsite. Any claims for damage or loss in shipment to be initiated by purchaser.

Submittals: Full submittals will be supplied approximately **4 to 6 weeks** after receipt and acceptance of purchase order at the Enviro-Care offices.

Shipment: Shipment time is approximately **20 to 22 weeks** after receipt of approved submittal is received at the Enviro-Care offices. Under no circumstances will verbal approval be accepted.

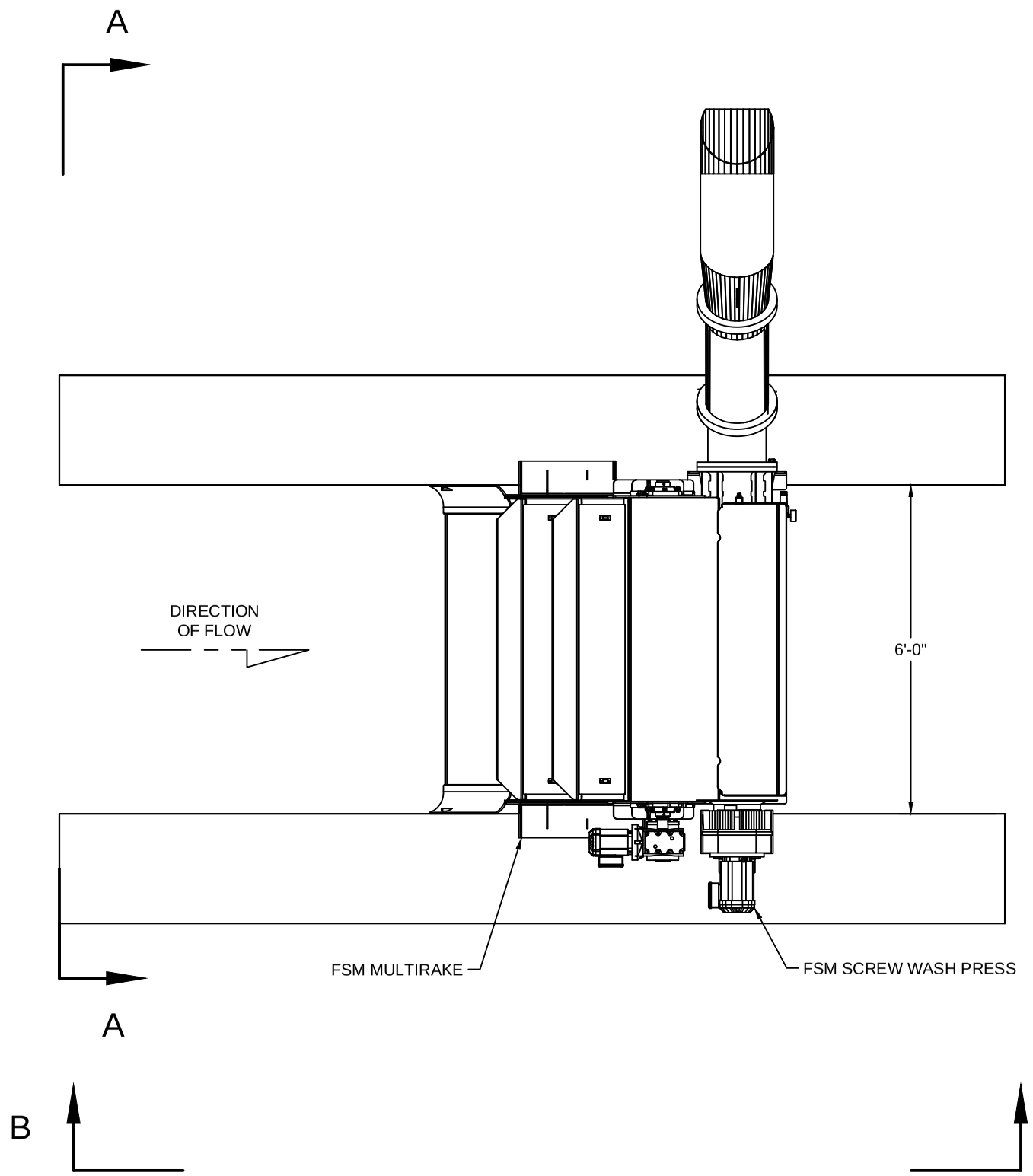
Additional Field Service: This service may be scheduled at $1,250.00 per day plus expenses or is available through a yearly service contract.

Material of Construction: Enviro-Care is providing the equipment from the type of material specified for this project. If from 304L stainless steel the concentration of chloride and hydrogen sulfide (H2S) in the equipment operating environment shall be kept below the following values:

- Chloride <200 mg/L
- Hydrogen Sulfide (H2S) <6ppm

If not already done so, Enviro-Care can provide the equipment from 316L stainless steel for a price adder for environments that exceed the values noted above.

NOTES:
1. DRAWING NOT FOR CONSTRUCTION



PLAN
SCALE: 3/8" = 1'-0"

PROCESS DESIGN INFORMATION (EACH SCREEN):

APPLICATION:	MUNICIPAL WASTEWATER SCREENING
PEAK DESIGN FLOW:	18.0 MGD
CHANNEL WIDTH:	6.0 FEET
CHANNEL DEPTH:	5.0 FEET
ANGLE OF INCLINATION:	75 DEGREES FROM HORIZONTAL
DISCHARGE HEIGHT:	4.0 FEET FROM TOP OF CHANNEL

Rev	Revision Description	Date	Rev By	Approver
D				
C				
B				
A				

Enviro-Care
A WAMGROUP® Company

Status: INFORMATION ONLY

Title
GENERAL ARRANGEMENT: TRAVERSE CITY WWTP
MODEL: HUR1500X75 FSM MULTIRAKE
SPW300-1300 FSM SCREW WASH PRESS

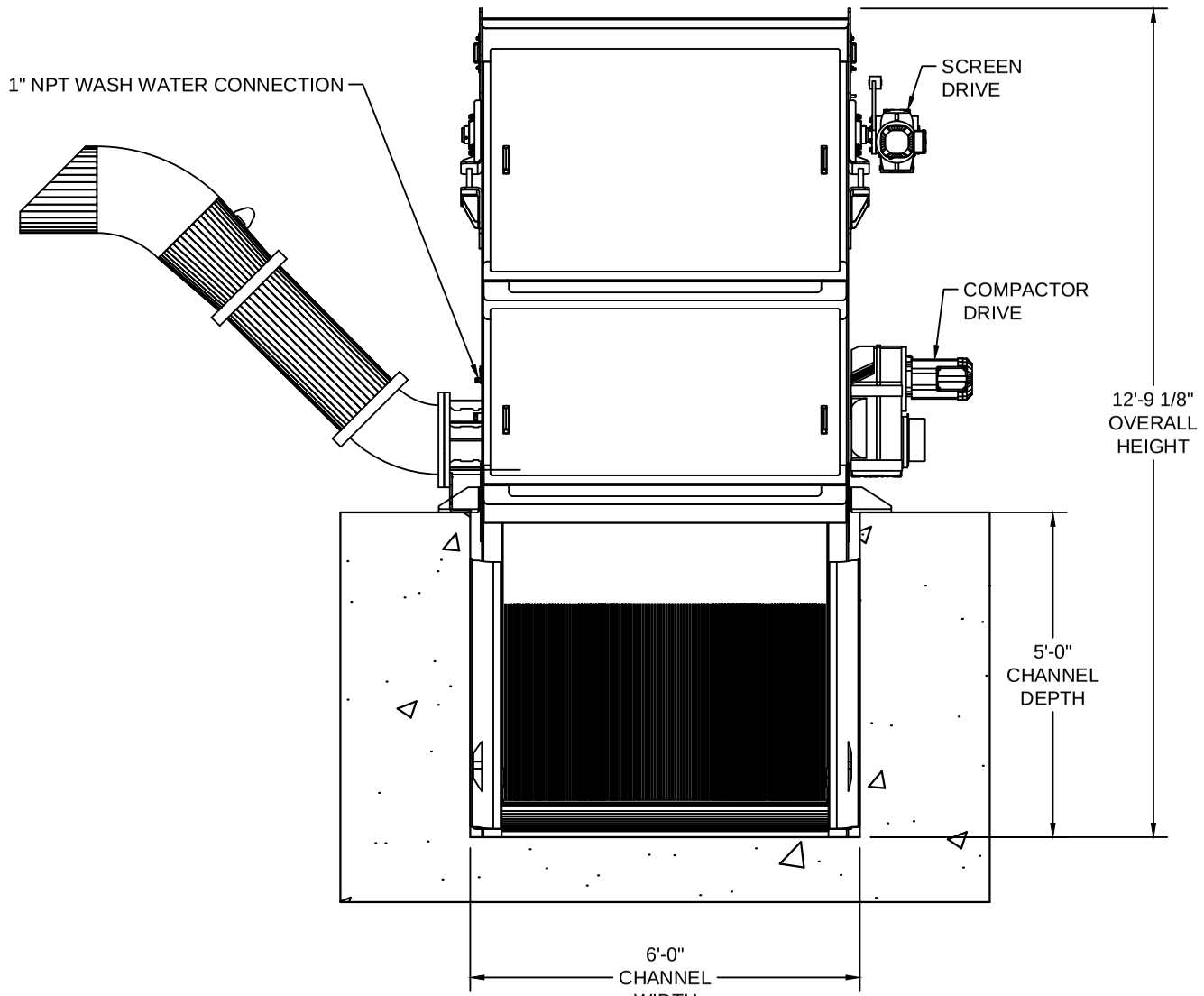
Designer	Checker	Date	Sheet
JW24	BE26	10-05-2019	1 of 2

Third Angle Projection

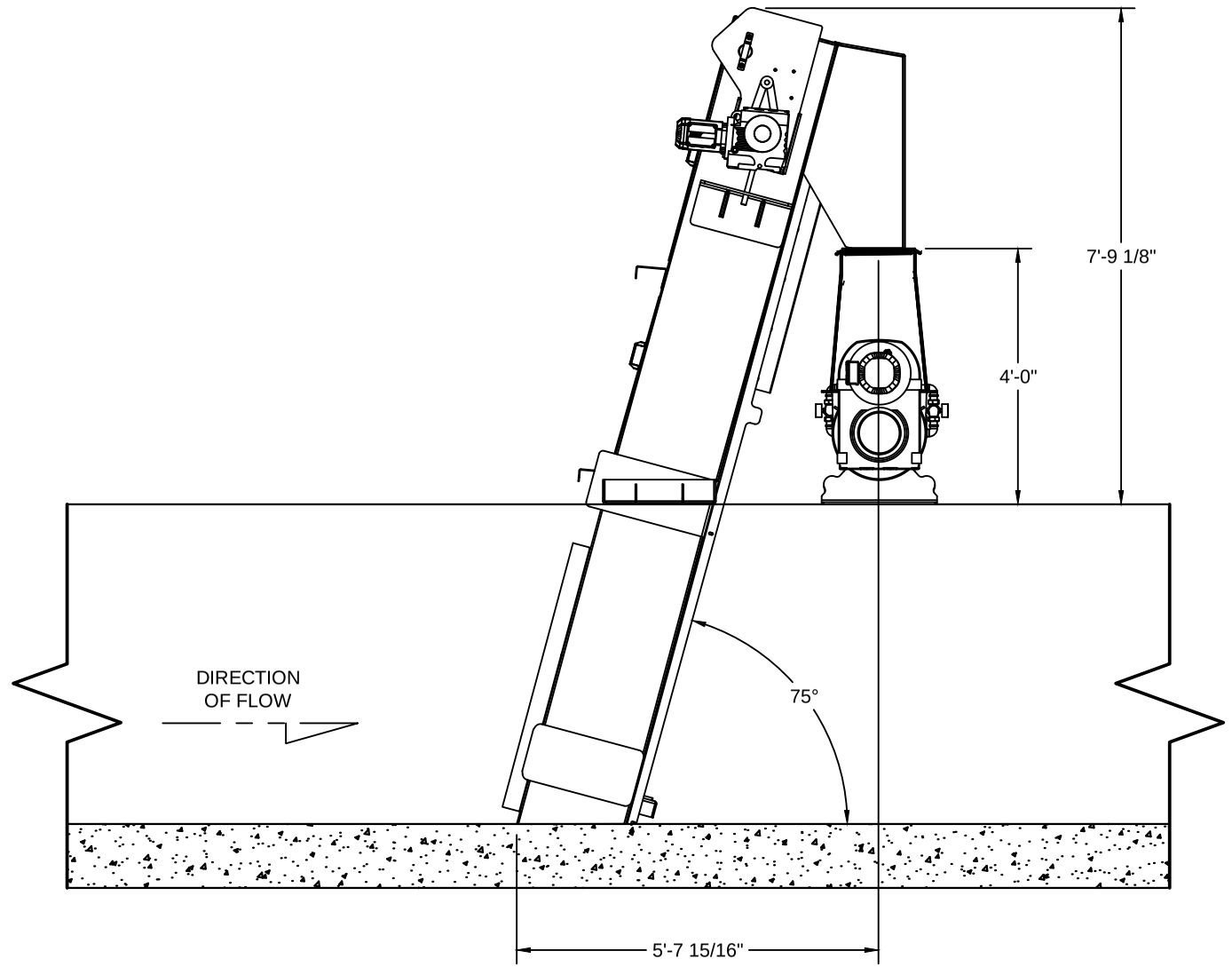
Drawing Number: WEC219343-A

Revision: -

NOTES:
1. DRAWING NOT FOR CONSTRUCTION



VIEW A-A



VIEW B-B

ELEVATION
SCALE: 3/8" = 1'-0"

Rev	Revision Description	Date	Rev By	Approver
D				
C				
B				
A				

Enviro-Care
A WAMGROUP® Company

Status: INFORMATION ONLY

Title
GENERAL ARRANGEMENT: TRAVERSE CITY WWTP
MODEL: HUR1500X75 FSM MULTIRAKE
SPW300-1300 FSM SCREW WASH PRESS

Designer	Checker	Date	Sheet
JW24	BE26	10-05-2019	2 of 2

Third Angle Projection

Drawing Number: WEC219343-A

Revision: -

Budgetary Proposal

Huber Technology, Inc.
9735 Northcross Center Ct.
Suite A
Huntersville, NC 28078
Office 704-949-1010
Fax 704-949-1020

Project: Traverse City, MI
Equipment: RakeMax Multi-Rake Bar Screen
Proposal Date: October 8, 2019
Revision: 0

Detailed Scope of Supply

Screen Details

Material	304L Stainless Steel
Screening Bars	Teardrop 8/5/60, 304L Stainless Steel
Chains	316L Links, AISI-431 Pins
Scraper	Polyethylene Blades
Motor	1.5HP, C1D1, 480VAC, 3ph, 60Hz, SF 1.0
Control Panel	NEMA 12 Painted Steel Enclosure, Allen Bradley MicroLogix PLC, AB PanelView Plus OIU, Huber Standard Components, Preprogrammed and Factory Tested
Level Controller	HydroRanger 200 Differential (per Screen)
LCS	Included
Options Selected	None

Model: RakeMax 3520x1575/6

Quantity	1	
Flow rate (Peak)	17	MGD
Channel Depth	5	ft
Channel Invert to Op. Floor	5	ft
Channel Width	6	ft
Screen Frame Width	5.72	ft
Screen Field Width	5.17	ft
Bar spacing	1/4	in
Installation Angle	75	[°]
Approx. Screen Weight	3342	lb
Discharge Height	10.33	ft

Washer Compactor Details

Body Material	304L Stainless Steel
Auger	Shafted, 304L Stainless Steel
Drain Pan	Latched, 3.5in NPT Connection
Inlet Hopper(s)	Inspection Hatch Included
Discharge Pipe	Endless Bagger Included
Drive Motor	5.0HP, C1D1, 480VAC, 3ph, 60Hz, SF 1.15
Solenoid Valve(s)	Brass-bodied, C1D1, 120VAC, 3ph
Controls	Included within VCP
LCS	Included
Options Selected	None

Model: WAP2

Quantity	1	
Screenings Capacity	70	ft3/hr
Wash Water Demand	13	gpm
Wash Water Pressure	30-60	psi
Approximate Weight	660	lbs

HUBER Technology, Inc.
Huber Technology, Inc.· 9735 NorthCross Center Court STE A · Huntersville, NC 28078
Phone (704) 949-1010 · Fax (704) 949-1020 · huber@hhusa.net · www.huber-technology.com
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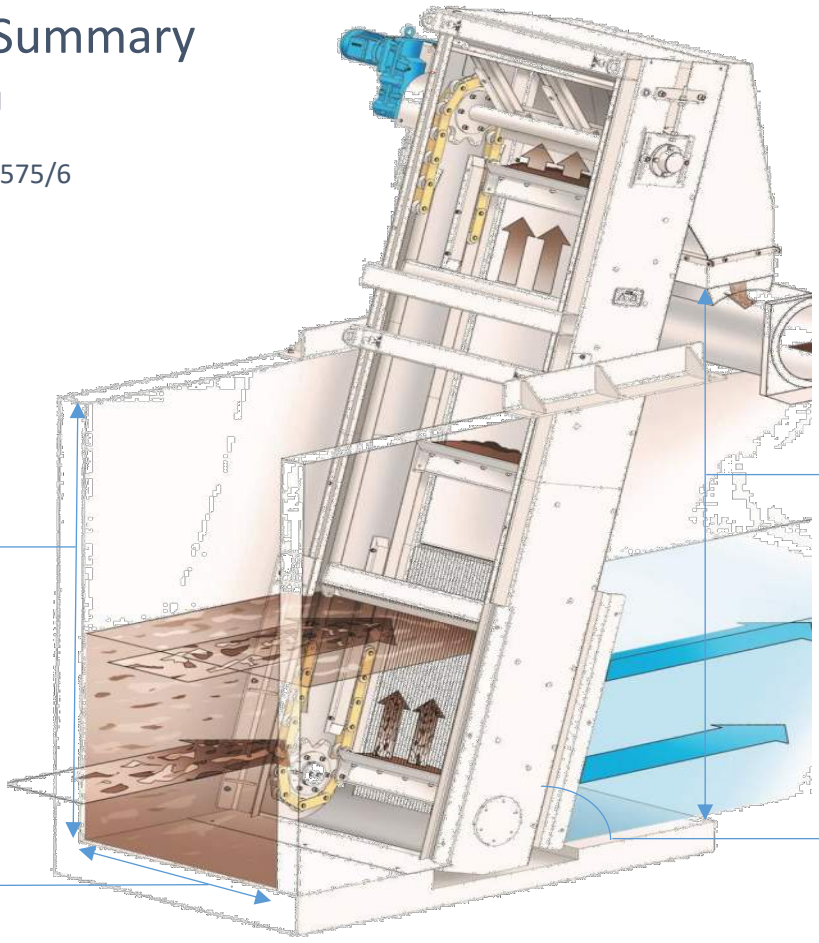
Screen Design Summary

Project: **Traverse City, MI**
Date: October 8, 2019
Screen: RakeMax 3520x1575/6



PHF per Screen
17 MGD
744.6 l/s

Screen Bar Spacing
1/4 in
6 mm

Channel Depth
5 ft
1.52 m

Depth to Operating Floor
5 ft
1.52 m

Channel Width
6 ft
1.83 m

Screen Weight
3342 lb
1519 kg

Discharge Height
10.33 ft
3.15 m

Inclination
75 °

Blinding	*Headloss (delta h)*		*Upstream Head (ho)*		*Flow Velocity Between Slots (vr)*	
[%]	*[in]*	*[mm]*	*[in]*	*[mm]*	*[ft/sec]*	*[m/sec]*
0	**1**	34	**26**	669	**5.23**	1.59
10	**3**	72	**28**	1560	**5.49**	1.67
20	**5**	116	**30**	1584	**5.82**	1.77
30	**7**	167	**32**	1615	**6.23**	1.90
35	**9**	218	**34**	1649	**6.30**	1.92
40	**11**	270	**36**	1687	**6.44**	1.96
50	**13**	334	**38**	1737	**7.21**	2.20

Given / Assumed Data:

Screen field width	**62.01**	in	[A]
Flow rate (PHF)	**17**	MGD	[Q]
Water level behind screen	**25**	in	[hu]
Flow velocity in channel	**2.10**	ft/s	[vg]
Bar spacing	**1/4**	in	[e]
Bar thickness	**0.31496**	in	[s]
Bar geometry coefficient	**0.84**	[-]	[b]
Installation angle	**75**	[°]	[a]

Calculation Basis:

Free surface factor	ao = e/(s+e)	**42.9%**
Flow velocity between slots	vr = Q/(A*ho*ao*(1-b))*sin(alpha)	
Blinding factor z	z = e - ynet*(e+s)	
Relative flow area	y net = e/(s+e)-b*e/(s+e)	
Headloss	delta h = beta*((s+z)/(e-z))^4/3*sin(alpha)* vo^2/2*g	
Upstream head	ho = hu + delta h	
Velocity in the screen	vo = Q/(ws*ho)	

HUBER Technology, Inc.
Huber Technology, Inc.· 9735 NorthCross Center Court STE A · Huntersville, NC 28078
Phone (704) 949-1010 · Fax (704) 949-1020 · huber@hhusa.net · www.huber-technology.com
A Member of the HUBER Group

Budgetary Pricing

EQUIPMENT	Quantity	Model	Pricing
RakeMax® Multi-Rake Bar Screen	1	RakeMax 3520x1575/6	Included
WAP Screenings Wash Press	1	WAP2	Included
Standard Manufacturer's Services & Freight			Included
		BUDGETARY TOTAL:	**$160,000.00**

Thank you for your interest in Huber Technology, Inc.'s multiple rake bar screen, the RakeMax. Enclosed you will find a detailed scope of supply, hydraulic calculations and technical clarifications. If you have any questions, please do not hesitate to contact our Regional Sales Director or our local sales representative.

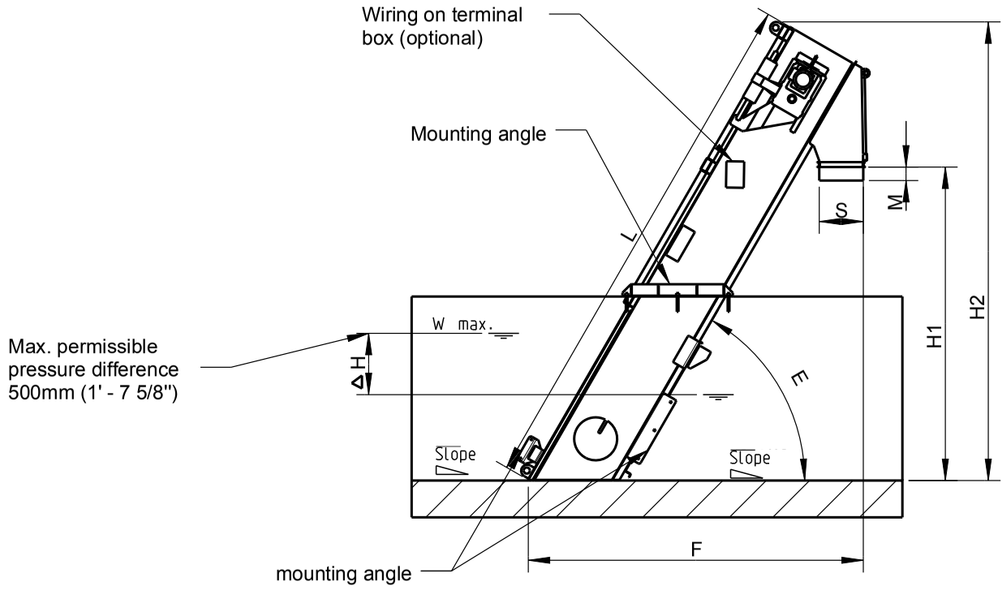
Huber Sales	***Local Sales Representative***
Name: Gary Wesselschmidt	Firm: Hesco
Title: Regional Sales Director - Central	Name: Glenn Hummel
Phone: 816-623-9955	Phone: (586) 978-7200
Email: Gary@hhusa.net	Email: glenn@hesco-mi.com

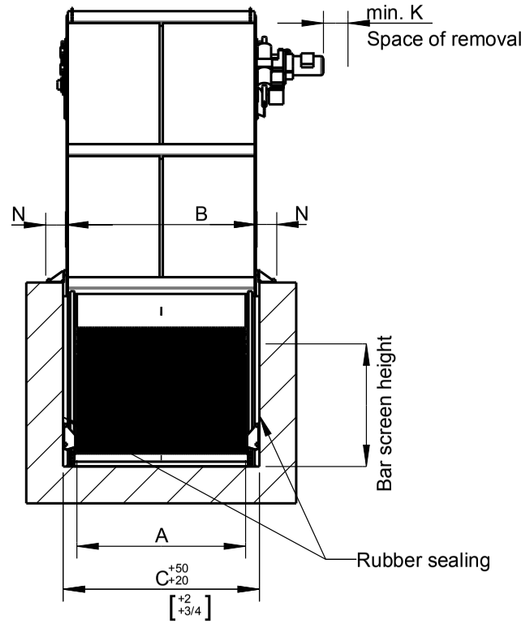
Technical Clarifications

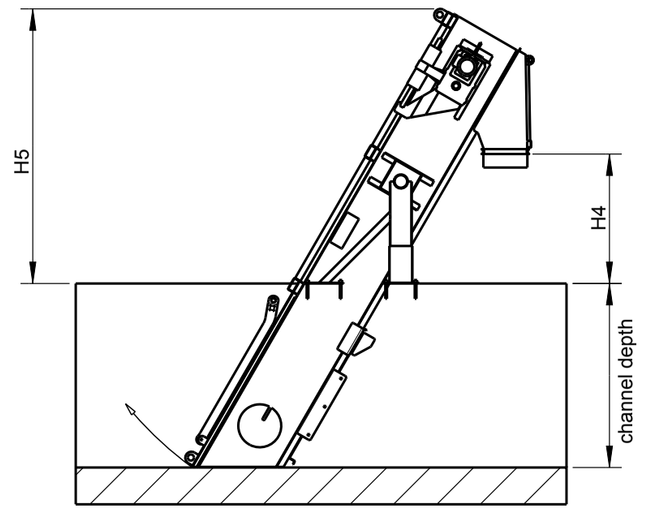
1. Equipment specification is available upon request
2. If there are site-specific hydraulic constraints that must be applied, please consult the manufacturer's representative to ensure compatibility with the proposed system
3. Electrical disconnects required per local NEC code are not included in this proposal
4. Huber Technology warrants all components of the system against faulty workmanship and materials for a period of 12 months from date of start-up or 18 months after shipment whichever occurs first
5. Budget estimate is based on Huber Technology's standard Terms & Conditions and is quoted in US$ unless otherwise stated
6. Huber has estimated the Control Panel cost based information provided with the RFQ. If control panel information is not provided with RFQ Huber will use a cost and scope of supply based on our standard panel. Huber reserves the right to change the price and scope at time of bid based on the final plans and specifications.
7. All items listed as "Available Options" are not included in the budgetary pricing.
8. Equipment that is broken out in "Pricing" tab are only valid when packaged together.

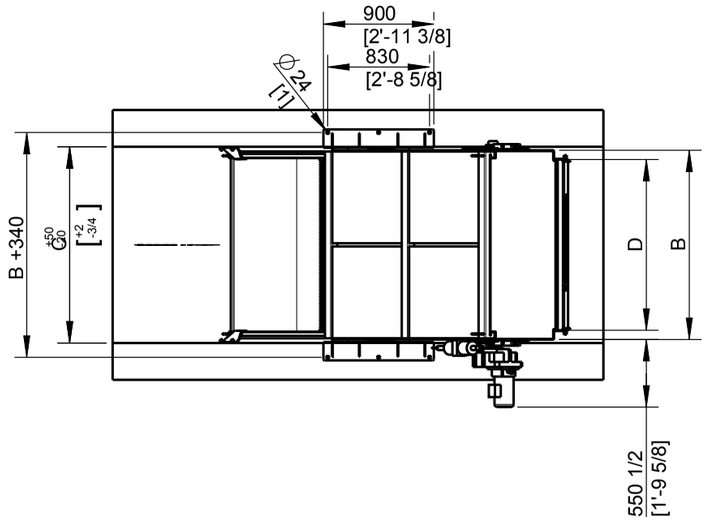
RakeMax® sheet of dimensions

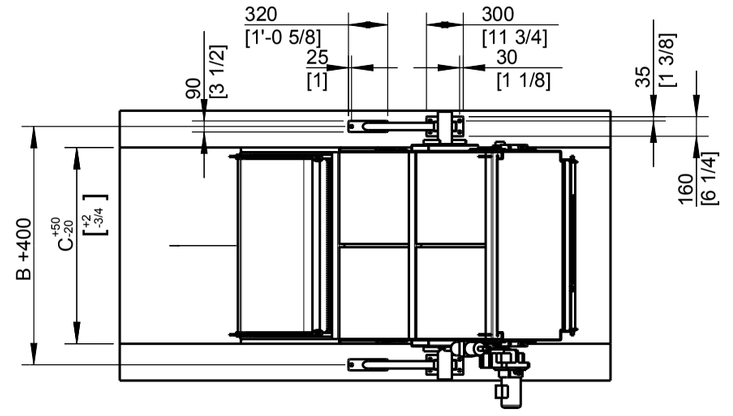
Support instead of the mounting angle
- pivotable versin (size <= 4160)
- discharge height H4 >= channel depth
- H5 >= 3000 mm (9' - 10 1/8")
- installation angle <= 55°











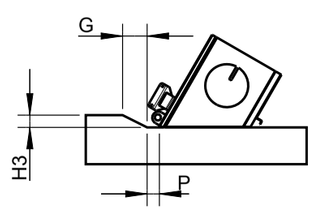
* Trapezoidal channel in front of RakeMax

* These anchor bolts are only permissible in concrete with a resistance of >=C20/25<=C50/60

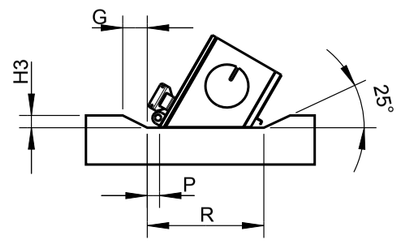
* If there is not sufficient room height we recommend to provide an opening in the roof.

Additional suggestions for hydraulic improvement

Step in channel bottom



Recess in channel bottom



Note:
Channel walls must be absolutely vertical in the area of the screen. In the area of the screen bottom plate the channel surface must be plane with a max. tolerance of +/- 3mm or +/- 0' - 1/8".

Accident prevention acc. GUV and machine directives (railing, cover, ..) or country specific regulations by others.

Pos. Item	Quantity	Specification	Material/Supplier	Annotations
-	-	----------	----------	

HUBER TECHNOLOGY
Tel.: 704-949-1010

Subject to change | ISO 2768-mK

Revision	Modified	Date	Name		Datum/Date	Name
				Rev.	01.03.2016	rwo
				Appr.	01.03.2016	rwo
-				Norm.		
				Scale: 1:50		

HUBER Multi-Rake Bar Screen
Dimension sheet
RakeMax®

Project	number	sheet
	50963000	1/1

GREAT WHITE CENTER FLOW SCREEN & WHITETIP SHARK WASHING COMPACTOR PROPOSAL PACKAGE

FOR: TRAVERSE, MI

ORIGINAL EQUIPMENT MANUFACTURED BY

HYDRO DYNE ENGINEERING
DESIGNED TO PROTECT. BUILT TO PERFORM.™

4750 118th Avenue North • Clearwater, Florida 33762
Phone: 813-818-0777 • Fax: 813-818-0770
Email: info@hydro-dyne.com

Great White Center Flow Screen Equipment Sizing

HYDRO DYNE ENGINEERING

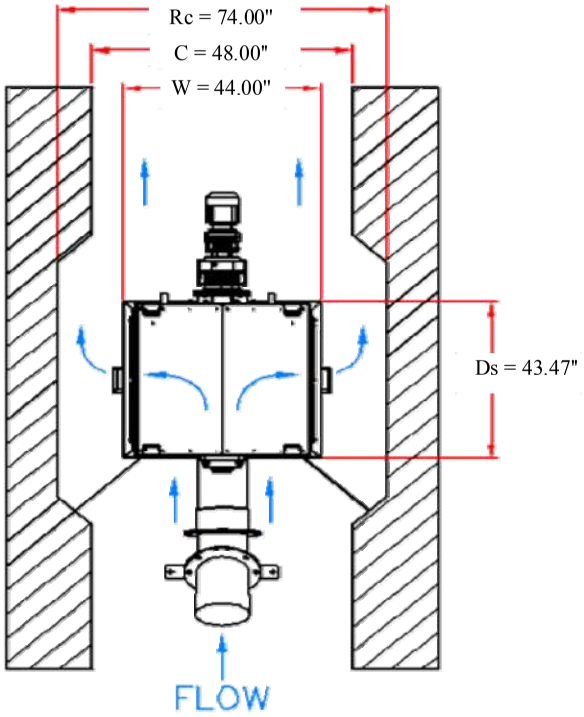
Tel: 813-818-0777 Fax: 813-818-0770

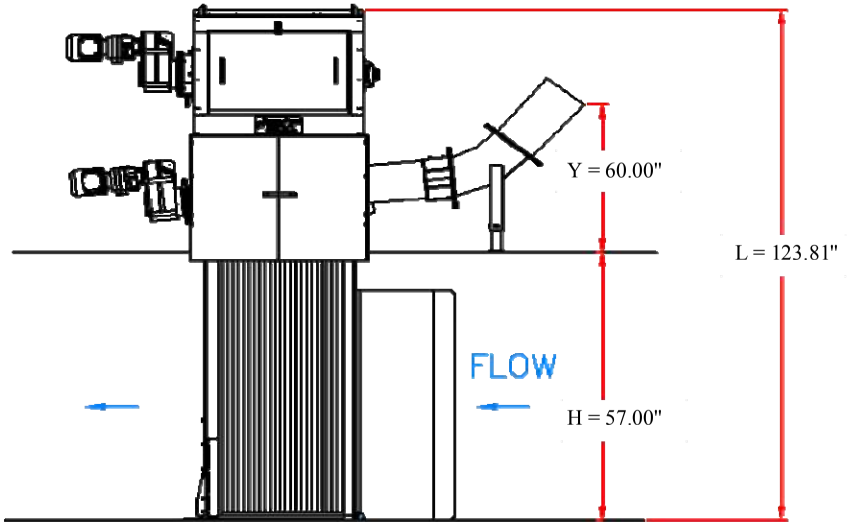
Project: Traverse, MI
Date: 10/11/2019
Rep: Waterworks
By: JMB **Checked:**

Model # **CF** 44 – 43 – 124 – 3 – L

Channel Dimensions:		English Units	SI Units
C	Channel Width	48.00 in	1219 mm
H	Channel Height	57.00 in	1448 mm
Rc	Recess Width,	74.00 in	1880 mm
Rd	Channel Recess Depth	72.60 in	1844 mm
TC	Height from Grade to Top of Channel	0.00 in	0 mm

Equipment Dimensions:		English Units	SI Units
L	Length of Screen	123.81 in	3145 mm
W	Width of Screen	44.00 in	1118 mm
Ds	Depth of Screen	43.47 in	1104 mm
Y	Discharge Height from the Compactor	60.00 in	1524 mm
Screen Grid Parameters:			
S	Grid Opening Spacing	3mm Link	
Obs	Percent of Screen Obstructed 50 %	Hook Link	16 ga
OA_{eff}^{*}	Effective Percent of Grid Opening 34.73 %	Straight Link	18 ga





NOTE: * Effective Percent of Grid Opening = Percent of Grid Opening at 3mm Opening × (1 - Proposed 50% of Screen Obstructed).

Great White Center Flow Screen Hydraulic Performance

HYDRO DYNE ENGINEERING

Tel: 813-818-0777 Fax: 813-818-0770

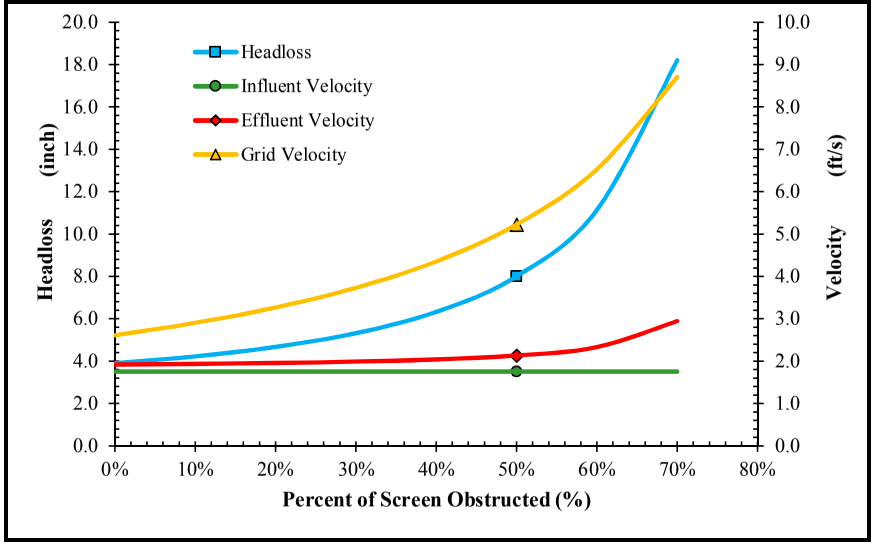
Project: Traverse, MI
Date: 10/11/2019
Rep: Waterworks
By: JMB **Checked:**

Model # CF 44 – 43 – 124 – 3 — L

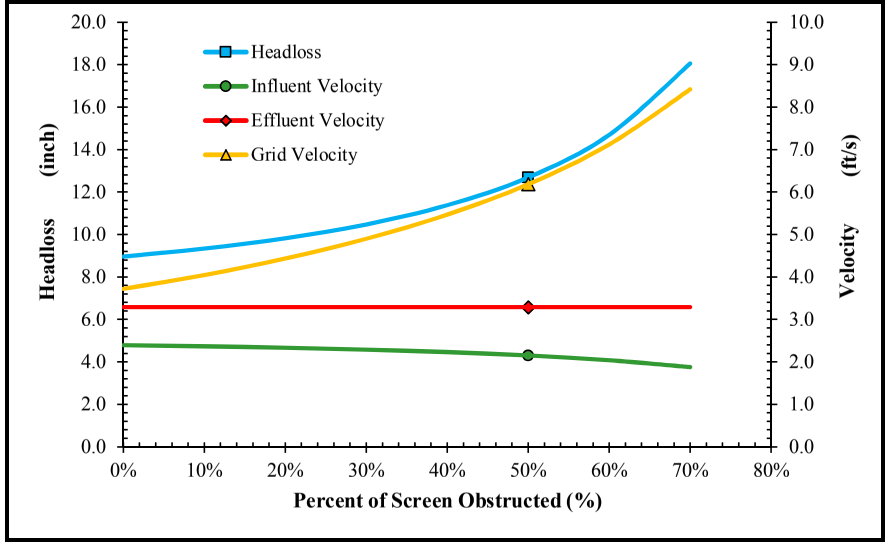
Fixed D_1 Condition @ 50% Obs		English Units		SI Units	
Q	Flow Rate	17.00 MGD	11806 gpm	745 L/s	64352 m^3/d
D_1	Upstream Water Depth	45.00 in		1143 mm	
D_2	Downstream Water Depth	37.00 in		940 mm	
ΔH	Total Headloss	8.00 in		203 mm	
F	Freeboard	12.00 in		305 mm	
V_1	Influent Channel Velocity	1.75 ft/s		0.53 m/s	
V_T	Throat Velocity of Screen	3.17 ft/s		0.97 m/s	
V_G	Velocity Through Grid	5.22 ft/s		1.59 m/s	
V_{Re}	Recess Zone Velocity	2.95 ft/s		0.90 m/s	
V_2	Effluent Channel Velocity	2.13 ft/s		0.65 m/s	

Fixed D_2 Condition @ 50% Obs		English Units		SI Units	
Q	Flow Rate	17.00 MGD	11806 gpm	745 L/s	64352 m^3/d
D_1	Upstream Water Depth	36.69 in		932 mm	
D_2	Downstream Water Depth	24.00 in		610 mm	
ΔH	Total Headloss	12.69 in		322 mm	
F	Freeboard	20.31 in		516 mm	
V_1	Influent Channel Velocity	2.15 ft/s		0.66 m/s	
V_T	Throat Velocity of Screen	4.10 ft/s		1.25 m/s	
V_G	Velocity Through Grid	6.18 ft/s		1.88 m/s	
V_{Re}	Recess Zone Velocity	4.20 ft/s		1.28 m/s	
V_2	Effluent Channel Velocity	3.29 ft/s		1.00 m/s	

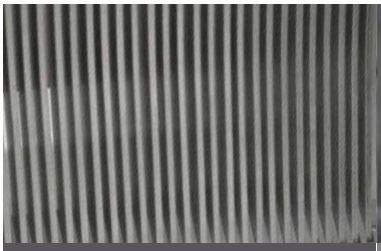
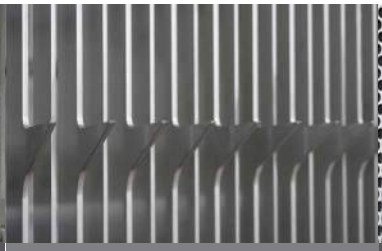
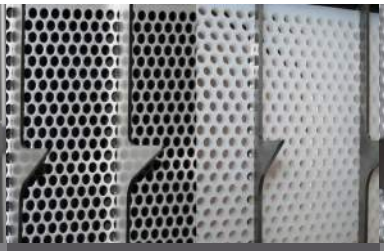
Screen Performance VS. Screen Blocking at Fixed D_1



Screen Performance VS. Screen Blocking at Fixed D_2



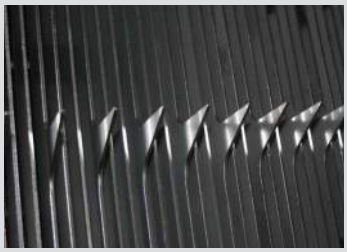
Screen Grid Options

	 **Stainless Steel Bars** Rectangular Openings from 5-300mm	 **Stainless Steel Laced Links** Rectangular Openings from 1-75mm	 **Stainless Steel & UHMWPE Perforated Panels** Round Openings from 1-9mm	 **Stainless Steel Woven Mesh Panels** Square Openings from 0.5-25mm
Applications	Municipal water and wastewater Combined storm overflow Pump and lift systems Food processing	Municipal water and wastewater Prisons and correctional facilities Combined storm overflow Pump and lift systems Sludge and septage receiving Food processing	Municipal water and wastewater Membrane Bioreactor (MBR) Protection Pulp and paper plants Food Processing	Water intakes Industrial processes Membrane Bioreactor (MBR) Protection Cooling water intake Algae removal
Advantages	Extremely strong grid Dry unloading of screenings Wide range of opening sizes Versatile and proven Easily handles large flows	Strongest grid available Excellent unloading of screenings Highest open area percentage/ very efficient Smaller footprint Wide range of opening sizes Versatile and proven Easily handles large flows	Highest Screening Capture Ratio Patented grid design maintains strength and openings tolerances for life Effectively removes hairs/fibrous material	High Screening Capture Ratio Patented grid design maintains strength and openings tolerances for life High open area percentage
Limitations	Less efficient capture of hair and fibrous material Lower Screening Capture Ratio Large solids can jam bottom and if reversing cannot clear, they must manually be removed	Less efficient capture of hair and fibrous material Lower Screening Capture Ratio	Greater water pressure/volume requirements Significant collection of fecal matter in municipal wastewater Higher headlosses	Greater water pressure/volume requirements Difficulty in unloading stringy/ fibrous material

Stainless Steel Laced Links & Bars
Rectangular Openings from 1-300mm

3mm Laced Link

6mm Laced Link



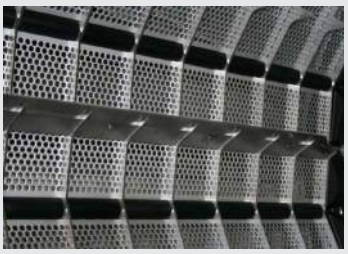
25mm Laced Link

Stainless Steel & UHMWPE Perforated Panels
Round Openings from 1-9mm

2mm Stainless Steel

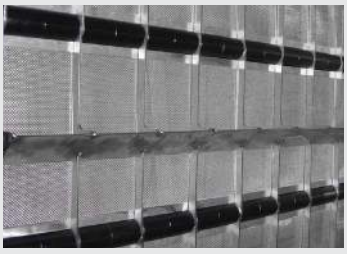
5mm Stainless Steel

6mm UHMWPE

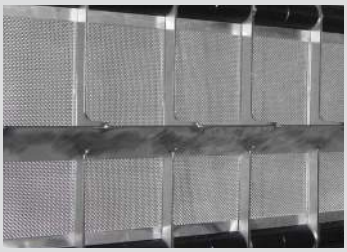


Stainless Steel Woven Mesh Panels
Square Openings from 0.5-25mm

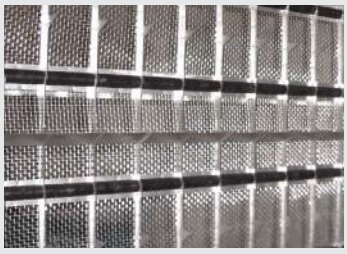
1mm



2mm



6mm



To learn more visit: www.hydro-dyne.com
sales@hydro-dyne.com | +1 (813) 818-0777

Coarse Screens | Fine Screens | Screenings Handling | Grit Removal Equipment

Designed & Manufactured in the USA
4750 118th Avenue North Clearwater, FL 33762

ISO 9001:2015 Certified

HYDRO DYNE® ENGINEERING
Designed to Protect. Built to Perform.™

Great White Center/Dual Flow Screen

Highest Screenings Capture Ratio Available

- Independently certified[1] highest SCR water/wastewater screen
  - 93.25% with 2mm opening
  - 84% with 6mm opening
- Continuous band screen design eliminates bypass and carryover
- Excellent sensitive process and membrane protection
- Proprietary design features easily capture and offload screenings including rags and stringy material
- All T304 or T316 stainless steel fabrication

About the Great White Center/Dual Flow Screen

The Great White Shark is an apex predator that rules almost every body of water around the world. Like the Great White, our Center/Dual Flow Screen is designed and manufactured at the pinnacle of quality and dominates application environments.

The Great White Center/Dual Flow continuous band screen is designed to handle low-to-high flows and has been independently[1] certified to have the highest screenings capture ratio of all band screens on the market. Dual spray wash, patented grid design, proprietary sealing system and UHMWPE guide links make this an exceptional product for the filtering and offloading of water and wastewater screenings.

[1] *UK Water Industry Research in National Screen Evaluation Facility Inlet Screen Evaluation Comparative Report (1999-2011)*

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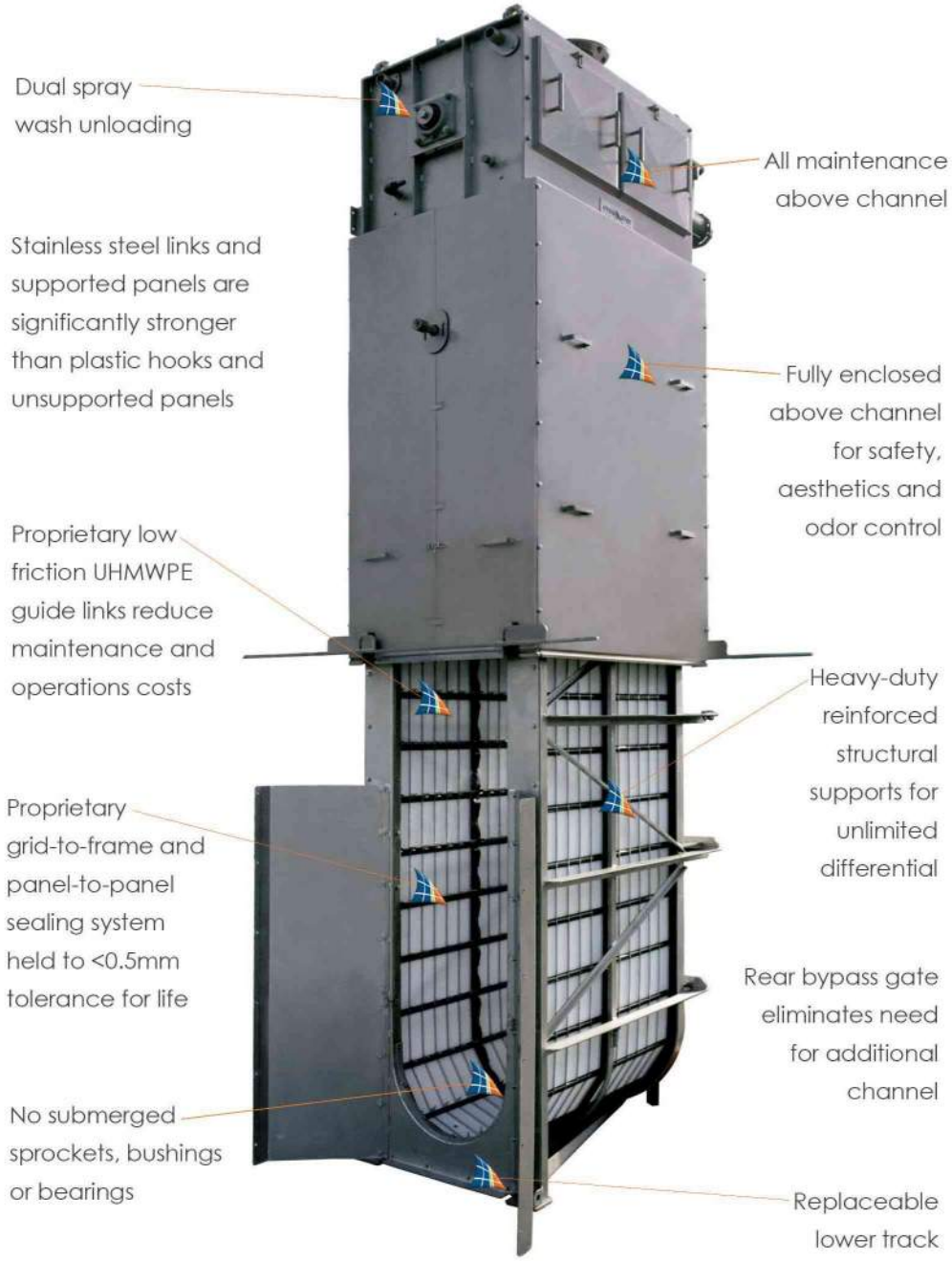

At-a-glance

models
Center Flow (center entrance/side exit)
Dual Flow (side entrance/rear exit)

grid opening range
0.5-25mm

flow capacity
0.1mgd (5 L/s) to 125+mgd (5,500+ L/s)

grid types
Stainless steel laced link
Stainless steel wire mesh
Stainless steel perforated panel
UHMWPE perforated panel

Patented Drive Features

- Grid does not contact drive or unloading mechanism
- Direct drive uses no chains or sprockets
- Fully supports grid for negligible wear
- Fractional hp requirements

Optional Equipment

- Specialty stainless steel construction
- Cold weather/freeze protection
- Basic to sophisticated automation controls
- Sectional construction for restricted area assembly
- Integrated screenings handling equipment
- Electric, hydraulic or explosion-proof drives

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Whitetip Shark Washing Compactors

Effective Design Adapted to your Application

- Multiple models and options to suit individual applications
- Designed to collect, condition, dewater and compact screenings from any screen, launder/sluice or conveyor
- Screenings meet strict landfill requirements
- Returns organics and wash water to channel
- Reduces disposal weight and volume
- All T304 or T316 stainless steel fabrication
- Standard screw diameters: 6", 8", 10", 12" ,16" and 20"

Whitetip Shark Washing Compactors

The Whitetip Shark is a fierce but slow-moving shark, notable for its long, rounded fins which feature an iconic white tip. Hydro-Dyne's family of Whitetip Shark Washing Compactors thoroughly wash and compact screenings to produce the clean, compact white screening plugs they are known for by efficiently returning organics to the channel. Every compactor is custom-designed for individual applications, taking into account the type of flow and solids collected. Multiple models are available to ensure organic material is returned to the treatment plant's process and inorganic materials are separated, cleaned and dewatered in the most effective and efficient way possible. Stainless steel construction provides an enduring solution to exceed ever increasing disposal requirements.

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Whitetip Shark Washing Compactor

The Whitetip Shark Washing Compactor features screenings washing, compaction and dewatering zones. Spray wash nozzles are recessed to minimize ragging and set at different angles to maximize the rinse cycle. Stainless steel anti-rotation bars improve compaction and significantly increase equipment lifespan.

- Washing
- Compaction
- Dewatering

Whitetip Shark with Additional Wash Cycle

The Whitetip Shark Washing Compactor with additional wash cycle adds a reversing function to the auger and timers so that the screened material is aggressively agitated during a longer wash cycle. Organic material is further broken down and washed back into the system through the drain.

- Aggressive Washing Cycle
- Compaction
- Dewatering

Whitetip Shark with Wash Module

An average of 80% decrease in the total weight of solids output is achieved by this model with the addition of deluge and washing module zones. The deluge zone significantly improves the separation of organic and inorganic material, and washing module and compression zones thoroughly rinse and compact captured screenings.

- Up to 80% reduction in solids output weight
- Deluge zone
- Wash module zone
- Compaction
- Dewatering

Optional Equipment

- Basic rinsing to thorough washing
- Integrated models located within screens
- External models fed via sluice or conveyor
- Trough types: perforated, slotted, wedgewire
- Shafted or shaftless flight
- Electric or hydraulic drive
- Cold weather/freeze protection

Discharge Options

- Dual Bearing: Dewatering
- Reduction Flange: Dewatering and some compaction
- Hinged Gate: Dewatering and compaction
- Press Elbow: Maximum dewater and compaction plus elevation

Screenings Collection Options

- Screenings collection bagging system
- Self-leveling bins
- Stainless steel discharge chute
- Lay flat hose or flexible pipe

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Made in the USA

Urquhart, Douglas

From: Joe Gentle <joe@peswater.com>
Sent: Friday, October 18, 2019 11:30 AM
To: Benoit Dennis J.
Subject: FW: Traverse City MI WWTP Upgrades
Attachments: GH-46 Submerged Slide Gate.doc; 46-FCE-MTD-hc-med.pdf; 46-FCE-MTD-hw-wb-ped-bltinv.pdf; 46-sc-spigot-mtd-around-rcp-pipe-hw Model (1).pdf

Dennis,

I may have forgotten to send this quote for the Golden Harvest gates. Kusters is also working on the screen quote but they are swamped so I told them that we are very early in the project development so if they need a few more days no biggie.

Have a great weekend Dennis. It looks like it's going to be a nice one.

Best,

Joe

From: Thomas Harris [mailto:ThomasH@goldenharvestinc.com]
Sent: Friday, October 11, 2019 11:19 AM
To: Tashia Hart; Joe Gentle; Frank Bazzano
Cc: David Wise; Brian Buchanan
Subject: RE: Traverse City MI WWTP Upgrades

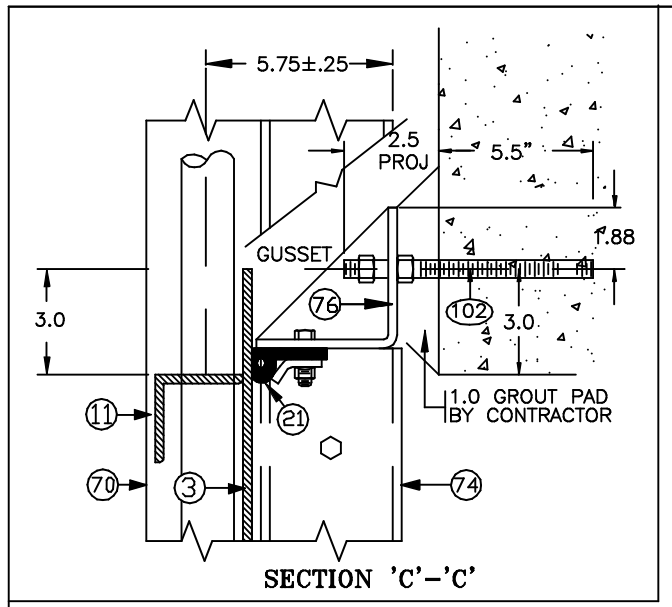
I have attached our spec and a few sample drawings of various configurations for your convenience and review. If you have any questions please let us know.

BUDGETARY PRICE of $40,075.00 FOR:
SEVEN 24" x 24" wall mounted slide gate
304 Stainless steel
yoke mounted hand wheel operator
including shipping

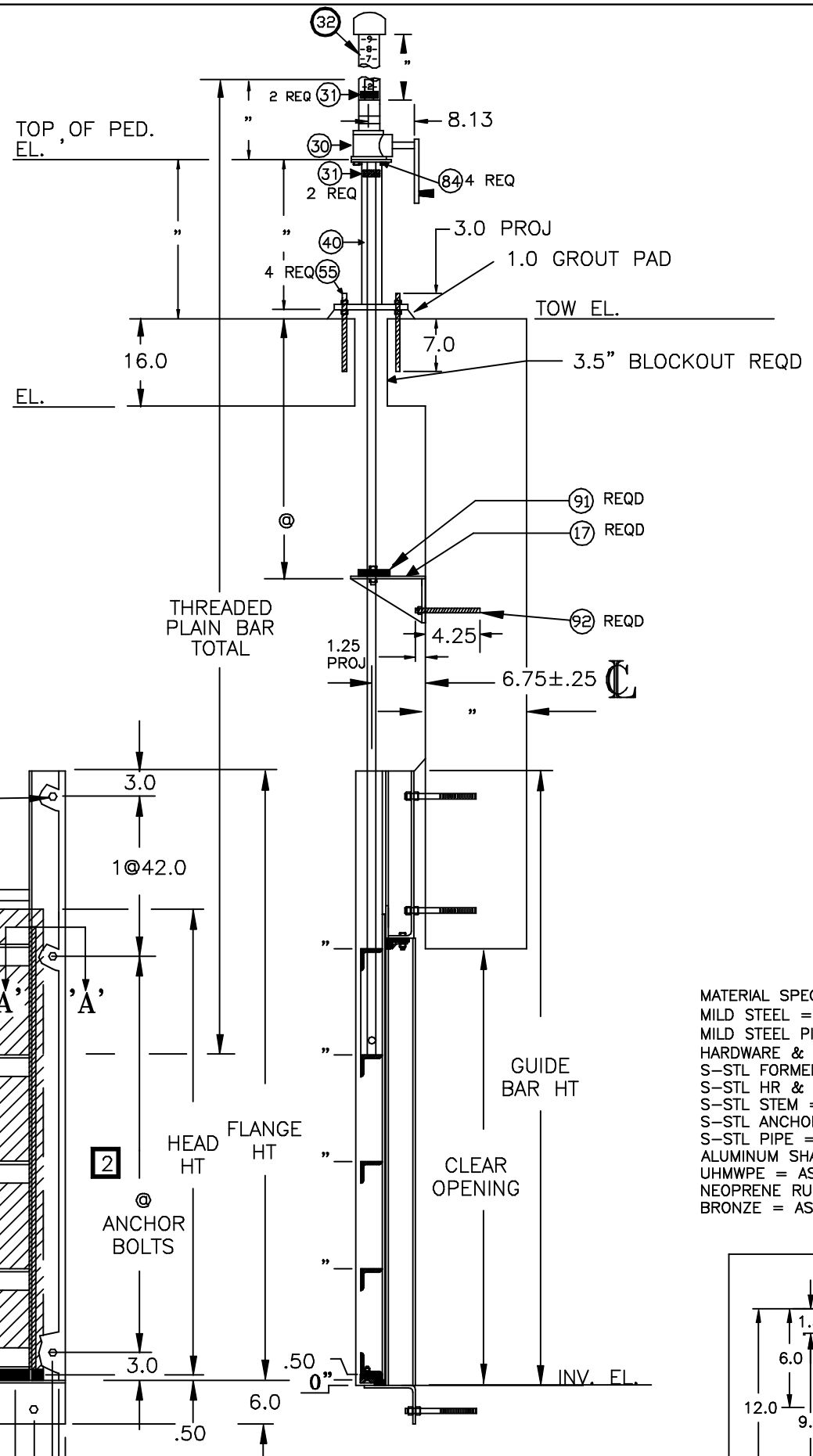
Lead time of 12-18 weeks after submittal approval. Expedited delivery available for a surcharge. (Please specify date needed.)

Thomas Harris
Golden Harvest, Inc.
11944 Westar Lane
Burlington, WA 98233

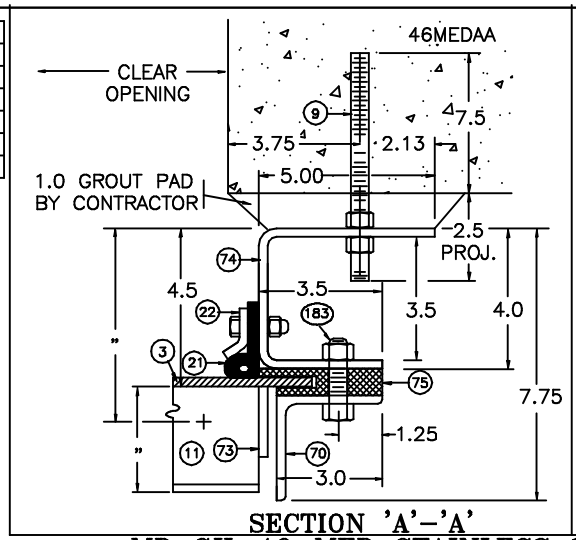
Phone: (360) 757-4334
Fax: (360) 757-1135
Email: thomash@goldenharvestinc.com
Web: www.goldenharvestinc.com



SECTION 'C'–'C'



GOLDEN HARVEST	
ORIGINAL	DW
CHECKED	
CHECKED	
TRANS RET	
SUB CUT SHT	
PKG FINAL RELEASE	



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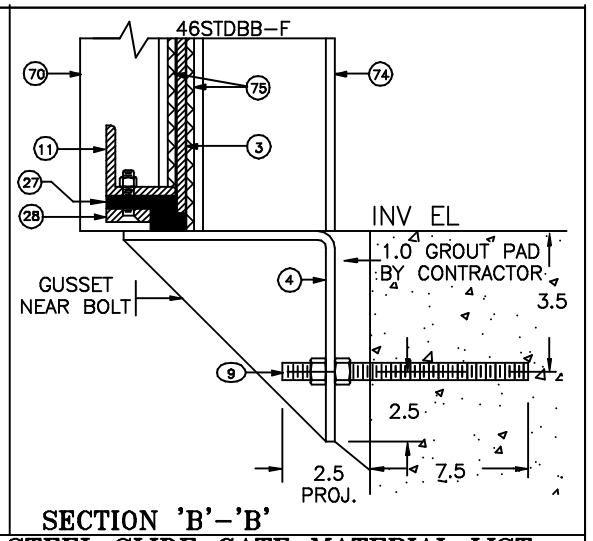


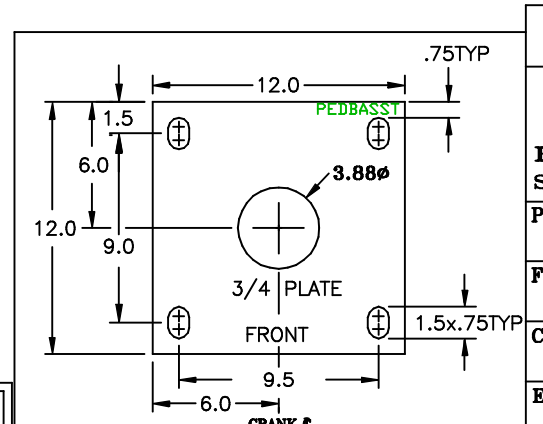
SECTION 'B'–'B'

MD GH–46–MED STAINLESS STEEL SLIDE GATE MATERIAL LIST

1	STEM	DIAMETER, S–STL, 4 TPI, W/L HAND SINGLE ACME ROLLED THREADS, 16 MICRO IN. RMS OR LESS FINISH
3	GATE HEAD	1/4" S–STL PLATE
4	INVERT MEMBER	6" X 6" X 1/4" FORMED S–STL ANGLE
*9	ANCHOR BLT	5/8" X 10.0" S–STL ANCHOR ROD, W/2 NUTS
11	STIFFENER	4.0" X 3.0" 1/4" FORMED S–STL ANGLE
17	STEM GUIDE 1–8 HVY	SS, W/UHMW STEM GUIDE BUSHING
21	P–BULB SEAL	NEOPRENE RUBBER
22	P–SEAL RETAINER	3/16" X 2" S–STL FLAT BAR WITH SLOTED HOLES
27	INVERT SEAL	NEOPRENE RUBBER PART# 7509
28	INV. SEAL RETNR.	3/8" X 1 1/4" S–STL FLAT BAR
30	OPERATOR	MG–A03, 2:1 GEAR RED, 15" HANDCRANK, CAST STL HSG, BEVEL GEARS MECH SEALS, ROLLER BRNG SUPT, BRONZE LIFT NUT, GREASE ZERK, OPEN DIRECTION ARROW
31	STOP NUTS	BRONZE
32	STEM COVER	CLEAR BUTYRATE PLASTIC WITH MYLAR STRIP INDICATOR CALIBRATED IN 1/10" & 1" INCREMENTS WITH PVC END CAP
40	STR PED	MILD STEEL
*55	PED. ANCHOR BLT	5/8" X 10" S–STL ANCHOR ROD, W/2 NUTS & 2 F/W
70	GUIDE RAIL	3" X 3" X 1/4" S–STL ANGLE
72	STEM COULPER	S–STL W/HARDWARE
73	VERT. STIFF.	1/4" X 4.0" S–STL FLAT BAR
74	SPIGOT RAIL	5.0" X 4.0" X 3.5" X 1/4" FORMED S–STL CHANNEL
75	GUIDE BEARING BAR	UHMW PE (UHMW–01)
76	TOP SPIGOT	4.13" X 4.0" X 1/4" FORMED S–STL ANGLE
84	OP. MTD BLT	5/8" X 2.0" S–STL HEX HEAD BOLT, L/W & F/W
91	SG MOUNTING BLT	3/8" X 1 3/4" S–STL HEX BOLT, NUT, L/W,
*92	SG ANCHOR BLT	1/2" X 5 1/2" S–STL ANCHOR ROD, W/NUT & F/W
*102	ANCHOR BLT	1/2" X 8.0" S–STL ANCHOR ROD, W/2 NUTS
183	CLAMP BLT	1/2" X 2" S–STL HEX BOLT, W/NUT & L/W
190	CENT. STIFF.	1/4" X 3.0" S–STL FLAT BAR
195	STEM POCKET	3/8" X 3.0" S–STL FLAT BAR

* ANCHOR BOLTS ARE DESIGNED FOR USE WITH HILTI HY 150 ADHESIVE INJECTION SYSTEM OR EQUAL (ADHESIVE BY CONTRACTOR)

MATERIAL SPECIFICATIONS:
MILD STEEL = ASTM–A36 W/8.0 MILS EPOXY COATING
MILD STEEL PIPE = A–120 W/8.0 MILS EPOXY COATING
HARDWARE & FASTENERS = TYPE 316 SS ASTM–F593 / F594
S–STL FORMED & PLATE = 316L SS ASTM–A240
S–STL HR & FLAT BAR SHAPES = TYPE 316L SS ASTM–A276
S–STL STEM = TYPE 316 SS ASTM–A276
S–STL ANCHOR ROD = TYPE 316 SS ASTM–A276
S–STL PIPE = TYPE 316 ASTM A–312
ALUMINUM SHAPES = 6061–T6
UHMWPE = ASTM–D4020
NEOPRENE RUBBER = ASTM–D2000
BRONZE = ASTM–B584

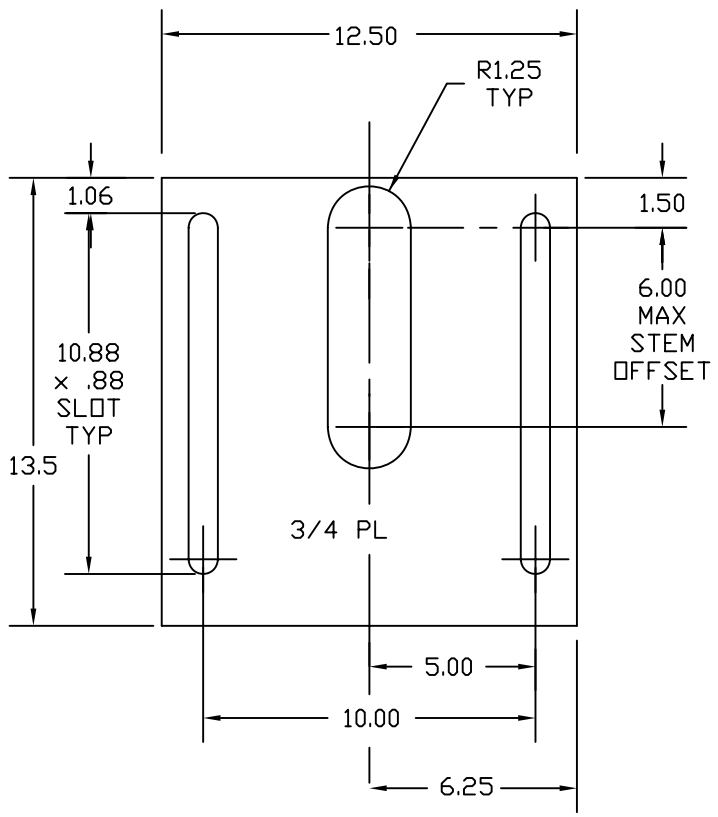


STRAIGHT PED. BASE ANCHOR BOLT LAYOUT

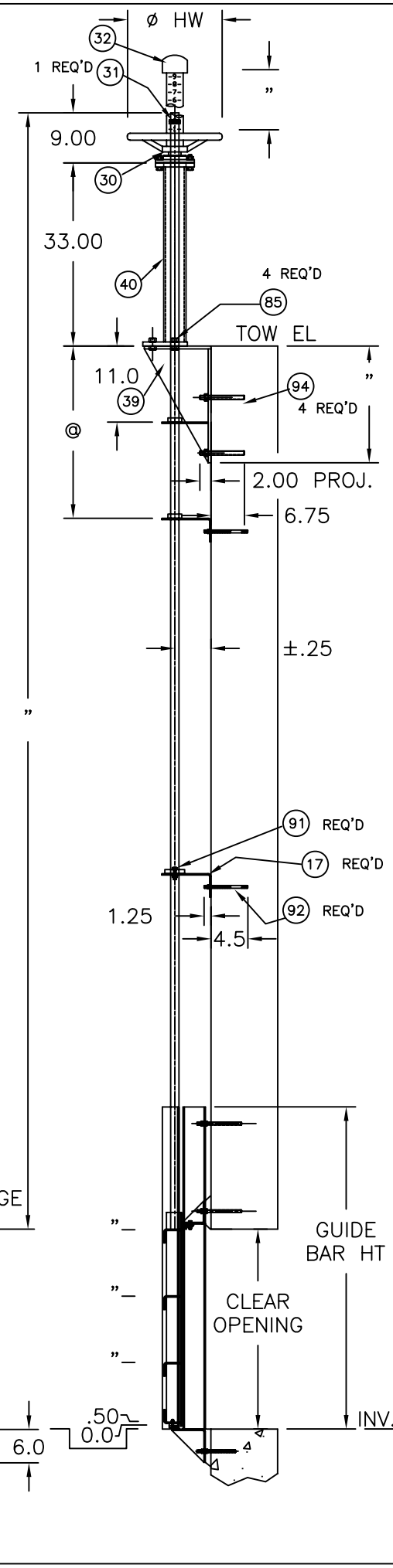
Max Seating Head = 20.0 Ft. – Max Unseating Head = 5.0 Ft.
Max Operating Head = 15.0 Ft. Measured From Gate Invert

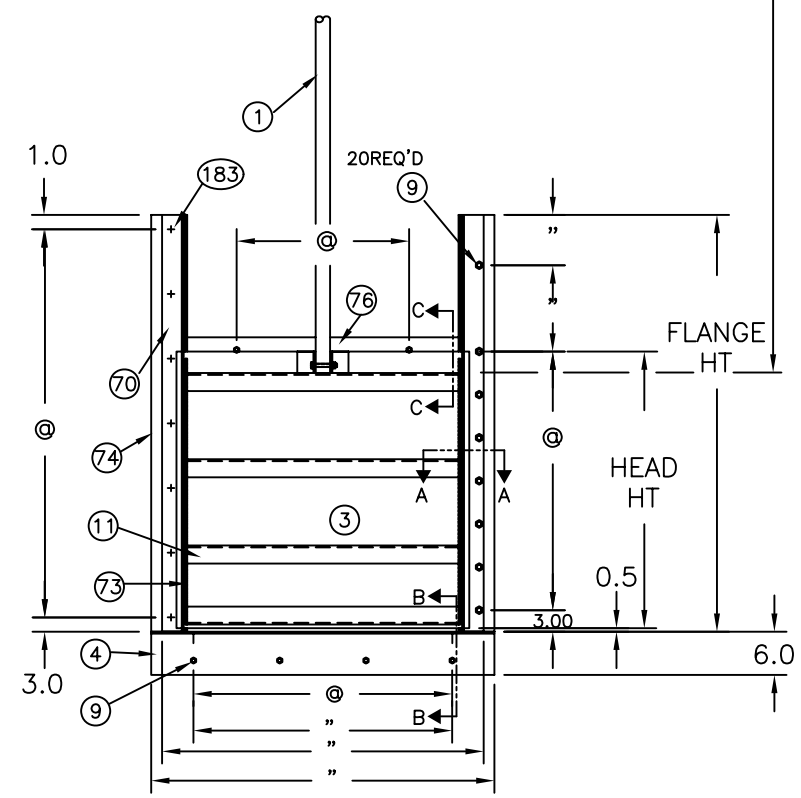
" x " MD GH–46–MED FLANGE MTD S–STL SLIDE GATE	GOLDEN HARVEST GOLDEN GATES 1–800–338–6238 P.O. BOX 287 Burlington, WA 98233	– REQ.
Project Description:		Date Drawn:
For:		Revision:
Contractor:		Revision:
Engineer:		Revision:
		G.H. Drawing #:

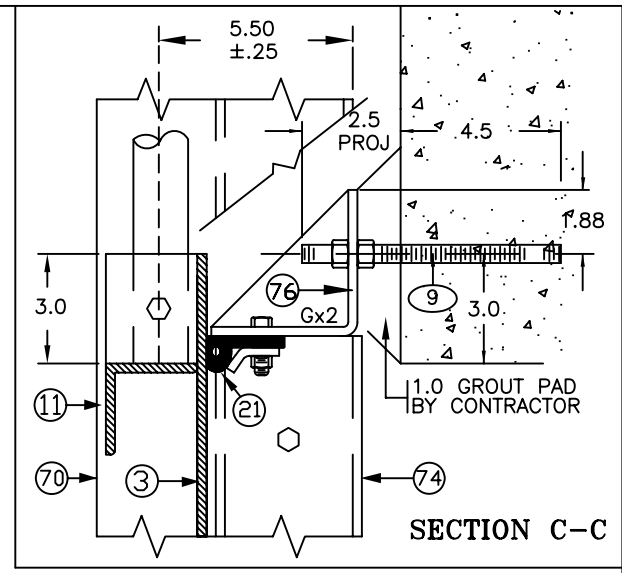
Drawn By:			Scale:	Job No.:	Contract Sht #:
DW	X X	FL = # X	NTS		



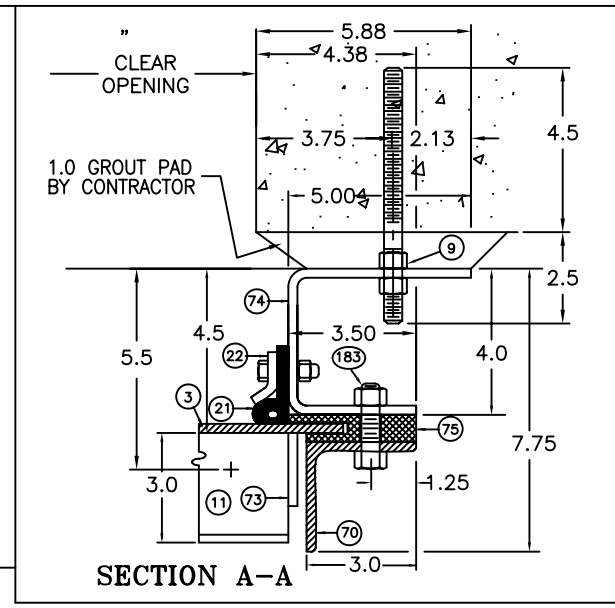
B4-14 WB TO PEDESTAL MOUNTING LAYOUT



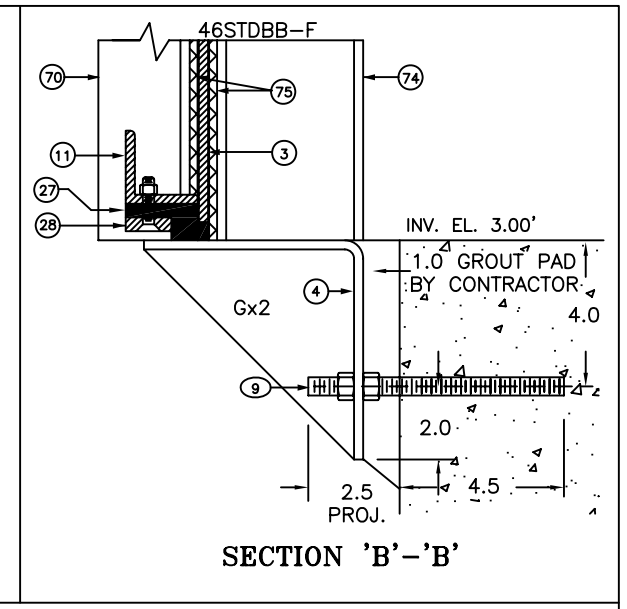




SECTION C-C



SECTION A-A



SECTION 'B'-'B'

MD GH-46 STAINLESS STEEL SLIDE GATE MATERIAL LIST

1	STEM	1.25 DIA S-STL, 4TPI W/LH DOUBLE ACME ROLLED THREADS 16 MICRO IN. RMS OR LESS FINISH
3	GATE HEAD	1/4" S-STL PLATE
4	INV. MEMBER	6.0x6.0x1/4" FORMED SSTL ANGLE
*9	ANCHOR BLT	1/2x7.0 SSTL ANCHOR ROD, W/2 NUTS
11	STIFFENER	3.0x3.0x1/4 FORMED SS ANGLE
17	STEM GUIDE TYPE 1-8	SS W/UHMW STEM GUIDE BUSHING
21	P-BULB SEAL	NEOPRENE RUBBER
22	RETAINER	3/16x2.0 SSTL FLAT BAR, W/SLOTTED HOLES
27	INVERT SEAL	NEOPRENE RUBBER, PART# 7509
28	INV. SEAL RTNR	3/8" X 1 1/4" S-STL FLAT BAR
30	OPERATOR	MD-MG-AN GEARED ANODIZED ALUM CAST SPHEROIDAL GRAPHITE IRON HOUSING, BVL GEARS, SEALED BEARING SUPPORTED BRONZE WORM, ACME NUT, GREASE ZERK, CAST IRON POSITION INDICATOR, MANUAL HANDWHEEL, CRANK
31	STOP NUT	BRONZE
32	STEM COVER	CLEAR BUTYRATE PLASTIC WITH MYLAR STRIP INDICATOR CALIBRATED IN 1/10" INCREMENTS WITH PVC END CAP
39	WALL BRACKET B4-14	STEEL
40	WB PEDESTAL	MILD STEEL
70	GUIDE RAIL	3.0x3.0x1/4 HR SSTL ANGLE
73	VERT. STIFF.	1/4x2.5 SSTL FLAT BAR
74	VERT. SPIGOT RAIL	5.0x4.0x3.5x1/4 FORMED SSTL CHANNEL
75	GUIDE BEARING BAR	UHMW POLYETHYLENE EXT# UHMW-01
76	HORIZONTAL SPIGOT	4.13x4.0x1/4 FORMED SSTL ANGLE
85	PED. MOUNTING BOLT	5/8x2.5 SS HEX HEAD BOLT W/NUT, FW AND LW
91	SG MOUNTING BOLT	3/8x1.75 SS HEX HEAD BLOT W/NUT, LW, (2)3/8" FW & (1)1/2" FW
*92	SG ANCHOR BOLT	1/2x5.5 SS ANCHOR ROD W/NUT & FW
*94	WB ANCHOR BOLT	3/4x8.75 SS ANCHOR ROD W/NUT & FW
183	CLAMP BLT	1/2x2.0 SSTL HEX BOLT, W/NUT & F/W

* ANCHOR BOLTS ARE DESIGNED FOR USE WITH EPCON A-7 ADHESIVE INJECTION SYSTEM OR EQUAL (ADHESIVE BY CONTRACTOR)

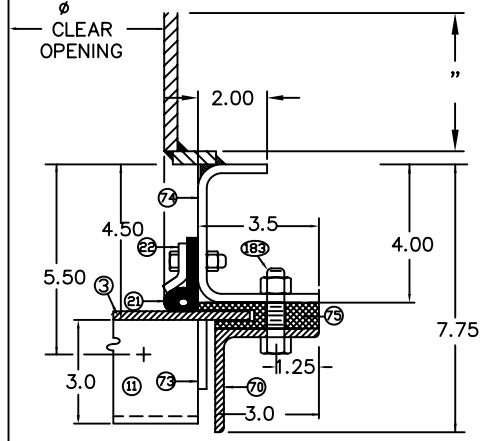
MATERIAL SPECIFICATIONS:
HARDWARE & FASTENERS = TYPE 316 SS ASTM-F593 / F594
S-STL FORMED & PLATE = 316L SS ASTM-A240
S-STL HR & FLAT BAR SHAPES = TYPE 316L SS ASTM-A276
S-STL STEM = TYPE 316 SS ASTM-A276
S-STL ANCHOR ROD = TYPE 316 SS ASTM-A276
UHMWPE = ASTM-D1248
NEOPRENE RUBBER = ASTM-D2000
BRONZE = ASTM-B584

GOLDEN HARVEST	
ORIGINAL	RLD
CHECKED	MM
CHECKED	KB

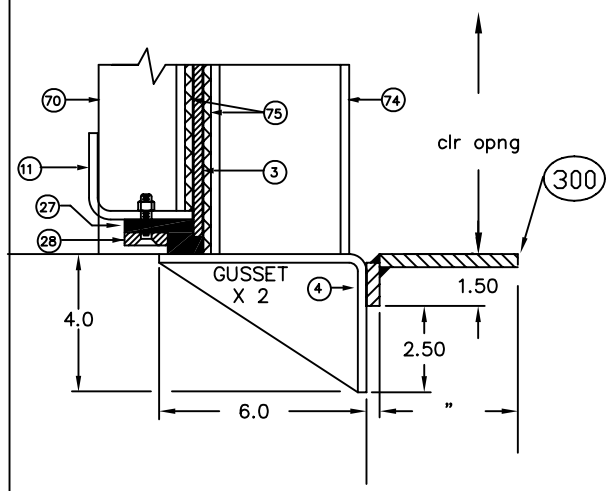
Max Seating Head = Ft. **Max Unseating Head = Ft.**
Max Operating Head = Ft. **Measured From GATE INVERT**

X MD GH-46 WALL MNT SS SLIDE GATE	GOLDEN HARVEST GOLDEN GATES 1-800-338-6238 P.O. BOX 287 Burlington, WA 98233	– REQ'D

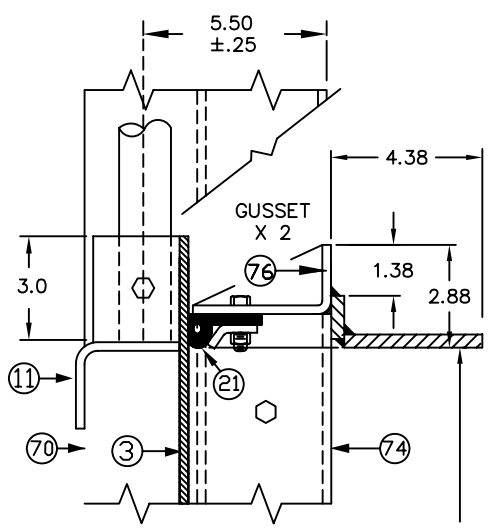
Project Description:				**Date Drawn:**	
For:				**Revision:**	
Contractor:				**Revision:**	
Engineer:				**Revision:**	
				G.H. Drawing #:	
Drawn By:		**FL = 59#** **PO = 1.7**	**Scale:** NTS	**Job No.:**	**Contract Sht #:**



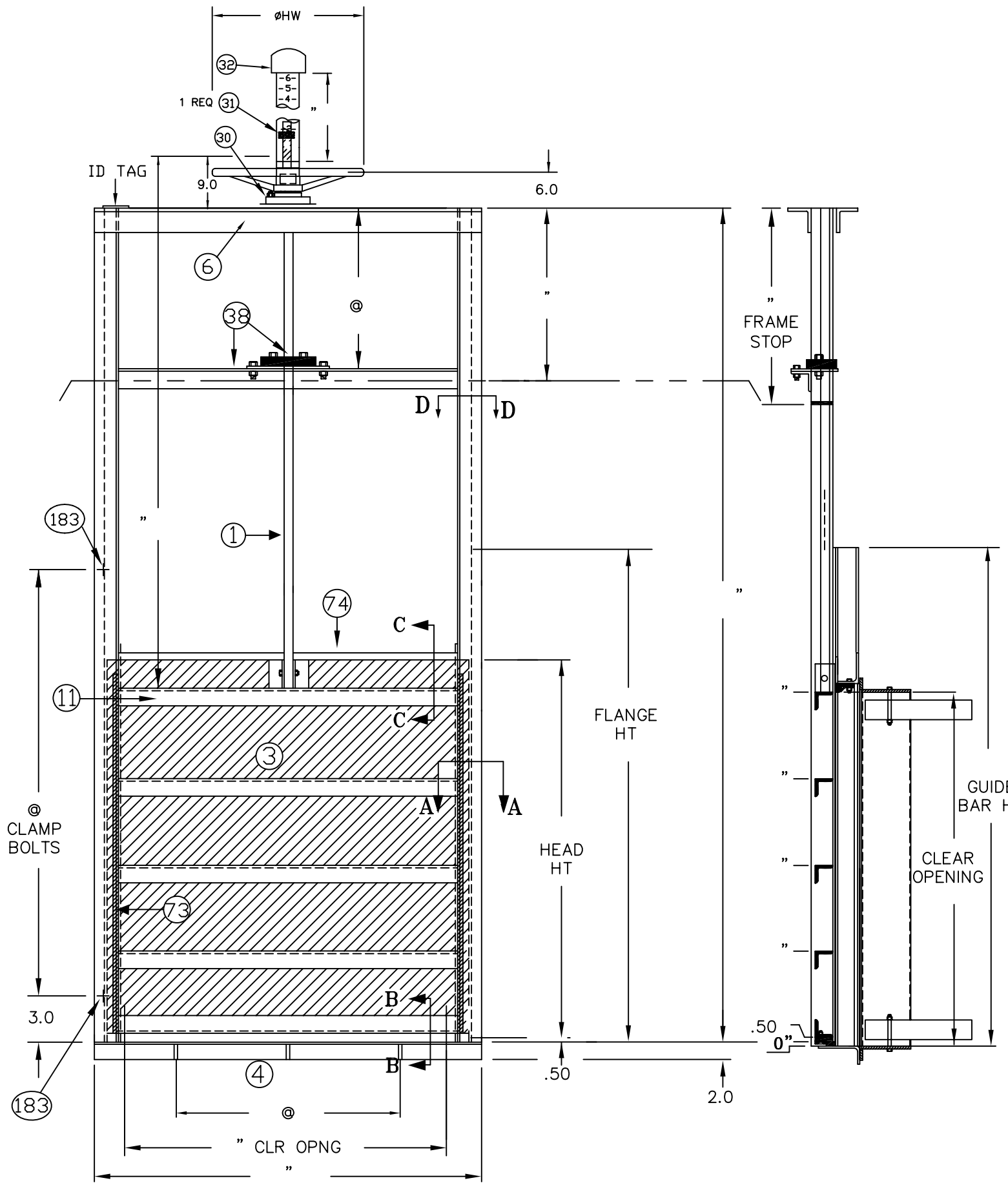
SECTION A–A



SECTION B–B



SECTION C–C



MD GH–46 STAINLESS STEEL SLIDE GATE MATERIAL LIST

1	STEM	DIA SSTL, TPI/LH ROLLED ACME THD, 16 MICRO IN. RMS OR LESS FINISH
3	GATE HEAD	SSTL PLATE
4	INV. MEMBER	FORMED SSTL ANGLE
6	YOKE	FORMED SSTL ANGLE
11	STIFFENER	FORMED SSTL ANGLE
21	P–BULB SEAL	NEOPRENE RUBBER GHI# 7274
22	RETAINER	SSTL FLAT BAR, W/SLOTTED HOLES
27	INVERT SEAL	NEOPRENE RUBBER, PART# 7509
28	INV. SEAL RTNR	SSTL FLAT BAR
30	OPERATOR	GH–1, NON GEARED, ANODIZED ALUM HSG.,MECH SEALS, ROLLER BRNG SUPPORTED BRONZE LIFT NUT, GREASE ZERK, OPEN DIRECTION ARROW, 24"HANDWHEEL
31	STOP NUT	BRONZE
32	STEM COVER	CLEAR BUTYRATE PLASTIC WITH MYLAR STRIP INDICATOR CALIBRATED IN 1/10" INCREMENTS WITH PVC END CAP
38	STEM GUIDE	SSTL HR ANGLE, W/UHMW STEM GUIDE BUSHING
70	GUIDE RAIL	HR SSTL ANGLE
73	VERT. STIFF.	SSTL FLAT BAR
74	VERT. SPIGOT RAIL	FORMED SSTL CHANNEL
75	GUIDE BEARING BAR	UHMW POLYETHYLENE EXT# UHMW–01
76	HORIZONTAL SPIGOT	FORMED SSTL ANGLE
183	CLAMP BLT	SSTL HEX BOLT, W/NUT & F/W
300	125# ADAPTER	SSTL GHI DWG# 4
305	ANCHOR TAB	FORMED SSTL ANGLE GHI DWG# 01Shop

MATERIAL SPECIFICATIONS:
HARDWARE & FASTENERS = TYPE 304/316 SS ASTM–F593 / F594
SSTL FORMED & PLATE = 304/304L/316L ASTM–A240
SSTL HR & FLAT BAR SHAPES = TYPE 304/304L/316 SS ASTM–A276
SSTL STEM = TYPE 304/316 SS ASTM–A276
SSTL ANCHOR ROD = TYPE 304/316 ASTM–A276
UHMWPE = ASTM–D1248
NEOPRENE RUBBER = ASTM–D2000
BRONZE = ASTM–B584

GOLDEN HARVEST	
ORIGINAL	PH
CHECKED	KB
CHECKED	DW

Max Seating Head = Ft. – Max Unseating Head = Ft.
Max Operating Head = 9.0 Ft. Measured From Gate Invert

X MD GH–46 SPIGOT MTD OVER PIPE SSTL SLIDE GATE	GOLDEN HARVEST GOLDEN GATES 1–800–338–6238 P.O. BOX 287 Burlington, WA 98233	– – – REQ.
Project Description:		Date Drawn:
For:		Revision:
Contractor:		Revision:
Engineer:		Revision: G.H. Drawing #: #

Drawn By:		FL =	Scale:	Job No.:	Contract Sht #:
DW		X	NTS	pq04–0525	

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Thursday, October 24, 2019

To:	Hubbell Roth & Clark Dennis Benoit 801 Broadway NW Suite 215 Grand Rapids, MI 49504 United States	RFQ #:	Verbal
		Quote #:	0719880534HB Please refer to this number when ordering
Phone:	616-454-4286	Quoted by:	Heather Walker
Fax:	616-454-4278		Heather.walker@hesco-mi.com
E-mail:	dbenoit@hrc-engr.com		

PRICE QUOTE
HRC 24" Knife Gate

Item	Description	Qty	Unit Price	Subtotal
1.00	**OPTION #1 STAINLESS STEEL BODY** 24" ITT C37R Bonnetless Knife gate with handwheel 304 Body & gate, integral seat	1	$12,450.00	$12,450.00
2.00	**OPTION #2 DUCTILE IRON BODY** 24” ITT C45D Cast Bonnetless Knife Gate with handwheel Ductile iron body, 304SS Gate, integral seat	1	$8,777.00	$8,777.00

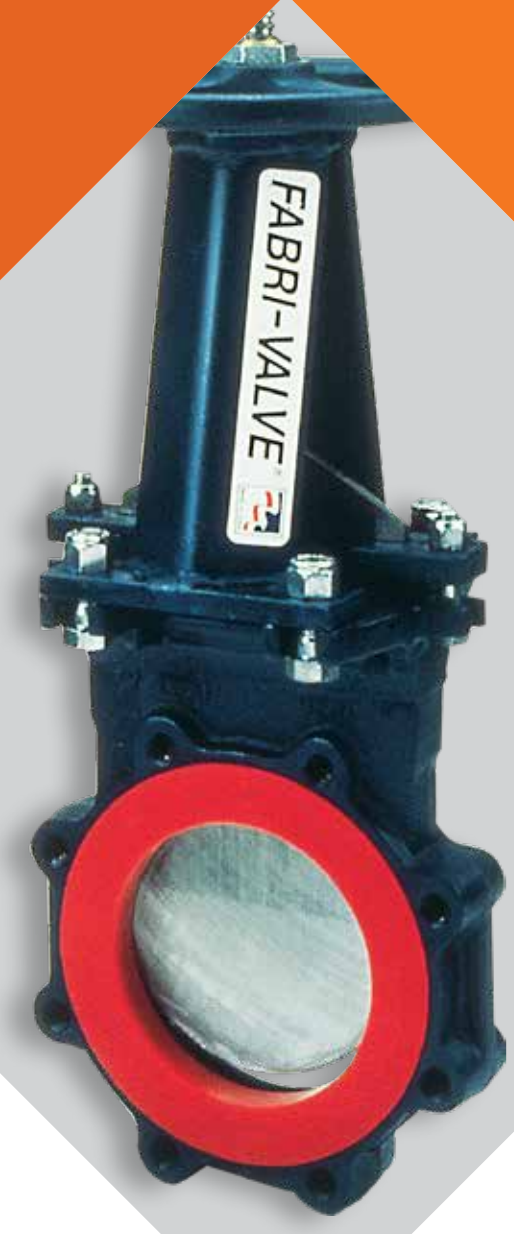
Subtotal	$21,227.00
Taxable Subtotal	$0.00
Sales Tax [0.0000%]	$0.00
Misc. Charge	$0.00
Shipping & Handling Best Way	$0.00
Grand Total	**$21,227.00**

Terms & Conditions			
Proposed Shipping Date	TBD at time of order	**Payment Terms**	Net 30
Shipping Method	Best Way	**Shipping Terms**	Prepaid and Added to Invoice
F.O.B.	Factory	This Quotation is valid until 11/23/2019.	

Thank you for your inquiry!

Engineered Valves

Fabri-Valve C45 Ductile Iron Knife Gate Valve



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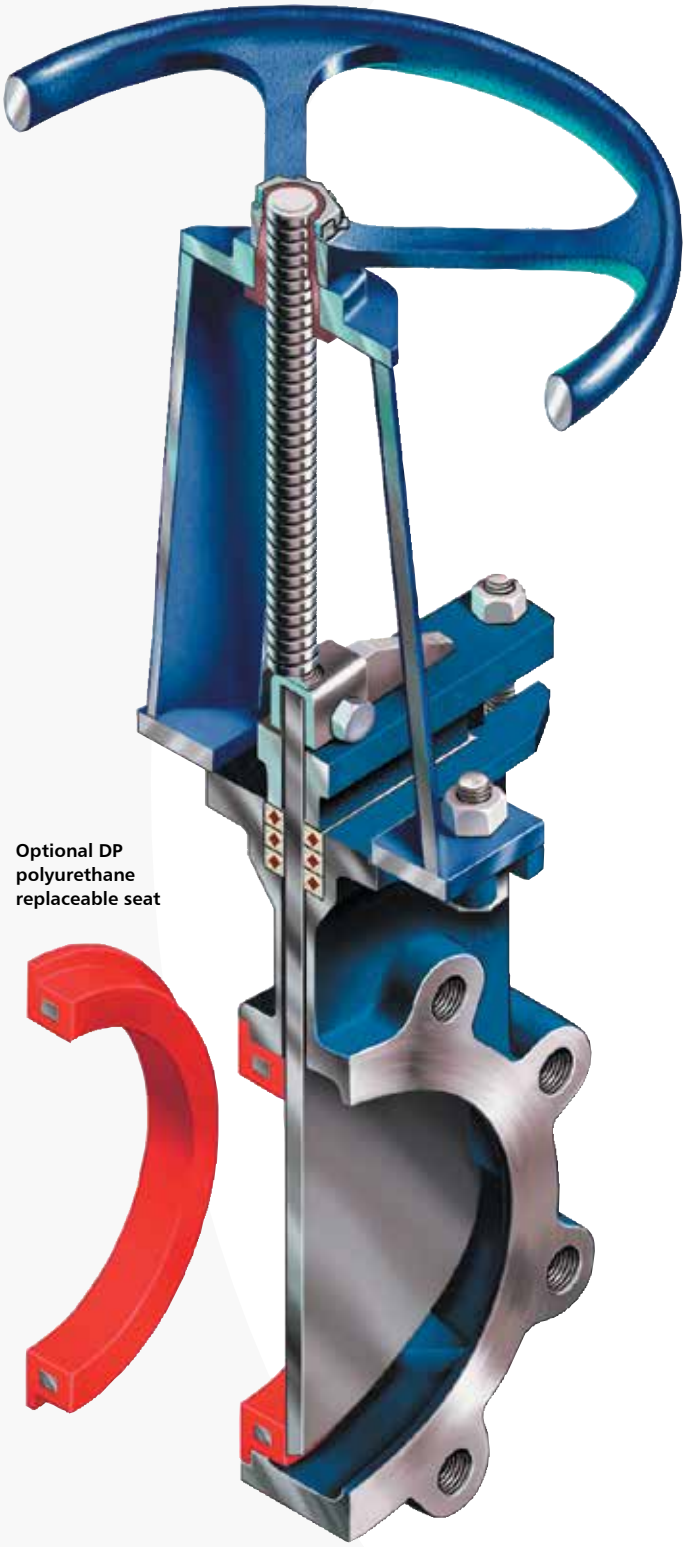
ENGINEERED FOR LIFE

C45 Ductile Iron Knife Gate Valve



Optional DP polyurethane replaceable seat

Replaceable seat is held in place by the adjacent mating flange.

Shown with energized cored packing.

Standard with 6"(DN 150) and larger Figure C45 valves.

The basic Fabri-Valve C45 features a solid ductile iron or carbon steel body with an integral cast metal seat. However, this valve is most often used with the patented, pop-in style replaceable seats, which are available in a variety of rubbers, polyurethane, UHMW-P, TFE, and hard-faced metal. The pop-in seats feature a much larger cross section and seating area than conventional knife gate valve seats thus providing a seating surface far removed from the flow stream. Replaceable seats offer a unique advantage; abrasion resistance, long seat life, and the convenience of easy seat replacement.

All C45 knife gate valves with handwheels include a provision for a locking device.
Caution: (Replaceable soft seats)
Review Fabri-Valve gasket/mating flange recommendations.

Specifications

Size Range
2" – 24"
Pressure Rating
150 psi (10.3 bar) CWP (cold working pressure)
Temperature Rating
Maximum temperature 250°F (121°C).
See Materials of Construction (seat section).
Service temperatures above 400°F (204°C) require high temperature fasteners. Specify service imperature on paperwork.
Flange Drilling
Flat faced ANSI 125/150

Testing

Every Fabri-Valve C45 valve is fully tested prior to shipment. Testing includes a body shell test, a seat test, and a cycling test to insure proper functioning of moving parts. Additional testing is also available. Please let us know your requirements.

Standard Shell test:

- Hydro test at 1.5 times the rated CWP (cold working pressure) – Zero allowable leakage

Standard Seat test:

- Metal Seat: Hydro test at 40 psi (2.8 bar) and at the rated CWP
- Resilient Seat: Hydro test at 15 psi (1 bar) and rated CWP

Pressure/Temperature Ratings

The table below is the Maximum Pressure /Temperature Ratings for the metallic components only. When checking pressure/ temperature ratings, check the temperature rating and chemical compatibility of the packing material and, if applicable, the resilient seat material. In a majority of knife gate valve designs, the temperature limit or the chemical compatibility of the seat and/or packing material determines the practical pressure/ temperature limitations.

Figure C45
Pressure/Temperature Rating - psi

Temp °F	Temp °C	Cast Steel WCB A-216	Cast DI A536 GR 65-45-12
150	66	150	150
200	93	150	150
250	121	150	147
300	149	150	143
350	177	150	139
400	204	150	135
450	232	150	131
500	260	150	127
600	316	150	119
700	371	142	
800	427	103	
900	482	57	
1000	538	21	

Low Pressure Operation

Metal seated knife gate valves are seat tested at 40 psid (2.8 bar) in the preferred flow direction. When pressure falls below the 40 psid (2.8 bar) test pressure, less force is pushing the gate into the seat, which may result in additional seat leakage. When improved low-pressure shutoff performance is required, optional chest buttons should be specified.

Available Options

- "D" Ring Seat
- Lever Operator
- Dual Seats
- Poly Replaceable Seats
- UHMW Replaceable Seats
- PTFE Replaceable Seats
- Rubber Replaceable Seats
- Hard Faced Gate Edge
- Hard Gate Material
- Nickel-TFE Coated Gate
- Epoxy Coating
- Thru Drilled Flanges
- Flush Ports
- Chest Buttons: Not available 2" – 6"
- Cast Ni-Hard Deflection Cones: Available sizes 3" – 16"
- Fabricated Deflection Cones
- Locking Devices
- E-Z Spin Handwheel
- Live Loaded Packing
- Self-Supporting Yokes
- Bevel Gear
- Chainwheels
- Cylinder Actuators
- Electric Actuators
- Ratchet
- Extended Stems
- Rod Boots

Shutoff Performance

Metal Seat

- Single integral metal seat
  2" – 24" 40cc / minute / inch of valve size
- Single hardfaced replaceable metal seat
  2" – 24" 80cc / minute / inch of valve size
- Dual hardfaced replaceable metal seats
  Consult factory. All sizes.

Resilient Seat

- Single "D"ring, or single replaceable resilient seat (excluding PTFE)
  Zero leakage. All sizes.
- Dual seats
  Consult factory. All sizes.
- Single replaceable PTFE seat
  Consult factory. All sizes.

Flow Coefficients

The Cv values below represent U.S. gallons per minute 60°F water through a 100% open valve at a pressure drop of 1 psi. The metric equivalent, Kv, is the flow of water at 16°C through the valve in cubic meters per hour at a pressure drop of 1 kg/cm^2. To convert Cv to Kv, multiply the Cv by 0.8569.

Figure C45 Knife Gate Valves
C_V Ratings, Port Diameter and Area

Valve Size In.	Valve Size DN	Standard Port C_v	Standard Port Port I.D. Inches	Standard Port Port Area Sq. In.	With Replaceable Poly or Replaceable Rubber seat C_v	With Replaceable Poly or Replaceable Rubber seat Port I.D. Inches	With Replaceable Poly or Replaceable Rubber seat Port Area Sq. In.
2	50	288	2.00	3.1	288	2.00	3.1
3	75	648	3.00	7.1	648	3.00	7.1
4	100	1,152	4.00	12.6	1,152	4.00	12.6
6	150	2,592	6.00	28.3	2,592	6.00	28.3
8	200	4,608	8.00	50.3	4,608	8.00	50.3
10	250	7,208	10.00	78.5	7,208	10.00	78.5
12	300	10,400	12.00	113.1	10,400	12.00	113.1
14	350	12,650	13.25	137.9	10,080	12.00	113.1
16	400	16,750	15.25	182.6	14,200	14.25	159.5
18	450	21,450	17.25	233.7	18,500	16.25	207.4
20	500	26,700	19.25	291.0	22,700	18.00	254.5
24	600	38,900	23.25	424.6	33,900	22.00	380.1

Dimensions: C45 with Handwheel or Cylinder

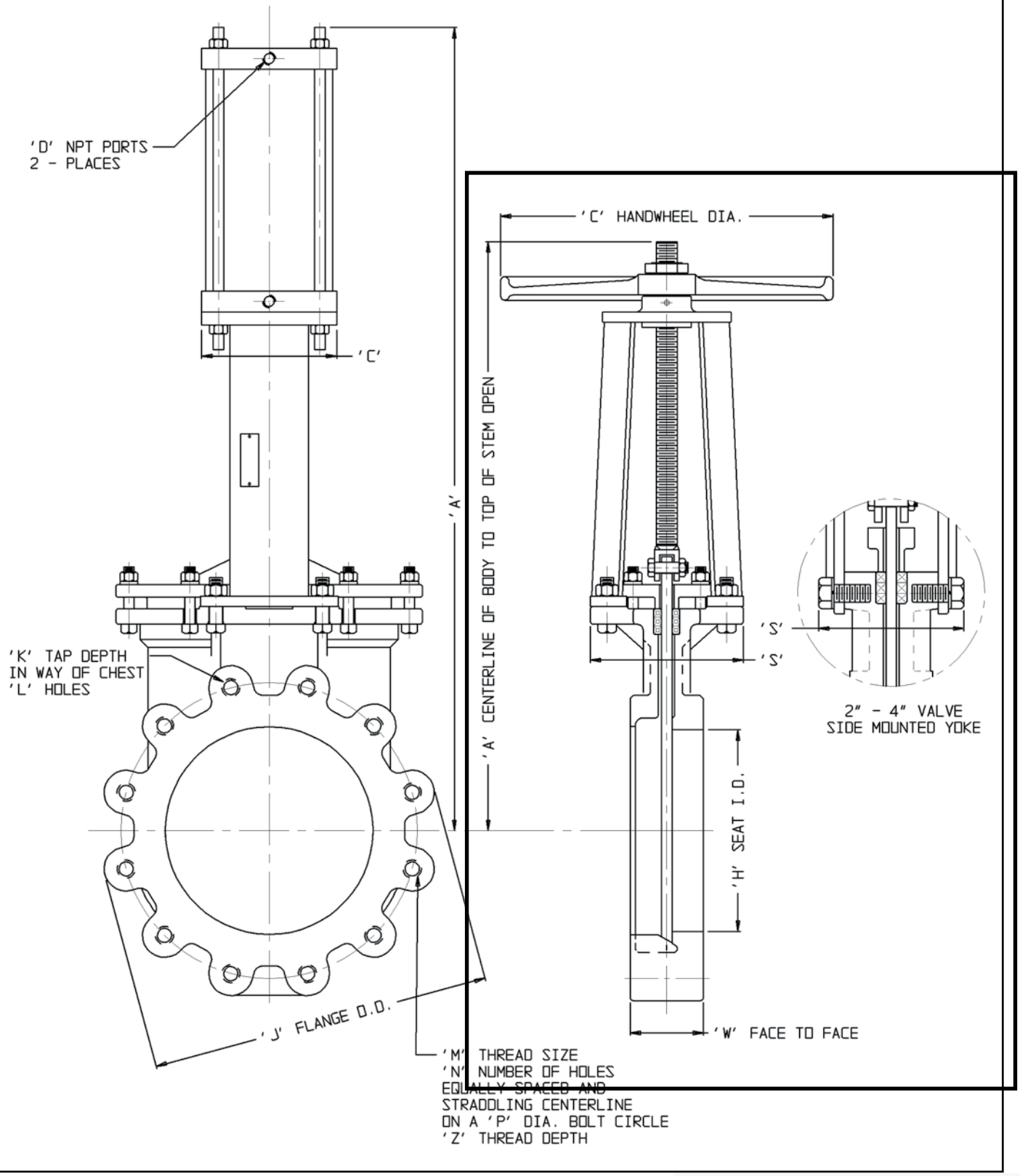
Valve Size		TABLE 1			DIMENSION Inches (mm) C45 with HANDWHEEL OR CYLINDER															
Inches	DN	A			C			D		H	J	K	L	M	N	P	S	W	Z	lb	kg
2	50	HW	2-1/2 CYL	3-1/4 CYL	HW	2-1/2 CYL	3-1/4 CYL	2-1/2 CYL	3-1/4 CYL												
		13-11/16 (348)	18-3/8 (467)	16-7/8 (429)	8 (203)	3 (76)	4 (102)	3/8-18	1/4-18	2 (51)	6 (152)	1/2 (12)	2	5/8-11NC	4	4-3/4 (121)	4 (102)	1-7/8 (48)	9/16 (14)	21	10
3	80	HW	2-1/2 CYL	3-1/4 CYL	HW	2-1/2 CYL	3-1/4 CYL	2-1/2 CYL	3-1/4 CYL												
		16-7/16 (418)	20-7/8 (530)	19-3/8 (492)	8 (203)	3 (76)	4 (102)	3/8-18	1/4-18	3 (76)	7-1/2 (191)	1/2 (12)	2	5/8-11NC	4	6 (152)	4 (102)	2 (51)	5/8 (16)	26	12
4	100	HW	3-1/4 CYL	4 CYL	HW	3-1/4 CYL	4 CYL	3-1/4 CYL	4 CYL												
		19-3/16 (487)	22-1/8 (562)	22-7/8 (581)	8 (203)	4 (76)	4-1/2 (114)	1/4-18	3/8-18	4 (102)	9 (229)	1/2 (12)	2	5/8-11NC	8	7-1/2 (191)	4 (102)	2 (51)	5/8 (16)	31	14
6	150	HW	4 CYL	6 CYL	HW	4 CYL	6 CYL	4 CYL	6 CYL												
		25-5/16 (643)	28-7/8 (733)	29-1/4 (743)	10 (254)	4-1/2 (114)	6-1/2 (165)	3/8-18	3/8-18	6 (152)	11 (279)	9/16 (14)	2	3/4-10NC	8	9-1/2 (241)	7-3/8 (187)	2-1/4 (57)	3/4 (19)	52	24
8	200	HW	6 CYL	8 CYL	HW	6 CYL	8 CYL	6 CYL	8 CYL												
		32-5/8 (829)	35-13/16 (910)	36-5/16 (922)	12 (305)	6-1/2 (165)	8-5/8 (219)	3/8-18	3/8-18	8 (203)	13-1/2 (343)	5/8 (16)	2	3/4-10NC	8	11-3/4 (298)	7-3/8 (187)	2-3/4 (70)	1 (25)	105	48
10	250	HW	8 CYL	10 CYL	HW	8 CYL	10 CYL	8 CYL	10 CYL												
		37-3/4 (959)	41-7/16 (1053)	42-3/16 (1072)	16 (406)	8-5/8 (219)	10-7/8 (276)	3/8-18	1/2-14	10 (254)	16 (406)	5/8 (16)	4	7/8-9NC	12	14-1/4 (362)	7-3/8 187)	2-3/4 (70)	1 (25)	145	66
12	300	HW	8 CYL	10 CYL	HW	8 CYL	10 CYL	8 CYL	10 CYL												
		44-9/16 (1132)	48 (1219)	48-3/4 (1238)	16 (406)	8-5/8 (219)	10-7/8 (276)	3/8-18	1/2-14	12 (305)	19 (483)	5/8 (16)	4	7/8-9NC	12	17 (432)	7-1/2 (191)	3 (76)	1 (25)	205	93
14	350	HW	12 CYL	14 CYL	HW	12 CYL	14 CYL	12 CYL	14 CYL												
		49-1/4 (1251)	54-1/16 (1373)	55-3/16 (1402)	20 (508)	12-3/4 (324)	14-3/4 (375)	1/2-14	3/4-14	13-1/4 (337)	21 (533)	21/32 (17)	4	1-8NC	12	18-3/4 (476)	7-3/4 (197)	3 (76)	1 (25)	235	107
16	400	HW	12 CYL	14 CYL	HW	12 CYL	14 CYL	12 CYL	14 CYL												
		56-1/2 (1435)	61-1/16 (1551)	62-3/16 (1580)	20 (508)	12-3/4 (324)	14-3/4 (375)	1/2-14	3/4-14	15-1/4 (387)	23-1/2 (597)	25/32 (20)	6	1-8NC	16	21-1/4 (540)	11-1/4 (286)	3-1/2 (89)	1-1/4 (32)	390	145
18	450	HW	12 CYL	14 CYL	HW	12 CYL	14 CYL	12 CYL	14 CYL												
		63-5/16 (1608)	66-1/2 (1689)	67-5/8 (1718)	20 (508)	12-3/4 (324)	14-3/4 (375)	1/2-14	3/4-14	17-1/4 (438)	25 (635)	3/4 (19)	6	1-1/8-7NC	16	22-3/4 (578)	11-1/4 (286)	3-1/2 (89)	1-3/8 (35)	515	177
20	500	HW	14 CYL	16 CYL	HW	14 CYL	16 CYL	14 CYL	16 CYL												
		68-5/8 (1743)	72-15/16 (1853)	73-7/16 (1865)	20 (508)	14-3/4 (375)	17 (432)	3/4-14	3/4-14	19-1/4 (489)	27-1/2 (699)	1-1/8 (29)	8	1-1/8-7NC	20	25 (635)	14 (356)	4-1/2 (114)	1-1/2 (38)	690	234
24	600	HW	16 CYL	18 CYL	HW	16 CYL	18 CYL	16 CYL	18 CYL												
		79-13/16 (2027)	84-11/16 (2151)	86-5/8 (2200)	20 (508)	17 (432)	19 (483)	3/4-14	3/4-14	23-1/4 (591)	32 (813)	1-1/16 (27)	8	1-1/4-7NC	20	29-1/2 (749)	14-1/8 (359)	4-1/2 (114)	1-1/2 (38)	923	313

* Valve and Handwheel

Reference Dimensions in (paretheses)

C45 with Handwheel or Cylinder

Refer to table on page 4 for dimensions



Materials of Construction

Part	Materials
Body and Chest	Ductile iron
Flanges	Ductile iron
Seat Rating	Integral metal, D-ring, or replaceable With integral seat 500°F (260°C) With RW seat 140°F (60°C) With RP seat 180°F (82°C) With RH seat 550°F (288°C) standard, 650°F (343°C) with special packing. With RT seat 400°F (204°C)
Gate	304 stainless steel finished to 63 RMS
Yoke	Carbon steel
Yoke Bolting	Plated steel
Packing	Acrylic/PTFE/silicone [1]
Packing Follower	Ductile iron w/plated steel bolting
Stem	304 stainless steel
Stem Nut	Acid resistant bronze
Lubrication Fitting	Plated steel
Handwheel	Cast iron
Handwheel Retaining Nut	Malleable iron
Tab Washer	Stainless steel

[1] Energized cored packing is standard with 6" (DN150) and larger C45 valves

Dimensions: C45 with Bevel Gear

Valve Size		TABLE 2 DIMENSION Inches (mm) C45 with BEVEL GEAR														
Inches	DN	A	B	C	D	E	H	J	K	L	M	N	P	S	W	Z
6	150	25-5/16 (643)	19-11/16 (500)	12 (305)	12-3/8 (314)	6-1/2 (165)	6 (152)	11 (279)	9/16 (14)	2	3/4-10NC	8	9-1/2 (241)	7-3/8 (187)	2-1/4 (57)	3/4 (19)
8	200	32-15/16 (837)	24-5/8 (625)	12 (305)	12-3/8 (314)	6-1/2 (165)	8 (203)	13-1/2 (343)	5/8 (16)	2	3/4-10NC	8	11-3/4 (298)	7-3/8 (187)	2-3/4 (70)	1 (25)
10	250	38-1/16 (967)	27-5/16 (694)	12 (305)	12-3/8 (314)	6-1/2 (165)	10 (254)	16 (406)	5/8 (16)	4	7/8-9NC	12	14-1/4 (362)	7-3/8 (187)	2-3/4 (70)	1 (25)
12	300	44-9/16 (1132)	31-13/16 (808)	12 (305)	12-3/8 (314)	6-1/2 (165)	12 (305)	19 (483)	5/8 (16)	4	7/8-9NC	12	17 (432)	7-1/2 (191)	3 (76)	1 (25)
14	350	49-13/16 (1265)	34-3/4 (883)	12 (305)	12-3/8 (314)	6-1/2 (165)	13-1/4 (337)	21 (533)	21/32 (17)	4	1-8NC	12	18-3/4 (476)	7-3/4 (197)	3 (76)	1 (25)
16	400	56-9/16 (1437)	40-3/8 (1026)	12 (305)	12-1/16 (306)	6-1/2 (165)	15-1/4 (387)	23-1/2 (597)	25/32 (20)	6	1-8NC	16	21-1/4 (540)	11-1/4 (286)	3-1/2 (89)	1-1/4 (32)
18	450	63-5/16 (1608)	43-13/16 (1113)	12 (305)	12-1/16 (306)	6-1/2 (165)	17-1/4 (438)	25 (635)	3/4 (19)	6	1-1/8-7NC	16	22-3/4 (578)	11-1/4 (286)	3-1/2 (89)	1-3/8 (35)
20	500	68-5/8 (1543)	47-15/16 (1218)	12 (305)	12-1/16 (306)	6-1/2 (165)	19-1/4 (489)	27-1/2 (699)	1-1/8 (29)	8	1-1/8-7NC	20	25 (635)	14 (356)	4-1/2 (114)	1-1/2 (38)
24	600	79-7/8 (2029)	55-3/16 (1402)	12 (305)	12-1/16 (306)	6-1/2 (165)	23-1/4 (591)	32 (813)	1-1/16 (27)	8	1-1/4-7NC	20	29-1/2 (749)	14-1/8 (359)	4-1/2 (114)	1-1/2 (81)

Reference dimensions in (parentheses)
6" - 14" valves have a bevel gear ratio of 3:1
16" - 24" valves have a bevel gear ratio of 4:1

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Fabri-Valve®

CF37 Heavy Duty Knife Gate Valve

ITT

ENGINEERED FOR LIFE

CF37 Heavy Duty Knife Gate Valve

Figure C37 with energized cored packing.

Energized cored packing is standard with 6" (DN 150) and larger C37 valves and all F37 valves.

Fabri-Valve Figures C37 and F37 are some of the most popular knife gate valve configurations. Figure C37 knife gate valves through 24", feature a heavy duty, rugged one-piece cast body, chest and flanges (except 5", which is fabricated – F37). Sizes larger than 24" are fabricated from heavy plate. The Figure C/F37 is available in all stainless steel (designated "S") or with alloy steel wetted parts and carbon steel external parts (designated "R"). In sizes 1.5" through 24", the "S" and the "R" share the same solid cast body. Sizes larger than 24" feature fabricated bodies configured to the service conditions. The Figure C/F37 is available with the widest range of seats in the industry including: integral metal, replaceable hardfaced metal, rubber "D" ring, replaceable rubber, polyurethane, UHMW-P, and PTFE. Standard body materials include 304, 316, and 317L stainless steel. Special alloys such as 254 SMO® are also available. Special flange drillings are also available.

All Figure C/F37 knife gate valves with handwheels include a provision for a locking device. Consult factory for details.

Specifications

Size Range
1.5" – 96"

Pressure Rating

1.5" – 24":	150 psi (10.3 bar) CWP (cold working pressure)
25" – 48":	Designs available in 50 psi (3.5 bar), 100 psi (6.9 bar) or 150 psi (10.3 bar) CWP
Larger than 48":	Manufactured to customer specification

Temperature Rating
1.5" – 48" 450°F (232°C).
Service temperatures above 400°F (204°C) require high temperature fasteners. Specify service temperature on paperwork. Consult factory for sizes larger than 48"(DN 1200) and for service temperatures up to 1500°F (816°C).

Flange Drilling
ANSI 125/150

Testing

Every Fabri-Valve Figure C/F37 valve is fully tested prior to shipment. Testing includes a body shell test, a seat test and a cycling test to insure proper functioning of moving parts. Additional testing is also available. Please let us know your requirements.

Standard Shell test:

- Hydro test at 1.5 times the rated CWP (cold working pressure) – Zero allowable leakage

Standard Seat test:

- Metal Seat: Hydro test at 40 psi (2.8 bar) and at the rated CWP
- Resilient Seat: Hydro test at 15 psi (1 bar) and rated CWP

Pressure/Temperature Ratings

The tables below are the Maximum Pressure/Temperature Ratings for the metallic components only. When checking pressure/temperature ratings, check the temperature rating and chemical compatibility of the packing material and, if applicable, the resilient seat material. In a majority of knife gate valve designs, the temperature limit or the chemical compatibility of the seat and/or packing material determines the practical pressure/temperature limitations.

Figure C37

Pressure/Temperature Rating - psi

Temp °F	Temp °C	Cast 304	Cast 304L	Cast 316	Cast 316L	Cast 317L	Cast WCB A-216	Cast DI
150	66	150	150	150	150	150	150	150
200	93	142	142	150	150	135	150	150
250	121	135	135	142	142	128	150	147
300	149	129	129	134	134	121	150	143
350	177	123	123	128	128	116	150	139
400	204	118	118	123	123	112	150	135
450	232	114	114	118	118	108	150	131
500	260	111	111	114	114	105	150	127
600	316	104	104	108	108	100	150	119
700	371	101	101	104	104	96	142	
800	427	96	96	100	100	92	103	
900	482	93		99			57	
1000	538	89		97			21	
1100	593	64		76				
1200	649	41		46				
1300	704	28		29				
1400	760	20		20				
1500	816	15		14				

Figure F37

Pressure/Temperature Rating - psi

Temp °F	Temp °C	304	304L	316	316L	317L	A 36	A516Gr70
150	66	150	133	150	133	150	150	150
200	93	133	114	141	113	135	137	150
250	121	126	108	133	107	128	135	150
300	149	120	102	124	101	121	133	150
350	177	115	98	119	97	116	131	150
400	204	110	93	114	93	112	128	150
450	232	107	90	110	90	108	125	150
500	260	103	87	106	87	105	121	150
600	316	97	82	101	83	100	111	150
700	371	94	80	97	80	96	108	142
800*	427*	89	77	93	77	92		103
900*	482*	87		92				57
1000*	538*	83		90				21
1100*	593*	78		88				
1200*	649*	49		59				
1300*	704*	30		33				
1400*	760*	18		18				
1500*	816*	11		10				

* "R" Series valves have external, non-wetted, carbon steel components. Standard "R" Series valves are limited to 700°F (371°C); however alternate "R" Series constructions are available to 1000°F (538°C)

NOTE: Each valve is identified by Size-Figure-Series-etc. The "How To Order" section explains the Valve Model Codes.

Shutoff Performance

Metal Seat

- Single integral metal seat
  1.5" – 24" 40cc / minute / inch of valve size
  25" – 48" 60cc / minute / inch of valve size
  Above 48" Consult Factory
- Single hardfaced integral metal seat
  1.5" – 24" 80cc / minute / inch of valve size
  25" – 48" 120cc / minute / inch of valve size
  Above 48" Consult Factory
- Dual metal seats
  Consult factory. All sizes.
- Single hardfaced replaceable metal seat
  1.5" – 24" 80cc / minute / inch of valve size
  Above 24" Consult Factory

Resilient Seat

- Single "D" ring, or single replaceable resilient seat (excluding PTFE)
  Zero leakage. All sizes.
- Dual seats
  Consult Factory. All sizes.
- Single replaceable PTFE seat
  Consult Factory. All sizes.

Low Pressure Operation

Metal seated knife gate valves are seat tested at 40 psid (2.8 bar) in the preferred flow direction. When pressure falls below the 40 psid (2.8 bar) test pressure, less force is pushing the gate into the seat, which may result in additional seat leakage. When improved low-pressure shutoff performance is required, optional chest buttons and/or centerline buttons should be specified.

Available Options

- "D" Ring Seat
- Lever Operator
- Dual Seats
- Poly Replaceable Seats
- UHMW Replaceable Seats
- PTFE Replaceable Seats
- Rubber Replaceable Seats
- Hard Faced Replaceable Seats
- Elastomer Replaceable Seats
- Hard Faced Gate Edge
- Hard Gate Material
- Nickel-TFE Coated Gate
- Epoxy Coating
- Thru Drilled Flanges
- Flush Ports
- Chest Buttons: Not available 2"-6"
- Centerline Buttons
- Backing Ring
- Extra Wedges
- V-Port
- Cast Ni-Hard Deflection Cones Available 3"-16"
- Fabricated Deflection Cones
- Locking Devices
- Live Loaded Packing
- Self-Supporting Yokes
- Alternate Flange Drilling
- Bevel Gear
- Chainwheels
- Cylinder Actuators
- Electric Actuators
- Ratchet
- Extended Stems
- Gate Support Strips
- Rod Boots

Dimensions: C37 with Handwheel or Cylinder

Valve Size		TABLE 1			DIMENSION Inches (mm) Figure C37 with HANDWHEEL OR CYLINDER																	Weight **	
Inches	DN	A			C			D		H*	J	K	L	M	N	P	R	S	T	V	W	lb	kg
2	50	HW 13-11/16 (348)	2-1/2 CYL 18-3/8 (467)	3-1/4 CYL 16-7/8 (429)	HW 8 (203)	2-1/2 CYL 3 (76)	3-1/4 CYL 4 (102)	2-1/2 CYL 3/8-18	3-1/4 CYL 1/4-18	2 (51)	6 (152)	3/8 (10)	2	5/8-11NC	4	4-3/4 (121)	3-5/8 (92)	4 (102)	1/16 (2)	9/16 (14)	1-7/8 (48)	17	8
3	80	HW 16-7/16 (418)	2-1/2 CYL 20-7/8 (530)	3-1/4 CYL 19-3/8 (492)	HW 8 (203)	2-1/2 CYL 3 (76)	3-1/4 CYL 4 (102)	2-1/2 CYL 3/8-18	3-1/4 CYL 1/4-18	3 (76)	7-1/2 (191)	13/32 (10)	2	5/8-11NC	4	6 (152)	5 (127)	4 (102)	1/16 (2)	9/16 (14)	2 (51)	21	10
4	100	HW 19-3/16 (487)	3-1/4 CYL 22-1/8 (562)	4 CYL 22-7/8 (581)	HW 8 (203)	3-1/4 CYL 4 (76)	4 CYL 4-1/2 (114)	3-1/4 CYL 1/4-18	4 CYL 3/8-18	4 (102)	9 (229)	13/32 (10)	2	5/8-11NC	8	7-1/2 (191)	6-3/16 (157)	4 (102)	1/16 (2)	11/16 (17)	2 (51)	30	14
6	150	HW 25-5/16 (643)	4 CYL 28-7/8 (733)	6 CYL 29-1/4 (743)	HW 10 (254)	4 CYL 4-1/2 (114)	6 CYL 6-1/2 (165)	4 CYL 3/8-18	6 CYL 3/8-18	6 (152)	11 (279)	7/16 (11)	2	3/4-10NC	8	9-1/2 (241)	8-1/2 (216)	7-3/8 (187)	1/16 (2)	5/8 (16)	2-1/4 (57)	75	34
8	200	HW 32-5/8 (829)	6 CYL 35-13/16 (910)	8 CYL 36-5/16 (922)	HW 12 (305)	6 CYL 6-1/2 (165)	8 CYL 8-5/8 (219)	6 CYL 3/8-18	8 CYL 3/8-18	8 (203)	13-1/2 (343)	5/8 (16)	2	3/4-10NC	8	11-3/4 (298)	10-5/8 (270)	7-3/8 (187)	1/16 (2)	13/16 (21)	2-3/4 (70)	94	45
10	250	HW 37-3/4 (959)	8 CYL 41-7/16 (1053)	10 CYL 42-3/16 (1072)	HW 16 (406)	8 CYL 8-5/8 (219)	10 CYL 10-7/8 (276)	8 CYL 3/8-18	10 CYL 1/2-14	10 (254)	16 (406)	1/2 (13)	4	7/8-9NC	12	14-1/4 (362)	12-3/4 (324)	7-3/8 (187)	1/8 (3)	15/16 (24)	2-3/4 (70)	126	57
12	300	HW 44-9/16 (1132)	8 CYL 48 (1219)	10 CYL 48-3/4 (1238)	HW 16 (406)	8 CYL 8-5/8 (219)	10 CYL 10-7/8 (276)	8 CYL 3/8-18	10 CYL 1/2-14	12 (305)	19 (483)	1/2 (13)	4	7/8-9NC	12	17 (432)	15 (381)	7-1/2 (191)	3/16 (5)	1 (25)	3 (76)	177	80
14	350	HW 49-1/4 (1251)	12 CYL 54-1/16 (1373)	14 CYL 55-3/16 (1402)	HW 20 (508)	12 CYL 12-3/4 (324)	14 CYL 14-3/4 (375)	12 CYL 1/2-14	14 CYL 3/4-14	13-1/4 (337)	21 (533)	7/16 (11)	4	1-8NC	12	18-3/4 (476)	16-1/4 (413)	7-3/4 (197)	3/16 (5)	15/16 (24)	3 (76)	215	98
16	400	HW 56-1/2 (1435)	12 CYL 61-1/16 (1551)	14 CYL 62-3/16 (1580)	HW 20 (508)	12 CYL 12-3/4 (324)	14 CYL 14-3/4 (375)	12 CYL 1/2-14	14 CYL 3/4-14	15-1/4 (387)	23-1/2 (597)	9/16 (14)	6	1-8NC	16	21-1/4 (540)	18-1/2 (470)	11-1/4 (286)	3/16 (5)	1-1/16 (27)	3-1/2 (89)	268	122
18	450	HW 63-5/16 (1608)	12 CYL 66-1/2 (1689)	14 CYL 67-5/8 (1718)	HW 20 (508)	12 CYL 12-3/4 (324)	14 CYL 14-3/4 (375)	12 CYL 1/2-14	14 CYL 3/4-14	17-1/4 (438)	25 (635)	5/8 (16)	6	1-1/8-7NC	16	22-3/4 (578)	21 (533)	11-1/4 (286)	3/16 (5)	1-1/16 (27)	3-1/2 (89)	407	185
20	500	HW 68-5/8 (1743)	14 CYL 72-15/16 (1853)	16 CYL 73-7/16 (1865)	HW 20 (508)	14 CYL 14-3/4 (375)	16 CYL 17 (432)	14 CYL 3/4-14	16 CYL 3/4-14	19-1/4 (489)	27-1/2 (699)	29/32 (23)	8	1-1/8-7NC	20	25 (635)	23 (584)	14 (356)	3/16 (5)	1-3/16 (30)	4-1/2 (114)	523	237
24	600	HW 79-13/16 (2027)	16 CYL 84-11/16 (2151)	18 CYL 86-5/8 (2200)	HW 20 (508)	16 CYL 17 (432)	18 CYL 19 (483)	16 CYL 3/4-14	18 CYL 3/4-14	23-1/4 (591)	32 (813)	13/16 (21)	8	1-1/4-7NC	20	29-1/2 (749)	27-1/4 (692)	14-1/8 (359)	3/16 (5)	1-5/16 (33)	4-1/2 (114)	713	321

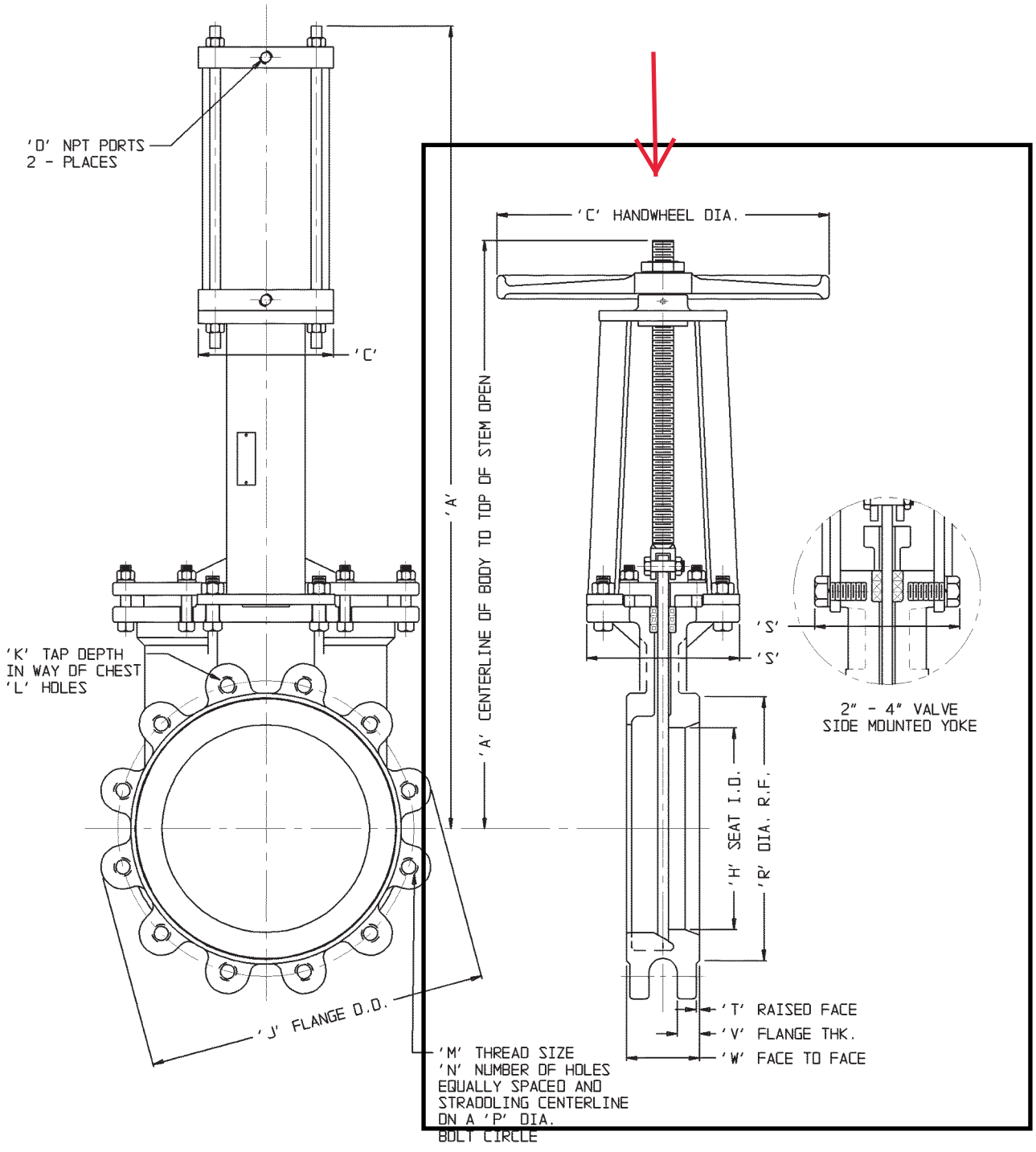
Reference dimensions in (parentheses)

* For 14" - 24" valves with rubber replaceable seats, use the port I.D. dimensions show in the Flow Coefficients Table (see last page).

** Figures C37R and C37S with Handwheels

C37 with Handwheel or Cylinder

Refer to TABLE 1 for dimensions



with Cylinder

with Handwheel

Dimensions: C37 with Bevel Gear

Valve Size		TABLE 2 DIMENSION Inches (mm) Figure C37 with BEVEL GEAR																
Inches	DN	A	B	C	D	E	H	J	K	L	M	N	P	R	S	T	V	W
6	150	25-5/16 (643)	19-11/16 (500)	12 (305)	12-3/8 (314)	6-1/2 (165)	6 (152)	11 (279)	7/16 (11)	2	3/4-10NC	8	9-1/2 (241)	8-1/2 (216)	7-3/8 (187)	1/16 (2)	5/8 (16)	2-1/4 (57)
8	200	32-15/16 (837)	24-5/8 (625)	12 (305)	12-3/8 (314)	6-1/2 (165)	8 (203)	13-1/2 (343)	5/8 (16)	2	3/4-10NC	8	11-3/4 (298)	10-5/8 (270)	7-3/8 (187)	1/16 (2)	13/16 (21)	2-3/4 (70)
10	250	38-1/16 (967)	27-9/16 (700)	12 (305)	12-3/8 (314)	6-1/2 (165)	10 (254)	16 (406)	1/2 (13)	4	7/8-9NC	12	14-1/4 (362)	12-3/4 (324)	7-3/8 (187)	1/8 (3)	15/16 (24)	2-3/4 (70)
12	300	44-9/16 (1132)	31-13/16 (808)	12 (305)	12-3/8 (314)	6-1/2 (165)	12 (305)	19 (483)	1/2 (13)	4	7/8-9NC	12	17 (432)	15 (381)	7-1/2 (191)	3/16 (5)	1 (25)	3 (76)
14	350	49-5/16 (1252)	34-3/4 (883)	12 (305)	12-3/8 (314)	6-1/2 (165)	13-1/4 (337)	21 (533)	7/16 (11)	4	1-8NC	12	18-3/4 (476)	16-1/4 (413)	7-3/4 (197)	3/16 (5)	15/16 (24)	3 (76)
16	400	56-9/16 (1437)	40-3/8 (1026)	12 (305)	12-1/16 (306)	6-1/2 (165)	15-1/4 (387)	23-1/2 (597)	9/16 (14)	6	1-8NC	16	21-1/4 (540)	18-1/2 (470)	11-1/4 (286)	3/16 (5)	1-1/16 (27)	3-1/2 (89)
18	450	63-5/16 (1608)	43-13/16 (1113)	12 (305)	12-1/16 (306)	6-1/2 (165)	17-1/4 (438)	25 (635)	5/8 (15)	6	1-1/8-7NC	16	22-3/4 (578)	21 (533)	11-1/4 (286)	3/16 (5)	1-1/16 (27)	3-1/2 (89)
20	500	68-5/8 (1543)	47-15/16 (1218)	12 (305)	12-1/16 (306)	6-1/2 (165)	19-1/4 (489)	27-1/2 (699)	29/32 (23)	8	1-1/8-7NC	20	25 (635)	23 (584)	14 (356)	3/16 (5)	1-3/16 (30)	4-1/2 (114)
24	600	79-7/8 (2029)	55-3/16 (1402)	12 (305)	12-1/16 (306)	6-1/2 (165)	23-1/4 (591)	32 (813)	13/16 (21)	8	1-1/4-7NC	20	29-1/2 (749)	27-1/4 (692)	14-1/8 (359)	3/16 (5)	1-5/16 (33)	4-1/2 (114)

Reference dimensions in (parentheses) 6" - 14" valves have a bevel gear ratio of 3:1 16" - 24" valves have a bevel gear ratio of 4:1

Materials of Construction

Parts	Materials	
	C37R & F37R	C37S & F37S
Body and Chest	1.5" – 24"(except 5") solid one piece. C37R-304: Cast 304 stainless steel C37R-316: Cast 316 stainless steel C37R-317L: Cast 317L stainless steel Larger than 24" and the 5" are fabricated with stainless steel wetted parts and carbon steel exterior parts.	1.5" - 24" (except 5") solid one piece. C37S-304: Cast 304 stainless steel C37S-316: Cast 316 stainless steel C37S-317L: Cast 317L stainless steel Larger than 24" and the 5" are fabricated of all stainless steel
Seat	Integral seat to 1500°F (816°C) with appropriate packing RH: Replaceable hardfaced seat to 750°F (399°C) standard Up to 1600°F(871°C) with proper packing and gaskets RT: Replaceable PTFE seat to 400°F (204°C) RW: Replaceable UHMWP seat to 140°F (60°C) RP: Replaceable polyurethane seat to 180°F (82°C)	
Gate	Stainless steel of same grade used in body, finished to 32 RMS	
Yoke	1.5" - 4", Cast ductile iron 6" and above fabricated carbon steel	1.5" - 4", cast 304 stainless steel 6" and above fabricated 304 stainless steel
Yoke Fasteners	Plated steel	Stainless steel
Stem	304 stainless steel	
Stem Nut	Acid resistant bronze	
Lubrication Fitting	Plated steel	
Packing	Acrylic/PTFE/silicone[1]	
Packing Follower	Ductile iron/carbon steel with plated steel bolts	304 stainless steel with stainless steel bolts
Handwheel	Cast iron	
Handwheel Retaining Nut	Malleable iron	Stainless steel
Tab Washer	Stainless steel	

[1] Energized cored packing is standard with 6" (DN150) and larger C37 valves and all F37 valves.

Flow Coefficients

The Cv values below represent U.S. gallons per minute 60°F water through a 100% open valve at a pressure drop of 1 psi. The metric equivalent, Kv, is the flow of water at +16°C through the valve in cubic meters per hour at a pressure drop of 1 kg/cm2. To convert Cv to Kv, multiply the Cv by 0.8569.

Figures C37 and F37
Cv Ratings, Port Diameter, and Area

Valve Size		Standard Port			With V-Seat			With Replaceable Poly or Replaceable Rubber seat		
In.	DN	Cv	Port I.D. Inches	Port Area Sq. In.	Cv	Port Inside Inches	Port Area Sq. In.	Cv	Port I.D. Inches	Port Area Sq. In.
2	50	288	2.00	3.1	165	2.00	2.8	288	2.00	3.1
3	75	648	3.00	7.1	355	3.00	6.3	648	3.00	7.1
4	100	1,152	4.00	12.6	515	4.00	9.5	1,152	4.00	12.6
6	150	2,592	6.00	28.3	1,350	6.00	24.9	2,592	6.00	28.3
8	200	4,608	8.00	50.3	2,050	8.00	38.1	4,608	8.00	50.3
10	250	7,208	10.00	78.5	3,200	10.00	59.0	7,208	10.00	78.5
12	300	10,400	12.00	113.1	4,450	12.00	82.3	10,400	12.00	113.1
14	350	12,650	13.25	137.9	5,350	13.25	98.8	10,080	12.00	113.1
16	400	16,750	15.25	182.6	6,950	15.25	128.4	14,200	14.25	159.5
18	450	21,450	17.25	233.7	10,700	17.25	198.2	18,500	16.25	207.4
20	500	26,700	19.25	291.0	13,250	19.25	245.4	22,700	18.00	254.5
24	600	38,900	23.25	424.6	15,400	23.25	284.7	33,900	22.00	380.1
30*	750*	49,850	26.69	559.4						
36*	900*	74,800	32.69	839.2						
42*	1050*	104,800	38.69	1175.5						
48*	1200*	136,700	44.19	1533.5						

Consult Factory

*50 psi (3.5 bar) CWP valve design. Contact factory for higher pressure designs.

ITT

ENGINEERED FOR LIFE

Engineered Valves, LLC
1110 Bankhead Ave
Amory, MS 38821
662.256.7185
www.engvalves.com

E & I CORPORATION
DIVISION OF McNish CORPORATION
214 Hoff Rd. - Suite M
Westerville, Ohio 43082
1-614-899-2282 (Phone)
1-614-899-0304 (Fax)

October 22, 2019

Project:	PRIMARY SETTLING TANK EQUIPMENT REPLACEMENT
Location:	TRAVERSE CITY, MI
Budgetary Proposal No:	G-8779 S
Subject:	CHAIN & FLIGHT SLUDGE COLLECTION MECHANISMS

We are pleased to submit this Budgetary Proposal to furnish the following equipment:

SCOPE OF SUPPLY

Four (4) - Primary 4-SHAFT Rectangular Collectors – 16'-0" W x 58'-6" L
Four (4) - Primary 4-SHAFT Rectangular Collectors – 14'-0" W x 52'-6" L
Four (4) – Rotating Scum Skimmer Pipes – 12" Dia. x 16'-0" L
Four (4) – Rotating Scum Skimmer Pipes – 12" Dia. x 14'-0" L

These units are to be supplied complete with all machinery parts including:

- Head Shafts, C-1018 Carbon Steel
- Idler Shafts, C-1018 Carbon Steel
- Head Shaft Sprockets, Split Type, 23 Tooth, Cast Nylon
- Drive Sprocket, Shear Pin Type, 11 Tooth, Cast Nylon with 316 Stainless Steel Hub
- Driven Sprocket, Split Type, Offset Type, 40 Tooth, Cast Nylon
- Idler Sprockets, 19 Tooth, Cast Nylon
- Drive Units, Helical Gear Reducer, ½ HP Motor, TEFC, 460 volts, 3-phase, 60 hertz
- Chain Guards, #14 Gauge, 304 Stainless Steel
- Drive Chains, NH-78, Non Metallic
- Snap Idle Chain Tighteners
- Limit Switches, NEMA IV
- Shaft Bearings, Cast Iron, Peak Cap, UHMW-PE lined, Self-Aligning
- Set Collars, Split Type, UHMW-PE
- Flights, FRP, 3"x8" nominal
- Filler Blocks, Polypropylene
- Collector Chain, NCS 720, Non Metallic
- Return Rail Angles, FRP, 3" x 3" x 3/8"
- Return Rail Wall Brackets, non-metallic co-polymer
- Wear Shoes, UHMW-PE
- Floor & Return Rail Wear Strips, UHMW-PE (virgin material)

- Skimmer Pipes, 12” Dia., 304 Stainless Steel, Schedule 30
    - Wall Bearings with UHMW-PE liners, 304 Stainless Steel
    - Worm Gear, Brass
    - Pinion half-wheel, toothed, 304 Stainless Steel
    - Handwheel Operator, Cast Iron
    - Gaskets, neoprene
    - O-ring Seals, oil resistant, Buna-N
- Anchors & Fasteners, 316 Stainless Steel

Not Included: Field paint, finish paint, field installation, controls, field control wiring, cross collectors, weirs and troughs, wall sleeves

PRICE:

Budgetary Price: Approximately $396,500 FOB factory with freight allowed to jobsite.

FIELD SERVICE:

The services of a factory field service technician for checkout, initial start-up, testing, commissioning, and/or instruction of plant personnel will be provided as follows:

Four (4) trips, Twelve (12) days of Service

EXISTING STRUCTURE NOTE:

The Owner or Contractor shall be solely responsible for measuring and providing E & I Corporation, a division of McNish Corporation with accurate as built dimensions for all existing structures where E & I Corporation is furnishing equipment. This information must be made available to E & I Corporation in a timely manner to avoid delaying the equipment delivery schedules outlined within this budgetary proposal. In the event dimensions are not provided or the provided dimensions are in error which results in modifications to either the equipment or the adjacent structures, the Owner shall be solely responsible for all labor, materials and associated costs to correct the resulting situation.

SHOP PAINTING:

All fabricated carbon steel shall be prime paint - SSPC-SP10 surface preparation with one (1) prime coat Tnemec Series 1 Omnithane, 2.5-3.5 mils DFT. Carbon steel shafts will not be painted but will be coated with a protective grease coating.

All standard machinery items i.e. reducers, motors, controls, bearings, sprockets, couplings etc. will be furnished with the vendor’s standard paint.

Aluminum, stainless steel, galvanized steel, plastic and other special materials will not be shop painted.

SPARE PARTS:

Not Included

FASTENERS:

All fasteners will be Type 304 stainless steel.

ANCHORAGE:

All anchorage will be Type 316 stainless steel.

ESTIMATED SCHEDULE:

Based on current deliveries by suppliers and our projected work load, we estimate that we can ship fabricated materials in accordance with the schedules listed below. Approval Schedule is shown in weeks after receipt of order with complete information. SCHEDULE COMMITMENTS ARE SUBJECT TO REVISION AND MUST BE CONFIRMED AT TIME OF ORDER.

Submittal of Approval Drawings . . . . . 6 - 8 weeks
Shipment, after Receipt of Approval . . . . 12 - 16 weeks

EXCLUSIONS:

Although they may be shown on the plans and/or specified, the following are not included in this offering:

1. Unloading, hauling or storage
2. All electrical controls, alarms and wiring except as specified above
3. Lubricating oil or grease
4. Piping unless specifically noted above
5. Field painting
6. Welding
7. Concrete work or erection
8. Embedded items
9. Shims/Shim Sets
10. Labor and materials to repair defects in galvanized or painted surfaces caused from shipping, handling or installation
11. Tools (no special tools required)

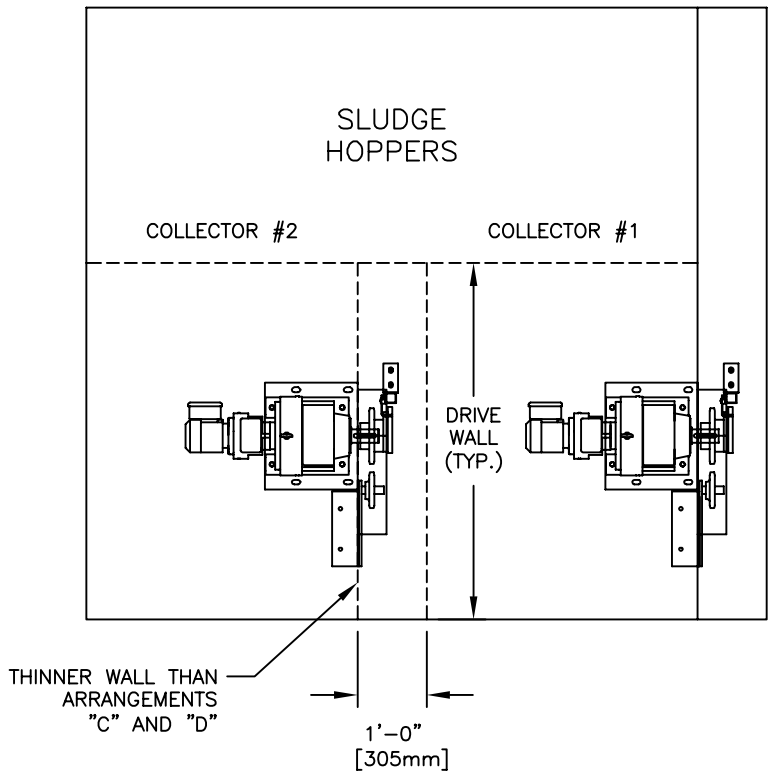
If we can furnish any clarifications or additional information, please contact our Representative, Dave Conners, Waterworks Systems & Equipment, at 989-860-9816. We look forward to the opportunity of working with you during the course of this project.

Sincerely,
E & I Corporation
Division of McNish Corporation

Kevin L. Strohl

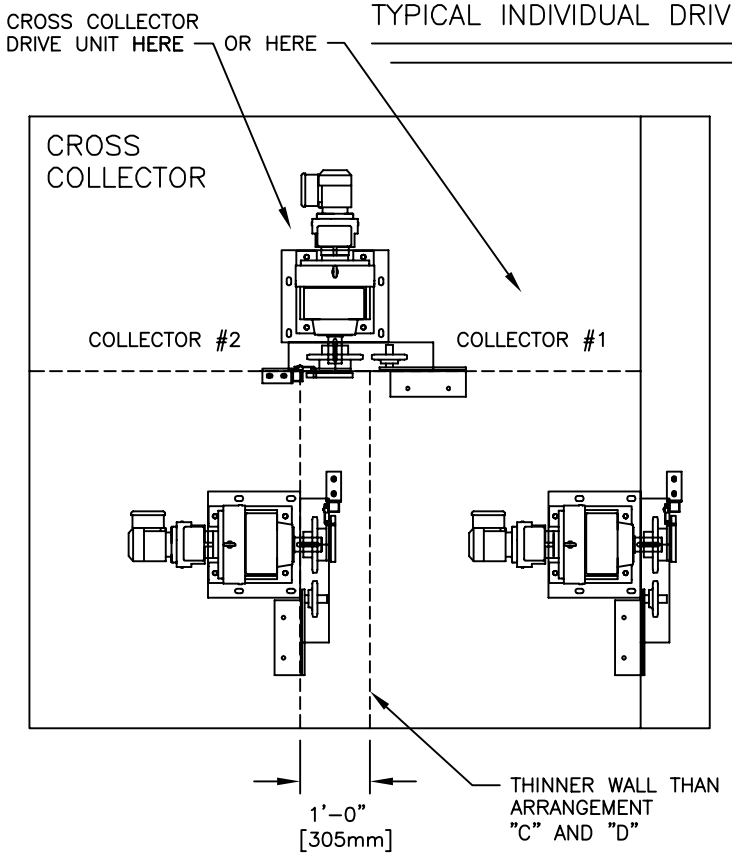
Kevin L. Strohl, P.E.
Applications Engineer

TYPICAL INDIVIDUAL DRIVE UNIT ARRANGEMENTS



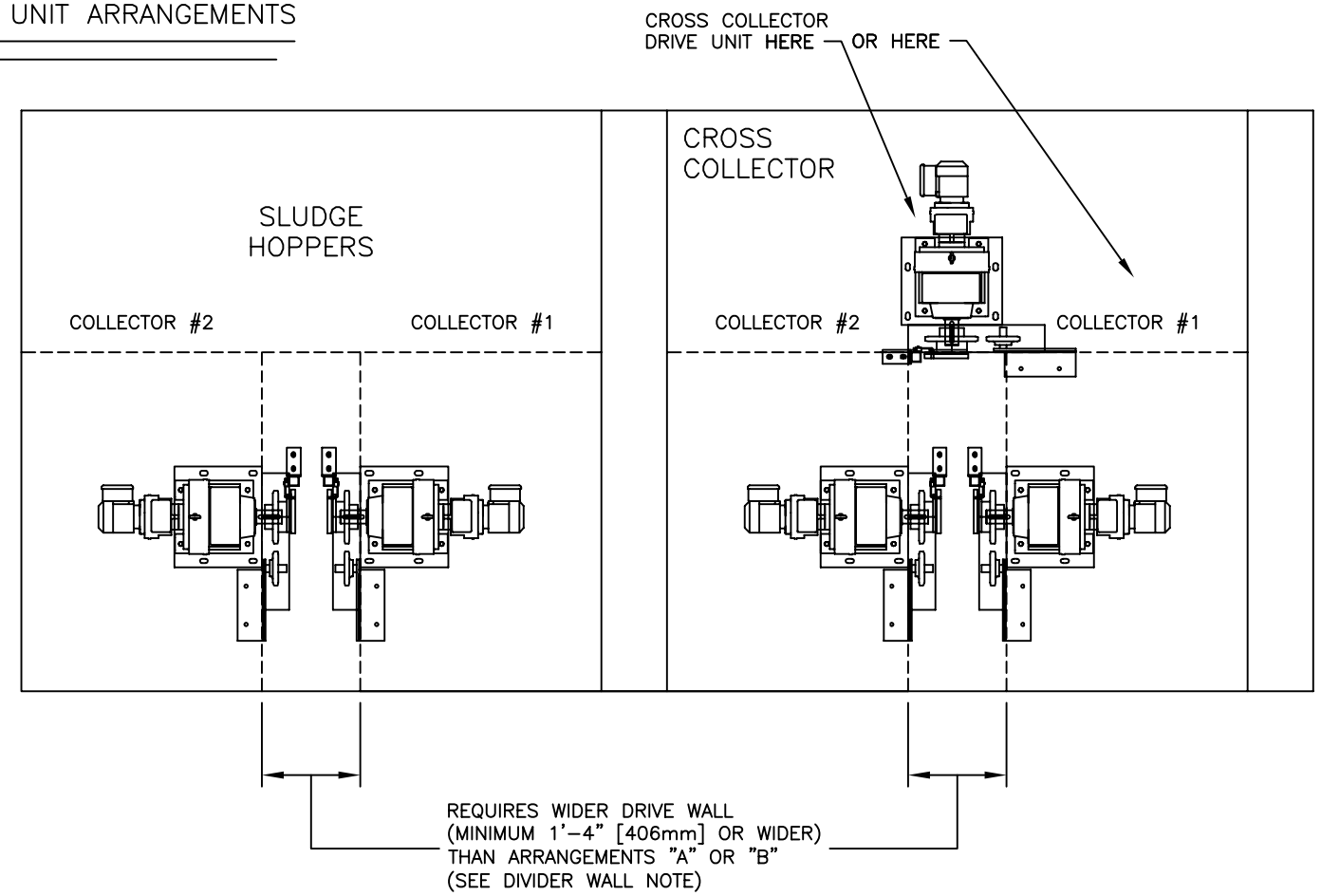
ARRANGEMENT "A"

(PREFERRED)



ARRANGEMENT "B"

(PREFERRED)



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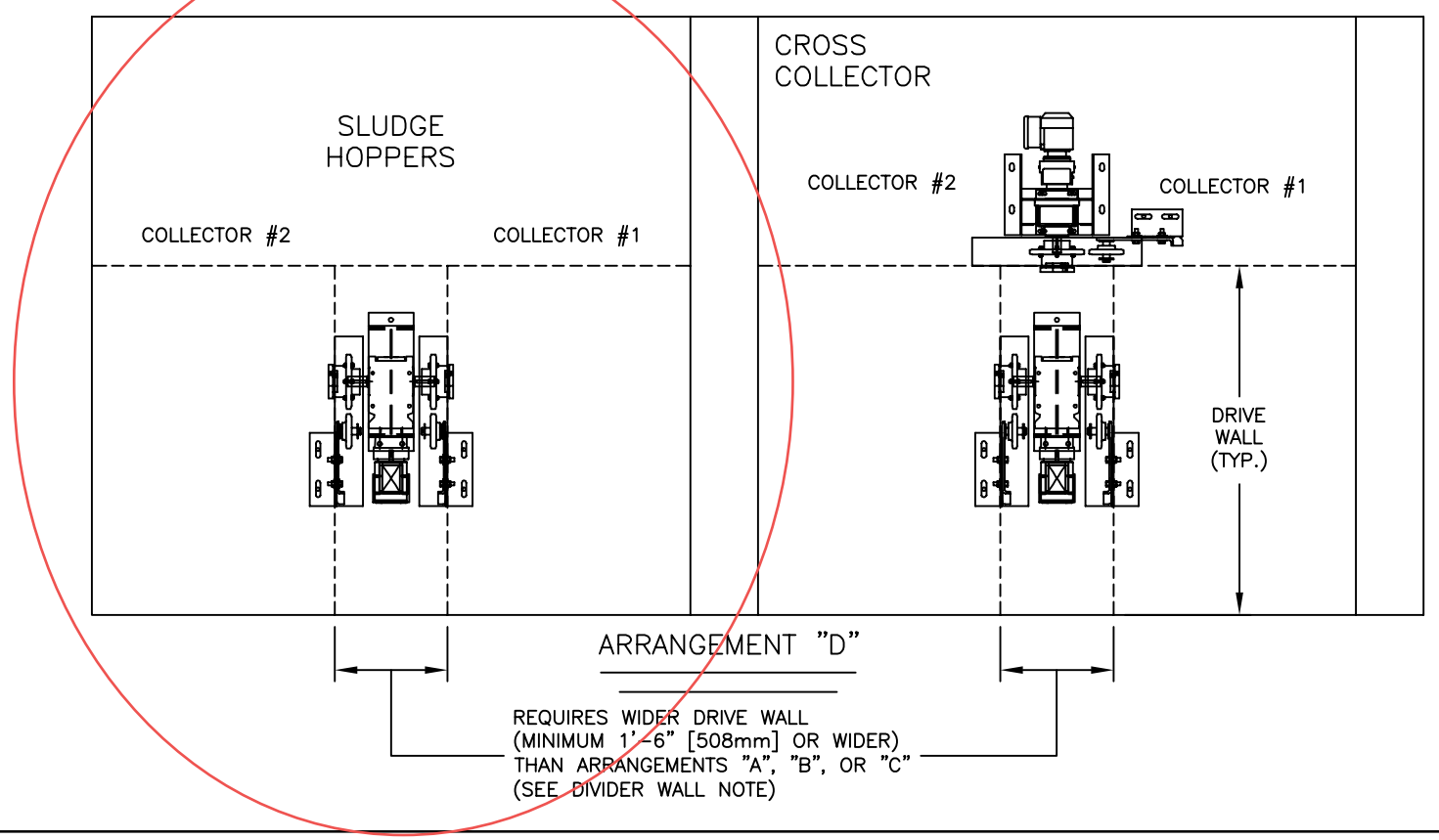


ARRANGEMENT "D"

DIVIDER WALL NOTE:

IF NARROWER DIVIDER WALLS (COLUMNS AND BEAMS) ARE DESIRED FOR THE REMAINING TANK LENGTH, 8 INCH (203mm) HIGH CONCRETE CORBELS (AT WATER LEVEL) AND CURBS (AT FLOOR LEVEL) ARE REQUIRED ON BOTH SIDES OF THE DIVIDER WALL.

CORBELS AND CURBS ARE ALSO REQUIRED ON THE NON–DRIVE SIDE WALL TO MAKE FLIGHTS SYMETRICAL AND INTERCHANGABLE BETWEEN TANKS.

MASTER REVISION JULY 2014

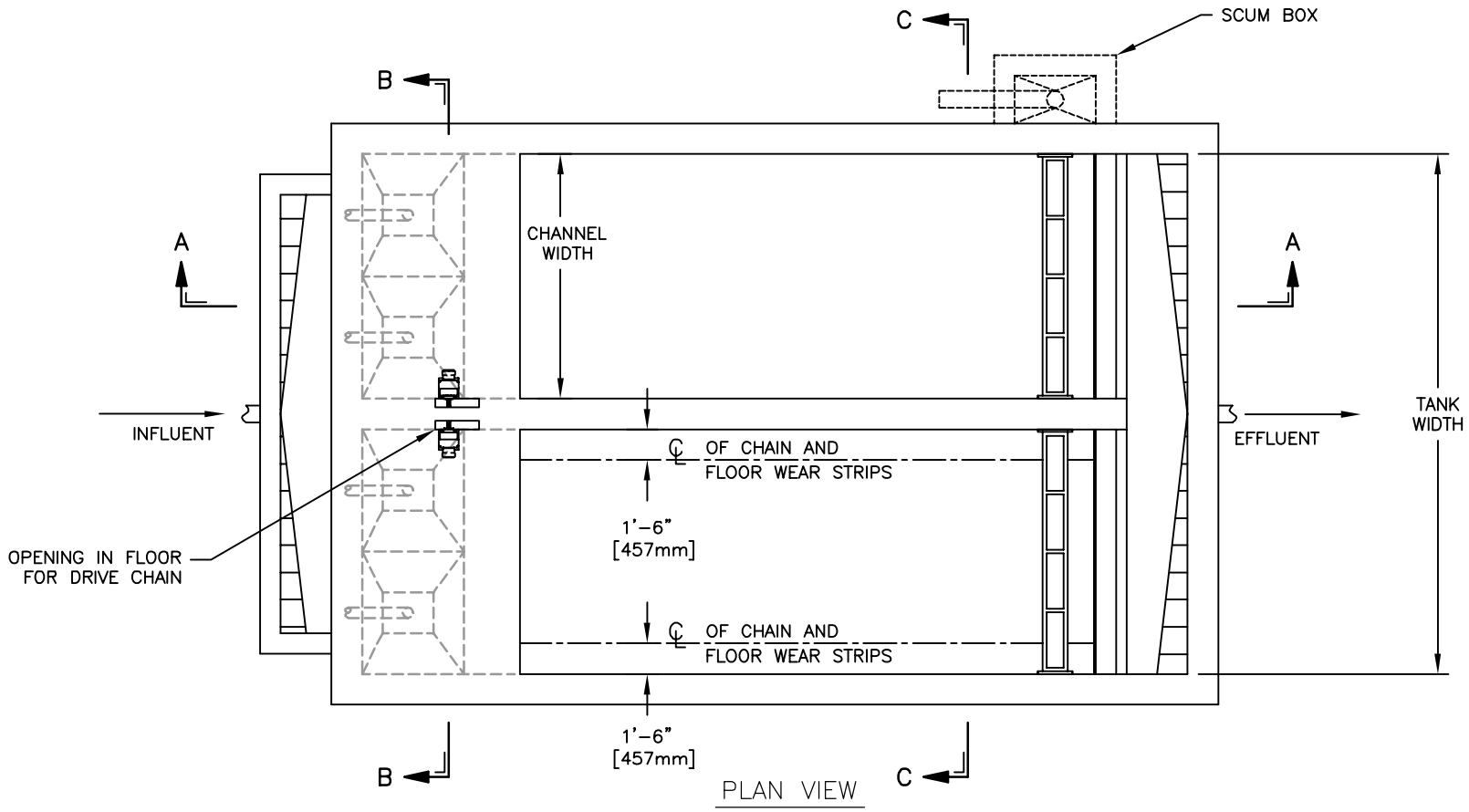
TITLE: ENVIREX CHAIN AND SCRAPER SLUDGE COLLECTORS
GENERAL ARRANGEMENT
SUGGESTED DRIVE ARRANGEMENTS

CUST.:
LOC.:
ENG.:

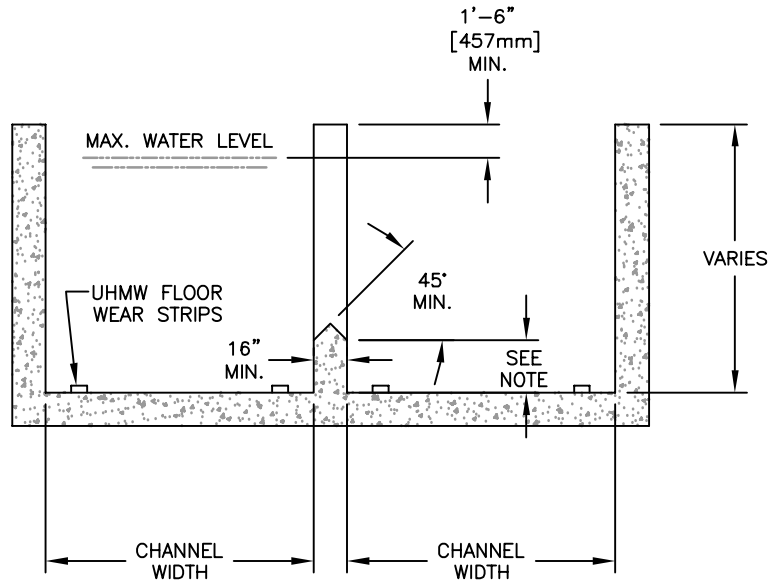
EVOQUA WATER TECHNOLOGIES
WATER TECHNOLOGIES
WAUKESHA, WI
262–547–0141

PROJECT	CODE	DRAWING	SHEET	REV
	4001	1.310D	OF	

STD: 1–0600–11X17B 07/23/2014 – 1:29 PM



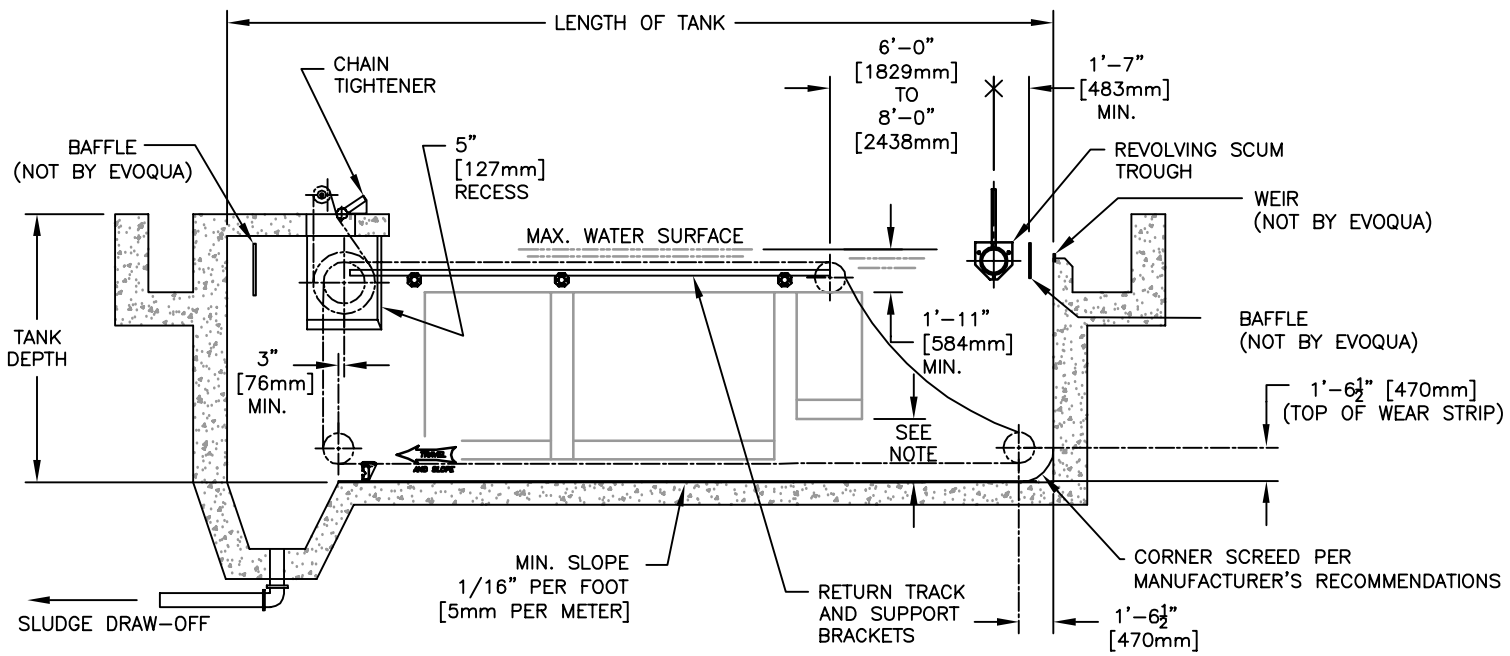
PLAN VIEW



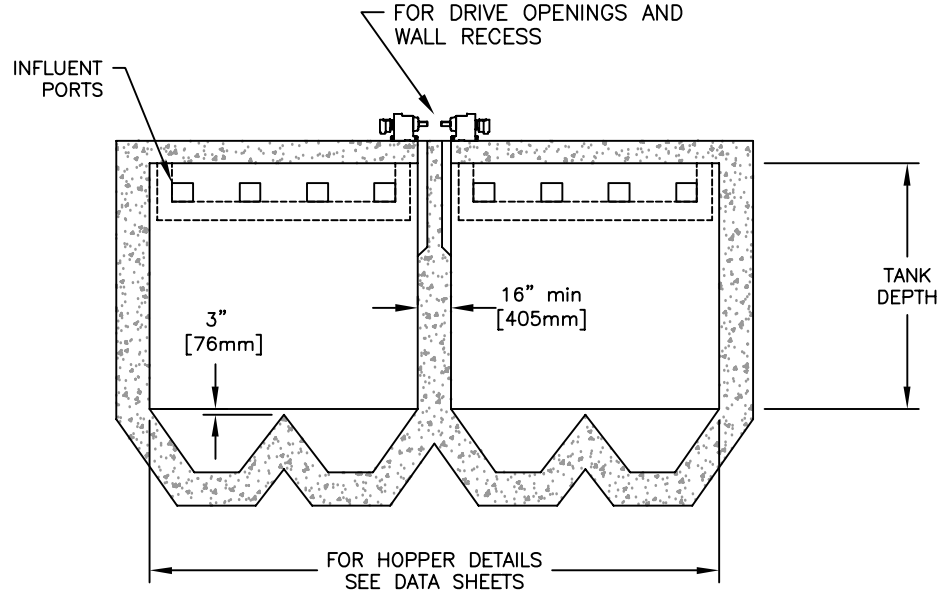
SECTION "C–C"

NOTE:

MINIMUM CENTER WALL VERTICAL HEIGHT IS 2'–10" (864mm) WHERE THE LOWER RETURN TRACK SUPPORT BRACKETS ARE MOUNTED AT THE EFFLUENT END OF CHANNEL AND EFFLUENT CORNERSHAFT LOCATION. AFTER THESE AREAS THE CENTER WALL CAN BE LOWERED TO 1'–0" (300mm).



SECTION "A–A"



SECTION "B–B"

NOT FOR CONSTRUCTION

DEFINITIONS:

BASIN = ONE OR MORE TANKS THAT SHARE COMMON INFLUENT AND EFFLUENT. ANY TANK CAN BE TAKEN OUT OF SERVICE.

TANK = ONE OR MORE CHANNELS HYDRAULICALLY COMMON TO EACH OTHER. MOST OFTEN THERE IS ONLY ONE CROSS COLLECTOR PER TANK.

CHANNEL = COLLECTOR BAY CONTAINING ONE COLLECTOR MECHANISM.

MASTER REVISION JULY 2014

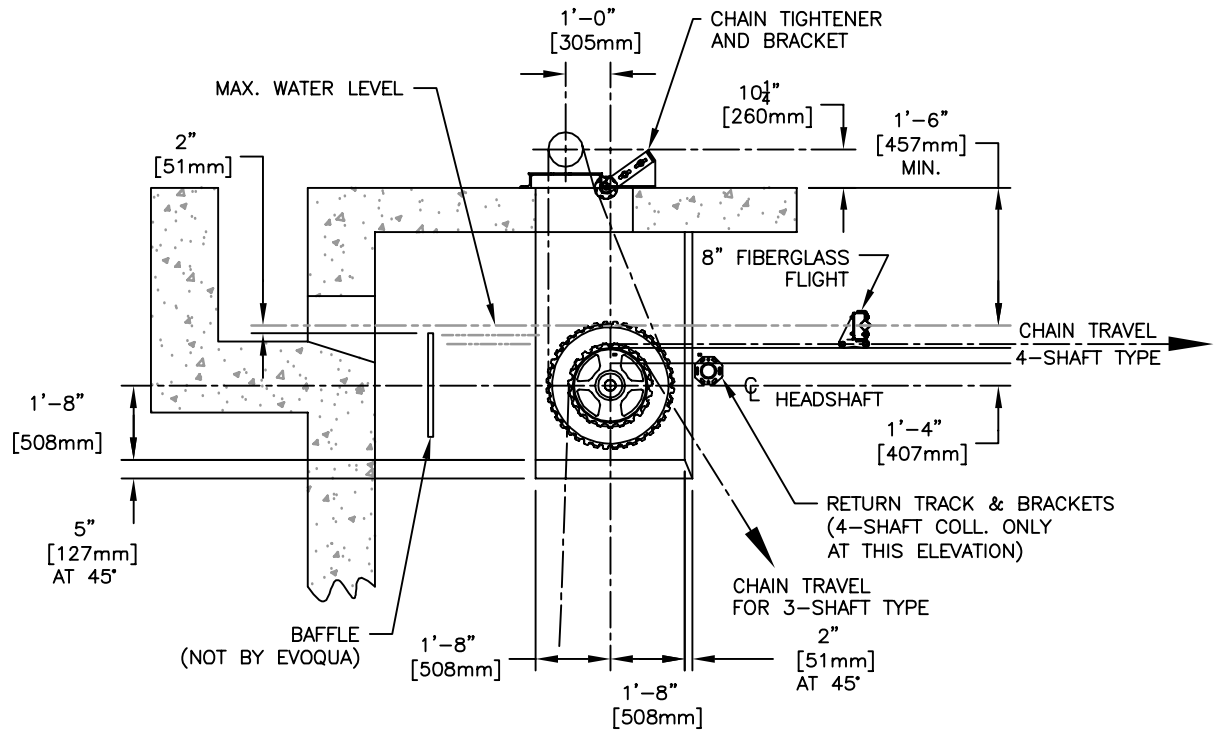
TITLE: ENVIREX CHAIN & SCRAPER SLUDGE COLLECTORS
GENERAL ARRANGEMENT
DOUBLE TANK – 4–SHAFT WITH COMMON DRIVE WALL

CUST.:
LOC.:
ENG.:

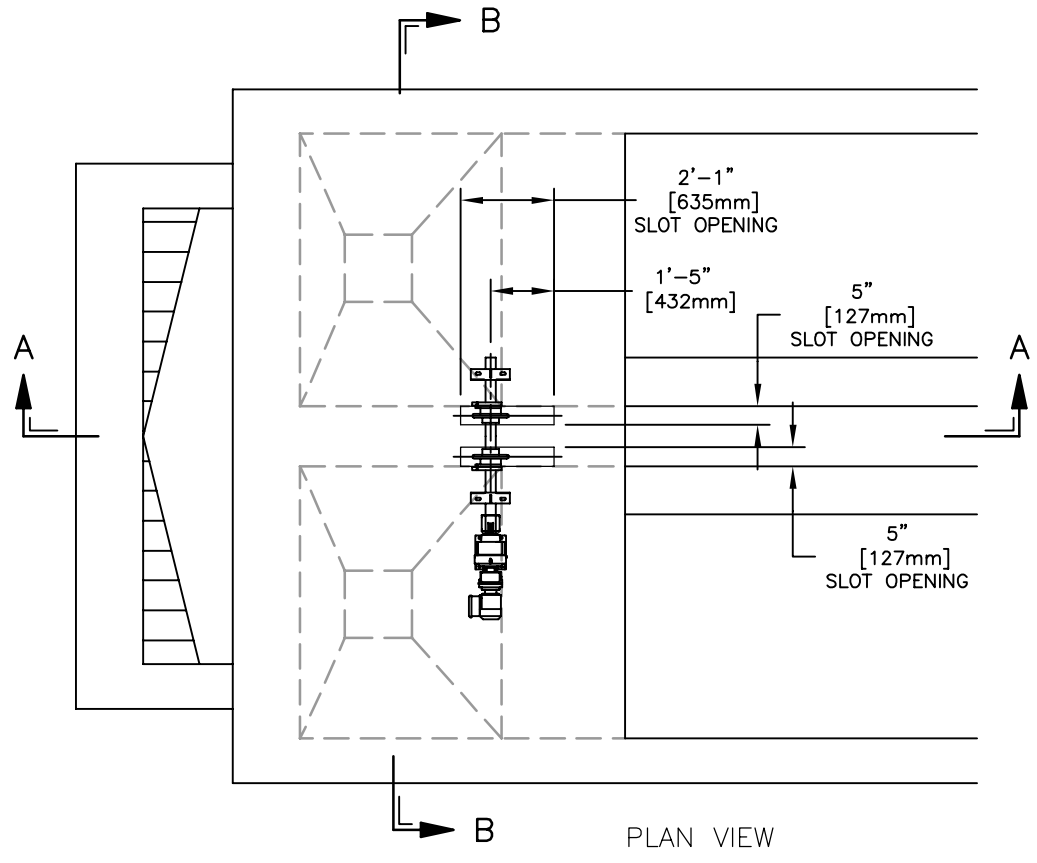
EVOQUA WATER TECHNOLOGIES
WATER TECHNOLOGIES
WAUKESHA, WI
262–547–0141

PROJECT	CODE	DRAWING	SHEET	REV
	4001	1.303	OF	

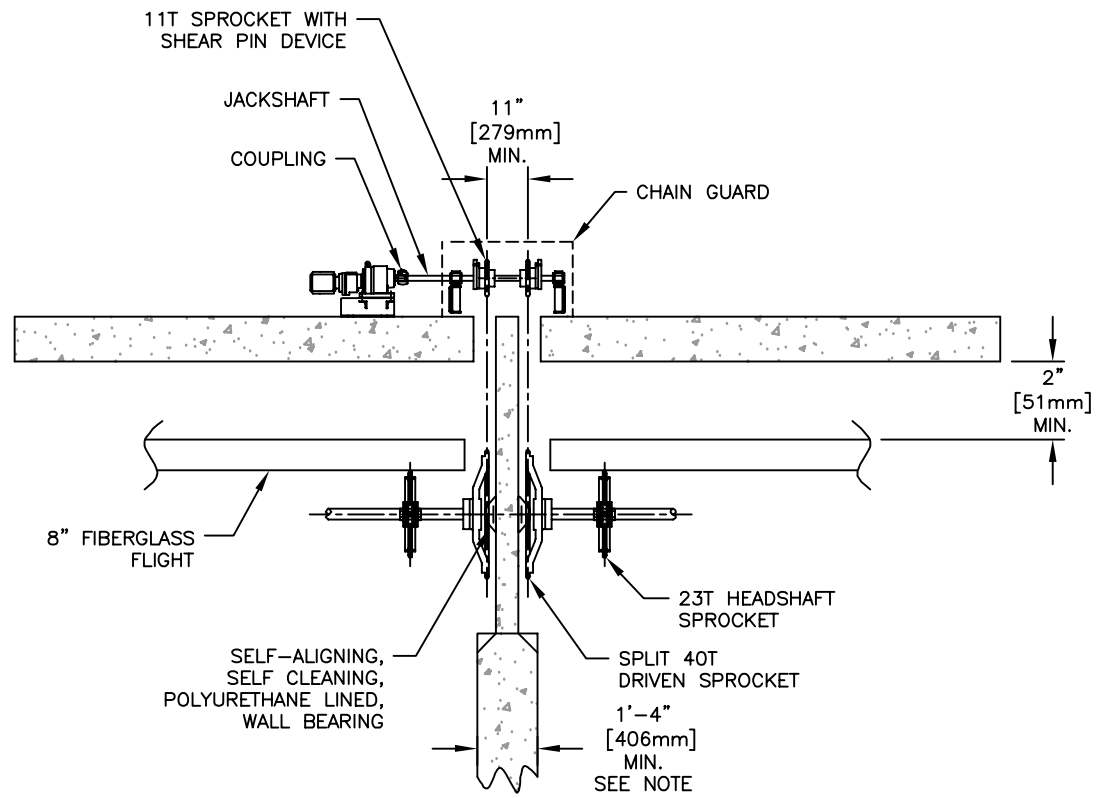
07/25/2014 - 9:29 AM



SECTION "A–A"



PLAN VIEW



SECTION "B–B"

NOTE: IF NARROWER DIVIDER WALLS (COLUMNS AND BEAMS) ARE DESIRED FOR THE REMAINING TANK LENGTH, 8 INCH (203mm) HIGH CONCRETE CORBELS (AT WATER LEVEL) AND CURBS (AT FLOOR LEVEL) ARE REQUIRED ON BOTH SIDES OF THE DIVIDER WALL.

CORBELS AND CURBS ARE ALSO REQUIRED ON THE NON–DRIVE SIDE WALL TO MAKE FLIGHTS SYMETRICAL AND INTERCHANGABLE BETWEEN TANKS.

MASTER REVISION JULY 2014

NOT FOR CONSTRUCTION

TITLE: ENVIREX CHAIN & SCRAPER SLUDGE COLLECTORS
DRIVE ARRANGEMENT – DOUBLE TANK W/COMMON WALL
JACKSHAFT WITH SOLID DIVIDING WALL

CUST.:
LOC.:
ENG.:

EVOQUA WATER TECHNOLOGIES
WATER TECHNOLOGIES
WAUKESHA, WI
262–547–0141

PROJECT	CODE	DRAWING	SHEET	REV
	4001	1.313	OF	

STD: 1–0600–11X17B 07/25/2014 – 11:48 AM

evoqua WATER TECHNOLOGIES CONFIDENTIAL ALL RIGHTS RESERVED	**Budget and Equipment Data Sheet** **Primary Tanks** **COLLECTOR MECHANISMS**	**Installation:** Traverse Cy, Mich. **Engineer:** Hubbell, Roth & Clarke **Proposal No.:** 14' x 66.5' 4-sh **Date:** October 2, 2019 **By:** Steve Ihde **Equipment No.:** 2 **Rev1**

A. CHARACTERISTICS

Manufacturer	Evoqua Water Technologies LLC (Evoqua) - Waukesha, Wisconsin USA
Equipment Description	Envirex® Sludge Collecting Equipment for Primary Sedimentation Basin - Wastewater Plant
Basin Quantity	2
Each Basin Contains	1 Tank
Each Tank Contains	2 Longitudinal Collector Mechanism
Total Sludge Collector Mechanisms	4
Collector Scraping Width	14.00 ft
Tank Length	66.5 ft
Max. WATER Depth (Measured at point nearest edge of hopper)	11.50 ft
New or Existing Tanks	Existing

Overall Channel Width	14.00 ft	**Dividing Wall Type**	N/A	**Dividing Wall(s') Thickness**	None

Budget Information

(4) ea Longitudinal Sludge Collectors

Scum Pipes (4) ea 10 Inch Dia X 14.0 ft Lg

Field Service Included:
Trips: **2**
8 Hr Days at Site: **4**

Estimated Freight included
FOB Shipping Point

Budget
Preliminary budget is based on limited information, Evoqua standard equipment selection, and standard terms of sale and warranty terms. Any variations from these standards may affect this budget. Additionally, please note that this budget is for review and informational purposes only and does not constitute an offer for acceptance. A copy of our standard Terms & Conditions are available upon request. Budget based on delivery within one (1) year from date of this submittal.

Est (2) Truck loads

$191,900 Total USD

Pairs of Sprockets per Collector	4	
Flight Speed	2.0 ft/min	
Flight Spacing - Longitudinal	10.0 ft	
Sludge Load (Average)	4.0 lb/ft	Primary at 4% sludge concentration with 8 inch (200mm) tall flights = 4 lb/ft
Friction Factors	0.20 to 0.30 (UHMW-PE on UHMW-PE - water lubricated) 0.05 to 0.10 (UHMW-PE on Stn. Stl. - water lubricated)	
Bearing Friction Factors	0.05 per shaft assembly	
Shaft Deflection	Less than 0.033 inches/ft of shaft length	

B. MATERIALS

CHAIN			
Flight Carry Chain	NCS720S-NX - Non-metallic, unfilled acetal resin chain and reinforced nylon resin pins, 3/8 inch (10mm) flight fasteners, working load 3100 lbf (13.8 kN), minimum ultimate 6,000 lbf (27 kN), weight 1.3 lb/ft (1.9 kg/m)		
Drive Chain	NH78 - Unfilled acetal links, SS pin, working load 1750 lb (7.78 kN), min. ultimate 4,000 lb (17.79 kN), weight 1.4 lb/ft (2.1 kg/m)		
FLIGHTS			
Flights	Sigma Plus FRP 3 x 8 inch (75 x 200 mm) - Modulus of elasticity (E, psi) x moment of inertia (I, in^4) >/= 6.83 x 10^6 lb-in^2 (19.5 kN-m^2) about its minor axis, 50 to 60% glass content		
WEAR SHOES			
Wear Shoes - Return Track	UHMW-PE with lug every flight Wear shoe (track) - Virgin Black UHMW-PE, ASTM D-4020, w/ lug 4.5 x 3 x 0.5 inch (114 x 76 x 12.7mm), min. 62 Shore "D" ASTM D-2240, 6,000 psi (41,400 KPA) ultimate tensile		
Wear Shoes - Floor	Wear shoe (floor) - Virgin Black UHMW-PE, ASTM D-4020 5.5 wide x 3 x 0.5 inch (140 x 76 x 12.7mm), min. 62 Shore "D" ASTM D-4020, 6,000 psi (41,400 KPA) ultimate tensile		
WEAR STRIPS			
Floor	UHMW-PE 5/8 X 2 5/8 inch (16 x 67mm) - 2 lines per tank		
Attachment	316SS convex washer, #14 x 1-1/2 inch (6 x 38mm) 316SS pan head self tapping screw and vinyl anchor		
Return Tracks	UHMW-PE 5/8 X 2 5/8 inch (16 x 67mm)		
Attachment	316SS convex washer, 1/4 inch (6mm) 410SS, zinc plated self-drilling & tapping pan head screw		
RETURN TRACKS	3 x 3 x 3/8 inch (76 x 76 x 9.5mm)	**Track Mat'l:**	FRP
Supports	Non-metallic - Polypropylene and Schedule 80 CPVC Pipe	**Support Mat'l:**	Non-metallic
Support Spacing	10.0 ft (3.0m)		
DEFLECTOR ANGLES	3 x 3 x 3/8 inch (76 x 76 x 10mm) with UHMW-PE wear strips and 316SS fasteners	**Track Mat'l:**	Carbon Steel
Supports	A500 Sch. 40 steel pipe with 1/4 inch (6mm) steel end plates	**Support Mat'l:**	Carbon Steel
	Note: Deflector angles will be furnished only if it is determined by Evoqua at time of drawing submittal that		
SHAFTING	**Shaft Material:** 1018 CRS with LPS-3 Rust Veto **Idler Shaft Material:** 304SS **Idler Shaft Bracket Material:** Cast Iron		
			Shafting Outside Diameter
Head Shaft	Solid cold rolled steel with keyways for Head Shaft sprockets		3 inch (76mm)
Lower Influent Idler Shaft	Stub shaft with cast iron base	**Shaft** Sch. 40S pipe	3.5 inch (89mm)
Lower Effluent Idler Shaft	Same as Lower Influent Idler Shaft	**Shaft** Sch. 40S pipe	3.5 inch (89mm)
Upper Effluent Idler Shaft	Same as Lower Influent Idler Shaft	**Shaft** Sch. 40S pipe	3.5 inch (89mm)
Set Collars for Head Shaft	Split UHMW set collar with 316SS band clamp		
COLLECTOR BEARINGS			
Head Shaft	Cast steel split housing, polyurethane, self-aligning bearing, water lubricated with provisions for greasing when unsubmerged		Solid Hub Ball
Upper Effl & Lower Effl Idler Shafts	Sprocket bore rotates on Virgin UHMW-PE sprocket sleeve bearing, sprocket position retained by UHMW-PE set collar		
Upper Effluent	Same as Lower Influent Idler Shaft		
GREASING PROVISIONS			
Greasing Provisions	Grease line for driven side Head Shaft bearing only, remaining bearings grease fitting in housing.		
Type / Material	Head Shaft driven side bearing with rubber flex line with Alemite grease fitting, 1/8 inch NPT, material		
COLLECTOR SPROCKETS			
Head Shaft	NCS720S, 23T-22.24 inch (565mm) PD w/ chain saver rim, split cast nylon, bolted hub with 316SS hdw. and set screws		
Idler Shaft	NCS720S, 17T-16.61 inch (422mm) PD w/ chain saver rim, solid cast nylon		

DRIVE SPROCKET and TORQUE LIMITER	N78-11T-9.26 inch (235mm) PD polyurethane tooth segments and shear pin torque limiter **Hub Material:** 316SS Torque Limiter
DRIVEN SPROCKET	N78-40T-33.25 inch (845mm) PD, split polyurethane hub, deep dished and replaceable polyurethane tooth segments, 316 SS hdw.
DRIVE UNIT	
SPEED REDUCER	
Each reducer will drive	two (2) longitudinal collectors
Longitudinal reducer will be	jackshaft with sprocket and shear pin torque limiter for each collector
Manufacturer	Eurodrive or equal
Specifications:	Helical gear, fully housed, running in oil, anti-friction bearings throughout
Sizing of reducer	Torque rated at minimum 1.25 S.F. of calculated sludge load
Motor attachment	C-face
Paint	Original factory finish
MOTOR	
Manufacturer	Baldor (C-face) or equal
HP (kw)	0.5 HP (0.37kw)
Service Factor	1.25
V / Ph / Hz	230/460 V 3 Ph 60 Hz
RPM	1750
Encl. / Insul. / NEMA (IP) Design	TEFC (IP55) Enclosure / Class F Insulation / NEMA Design B
Efficiency	Premium Efficient
Paint	Original factory finish
Torque Overload Protection Device	Shear pin torque limiter with combination NEMA 4X (IP67) / NEMA 7 (IEC Zone 0 and 1) limit switch
Drive Base	304SS
Chain Guard	14 Ga. (3mm) 304SS
Drive Chain Tightener	316SS bracket, self-aligning, self-lubricated with N78-7T Polyurethane Sprocket
ELECTRICAL CONTROLS	
Controls	Over torque indicating switches only - all other controls NOT by Evoqua
HARDWARE	
Flights	316SS HHCS's, flat washers, and locknuts
Miscellaneous connections	316SS
Thread Standard	Unified American Standard
Anchors	Stud anchors for all locations except adhesive for stub shaft brackets
Anchor material	316SS
PAINT	
Surface prep (Non-Subm)	Shop blast to SSPC-SP10
Surface prep (Submerged)	Shop blast to SSPC-SP10
Shop prime - Non-submerged	Sherwin-Williams Dura-Plate 235NSF red oxide epoxy 4-8 mil DFT or Equal
Shop prime - Submerged	Sherwin-Williams Dura-Plate 235NSF red oxide epoxy 4-8 mil DFT or Equal
Finish paint - Non-submerged	Field applied coating by others
Finish paint - Submerged	Field applied coating by others
Paint Note:	All non-stainless steel shafting, including Head Shafts, Idler Shafting and exposed machined surfaces are solvent wiped followed by one (1) coat of Evoqua standard shop preservative. Wood, stainless steel, nonferrous materials and galvanized surfaces are unpainted. Unless specified, structural stainless steel is not passivated.
SKIMMING EQUIPMENT	Scum pipes by Evoqua **See Separate Equipment Data Sheet (EDS)**
SPARE PARTS	Spare parts are Not included.

EXCLUSIONS

Our equipment does NOT include any controls except as specifically stated within this Proposal, tools (except chain tool for NCS720S chain), grease lines, troughs, weirs, baffles, pumps, valves, weir gates, floor or wall sleeves, shims, grout, anchor templates, setting of anchor bolts, lubricants, finish painting, installation, taxes or duties, or material excluded under the General Items of this Proposal.

NOTE:

Evoqua will furnish equipment as proposed for the Contractor to install. Labor, equipment necessary for alterations and/or installation of our equipment, repair, alterations or cleaning of the existing structures, is the responsibility of the Contractor. Evoqua is not responsible for the locations, condition or dimensions of existing concrete, anchors, or any equipment not furnished by Evoqua. For existing sludge collector mechanism installations, concrete modifications may be required to accommodate newer style components. Example: The driven sprocket recess may need to be made deeper and/or larger.

EVOQUA WATER TECHNOLOGIES CONFIDENTIAL ALL RIGHTS RESERVED	**Equipment Data Sheet** **Primary Tanks** **SCUM PIPES**	**Installation:** Traverse Cy, Mich. **Engineer:** Hubbell, Roth & Clarke **Proposal No.:** 14' x 66.5' 4-sh **Date:** September 30, 2019 **By:** SDI **Equipment No.:** **2**

A. CHARACTERISTICS

Manufacturer	Evoqua Water Technologies LLC (Evoqua) - Waukesha, Wisconsin USA
Equipment Description	Envirex® Scum Pipes Manual Lever
Total Scum Pipes	4
Scum Pipe Diameter	10 inch
Scum Pipe Length	14.00 ft
New or Existing Tanks	Existing
Budget Information	Scum Pipes are included in the Chain and Flight budget

B. MATERIALS

PIPE	
Material	Carbon steel - ASTM A53, Grade B, black
Size	10 inch
Wall Thickness	0.25 inch
Specifications	0.25 inch (6mm) wall thickness, 60 degree slotted weir openings and 2 inch (50mm) wide full periphery stiffening bands every 2 ft (610mm)
END SUPPORTS and SET COLLARS	
Material	Carbon steel
Specifications	Adjustable end plate with rolled collar and replaceable UHMW-PE bearing liner. Set collars, same material as end plate, secures pipe and seal position.
Seals - Wall to open end support	Plywood - 1/2 inch (12mm) thick, Marine Grade
Seals - Pipe to open end support	Hycar - Buna N synthetic rubber
OPERATOR	
Type	Manual Lever
Lever Material	Carbon steel - ASTM A53, Grade B, black
Lubrication	No lubrication required
Specifications	1.5 inch (38mm) dia. Sch. 40 pipe lever
Min. Pipe Rotation Each Direction	30 degrees
HARDWARE	
Miscellaneous connections	316SS
Thread Standard	Unified American Standard

Anchors	Stud anchors at all locations
PAINT	
Surface prep (Non-Subm)	Shop blast to SSPC-SP10
Surface prep (Submerged)	Shop blast to SSPC-SP10
Shop prime - Non-submerged	Sherwin-Williams Dura-Plate 235NSF red oxide epoxy 4-8 mil DFT or Equal
Shop prime - Submerged	Sherwin-Williams Dura-Plate 235NSF red oxide epoxy 4-8 mil DFT or Equal
Finish paint - Non-submerged	Field applied coating by others
Finish paint - Submerged	Field applied coating by others
Paint Note:	All non-stainless steel shafting and exposed machined surfaces are solvent wiped followed by one (1) coat of Evoqua standard shop preservative. Wood, stainless steel, nonferrous materials and galvanized surfaces are unpainted.

EXCLUSIONS

Our scum pipe(s) do NOT include any controls, tools, spray headers, nozzles, effluent troughs, baffles, wall sleeves, pipe sleeves, setting of anchor bolts, special or finish painting, equipment installation, taxes or duties, equipment installation, or materials noted under the General items of our Proposal.

CONTRACTOR NOTE:

Evoqua will furnish equipment as proposed for the Contractor to install. Labor, equipment necessary for alterations and/or installation of our equipment, repair, alterations or cleaning of the existing structures, is the responsibility of the Contractor. Evoqua is not responsible for the locations, condition or dimensions of existing concrete, anchors, or any equipment not furnished by Evoqua. For existing sludge collector mechanism installations, concrete modifications may be required to accommodate newer style components. Example: The driven sprocket recess may need to be made deeper and/or larger.

evoqua WATER TECHNOLOGIES CONFIDENTIAL ALL RIGHTS RESERVED	**Budget and Equipment Data Sheet** **Primary Tanks** **COLLECTOR MECHANISMS**	**Installation:** Traverse Cy, Mich. **Engineer:** Hubbell, Roth & Clarke **Proposal No.:** 16' x 66.5' 4-sh **Date:** September 30, 2019 **By:** Steve Ihde **Equipment No.:** **1**

A. CHARACTERISTICS

Manufacturer	Evoqua Water Technologies LLC (Evoqua) - Waukesha, Wisconsin USA
Equipment Description	Envirex® Sludge Collecting Equipment for Primary Sedimentation Basin - Wastewater Plant
Basin Quantity	2
Each Basin Contains	1 Tank
Each Tank Contains	2 Longitudinal Collector Mechanism
Total Sludge Collector Mechanisms	4
Collector Scraping Width	16.00 ft
Tank Length	66.5 ft
Max. WATER Depth (Measured at point nearest edge of hopper)	10.00 ft
New or Existing Tanks	Existing

Overall Channel Width	16.00 ft	**Dividing Wall Type**	N/A	**Dividing Wall(s') Thickness**	None

Budget Information

(4) ea Longitudinal Sludge Collectors

Scum Pipes (4) ea 10 Inch Dia X 16.0 ft Lg

Field Service Included:
Trips: **2**
8 Hr Days at Site: **4**

Estimated Freight included
FOB Shipping Point

Budget
Preliminary budget is based on limited information, Evoqua standard equipment selection, and standard terms of sale and warranty terms. Any variations from these standards may affect this budget. Additionally, please note that this budget is for review and informational purposes only and does not constitute an offer for acceptance. A copy of our standard Terms & Conditions are available upon request. Budget based on delivery within one (1) year from date of this submittal.

Est (2) Truck loads

$197,100 Total USD

Pairs of Sprockets per Collector	4	
Flight Speed	2.0 ft/min	
Flight Spacing - Longitudinal	10.0 ft	
Sludge Load (Average)	4.0 lb/ft	Primary at 4% sludge concentration with 8 inch (200mm) tall flights = 4 lb/ft
Friction Factors	0.20 to 0.30 (UHMW-PE on UHMW-PE - water lubricated) 0.05 to 0.10 (UHMW-PE on Stn. Stl. - water lubricated)	
Bearing Friction Factors	0.05 per shaft assembly	
Shaft Deflection	Less than 0.033 inches/ft of shaft length	

B. MATERIALS

CHAIN			
Flight Carry Chain	NCS720S-NX - Non-metallic, unfilled acetal resin chain and reinforced nylon resin pins, 3/8 inch (10mm) flight fasteners, working load 3100 lbf (13.8 kN), minimum ultimate 6,000 lbf (27 kN), weight 1.3 lb/ft (1.9 kg/m)		
Drive Chain	NH78 - Unfilled acetal links, SS pin, working load 1750 lb (7.78 kN), min. ultimate 4,000 lb (17.79 kN), weight 1.4 lb/ft (2.1 kg/m)		
FLIGHTS			
Flights	Sigma Plus FRP 3 x 8 inch (75 x 200 mm) - Modulus of elasticity (E, psi) x moment of inertia (I, in^4) >/= 6.83 x 10^6 lb-in^2 (19.5 kN-m^2) about its minor axis, 50 to 60% glass content		
WEAR SHOES			
Wear Shoes - Return Track	UHMW-PE with lug every flight Wear shoe (track) - Virgin Black UHMW-PE, ASTM D-4020, w/ lug 4.5 x 3 x 0.5 inch (114 x 76 x 12.7mm), min. 62 Shore "D" ASTM D-2240, 6,000 psi (41,400 KPA) ultimate tensile		
Wear Shoes - Floor	Wear shoe (floor) - Virgin Black UHMW-PE, ASTM D-4020 5.5 wide x 3 x 0.5 inch (140 x 76 x 12.7mm), min. 62 Shore "D" ASTM D-4020, 6,000 psi (41,400 KPA) ultimate tensile		
WEAR STRIPS			
Floor	UHMW-PE 5/8 X 2 5/8 inch (16 x 67mm) - 2 lines per tank		
Attachment	316SS convex washer, #14 x 1-1/2 inch (6 x 38mm) 316SS pan head self tapping screw and vinyl anchor		
Return Tracks	UHMW-PE 5/8 X 2 5/8 inch (16 x 67mm)		
Attachment	316SS convex washer, 1/4 inch (6mm) 410SS, zinc plated self-drilling & tapping pan head screw		
RETURN TRACKS	3 x 3 x 3/8 inch (76 x 76 x 9.5mm)	**Track Mat'l:**	FRP
Supports	Non-metallic - Polypropylene and Schedule 80 CPVC Pipe	**Support Mat'l:**	Non-metallic
Support Spacing	10.0 ft (3.0m)		
DEFLECTOR ANGLES	3 x 3 x 3/8 inch (76 x 76 x 10mm) with UHMW-PE wear strips and 316SS fasteners	**Track Mat'l:**	Carbon Steel
Supports	A500 Sch. 40 steel pipe with 1/4 inch (6mm) steel end plates	**Support Mat'l:**	Carbon Steel
	Note: Deflector angles will be furnished only if it is determined by Evoqua at time of drawing submittal that		
SHAFTING	**Shaft Material:** 1018 CRS with LPS-3 Rust Veto **Idler Shaft Material:** 304SS **Idler Shaft Bracket Material:** Cast Iron		
			Shafting Outside Diameter
Head Shaft	Solid cold rolled steel with keyways for Head Shaft sprockets		3.5 inch (89mm)
Lower Influent Idler Shaft	Stub shaft with cast iron base	**Shaft** Sch. 40S pipe	3.5 inch (89mm)
Lower Effluent Idler Shaft	Same as Lower Influent Idler Shaft	**Shaft** Sch. 40S pipe	3.5 inch (89mm)
Upper Effluent Idler Shaft	Same as Lower Influent Idler Shaft	**Shaft** Sch. 40S pipe	3.5 inch (89mm)
Set Collars for Head Shaft	Split UHMW set collar with 316SS band clamp		
COLLECTOR BEARINGS			
Head Shaft	Cast steel split housing, polyurethane, self-aligning bearing, water lubricated with provisions for greasing when unsubmerged		Solid Hub Ball
Upper Effl & Lower Effl Idler Shafts	Sprocket bore rotates on Virgin UHMW-PE sprocket sleeve bearing, sprocket position retained by UHMW-PE set collar		
Upper Effluent	Same as Lower Influent Idler Shaft		
GREASING PROVISIONS			
Greasing Provisions	Grease line for driven side Head Shaft bearing only, remaining bearings grease fitting in housing.		
Type / Material	Head Shaft driven side bearing with rubber flex line with Alemite grease fitting, 1/8 inch NPT, material		
COLLECTOR SPROCKETS			
Head Shaft	NCS720S, 23T-22.24 inch (565mm) PD w/ chain saver rim, split cast nylon, bolted hub with 316SS hdw. and set screws		
Idler Shaft	NCS720S, 17T-16.61 inch (422mm) PD w/ chain saver rim, solid cast nylon		

DRIVE SPROCKET and TORQUE LIMITER	N78-11T-9.26 inch (235mm) PD polyurethane tooth segments and shear pin torque limiter **Hub Material:** 316SS Torque Limiter
DRIVEN SPROCKET	N78-40T-33.25 inch (845mm) PD, split polyurethane hub, deep dished and replaceable polyurethane tooth segments, 316 SS hdw.
DRIVE UNIT	
SPEED REDUCER	
Each reducer will drive	two (2) longitudinal collectors
Longitudinal reducer will be	jackshaft with sprocket and shear pin torque limiter for each collector
Manufacturer	Eurodrive or equal
Specifications:	Helical gear, fully housed, running in oil, anti-friction bearings throughout
Sizing of reducer	Torque rated at minimum 1.25 S.F. of calculated sludge load
Motor attachment	C-face
Paint	Original factory finish
MOTOR	
Manufacturer	Baldor (C-face) or equal
HP (kw)	0.5 HP (0.37kw)
Service Factor	1.25
V / Ph / Hz	230/460 V 3 Ph 60 Hz
RPM	1750
Encl. / Insul. / NEMA (IP) Design	TEFC (IP55) Enclosure / Class F Insulation / NEMA Design B
Efficiency	Premium Efficient
Paint	Original factory finish
Torque Overload Protection Device	Shear pin torque limiter with combination NEMA 4X (IP67) / NEMA 7 (IEC Zone 0 and 1) limit switch
Drive Base	304SS
Chain Guard	14 Ga. (3mm) 304SS
Drive Chain Tightener	316SS bracket, self-aligning, self-lubricated with N78-7T Polyurethane Sprocket
ELECTRICAL CONTROLS	
Controls	Over torque indicating switches only - all other controls NOT by Evoqua
HARDWARE	
Flights	316SS HHCS's, flat washers, and locknuts
Miscellaneous connections	316SS
Thread Standard	Unified American Standard
Anchors	Stud anchors for all locations except adhesive for stub shaft brackets
Anchor material	316SS
PAINT	
Surface prep (Non-Subm)	Shop blast to SSPC-SP10
Surface prep (Submerged)	Shop blast to SSPC-SP10
Shop prime - Non-submerged	Sherwin-Williams Dura-Plate 235NSF red oxide epoxy 4-8 mil DFT or Equal
Shop prime - Submerged	Sherwin-Williams Dura-Plate 235NSF red oxide epoxy 4-8 mil DFT or Equal
Finish paint - Non-submerged	Field applied coating by others
Finish paint - Submerged	Field applied coating by others
Paint Note:	All non-stainless steel shafting, including Head Shafts, Idler Shafting and exposed machined surfaces are solvent wiped followed by one (1) coat of Evoqua standard shop preservative. Wood, stainless steel, nonferrous materials and galvanized surfaces are unpainted. Unless specified, structural stainless steel is not passivated.
SKIMMING EQUIPMENT	Scum pipes by Evoqua **See Separate Equipment Data Sheet (EDS)**
SPARE PARTS	Spare parts are Not included.

EXCLUSIONS

Our equipment does NOT include any controls except as specifically stated within this Proposal, tools (except chain tool for NCS720S chain), grease lines, troughs, weirs, baffles, pumps, valves, weir gates, floor or wall sleeves, shims, grout, anchor templates, setting of anchor bolts, lubricants, finish painting, installation, taxes or duties, or material excluded under the General Items of this Proposal.

NOTE:

Evoqua will furnish equipment as proposed for the Contractor to install. Labor, equipment necessary for alterations and/or installation of our equipment, repair, alterations or cleaning of the existing structures, is the responsibility of the Contractor. Evoqua is not responsible for the locations, condition or dimensions of existing concrete, anchors, or any equipment not furnished by Evoqua. For existing sludge collector mechanism installations, concrete modifications may be required to accommodate newer style components. Example: The driven sprocket recess may need to be made deeper and/or larger.

	Equipment Data Sheet **Primary Tanks** **SCUM PIPES**	**Installation:** Traverse Cy, Mich. **Engineer:** Hubbell, Roth & Clarke **Proposal No.:** 16' x 66.5' 4-sh **Date:** September 30, 2019 **By:** SDI **Equipment No.:** **1**

A. CHARACTERISTICS

Manufacturer	Evoqua Water Technologies LLC (Evoqua) - Waukesha, Wisconsin USA
Equipment Description	Envirex® Scum Pipes Manual Lever
Total Scum Pipes	4
Scum Pipe Diameter	10 inch
Scum Pipe Length	16.00 ft
New or Existing Tanks	Existing
Budget Information	Scum Pipes are included in the Chain and Flight budget

B. MATERIALS

PIPE	
Material	Carbon steel - ASTM A53, Grade B, black
Size	10 inch
Wall Thickness	0.25 inch
Specifications	0.25 inch (6mm) wall thickness, 60 degree slotted weir openings and 2 inch (50mm) wide full periphery stiffening bands every 2 ft (610mm)
END SUPPORTS and SET COLLARS	
Material	Carbon steel
Specifications	Adjustable end plate with rolled collar and replaceable UHMW-PE bearing liner. Set collars, same material as end plate, secures pipe and seal position.
Seals - Wall to open end support	Plywood - 1/2 inch (12mm) thick, Marine Grade
Seals - Pipe to open end support	Hycar - Buna N synthetic rubber
OPERATOR	
Type	Manual Lever
Lever Material	Carbon steel - ASTM A53, Grade B, black
Lubrication	No lubrication required
Specifications	1.5 inch (38mm) dia. Sch. 40 pipe lever
Min. Pipe Rotation Each Direction	30 degrees
HARDWARE	
Miscellaneous connections	316SS
Thread Standard	Unified American Standard

Anchors	Stud anchors for all locations except adhesive for stub shaft brackets
PAINT	
Surface prep (Non-Subm)	Shop blast to SSPC-SP10
Surface prep (Submerged)	Shop blast to SSPC-SP10
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Urquhart, Douglas

From: Joe Gentle <joe@peswater.com>
Sent: Tuesday, October 15, 2019 1:29 PM
To: Benoit Dennis J.
Subject: FW: Traverse City, MI Primary Clarifier Rehab AMWELL SO# 93061 and 93062 Budget Pricing October 2019 G-4555
Attachments: AMWELL Typical PSG Fabricated Pipe Skimmers.pdf

Dennis,

Here's Amwell's quote for the primaries, working on the rest now.

Joe

From: Paul Haizman [mailto:phaizman@amwell-inc.com]
Sent: Tuesday, October 15, 2019 12:02 PM
To: 'Joe Gentle'
Subject: RE: Traverse City, MI Primary Clarifier Rehab AMWELL SO# 93061 and 93062 Budget Pricing October 2019 G-4555

Joe,

In around 1995, AMWELL furnished the following chain and flight collection equipment to this facility:

- SO# 93061 - **Four (4)** Chain and flight collectors for tanks approximately 14' wide x 52' long x 11'-3" AWD **(Tanks 1N,2N, 1S & 2S)**
- SO# 93062 - **Four (4)** Chain and flight collectors for tanks approximately 16' wide x 65' long x 9'-4" AWD **(Tanks 3N,4N, 3S & 4S)**

The budget scope of supply for completely replacing this chain and flight collector equipment would be as follows:

- Anchorage, SS
- Gearmotor with Overload Protection device
- Drive Chain, NH-78 Non -metallic
- Shafts, Steel
- Bearings, CI with UHMW liner
- Sprockets, UHMW or Nylon
- Main Chain, 720S non-metallic Hydrolink
- Return Track and support brackets, FRP
- Sludge Flights, FRP
- Wear Shoes and Wear strips, UHMW
- Assembly fasteners, SS
- Delivery
- Approval Drawings
- I,O & M's

- Field Service

The approximate budget cost for replacing chain and flight equipment in all of these **eight (8)** tanks would be between **$ 295,000 – $ 325,000 complete.**

We did not supply any new scum troughs during the last contract. They used their existing units.

If needed, a budget scope for the required gear and handwheel operated pipe skimmers would be as follows:

- Anchorage
- Wall Seals, neoprene
- Bearings,304 SS
- Sleeves, 304 SS
- D Ring Seals, neoprene
- Slotted trough,304 SS
- Operator, 304 SS
- Hand Wheel, CI
- Approval Drawings
- Delivery
- Spare Parts

The approximate budget cost for replacing the gear and handwheel operated pipe skimmers (assume 10" dia. for budget purposes) in all of these **eight (8)** tanks would be between **$ 110,000 - $122,000 complete.**

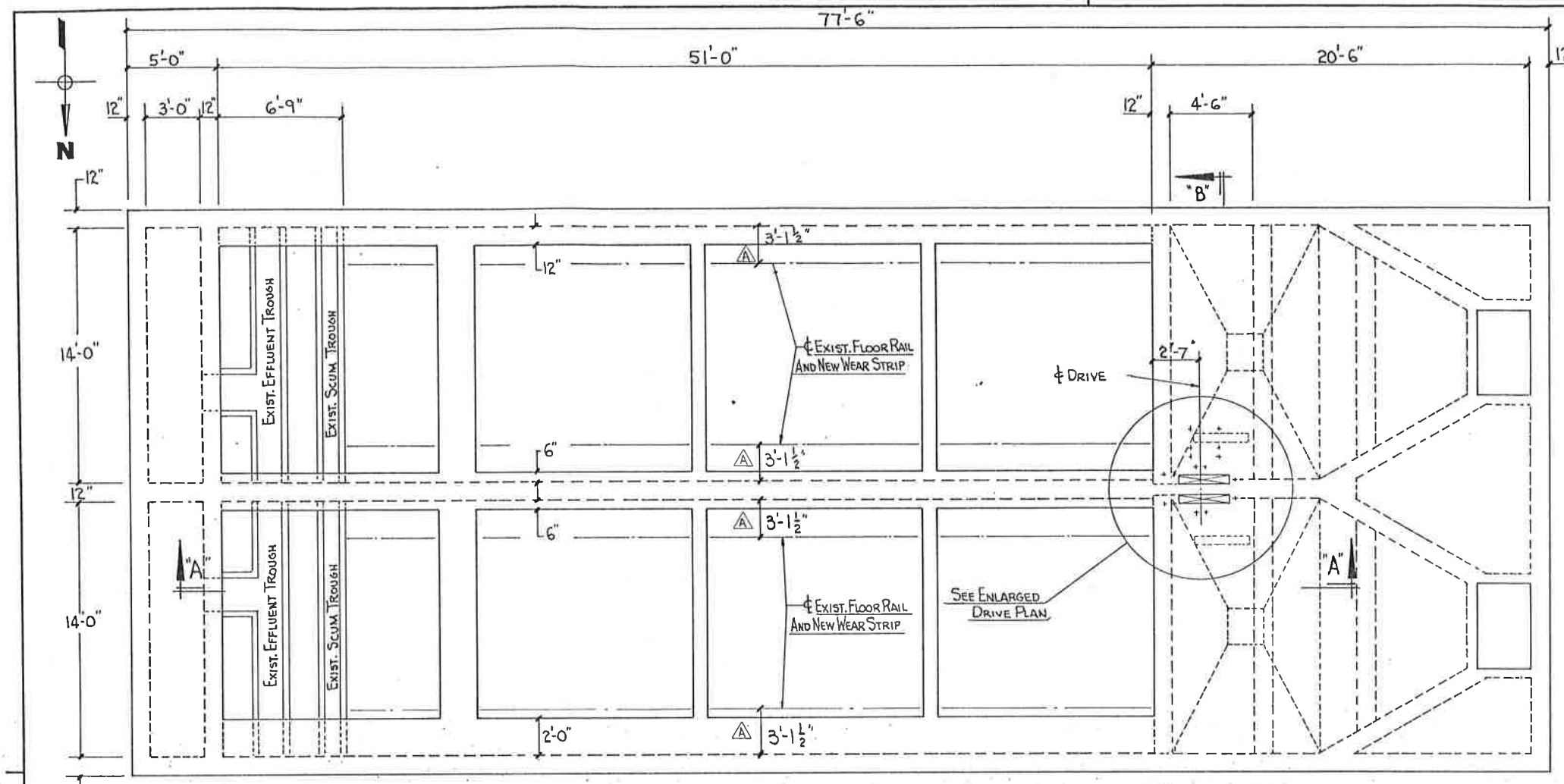
I have attached a general arrangement drawing of the gear and handwheel operated pipe skimmers in side by side tanks for your reference.

Let me know if you have any further questions.

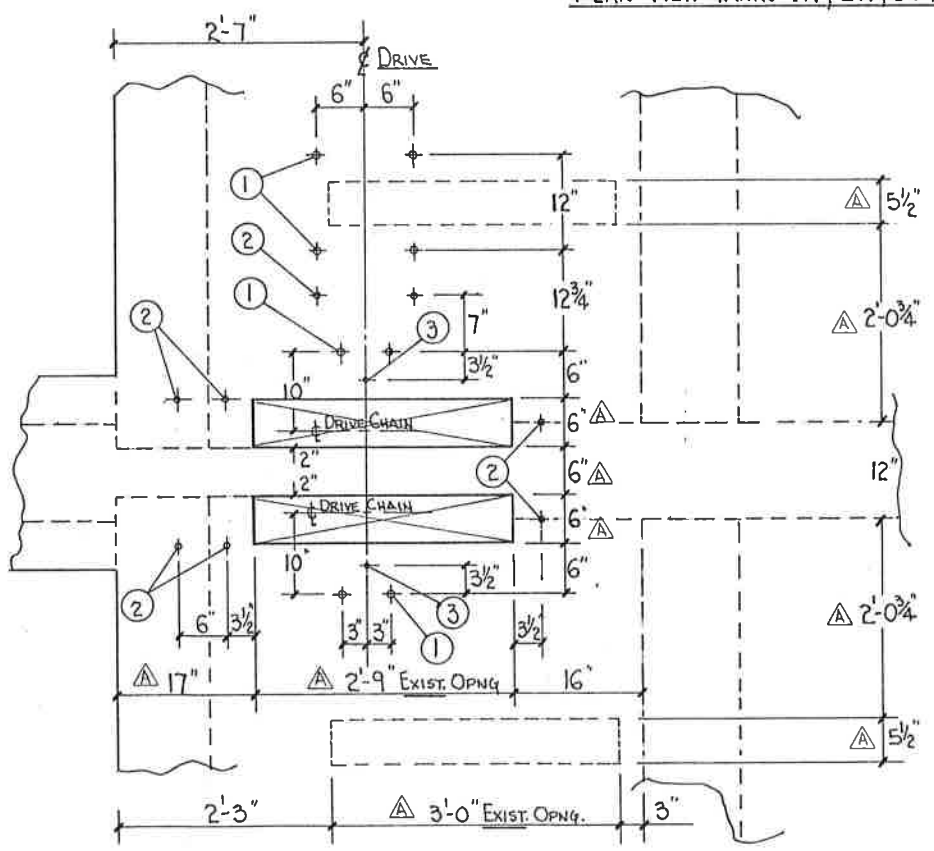
Regards,

Paul Haizman
AMWELL – A Division of McNish Corporation
600 North Commons Drive, Suite 116
Aurora, IL 60504
P: 630-898-6900 x3914
C: 630-347-9506
F: 630-898-1647

NO.	DESCRIPTION	MAT'L	QTY.	PART NO.



PLAN VIEW TANKS 1N, 2N, 1S & 2S



ENLARGED DRIVE PLAN

NOTES:
1) SECTION "A-A" SHOWN ON DWG. D101-42721-162.
2) SECTION "B-B" SHOWN ON DWG. D101-42722-162.
3) ANCHOR BOLT SCHEDULE SHOWN ON DWG. D101-42721-162.

PROJECT: TRAVERSE CITY, MI.

SYM.	REVISIONS	BY	CK'D.	DATE
⚠	DIM'S CONFIRMED, CORRECTED, OR PROVIDED BY CONTRACTOR	RON		9/24/15

AMWELL FURNISHES MECHANISM TO FIT TANK OF DIMENSIONS GIVEN, BUT IS NOT RESPONSIBLE FOR CONCRETE OR BY CUSTOMER TO FURNISH NECESSARY REINFORCING STEEL AND TO DETERMINE SIZE AND PLACEMENT OF FOOTINGS TO SUIT LOCAL CONDITIONS.

AMWELL DOES NOT FURNISH PIPING (EXCEPT AS NOTED) FLOOR RAILS, TROUGHS, GRATINGS, WEIR PLATES, OIL OR GREASE FOR LUBRICATION, ANY WIRING OR CONDUITS BETWEEN MOTORS, CONTROLS AND ALARMS OR ANY ELECTRICAL EQUIPMENT OF ANY KIND EXCEPT AS SPECIFICALLY STATED IN AMWELL SPECIFICATIONS

LIMITS UNLESS OTHERWISE SPECIFIED
FRACTIONAL
± DECIMAL
± DECIMAL
ANGULAR

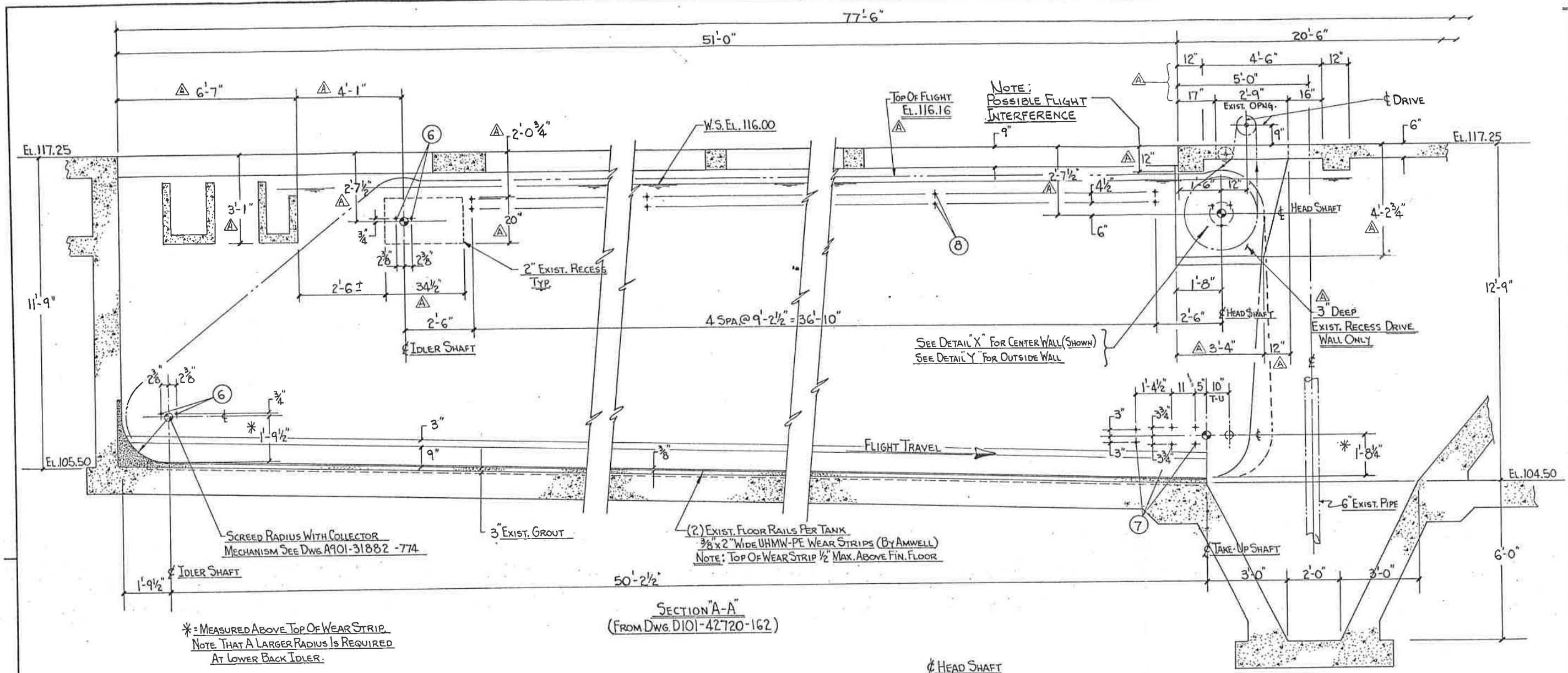
MICROFILMED
PATT. NO.

AMWELL
AURORA, ILLINOIS, USA
(ORIGINALLY AMERICAN WELL WORKS — EST. 1868)

DRAWN	RON
CHECKED	
APP'D.	
DATE	1/17/96
S.O.	930061-11
SCALE	¾"

DESCRIPTION: GENERAL ARRANGEMENT MODEL "CHP-42" RECTANGULAR COLLECTORS

DRAWING NO. D101142720116 2 REV. A

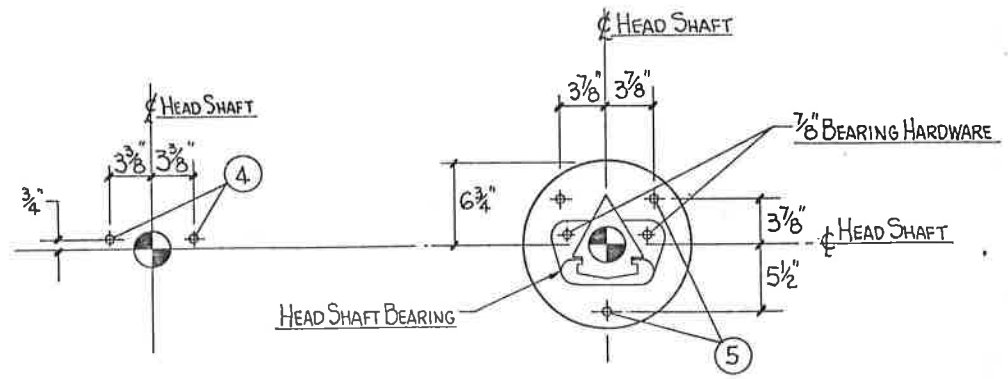


*= MEASURED ABOVE TOP OF WEAR STRIP. NOTE THAT A LARGER RADIUS IS REQUIRED AT LOWER BACK IDLER.

SECTION "A-A"
(FROM DWG. D101-42720-162)

EXPANSION ANCHOR BOLT SCHEDULE (304 STNLS. STL.)

№	SIZE	HOLE SIZE & DEPTH	LOCATION	TOTAL QTY.
1	⅝" x 6" Lg.	⅝" ϕ x 4" Dp.	DRIVE BASE & BEARING PEDESTAL	16
2	½" x 3¾" Lg.	½" ϕ x 3" Dp.	DRIVE CHAIN TAKE-UP & GUARDS	16
3	⅜" x 3" Lg.	⅜" ϕ x 2¼" Dp.	SHEAR PIN LIMIT SWITCH BRACKET	4
4	⅞" x 8" Lg.	⅞" ϕ x 5½" Dp.	HEAD SHAFT BEARING	8
⚠ 5	¾" x 12" THRD. ROD	¾" ϕ THRU	HEAD SHAFT BEARING MOUNTING PLATE	6
6	¾" x 6¼" Lg.	¾" ϕ x 4¼" Dp.	IDLER SHAFT BEARING	32
7	¾" x 5½" Lg.	¾" ϕ x 4½" Dp.	MAIN CHAIN TAKE-UP ASS'Y.	48
8	⅝" x 5" Lg.	⅝" ϕ x 3½" Dp.	RETURN TRACK SUPPORT BRACKET	96



DETAIL "Y"
@ OUTSIDE WALL ONLY

DETAIL "X"
¾" THK. HEAD SHAFT BEARING MOUNTING PLATE EACH SIDE OF CENTER WALL (DRIVE WALL)

PROJECT: TRAVERSE CITY, MI.

MICROFILMED
PATT. NO.

SYM.	REVISIONS	BY	CK'D.	DATE
⚠	DIM'S. CONFIRMED, CORRECTED OR PROVIDED BY CONTRACTOR	RON		9/26/96

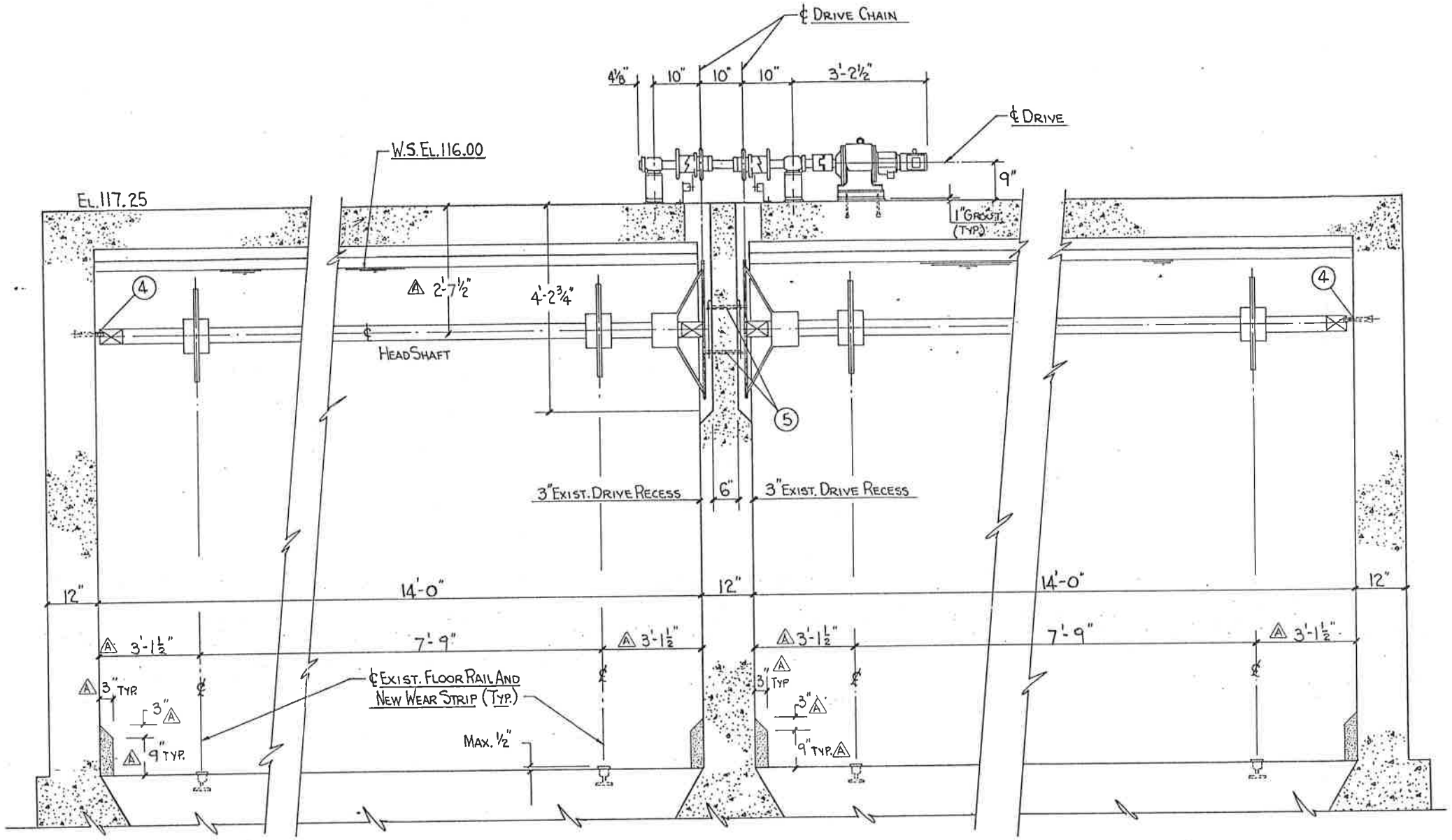
AMWELL FURNISHES MECHANISM TO FIT TANK OF DIMENSIONS GIVEN. BUT IS NOT RESPONSIBLE FOR CONCRETE DESIGN. CUSTOMER TO FURNISH NECESSARY REINFORCING STEEL AND TO DETERMINE SIZE AND PLACEMENT OF FOOTINGS TO SUIT LOCAL CONDITIONS.

AMWELL DOES NOT FURNISH PIPING (EXCEPT AS NOTED) FLOOR RAILS, TROUGHS, GRATINGS, WEIR PLATES, OIL OR GREASE FOR LUBRICATION, ANY WIRING OR CONDUITS BETWEEN MOTORS, CONTROLS AND ALARMS OR ANY ELECTRICAL EQUIPMENT OF ANY KIND EXCEPT AS SPECIFICALLY STATED IN AMWELL SPECIFICATIONS

LIMITS UNLESS OTHERWISE SPECIFIED
FRACTIONAL
2 DECIMAL
3 DECIMAL
ANGULAR

DRAWN	RON
CHECKED	
APP'D.	
DATE	1/19/95
S.O.	93061-11
SCALE	
DESCRIPTION	GENERAL ARRANGEMENT
DRAWING NO.	D101427211162
REV.	A

NO.	DESCRIPTION	MAT'L	QTY.	PART NO.



Section "B-B"
(From Dwg. D101-42720-162)

Note:
1.) Anchor Bolt Schedule Shown On Dwg. D101-42721-162.

Project: Traverse City, MI.

MICROFILMED

PATT. NO.

SYM.	REVISIONS	BY	CK'D.	DATE
	DIM'S CONFIRMED, CORRECTED OR PROVIDED BY CONTRACTOR.	RON		6/14/95

AMWELL FURNISHES MECHANISM TO FIT TANK OF DIMENSIONS GIVEN, BUT IS NOT RESPONSIBLE FOR CONCRETE DESIGN. CUSTOMER TO FURNISH NECESSARY REINFORCING STEEL AND TO DETERMINE SIZE AND PLACEMENT OF FOOTINGS TO SUIT LOCAL CONDITIONS

AMWELL DOES NOT FURNISH PIPING (EXCEPT AS NOTED) FLOOR RAILS, TROUGHS, GRATINGS, WEIR PLATES, OIL OR GREASE FOR LUBRICATION, ANY WIRING OR CONDUITS BETWEEN MOTORS, CONTROLS AND ALARMS OR ANY ELECTRICAL EQUIPMENT OF ANY KIND EXCEPT AS SPECIFICALLY STATED IN AMWELL SPECIFICATIONS

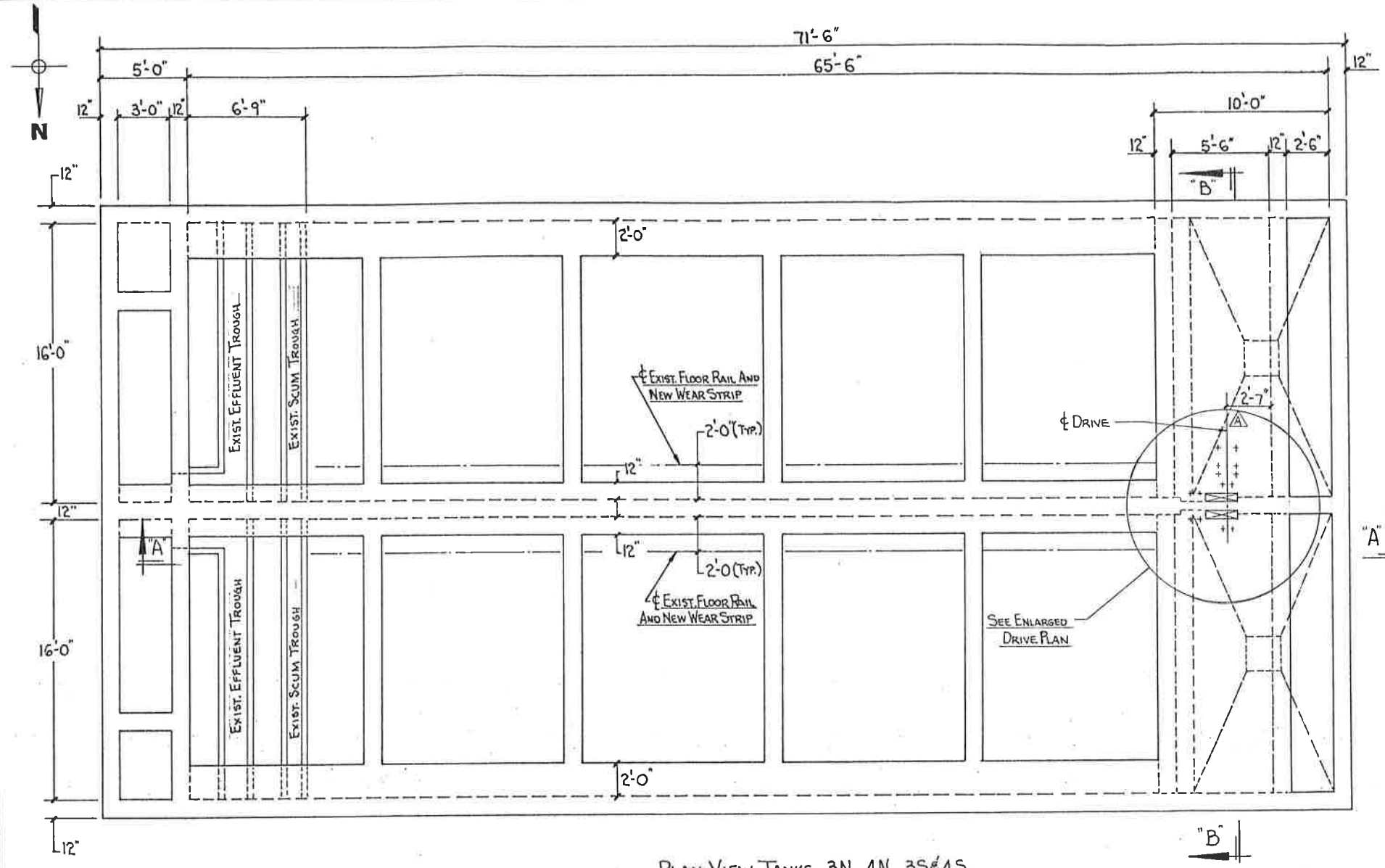
LIMITS UNLESS OTHERWISE SPECIFIED	
FRACTIONAL	
2 DECIMAL	
3 DECIMAL	
ANGULAR	

DRAWN	RON
CHECKED	
APP'D.	
DATE	1/20/95
S.O.	93061-11
SCALE	NTS

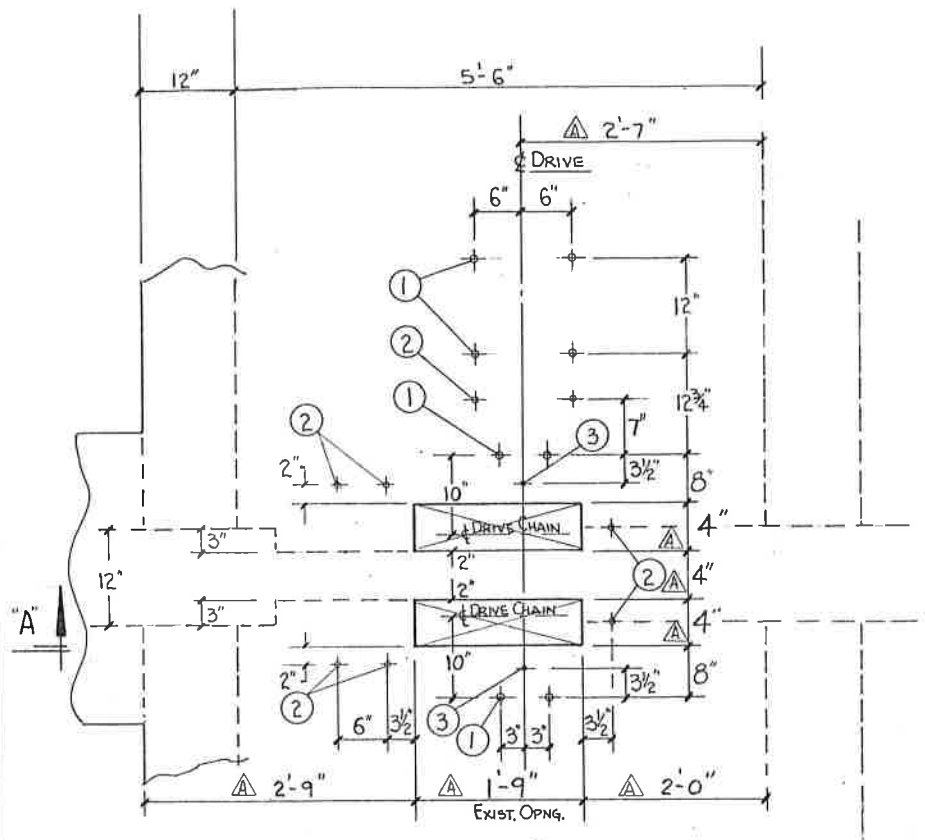
DESCRIPTION: General Arrangement

DRAWING NO. D101427221162 REV. A

NO.	DESCRIPTION	MAT'L	QTY.	PART NO.



PLAN VIEW TANKS 3N, 4N, 3S & 4S



ENLARGED DRIVE PLAN

NOTES:
1.) SECTION "A-A" SHOWN ON DWG. D101-42726-162.
2.) SECTION "B-B" SHOWN ON DWG. D101-42727-162.
3.) ANCHOR BOLT SCHEDULE SHOWN ON DWG. D101-42726-162.

PROJECT: TRAVERSE CITY, MI.

SYM.	REVISIONS	BY	CK'D.	DATE
A	DIM'S. CONFIRMED, CORRECTED OR PROVIDED BY CONTRACTOR.	RON		1/20/95

AMWELL FURNISHES MECHANISM TO FIT TANK OF DIMENSIONS GIVEN, BUT IS NOT RESPONSIBLE FOR CONCRETE DESIGN. CUSTOMER TO FURNISH NECESSARY REINFORCING STEEL AND TO DETERMINE SIZE AND PLACEMENT OF FOOTINGS TO SUIT LOCAL CONDITIONS

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LIMITS UNLESS OTHERWISE SPECIFIED
FRACTIONAL
2 DECIMAL
3 DECIMAL
ANGULAR

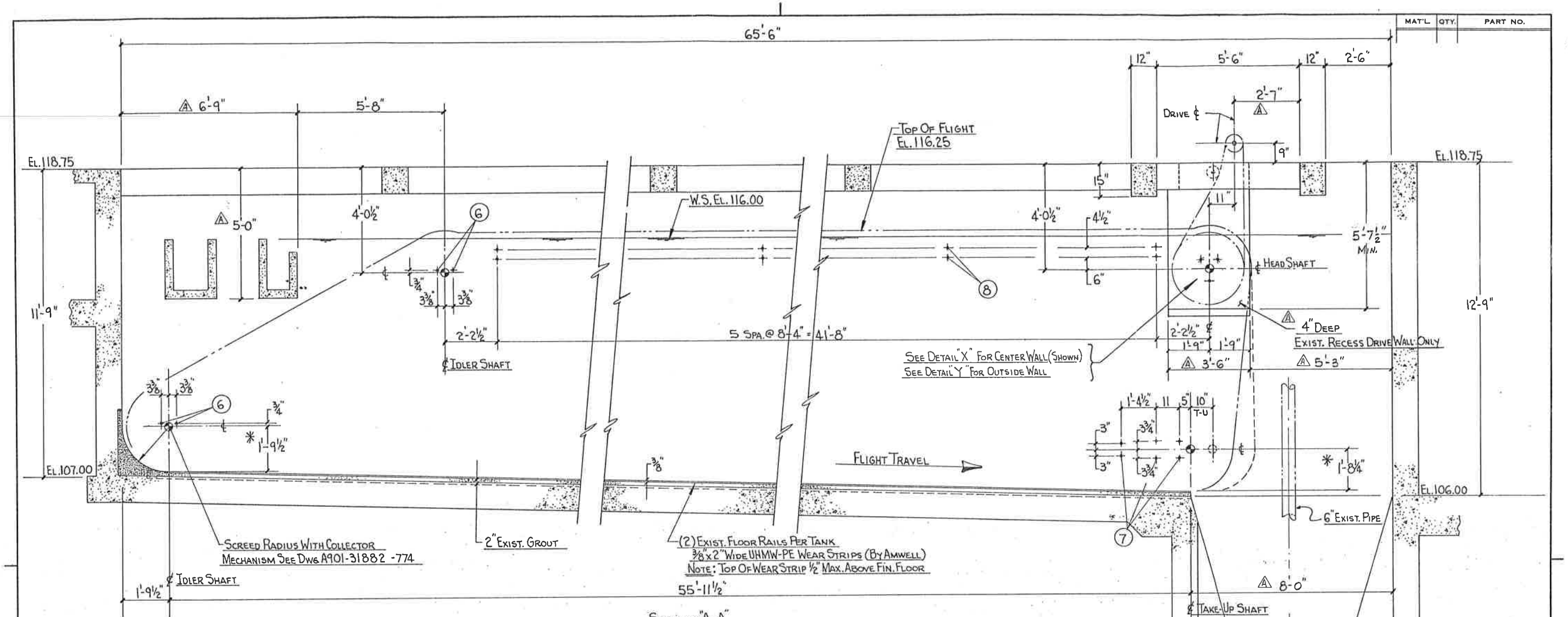
MICROFILMED
PATT. NO.

AMWELL
AURORA, ILLINOIS, USA
(ORIGINALLY AMERICAN WELL WORKS — EST. 1868)

DRAWN	RON
CHECKED	
APP'D.	
DATE	1/17/95
S.O.	93062-11
SCALE	3/4"

DESCRIPTION
GENERAL ARRANGEMENT MODEL "CHP-42"
RECTANGULAR COLLECTORS

DRAWING NO. D101142725116 2 REV. A

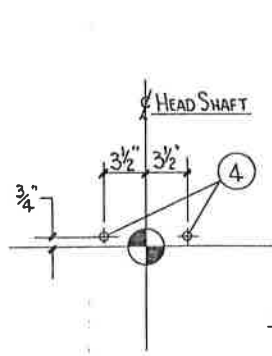


* = MEASURED ABOVE TOP OF WEAR STRIP. NOTE THAT A LARGER RADIUS IS REQUIRED AT LOWER BACK IDLER.

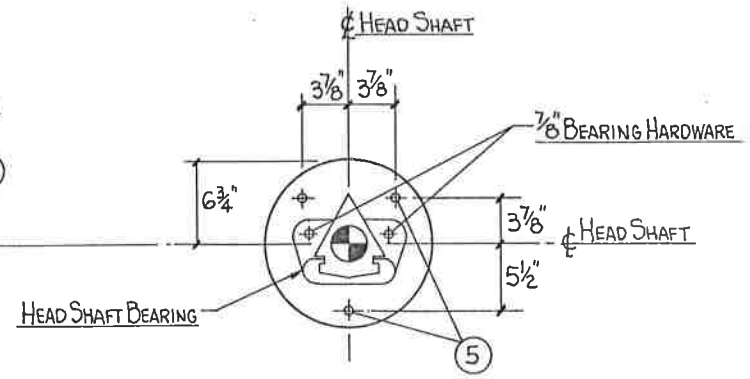
SECTION "A-A"
(FROM DWG. D101-42725-162)

EXPANSION ANCHOR BOLT SCHEDULE (304 STNLS. STL.)

№	SIZE	HOLE SIZE & DEPTH	LOCATION	TOTAL QTY.
1	⅝"x6" LG.	⅝"ø x 4" DP.	DRIVE BASE & BEARING PEDESTAL	16
2	½"x3¾" LG.	½"ø x 3" DP.	DRIVE CHAIN TAKE-UP & GUARDS	16
3	⅜"x3" LG.	⅜"ø x 2¼" DP.	SHEAR PIN LIMIT SWITCH BRACKET	4
4	⅞"x8" LG.	⅞"ø x 5½" DP.	HEAD SHAFT BEARING	8
⚠ 5	¾"x10" THRD. ROD	¾"ø THRU	HEAD SHAFT BEARING MOUNTING PLATE	6
6	⅞"x8" LG.	⅞"ø x 5½" DP.	IDLER SHAFT BEARING	32
7	¾" x 5½" LG.	¾"ø x 4½" DP.	MAIN CHAIN TAKE-UP ASS'Y.	48
8	⅝"x5" LG.	⅝"ø x 3½ DP.	RETURN TRACK SUPPORT BRACKET	



DETAIL "Y"
@ OUTSIDE WALL ONLY



DETAIL "X"
¾" THK. HEAD SHAFT BEARING MOUNTING PLATE EACH SIDE OF CENTER WALL (DRIVE WALL)

PROJECT: TRAVERSE CITY, MI.

SYM.	REVISIONS	BY	CK'D.	DATE
⚠	CUST'S. CONFIRMED, CORRECTED OR PROVIDED BY CONTRACTOR	RON		9/26/95

AMWELL FURNISHES MECHANISM TO FIT TANK OF DIMENSIONS GIVEN, BUT IS NOT RESPONSIBLE FOR CONCRETE DESIGN. CUSTOMER TO FURNISH NECESSARY REINFORCING STEEL AND TO DETERMINE SIZE AND PLACEMENT OF FOOTINGS TO SUIT LOCAL CONDITIONS.

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LIMITS UNLESS OTHERWISE SPECIFIED
FRACTIONAL
2 DECIMAL
3 DECIMAL
ANGULAR

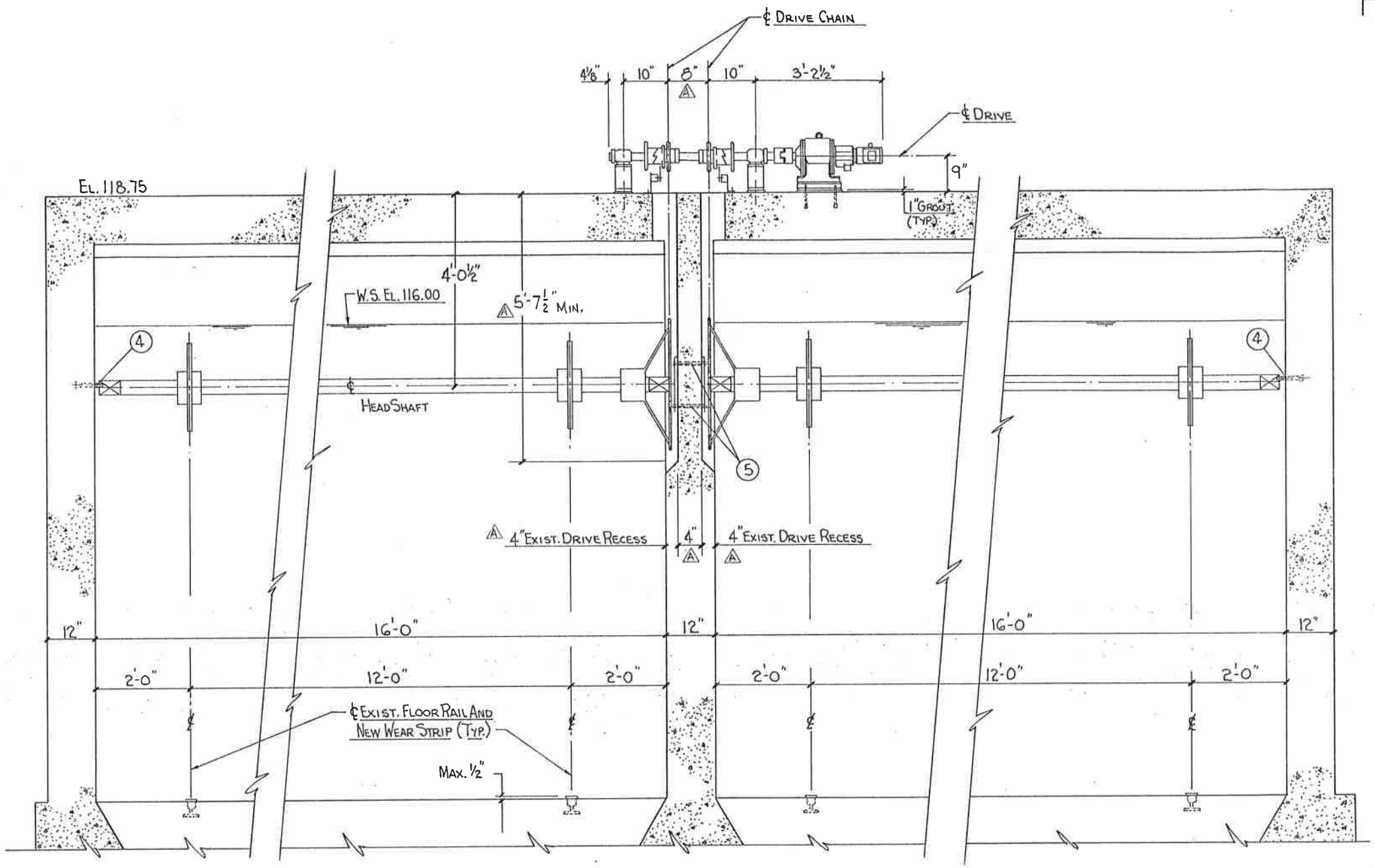
MICROFILMED
PATT. NO.

DRAWN	RON
CHECKED	
APP'D.	
DATE	1/18/95
S.O.	93062-11
SCALE	¾"

DESCRIPTION: GENERAL ARRANGEMENT

DRAWING NO. D101427261162 REV. A

NO.	DESCRIPTION	MAT'L	QTY.	PART NO.



SECTION "B-B"
(FROM DWG. D101-42 -162)

NOTE:
1.) ANCHOR BOLT SCHEDULE SHOWN ON DWG. D101-42726-162.

PROJECT: TRAVERSE CITY, MI.

SYM.	REVISIONS	BY	CK'D.	DATE
1	REVISED PER. APPR.	RON		9/21/95

AMWELL FURNISHES MECHANISM TO FIT TANK OF DIMENSIONS GIVEN, BUT IS NOT RESPONSIBLE FOR CONCRETE DESIGN. CUSTOMER TO FURNISH NECESSARY REINFORCING STEEL AND TO DETERMINE SIZE AND PLACEMENT OF FOOTINGS TO SUIT LOCAL CONDITIONS.

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MICROFILMED

PATT. NO.

AMWELL
AURORA, ILLINOIS, USA
(ORIGINALLY AMERICAN WELL WORKS — EST. 1868)

LIMITS UNLESS OTHERWISE SPECIFIED
FRACTIONAL
2 DECIMAL
3 DECIMAL
ANGULAR

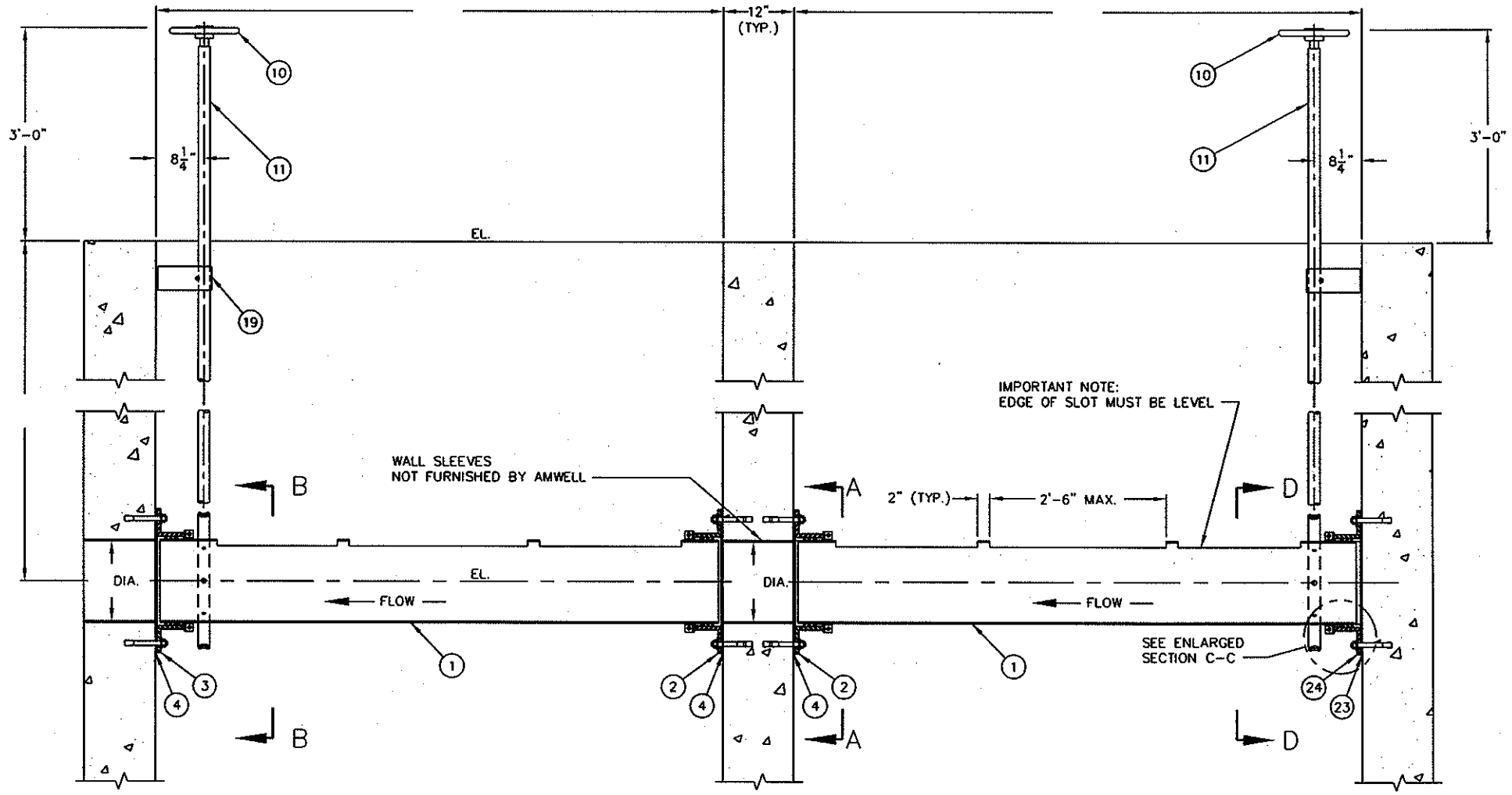
DRAWN RON
CHECKED
APP'D.
DATE 1/20/95
S.O. 93062-11
SCALE NTS

DESCRIPTION
GENERAL ARRANGEMENT

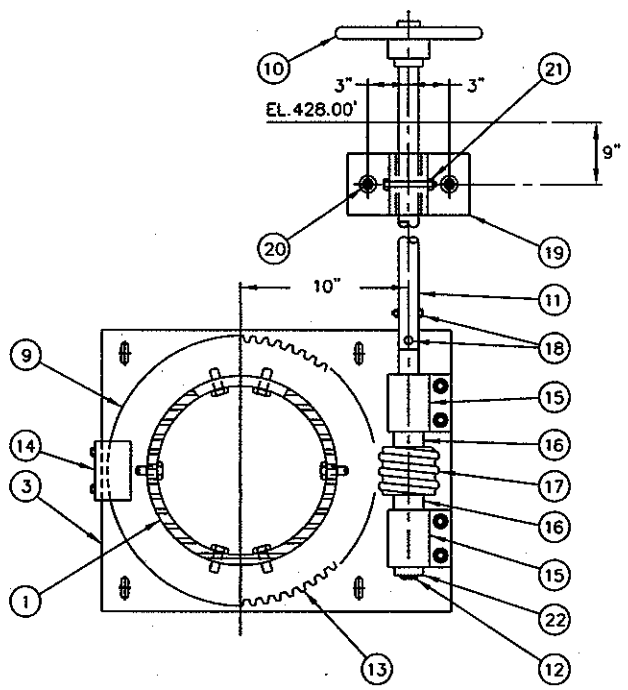
DRAWING NO. D10,114,272,711,62 REV. A

NOMENCLATURE

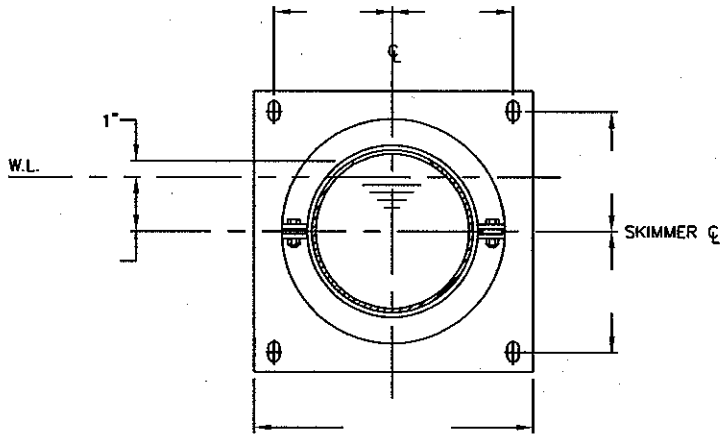
1. SKIMMER PIPE
2. WALL BEARING
3. OPERATOR WALL BEARING – R.H.
4. 1/4" THICK NEOPRENE GASKET
5. SET COLLAR
6. BUNA-N RING SEAL
7. WEAR BAR UHMW-PE
8. ADHESIVE ANCHORS, 3/4" X 8" LG. DRILL 3/4" X 6" DEEP HOLE (4 PER WALL BEARING)
9. GUIDE LUG
10. HANDWHEEL
11. SHAFT EXTENSION
12. WORM SHAFT
13. WORM GEAR
14. RETAINER
15. BABBITTED BEARING
16. SPACER
17. WORM
18. CAPSCREW, 3/8" X 2 1/2" LG. W/ LOCKNUT
19. SHAFT EXTENSION GUIDE (IF REQUIRED)
20. ADHESIVE ANCHORS, 5/8" X 6" LG. DRILL 5/8" X 5" DEEP HOLE (2 REQ'D.)
21. CAPSCREW, 3/8" X 2 3/4" LG. W/ LOCKNUT
22. SET COLLAR
23. 1/4" THICK NEOPRENE GASKET (CLOSED END)
24. OPERATOR WALL BEARING – L.H.



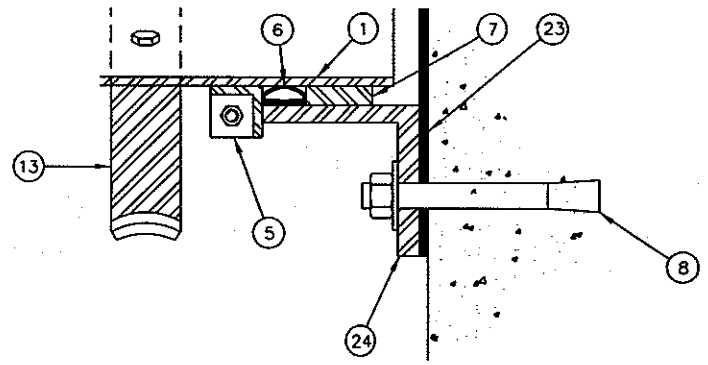
SECTIONAL ELEVATION



SECTION B–B (AS SHOWN)
SECTION D–D (OPP. HAND)



SECTION A–A



SECTION C–C

INFORMATION ONLY

CAD FILE: PROP-#710

MASTER D-59350

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AMWELL
A Division of Mcnish Corporation
AURORA, ILLINOIS, USA
(ORIGINALLY AMERICAN WELL WORKS – EST. 1868)

SYM	REVISION	BY	DATE	CHKD
4				
3				
2				
1				

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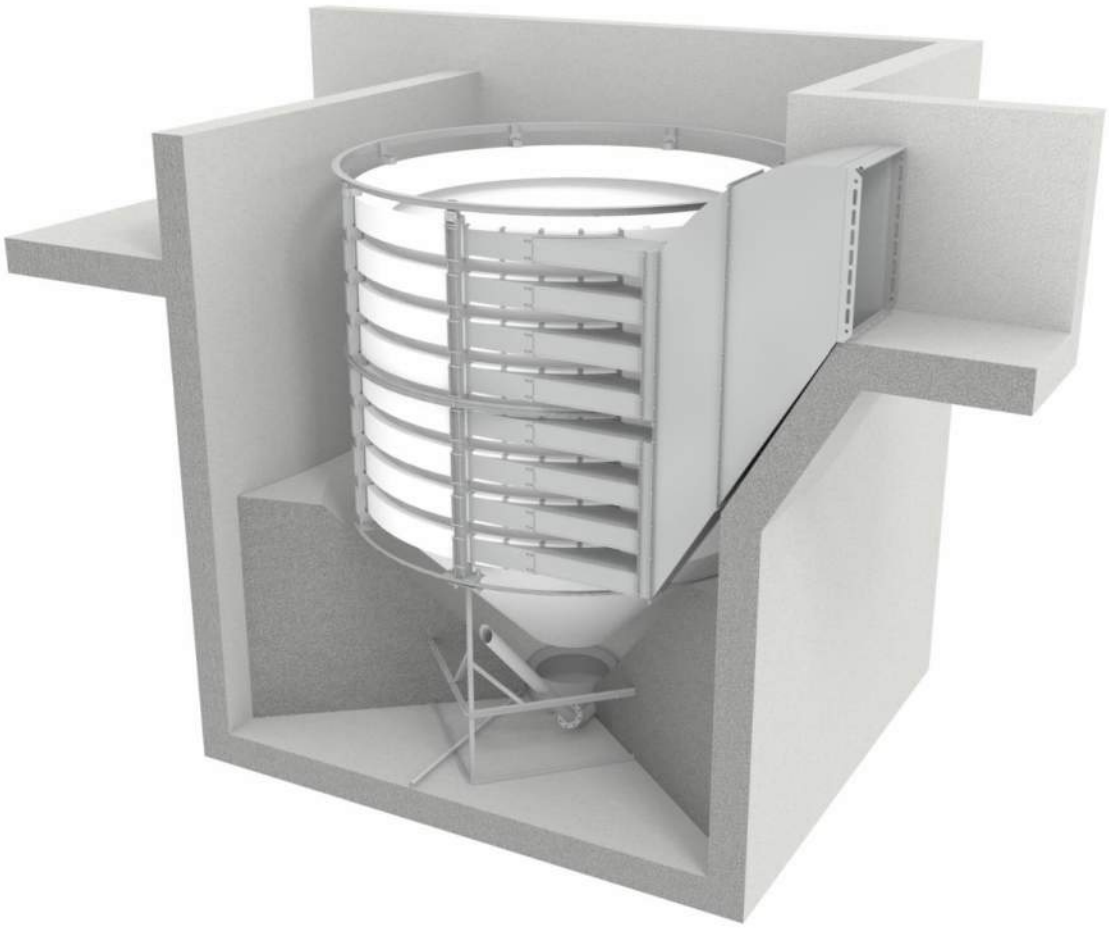
DRAWN	
CHECKED	
APP'D.	
DATE	
S.O.	
SCALE	NONE

DESCRIPTION
TYPICAL ARRANGEMENT FOR WORM GEAR OPERATED PIPE SKIMMER

DRAWING NO. PROP. #710 REV.



Grit Removal System Proposal Package
Traverse City, MI WWTP
Hubble, Roth & Clark

Manufacturer

Hydro International
2925 NE Aloclek Suite 140
Hillsboro, OR 97124
(866) 615-8130 ph
(503) 615-2906 fax
hydro-int.com

Representative

Waterworks Systems & Equipment Inc.
5275 Redding Drive
Lakeland, MI 48143
(810) 231-1200 ph
(810) 231-1331 fax
waterworkssystems.com

February 26, 2020

Mr. Dennis Benoit
Hubble, Roth & Clark, Inc.
801 Broadway NW, Suite 215
Grand Rapids, MI 49504

RE: Primary Clarification
Travers City, MI WWTP
File #19_11_0513 D

Dear Mr. Benoit:

Thank you for your interest in Hydro International. We are pleased to present our proposal for a HeadCell® Grit Removal, Classification, Washing, and Dewatering System. Hydro International is dedicated to providing innovative, high performance advanced grit management systems grit removal equipment. Supported by over 30 years of research, testing both in our lab and in the field, product development and superior engineering we pride ourselves on providing high-quality products and unmatched customer service. Our extensive experience includes thousands of installations throughout the world.

Grit is continually introduced into collection systems, but is not uniformly carried to treatment facilities. As flows increase, the grit load entering the plant elevates. Once in the treatment plant, where velocities are slower, grit will deposit in processes, disrupting systems, decreasing equipment longevity, and increasing maintenance costs. The HeadCell® Grit Removal System offers many benefits over conventional grit removal systems including:

- Complete system designed to process the solids load as well as the hydraulic load through each step of the process, collection, washing/classification and dewatering and producing a clean, dry product.
- Removing fine and slowly settling grit, protecting equipment and processes from abrasive wear and sedimentation
- All-hydraulic design with no moving parts, minimizing operating and maintenance costs
- Small footprint yet capable of high efficiency solids capture and removal
- Robust design allowing long component life with minimal wear

We sincerely appreciate your interest in our equipment and look forward to working with you on this project. As you progress with the design, we can quickly generate CAD drawings, budget updates, and specifications as well as provide review of equipment layouts and specifications for your particular application. Reference lists are available through your local representative. If you have any questions or concerns, do not hesitate to contact us.

Regards,
Hydro International

Nathaniel McArthur
Nate McArthur
Applications Engineer

Hydro International
2925 NE Aloclek Suite 140 · Hillsboro, OR 97124
Tel: (866) 615-8130 Fax: (503) 615-2906 Web: hydro-int.com

Performance Objective

Hydro International is pleased to propose the following HeadCell® grit removal, washing, and dewatering system to be installed in an existing plant which has flows of 8.5 mgd average and 17 mgd peak. Each component of the grit removal systems performance shall be outlined below.

Proposed Equipment Summary

HeadCell® Grit Concentrator Unit

The HeadCell® is an all-hydraulic grit concentrator, which uses vortex flow and a stacked tray design to efficiently capture and settle fine grit via large surface area and short settling distances. The unit can be installed into the process flow, downstream of screening, in any system where limited head is available. The unit requires no external power source, has no internal moving parts, is self-cleaning, and has a compact modular construction. Wide turndown ratios can be accommodated in the HeadCell® when it is combined with Hydro's high performance washing system.

Specifications

Quantity:	2 (1 online during average flow, 2 online during peak)
Size:	9' diameter
Number of Tray/Unit:	8
Surface Area/Unit:	509 ft^2
Loading Rate @ Peak Flow/Unit:	11.6 gpm/ft^2
Performance @ Peak Flow:	95% removal of all grit (SG 2.65) ≥ 106 microns
Performance @ Average Flow:	95% removal of all grit (SG 2.65) ≥ 106 microns
Peak Flow/Unit:	8.5 mgd with 12" headloss
Average Flow/Unit:	8.5 mgd with 12" headloss
Discharge:	Weir
Underflow Connection:	4" flanged pipe
NPW Connection:	2" NPT
NPW Requirement/Unit:	Intermittent 80 gpm @ 50 psig
Material of Construction:	304 SS Support Structure/Duct/Underflow Polyethylene Trays
Weight Dry (approximate):	2400 lbs

Hydro GritCleanse™ Grit Washing / Dewatering Unit

The Hydro GritCleanse™ is a fully automated, high efficiency unit that effectively removes, washes, and dewaters fine grit, sugar sand, and high density fixed solids from grit slurries. The large conical clarifier with tangential inlet and internal baffle enhances the settling of fine particles and the fluidized sand bed scrubs off and separates attached organics, resulting in a dry grit with extremely low organic content suitable for landfill disposal.

Specifications

Quantity:	2 (1 online during average flow, 2 online during peak)
Size:	8412
Design Flow/Unit:	250 gpm with 2" headloss
Influent Solids Concentration:	≤1.5%
Influent Connection:	6" flanged pipe
Capacity:	up to 1.5 cy/hr
Screw Diameter:	12"
Clarifier Size:	84"
Min. Free Water Surface Area:	38.5 ft^2
Auger Motor:	1.5hp, TENV, 480V/3 phase/ 60 Hz
Agitator Motor:	1hp, TENV, 480V/3 phase/ 60 Hz
Effluent Connection:	8" flanged pipe

Organics Discharge Connection:	4” flanged pipe
Drain Connection:	3” NPT pipe
NPW Connection:	1” NPT (2 No.)
NPW Requirement Fluidized Bed:	25 gpm @ 50 psig Continuous
NPW Requirement Organics Flush:	25 gpm @ 50 psig (20-30 sec. hourly)
Operation:	Continuous or a minimum of 10-15 minutes
Body Material:	304 SS
Weight Dry/Wet (approximate):	3,600/10,400 lbs.
Performance:	95% removal of all grit (specific gravity 2.65) ≥ 106 microns with less than 5% volatile solids and greater than 85% total solids

Grit Pump

The grit pump shall be designed to convey grit slurry from the HeadCell® grit concentrator unit to GritCleanse™ grit washing/ dewatering equipment. The grit pump shall be a recessed impeller, vortex-type unit, specifically designed to pump slurries of grit, debris and organic solids without clogging. The parts exposed to abrasive wear (case, impeller and wearplate) shall have a minimum 650 Brinell hardness for maximum wear resistance.

Specifications

Quantity:	2
Style:	Dry- Pit
Nominal Size:	TBD
Design Flow Rate:	250 gpm
Design TDH:	30’
Power Supply:	480V/3-phase
Horsepower:	TBD

Control Panel

The panel shall contain all timers, VFDs, switches, and indicator lights to operate one (1) HeadCell® NPW unit, one (1) GritCleanse™ unit, and one (1) grit pump in either fully automated or manual mode.

Specifications

Quantity:	2
Enclosure Material:	304 SS
Enclosure Type:	NEMA 4X
Power Supply:	480V/3-phase
Control Logic:	AB MicroLogix 1400 PLC, PanelView 600 Plus OIU
Grit Pump Control:	VFD
Hydro GritCleanse™ Motor Control:	VFDs (2 No.)

System Hydraulics

System hydraulics is the responsibility of the design engineer. Hydro International can provide information on HeadCell® hydraulics, flow vs. headloss curves and pumping and piping FAQ’s to assist the engineer in determining system hydraulics and pump requirements, upon request.

Design Recommendations

- 1/2” or finer screening prior to the grit removal system
- Velocity through bar screen openings/slots/apertures should not exceed 4 ft/s at peak flow as recommended by industry design manuals.
- Estimated grit load at peak flow is 0.19 yd^3/hr.
- Stated output grit quality (total solids/volatile solids) is based on a minimum plant influent grit quantity of 50 pounds FS/million gallon.
- All piping connected to Hydro equipment must be supported by other means than the Hydro equipment
- 2 – 3 ft/s channel velocities at peak flow as recommended by industry design manuals
- 4 – 7 ft/s grit slurry pipe velocities as recommended by industry design manuals
- Incorporate a drain line, piped to a floor drain, in the grit dumpster to allow for further dewatering prior to disposal
- A minimum 18” of access clearance around all equipment and minimum 3’ of access clearance above equipment
- Operators find that it is useful to locate a spray hose adjacent to the equipment so that they can spray all equipment down during an inspection
- Incorporate a minimal access platform to facilitate inspection access to the top of the equipment
- Discharge chutes for grit should be at a minimum 45° incline if it is open chute. If it is an enclosed chute/pipe/tube then a minimum angle of 60° is required to ensure plugging does not occur.
- Grit pumps may require NPW for seal flushing. Requirements for flushing are dependent on the make, model, and seal type of the pump specified by the engineer.

Start-up

One (1) factory trained representative, two (2) trips, for start-up and instruction services as required totaling four (4) days.

Quote Validity: 30 days After expiration of validity Hydro International reserves the right to adjust pricing to account for any significant increases in material costs.

Exclusions

Any item(s) not specifically described above are excluded and are not to be supplied by Hydro International including but not limited to the following:

- Field assembly, erection and installation
- Anchor Bolts
- Interconnecting piping and valving not expressly stated above
  Pipe connections and fittings not expressly stated above
- All pipe supports, hangers and braces
- Controls, switches, control panels and instrumentation of any kind not expressly stated above
- Wiring and conduit
- Grit pump associated piping, valving, gauges
- Covers and access hatches
- Field or touch-up paint, painting, blasting and touch-up of surface finish
- Spare parts not specifically stated above
- Unloading, hauling and storage charge
- Lubricating oil and greases
- Grit study, field performance testing, laboratory testing and sample collection and analysis
- All concrete and grouting work
- Insulation and heat tracing of any kind
- Structural / Seismic analysis
- Performance, Warranty, Efficacy and/or Supply Bond(s)
- Grit dumpsters
- Translation Services

Options

Quotes will be provided upon request for the following optional features:

- Stainless steel valve bodies
- Additional field days for startup or training
- Explosion proof upgrade
- Upgrade 304 to 316 Stainless Steel
- Structural / Seismic Anchorage Certification
- Field performance testing, laboratory testing and sample collection and analysis
- Service & maintenance contract
- Extended warranty

Warranty

Hydro International's Standard Warranty shall apply per the Terms and Conditions of Sale.

Delivery

Please allow 4 to 6 weeks after receipt of purchase order for approval drawings. Shipment is typically a maximum of 12-16 weeks after receipt of "Approved" or "Approved As Noted, Resubmittal Not Required" submittal package. Price includes truck freight to jobsite, but does not include any state or local taxes if required.

Terms & Conditions

This proposal is made pursuant to Hydro International's standard Terms & Conditions of Sale, attached hereto and made a part hereof.

Contacts

Plant Representative:

Mr. Dave Connors

Waterworks Systems & Equipment

5275 Redding Drive

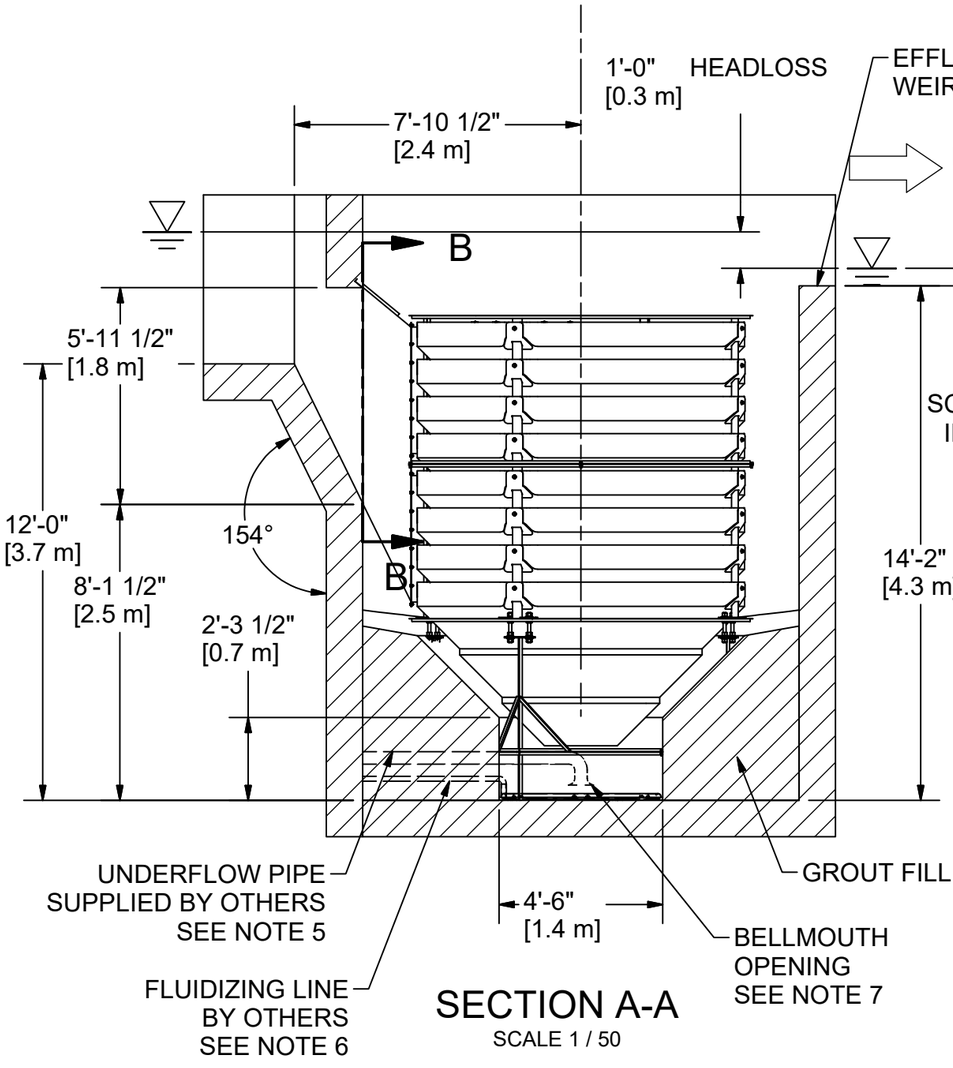
Lakeland, MI, 48143

(810) 231-1200 ph

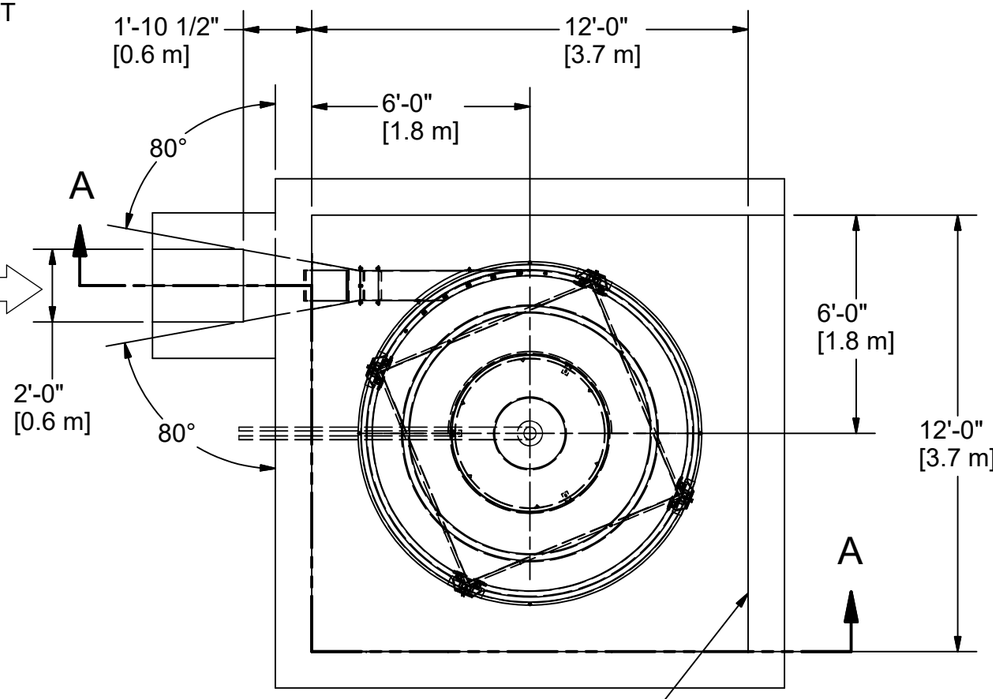
(810) 231-1331

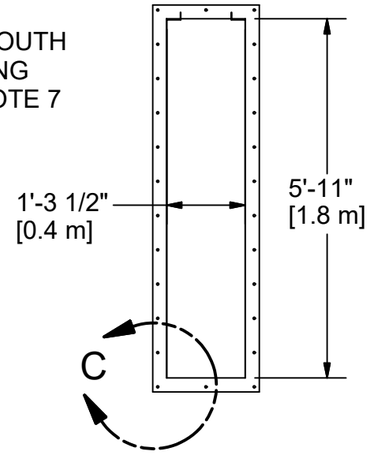
dconnors@waterworkssystems.com

DO NOT CHANGE DUCT LAYOUT OR PIPE ORIENTATION
WITHOUT CONSULTING HYDRO INTERNATIONAL

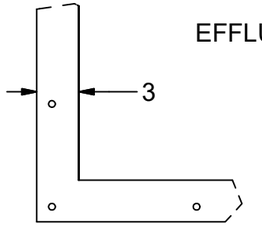


SECTION A-A
SCALE 1 / 50





SECTION B-B
SCALE 1 / 30



DETAIL C
SCALE 1 / 10

PROJECTION

COMMENTS:
1. ALLOW GRIT PUMP TO FULLY DRAIN HEADCELL TANK.

2. PLANT FLOW BYPASS RECOMMENDED TO ALLOW THE HEADCELL TO BE TAKEN OUT OF SERVICE FOR MAINTENANCE.

3. CLOCKWISE & COUNTERCLOCKWISE UNITS ARE AVAILABLE.

4. ALTERNATE EFFLUENT CONFIGURATIONS ARE AVAILABLE.

5. THE GRIT PUMP SUCTION LINE SHOULD BE DESIGNED FOR A 4-7 FT/S [1.2-2.2 M/S LINE VELOCITY.

6. FLUIDIZING WATER REQUIREMENTS
32 GPM [2.0 L/S] FOR 9' HEADCELL AT 50PSI

7. DISTANCE BETWEEN BELL MOUTH AND BOTTOM OF TANK 1.25 X SUCTION PIPE DIAMETER

REVISION HISTORY			
REV	BY	DESCRIPTION	DATE
-		FIRST RELEASE	

DATE:	SCALE: 1 / 50

DRAWN BY:	CHECKED BY:	APPROVED BY
JMC	LS	JG

Title
HEADCELL
9' DIAMETER
8 TRAYS
CONCRETE DUCT
INTERMITTENT UNDERFLOW

Proposal

Hydro International

2925 NW Aloclek Drive
Suite 140
Hillsboro, OR 97124
Tel: +1 (503) 615-8130
Fax: +1 (503) 615-2906
hydro-int.com

DO NOT SCALE DRAWING

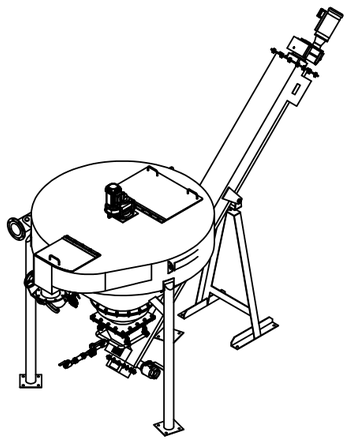
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES.

TOLERENCES ARE:
FRACTIONS ± 1/16
DECIMALS:
X.X ± .06
X.XX ± .03
X.XXX ± .015
ANGLES: ± .5°

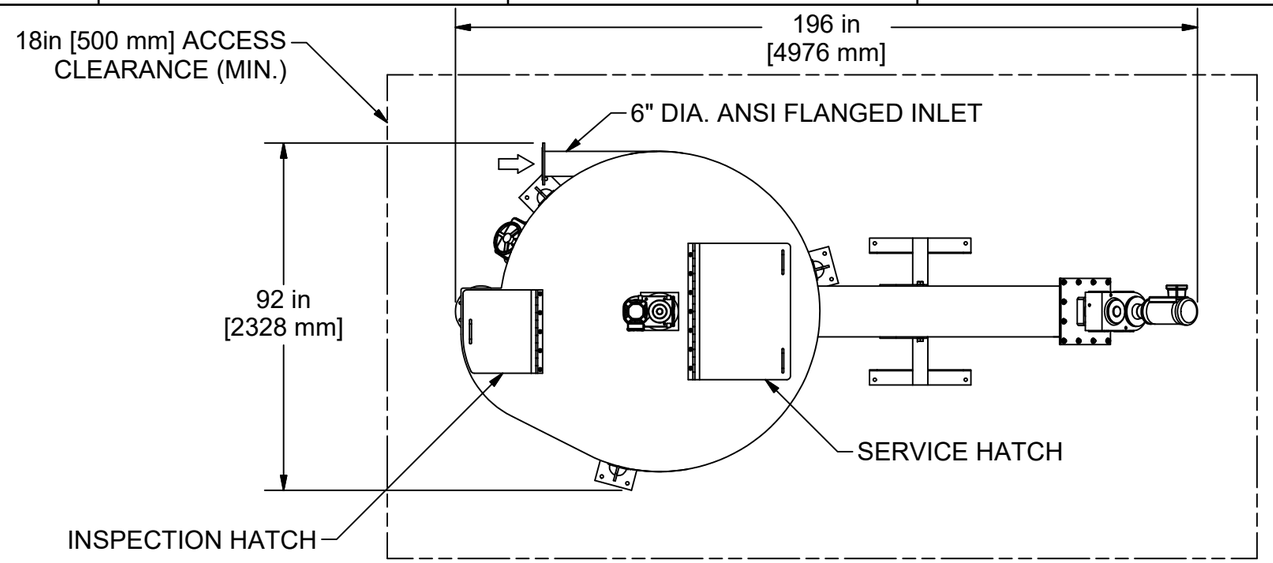
WEIGHT:	MATERIAL:
N/A	

DRAWING NO.:
9FT/8/1.08/INT/CON

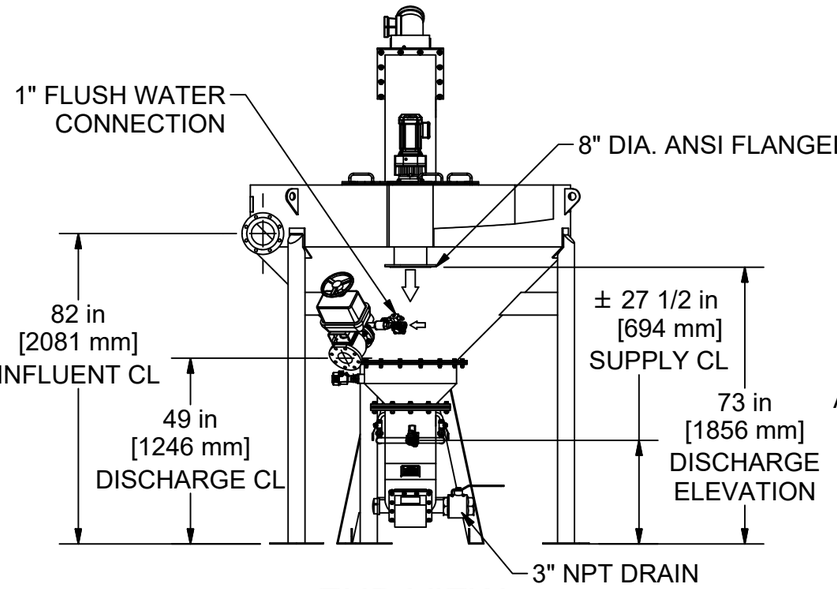
SHEET SIZE:	SHEET:	Rev:
B	1 OF 1	-



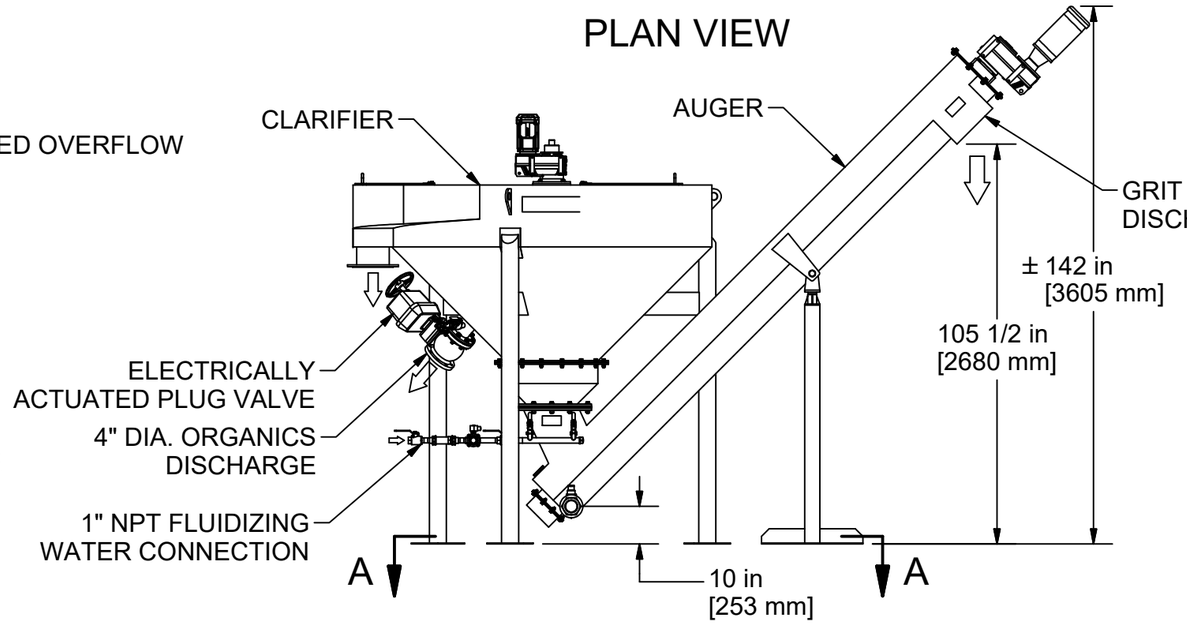
ISOMETRIC VIEW
NTS



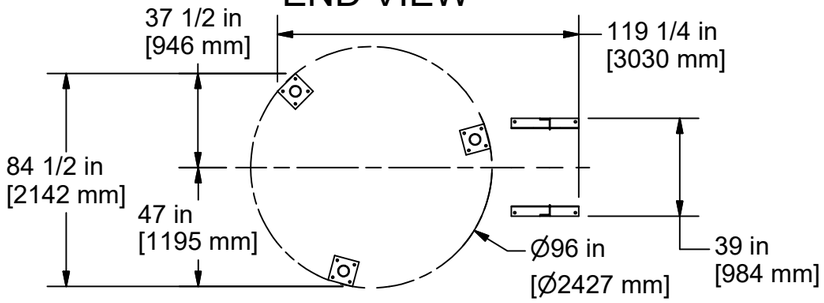
PLAN VIEW



END VIEW



SIDE VIEW



FOOTPRINT A-A
NTS

PROJECTION

COMMENTS:

1. PROVIDE ADEQUATE CLEARANCE FOR SERVICE AND MAINTENANCE ACCESS

2. NPW REQUIREMENTS:
25 GPM @ 50 PSI CONTINUOUS
50 GPM @ 50 PSI INTERMITTENT

3. EQUIPMENT WEIGHTS:
DRY: 3,600 LBS [1,630 KG]
WET: 10,400 LBS [4,700 KG] (MAX)

REVISION HISTORY

REV	BY	DESCRIPTION	DATE
A	SR	3-INCH DRAIN	17-Jul-19
-		FIRST RELEASE	

DATE: 19-Jun-18
SCALE: 1 / 40
DRAWN BY: SR
CHECKED BY: SR
APPROVED BY

Title
HYDRO GRITCLEANSE 8412

COMPLETE UNIT

PROPOSAL DRAWING

Hydro International

2925 NW Aloclek Drive
Suite 140
Hillsboro, OR 97124
Tel: +1 (503) 615-8130
Fax: +1 (503) 615-2906
hydro-int.com

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES.

TOLERENCES ARE:
FRACTIONS ± 1/16
DECIMALS:
X.X ± .06
X.XX ± .03
X.XXX ± .015
ANGLES: ± .5°

WEIGHT: 3513.1 lbmass
MATERIAL:
NEXT ASSEMBLY: N/A
DRAWING NO.: PROPOSAL
SHEET SIZE: B
SHEET: 1 OF 1
Rev: A

North American Grit Gradations

Hydro International is pleased to announce the availability of national and regional grit gradation data. This data, which has been compiled from over 120 tests across North America, contains average physical size data as well as settling velocity (SES) data, making it the most comprehensive information available on grit and its behavior.

Virtually all conventional grit removal processes rely on gravity sedimentation to achieve the separation of grit from wastewater. Most conventional grit removal processes are designed based on the assumption that grit is spherical and has a specific gravity 2.65. However, not all grit maintains a specific gravity of 2.65 and other factors such as shape and encapsulation by fats, oils and grease significantly impact its settling velocity. Therefore, the best means to analyze grit is to determine the settling velocity for given particle size ranges. Settling velocity data can be correlated to the measured settling velocity of a clean sand sphere. The settling velocity is expressed as the Sand Equivalent Size (SES), which is the sand particle size having the same settling velocity as the more buoyant grit particle. The correlated particle size, or Sand Equivalent Size can then be used for design of the grit removal process.

When settling velocity is considered in the design actual removal efficiency of grit particles can be estimated more realistically.

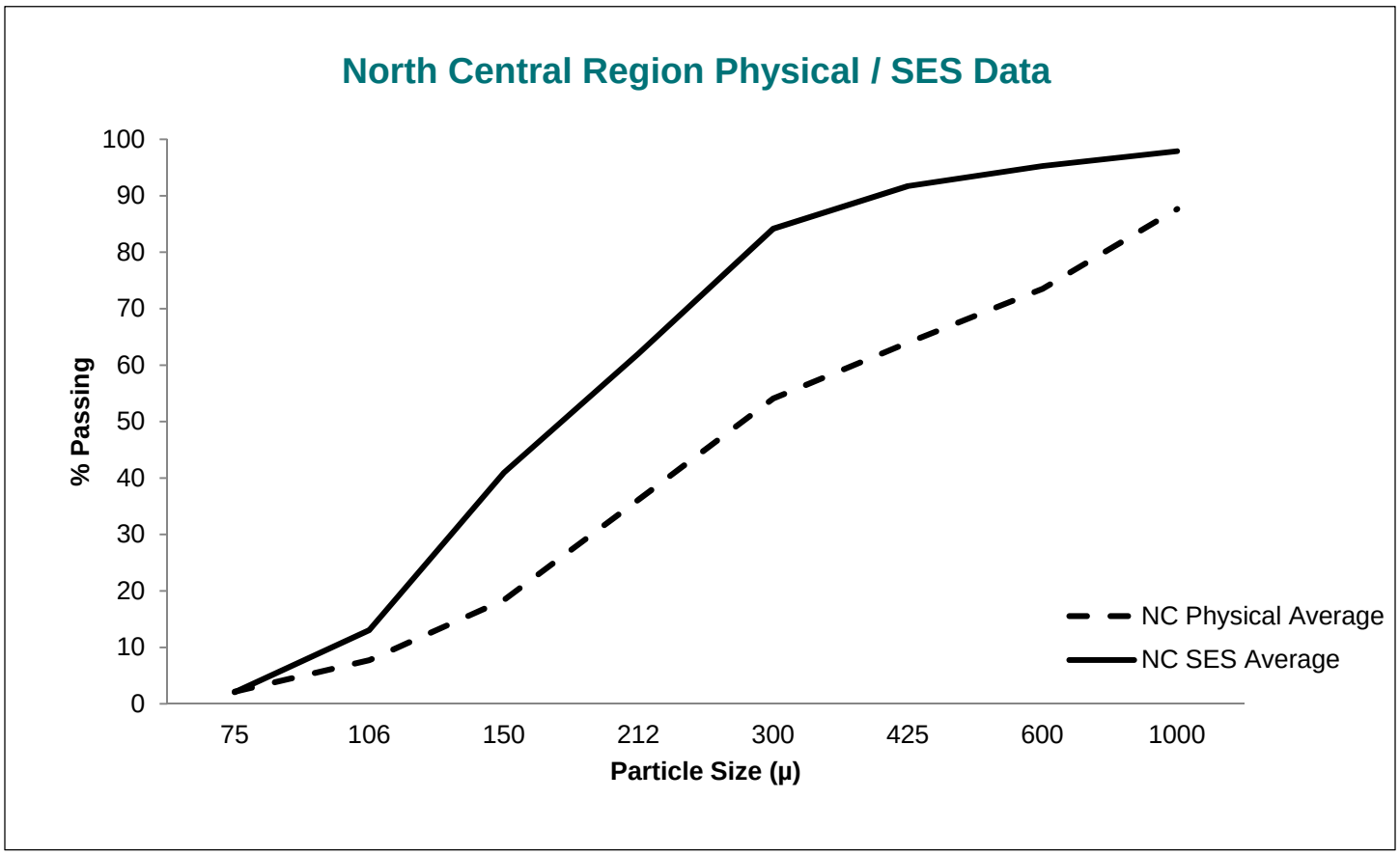
Data is available for the following regions:

Region	States / Provinces Included
Northeast	ME, VT, NH, MA, RI, NY, CT
Mid-Atlantic	PA, NJ, MD, DE, DC, VA, WV
Southeast	NC, SC, GA, AL, FL, MS
North Central	MO, KS, KY, IN, OH, IL, MI, WI, IA, MN, ND, SD, NE
South Central	TN, AR, OK, TX, LA
West	WA, OR, CA, AK, HI, AZ, NV, NM, CO, ID, MT, UT, WY
Western Canada	AB, MB, SK
Ontario Canada	ON

State data is available for individual states where more than 5 data points are available; those states currently include: Georgia, Texas, Florida, California, and Virginia.

Hydro International – Water & Wastewater
2925 NW Aloclek Suite 140, Hillsboro, OR 97124
Tel: (503) 615-8130 Fax: (503) 615-2906 Web: www.hydro-int.com

North Central Regional Gradation



Micron	% Passing 75	106	150	212	300	425	600	1000	
NC Physical Average	2.2	7.8	18.4	36.2	54.1	64.0	73.5	87.7	*Physical*
NC SES Average	2.0	13.0	41.0	62.0	84.2	91.7	95.3	97.9	*SES*

The above table shows the % of grit passing through various sieve sizes based on physical size (unshaded) and Sand Equivalent Size (SES) (shaded). SES provides the settling velocity distribution of the grit particles.

Appendix C — Structural Inspection Report

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

Memorandum

To: Mr. Art Krueger
Director of Municipal Utilities

From: Christa K. Crist, P.E.
Hubbell, Roth & Clark, Inc.

Date: December 18, 2020

Subject: Rectangular Primary Tank Structural Inspections HRC Job No. 20190115

General Background

On October 14, 2020, Hubbell, Roth, & Clark, Inc. (HRC) was on site at the Traverse City Wastewater Treatment Plant to conduct a structural inspection of the Primary Tanks. Using visual and non-destructive inspection methods, HRC's structural inspection was conducted as part of an effort to provide a more conclusive and definitive course of action relative to options for the rehabilitation of the existing Primary Tanks or construction of new circular clarifier tanks.

Photo 1- Aerial view of the Traverse City WWTP

In addition, HRC arranged for concrete compressive strength testing and petrographic analysis of core samples, the locations of which were determined based on the structural inspection observations. Reports on the compressive strength testing and petrographic analysis are included as part of the complete study package.

Based on the observations made by HRC on 10/14/2020, the structural condition of the concrete in Tanks 1S and 3N was sound. Together with the results and conclusions of the compressive strength tests and petrographic analyses of the cores taken as part of the study scope, HRC recommends that the Primary Tanks are good candidates for reuse provided the service and exposure types are not changed significantly from current. Minor to moderate structural repairs are recommended to extend the service life of the tanks.

The Primary Tanks were constructed at different times, the first set in the 1930s and the second set in the 1950s. The four compartments in the '30s vintage tanks are referred to herein as Tanks 1S through 4S. Similarly, the four compartments in the '50s vintage tanks are referred to as Tanks 1N through 4N.

On October 14th, HRC inspected the interiors of Tanks 1S and 3N. The above grade portions of all the tanks were also inspected as were the below grade galleries at the sump ends (west) of each tank.

Below is a detailed summary of findings, conclusions, and recommendations, including photographic documentation.

Summary of Findings

Tank 1S

The tanks were covered with fiberglass covers, identifiable by their turquoise green color in Photo 1. Installed in the mid-1990s, the covers have degraded since that time and are no longer suitable for the support of foot traffic. However, they can be lifted and moved around minimally to facilitate entry into the tanks.

The interior of Tank 1S was inspected first. The concrete walls, base slab and underside of top slab were in good condition. The grout infill in the boxouts around the mechanical drive on the east end were sound. HRC observed what looked like a repaired diagonal crack in the south wall near the boxout (Photo 2). Potential repairs along vertical full height joints or cracks were noted in two additional locations along the south wall. Patch repairs were observed in four locations on the north wall at approximately five feet down from the top of the wall. No efflorescence was noted at any of the repaired areas. Areas of concrete local to the repairs were "sounded" with a chipping hammer. All returned with a healthy ringing sound, as opposed to a flat or hollow sound, which would indicate delaminated concrete beneath the surface.

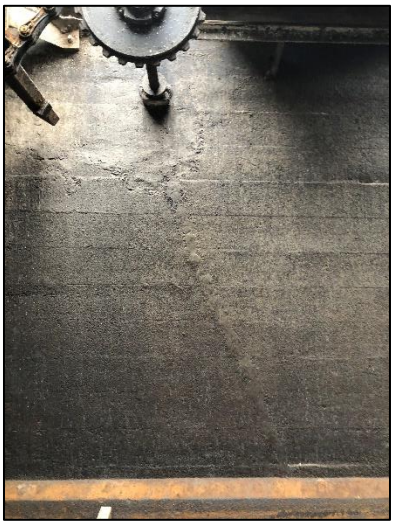


Photo 2- Grout infill and crack repair at boxout

Patterns from the lumber formwork used in the original construction of the tank were evident throughout (Photo 2). No signs of cement paste or aggregate loss were noted anywhere on the wall surfaces. In multiple locations, HRC wire brushed debris from the concrete, revealing a uniform shiny surface below. HRC concluded that the walls may have been coated at some point in their lifetime.

Photo 3- Concrete slab beneath hardened sludge

The underside of the scum trough on the east end of the tank was in fair condition for the most part, as were the strut beams and cantilevered walkways on the sides of 1S. A few exceptions were noted. Along the underside of the cantilevered walkways on the sides nearest the concrete scum and FRP troughs, heavy sludge buildup was observed with isolated locations of delaminated concrete. No exposed rebar was evident.

On the west end, an isolated location of deterioration on the underside of a beam spanning over the sump was noted. The

degree of deterioration was similar to that noted on the east end. A minor spall was recorded on a different beam on the west end. Neither were of structural concern but may merit surface repair to protect the steel reinforcement within the beams.

Along the strut beams, localized areas of patching with a cementitious repair material were noted. All repairs looked sound.

The base slab was inspected both visually and physically by dragging chains across it. Chain dragging is another method for detecting areas of delaminated concrete in a concrete slab, similar to using the chipping hammer on the walls. No areas of delamination were noted anywhere across the base slab. The concrete surface of the base slab was also wire brushed after first removing a crust of hardened sludge. The wire brush removed a black powdery layer, revealing a uniform surface with lightly exposed aggregate, likely due to mechanical wear from the grit in the water that has been processed through the tank over its lifetime (Photo 3).

Photo 4- Deteriorated concrete along top slab of grit chamber

Photo 5- Standing water across top slab on west end of Tanks 1 and 2S

The concrete across the top sides of Tanks 1 and 2S was also inspected. Cracked concrete with efflorescence was noted along the top slab and walls of the grit chamber at each the east and west ends (Photo 4).

The top slab across the sump ends (west) of both Tanks 1S and 2S was covered with standing water on the day of the inspection (Photo 5). The concrete was deteriorated across the surface in multiple locations. Loose aggregate was observed all around. Sludge-like material was also observed in the water though the exact source was not confirmed. The top slab for Tanks 3 and 4S, which is adjacent to Tanks 1 and 2S was higher by a couple of feet leading to somewhat of a "bathtub" effect at 1 and 2S, where water collected and did not readily drain away. Similar deterioration was noted across the top slab on the east end of Tanks 1 and 2S. It is worth noting that while Tanks 1 and 2N were at a similarly low elevation relative to adjacent Tanks 3 and 4N, the top slabs at both the east and west ends of 1N and 2N were dry.

Photo 6- Cement paste loss and exposed aggregate at scum troughs

The fiberglass covers over the scum troughs on the east end of Tanks 1S were opened revealing heavy cement paste loss along the surface of the concrete. Uniformly exposed aggregate and localized locations of missing concrete were observed along the length of the trough (Photo 6).

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

Tank 3N

The condition of the concrete in Tank 3N was similar to Tank 1S. Generally, the condition of the walls, base slab and underside of top slab were in good to fair condition.

The most notable deterioration was observed at the waterline where it appeared that the original concrete coating had failed, leading to localized shallow spalls on the surface. This water surface elevation was approximately three feet below the top of wall. Peeling coating and spalls were noted regularly along the full length of both walls of the tank (Photo 7). Frequent locations of peeling coating were noted on the faces of the strut beams as well.

The grout infill in the boxouts around the mechanical drive on the east end were sound. Repair of a full height vertical crack was noted on the north wall and was in good condition. The area of concrete local to the repair was "sounded" with a chipping hammer and returned a healthy ringing sound.

Photo 7- Coating failure at waterline

The underside of the concrete scum trough on the east end of the tank showed deterioration of the concrete. The coating had failed, and aggregate exposure was moderate to severe particularly along the beam that spanned across the opening to the inlet chamber. The contoured concrete at the base slab under the scum trough had a crack in it, which was damp on the day of the inspection.

On the west end, deterioration of the coating on the underside of the beams spanning over the sump was noted. This was similar to what was observed along the faces of the strut beams.

The base slab was inspected both visually and physically by dragging chains across it. No areas of delamination were noted anywhere across the base slab.

The concrete across the top sides of Tanks 1 through 4N was also inspected. Stone bedding covered the transition between Tanks 1/2N and the taller Tanks 3/4N to the north. A section of sunken concrete slab was noted on the west end of this transition.

Photo 8- Deterioration along grit chamber walls

Concrete deterioration along the top slab and walls of the grit channel along Tank 1N was like that which was observed along 1S though evidence of previous repair attempts were noted (Photo 8).

Cracks were noted at regular intervals across the tops of the cantilevered walkways between the tanks. These cracks continued down and around the undersides of the walkway slabs and could be seen from inside Tank 3N. This was typical for the full length of the interior. The cracks across

the tops of the walkways at 4N also continued down the outside face of the tank's north wall, which was exposed approximately three feet above grade for the full length (Photo 9). The cracks across the tops of the slabs and down the sides of the walls at all the "north" tanks had been routed out and filled with sealant and were in good condition.

Photo 9- Repairs along north wall of Tank 4N

Gallery

HRC also inspected the below grade gallery on the west end of the tanks. The walls and underside of top slab throughout the gallery were in fair condition. Cracks with efflorescence were noted throughout, which is typical of a below grade structure such as this. Structural modifications were made to the original 1930s vintage gallery when the new tanks were built in the '50's, extending the gallery to the north and south. The structural modifications were in fair condition and showed a moderate degree of deterioration.

Photo 10- Deteriorated concrete w/ exposed reinforcement at column base

Measures to capture water leaking from overhead were noted, particularly under the area where HRC observed standing water and deteriorated concrete across the top slab on the west end of Tanks 1S and 2S.

Of particular note was the condition of the bottoms of the concrete columns near the floor. In multiple locations, the concrete was deteriorated to the extent that the steel reinforcement ties were exposed and corroded (Photo 10). The floor was wet in many areas throughout the gallery, including around the deteriorated columns.

Conclusions and Recommendations

Based on the observations made by HRC on 10/14/2020, the structural condition of the concrete in Tanks 1S and 3N was sound. Together with the results and conclusions of the compressive strength tests and petrographic analyses of the cores taken as part of the study scope, HRC recommends that the Primary Tanks are good candidates for reuse provided the service and exposure types are not changed significantly from current. Minor to moderate structural repairs are recommended to extend the service life of the tanks.

It should be noted that the interiors of Tanks 1S and 3N were inspected as a representative sample of the whole. Therefore, it is assumed that the other tanks that were not entered by HRC are of similar condition.

HRC recommends that the following structural concrete rehabilitation items be addressed as part of an improvements project:

Concrete Scum Trough/Inlet Boxes

If the concrete scum troughs are to be reused as part of the future function of the tanks, they will require a combination of structural rebuilding and repair. The limits and extents of both the rebuilding and repair would be determined during a more in-depth inspection of the trough and inlet areas. Deep repair of the undersides of the walkway slabs local to the trough are also recommended.

Walls and Beams

Walls and beams whose condition is like that which was observed in Tank 3N, should be cleaned to remove the existing coating followed by localized shallow repairs with a cementitious structural concrete material, particularly along the waterline. Any cracks that may become visible after removal of the surface debris and coating should be pressure injected with a structural epoxy adhesive.

Protective Coating

To aid in extending the service life of the Primary Tanks, application of a protective coating to all or many of the concrete surfaces on the interiors of the tanks is recommended following the reconstruction at the trough/ inlets and completion of the structural repairs to the walls and beams. HRC has successfully utilized a select few coating systems, each of which uses a different type of technology for protecting the concrete. Recommendations as to which system is most appropriate for the Primary Tanks would be based on consult with a few of these trusted manufacturers who specialize in this type of application. HRC would present the results of the compressive testing and petrographic analysis to the manufacturers as a valuable aid in determining the best choice for a coating system.

Gallery Repairs

Cracks in the walls and slabs should be injected with structural epoxy adhesive. At the columns where spalls were observed, the exposed steel reinforcement should be cleaned of rust and then protected with an application of a corrosion inhibitor. The surfaces of the columns should then be rebuilt with a cementitious structural concrete. Measures to mitigate standing water on the gallery floor will help to limit future deterioration of these column repairs.

Attachments: HRC 10/14/20 field notes

20190115

10.14.20

rkc

wire brushed floor and removed hardened layer of sludge to black powdered layer. Agg is exposed likely due to mech wear.

occasional hand patching noted on faces of strut beams etc but all looks sound.

Looks like interior may have been coated c Stone pt. Wire brushing surface debris off reveals somewhat shiny surface below. Looks "painted". Dimensional lumber formwork lines evident throughout.

grouted bypass @ mech drive on east end w/ possible repaired diag crack on S. wall. "Repair" looks sound. Add'l potential repairs @ full ht jts or cracks (nearly 100% vertical) on 2 locations ± 15' o.c. on s. wall. Also good condition. Patch repairs x 4 on N. wall C ± 5' from top

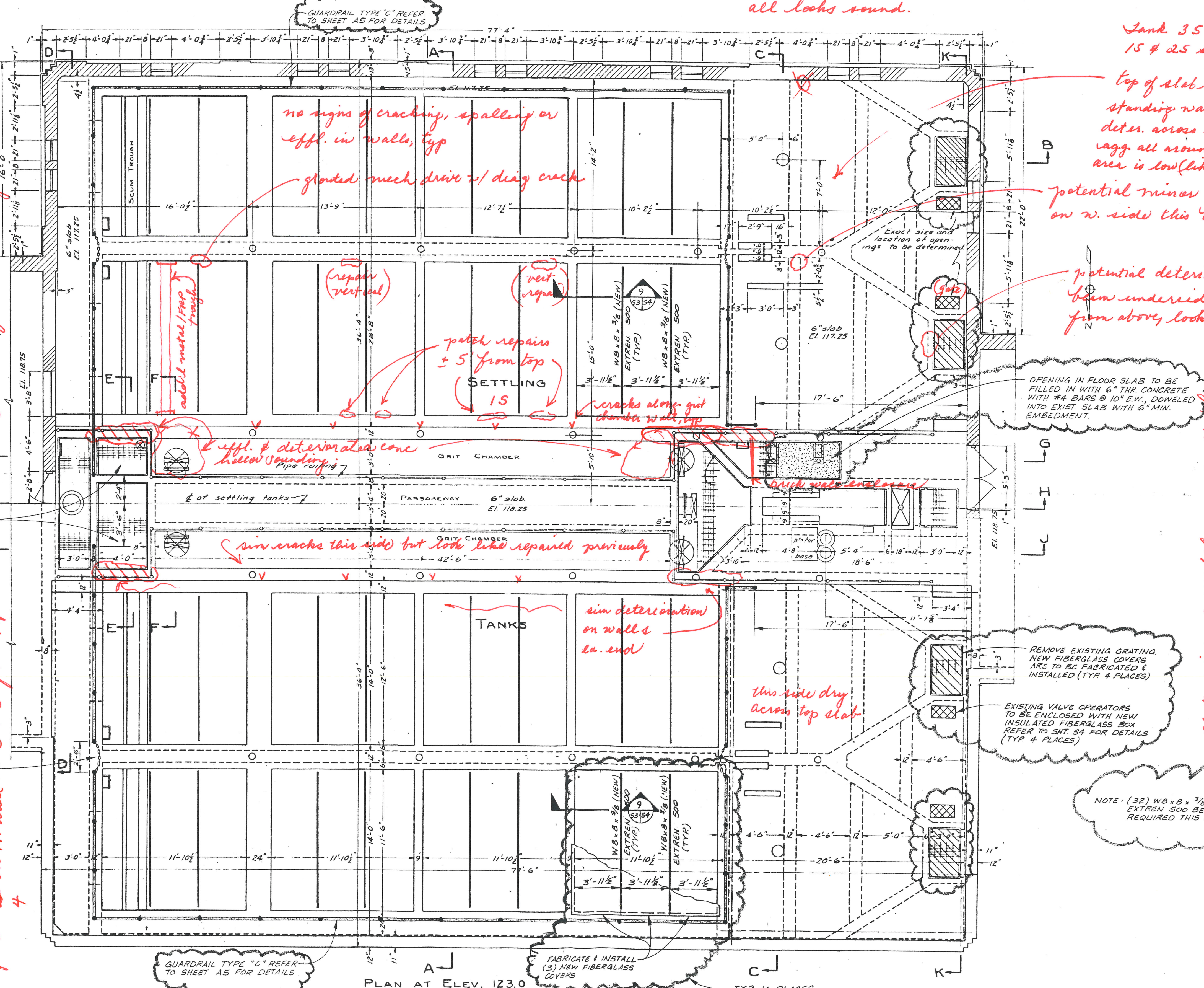
trough undersides fair as are undersides of strut beams and cantilevered walkways on sides. EXCEPTION: underside cantilevered walkway on side nearest trough. heavy sludge build up but looks like conc may be delam'd. Neither observed. Sounded cracks/jts, patch repairs - all healthy. Sounded floor - healthy

Tank 3S is higher than 1S & 2S so.... top of slab has substantial standing water and conc deter. across surface. loose agg. all around. this entire area is low (like a bathtub)

potential minor spall on n. side this beam

potential deterioration on beam underside here from above, looks like sim deter. as @ e. end

Note: imp. covered common wall between adjacent tanks but not exterior wall w/ soil/hydrostatic load



PLAN AT ELEV. 123.0

WW Engineering & Science
A Summit Company
5555 Glenwood Hills Parkway, SE • P.O. Box 874 • Grand Rapids, MI 49588-0874 • (616) 942-9600

REVISIONS — REVISED IN ACCORDANCE WITH CONSTRUCTION RECORDS

CITY OF TRAVERSE CITY
GRAND TRAVERSE COUNTY, MICHIGAN
1994 WWTP CAPITAL IMPROVMENTS
PRIMARY TANKS FIBERGLASS COVERS – PLAN

DESIGNED BY	R.T.B.	DATE	MAR. '94
DRAWN BY	R.J.S.	DATE	MAR '94
CHECKED BY	D.J.E.	DATE	JULY '94
FILE	89936S3	EDIT	RJS060194
SCALE	AS NOTED	DRAWING	1:1
PROJECT	89936		

S3

SHEET NO.

10.14.20 cbc

coating failure + exposed agg

Existing settling tank

stone bedding

slab sunken here

Repair down full ht of wall (looks good)

3N

along H_2O line, failure of coating and beginning of spalls beneath

topside cracks not filled

generally, walls and coating fair; same for beams update: frequent locations of coating failure on beam faces. undersides o.k.

these cracks go down and around underside of walkway slab: sim full length

cracks across tops / walls and down sides along north face have been routed out and filled w/ sealant

TOP PLAN

corrosion of conc w/ agg exposure heavy all along inlet chamber

coating failure + delam/spall typ above w.s.

coating failure typ

potential gw leak @ chamfered end about mid wall of tank

boy out good both sides

SECTION A-A

Note: North battery of tanks shown. South battery similar but opposite hand.

SECTIONAL PLAN OF OUTLET WEIR TROUGHS AT ELEVATION 116.8

Scale: 1/2" = 1'-0"

SECTION D-D

Scale: 1/2" = 1'-0"

See sht #11 for details of water proofing

SECTION E-E

Scale: 1" = 1'-0"

PLAN OF WEIR ON SIDE OF SLAB

SCALE: 3" = 1'-0"

McNAMEE, PORTER AND SEELEY CONSULTING ENGINEERS ANN ARBOR, MICHIGAN			
SCALE 1/8" = 1'-0"		ISSUED SEPT. 1957	
DRAWN R.M.E.	TRACED R.M.E.	CHECKED W.M.S.	
ISSUE	NATURE OF REVISION		DATE
	As CONSTRUCTED		3/4/58

TRAVELERS CITY, MICHIGAN
SEWAGE TREATMENT PLANT ADDITIONS

SETTLING TANK PLAN AND SECTION

CONTRACT 1

SHEET 5 OF 58

CONSULTING GROUP

December 16, 2020

Ms. Christa K. Crist, P.E.
Hubbell, Roth & Clark, Inc.
555 Hulet Drive
Bloomfield Hills, Michigan 48303-0824

Re: Letter on Structural Concrete Evaluation
Traverse City Regional Wastewater Treatment Plant
606 Franklin Street
Traverse City, Michigan
G2 Project No. 200895

Dear Ms. Crist:

As requested, G2 Consulting Group, LLC (G2) has obtained, tested, and evaluated samples of the existing reinforced concrete settling tanks at the wastewater treatment plant in Traverse City, Michigan. The concrete testing and evaluation program reported herein is part of a larger study being conducted by Hubbell, Roth & Clark, Inc. (HRC) to evaluate possible facility improvements. The purpose of the concrete testing and evaluation program is to provide both quantitative and qualitative information regarding concrete strength, aggregate properties, engineering properties, and overall concrete quality relative to the remaining service life of the subject structures.

SCOPE OF SERVICES

The field operations, laboratory testing, and engineering report preparation were performed under the direction and supervision of a licensed professional engineer. Our services were performed according to generally accepted standards and procedures in the practice of construction materials engineering and testing in this area. Our scope of services for this project consists of the following specific items:

1. We discussed the condition of the structures with the HRC site inspection team, reviewed original construction plans for the structures along with photographs taken during site inspections by HRC, and developed a concrete sampling plan in consultation with HRC.
2. We obtained four concrete samples for this project. All of the samples were obtained by core drilling. Two core samples, 1S-1 and 2S-1, were taken from the horizontal top surface of the concrete wall that divides tank 1S from tank 2S. The remaining two samples, 3N-1 and 3N-2 were taken from the north wall of tank 3N/4N. These samples were taken from exterior vertical wall surface. All of the core samples were delivered to our laboratory in Troy, Michigan for measurements and photographs. Samples 1S-1 and 3N-2 were tested in axial compression.
3. Samples 3N-1 and 1S-1 were shipped to Lankard Materials Laboratory in Columbus, Ohio for petrographic examination. Dr. David Lankard's evaluation report is included with this submittal.

FIELD OPERATIONS

G2 in consultation with HRC selected the location of the concrete samples. The locations are noted on Plates 1 and 2 contained in the Appendix. Cores samples were obtained by core drilling using an electric core drill with a 4-inch diameter diamond tipped barrel. As noted, the core barrel was advanced vertically downward through the top surface of the wall at tank 1S/2S and horizontally inward through

the exterior vertical surface of the north wall at tank 3N/4N. The samples obtained represent a partial thickness, nominally 7-1/2 inches to 8 inches, of the structural element in each case with the exception of sample 2S-1 which was retrieved in fragments and represents nominally 5 inches of the structure at that location. At completion of the core sampling, the core holes were patched with a quick set hydraulic cement patching material and the sites cleaned up as necessary.

LABORATORY TESTING

Photographs of the concrete samples prior to testing are shown in Figures 1 and 2 in the Appendix. Core samples 1S-1 and 3N-2 were trimmed using a diamond saw, capped with a sulfur based compound, and tested in axial compression in accordance with ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete. Test results are provided in the following table:

Concrete Core Sample Compressive Strength Test Results

Sample ID	Length (in.)	Diameter (in.)	L/D	Total Load (lbs.)	Correction Factor	Compressive Strength (psi)
1S-1	6.45	3.70	1.74	90,700	0.98	8,260
3N-2	7.33	3.70	1.98	90,540	1.00	8,420

PETROGRAPHIC EVALUATION

As noted, two samples were shipped to Lankard Materials Laboratory for evaluation. Dr. Lankard's general conclusion is that the "concretes are in sound condition and are of good quality". This conclusion is consistent with observations made by HRC's site inspection crew and the results of observations and compression tests conducted by G2. Rather than further characterize Dr. Lankard's report herein, the reader is encouraged to read the report in its entirety (Appendix).

As always, we appreciate the opportunity to be of service to Hubbell, Roth & Clark, Inc. In the meantime, if you have any questions regarding our concrete evaluation and testing program or any other matter pertaining to the project, please contact us.

Sincerely,

G2 Consulting Group, LLC

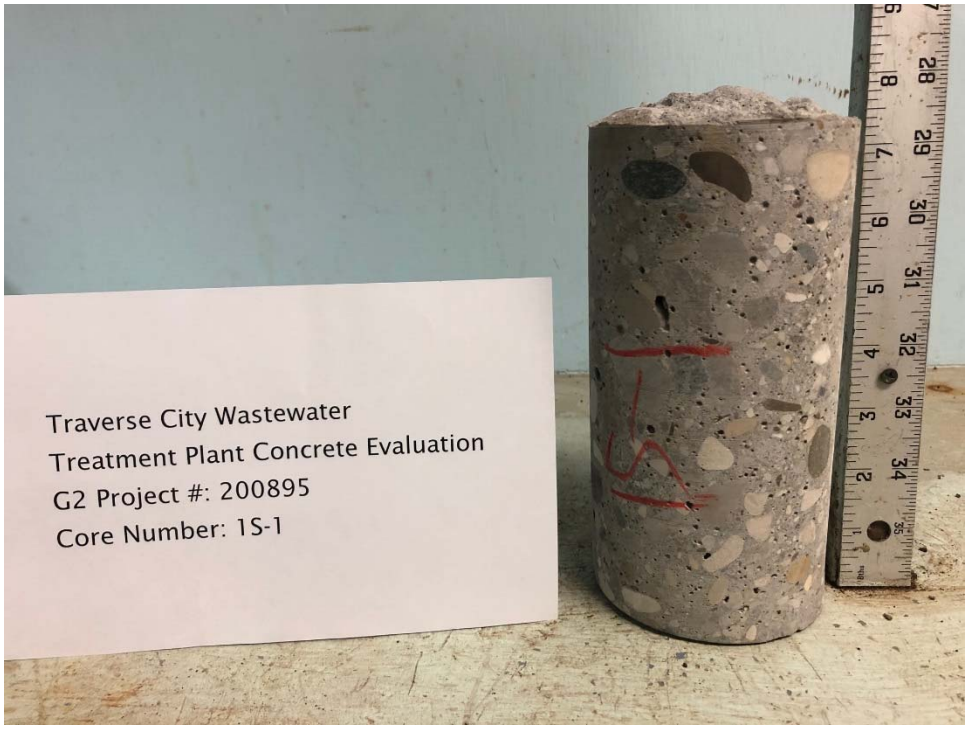
Grant Beahlen, P.E.
Project Engineer

James Berry, P.E.
Project Manager

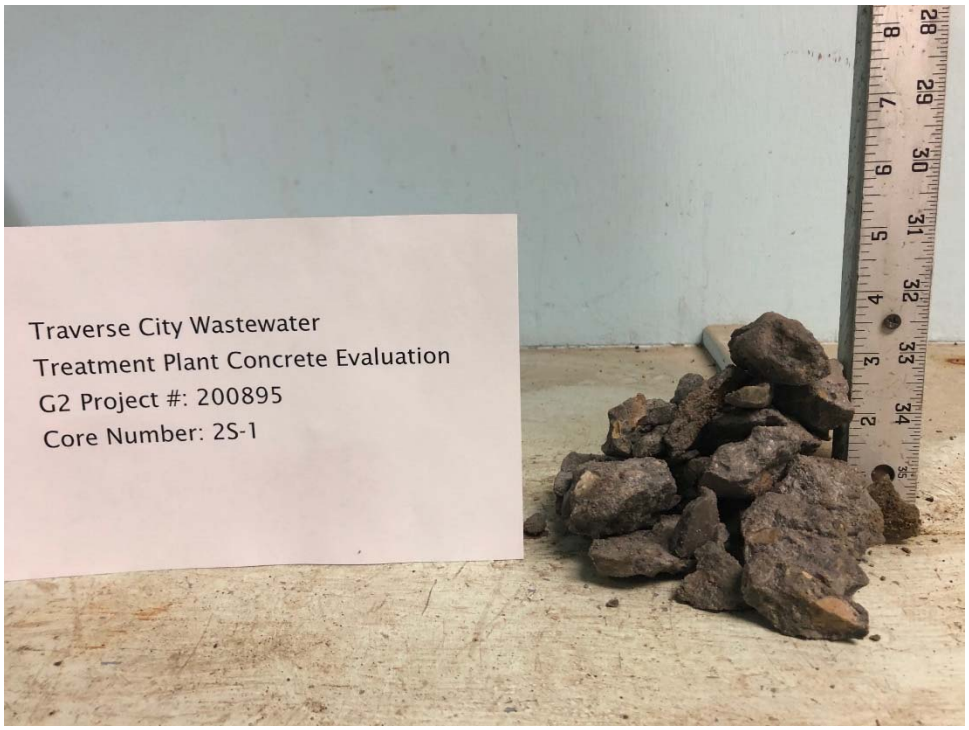
GMB/JLB/mlt

Encl: Core Sample Photographs — Figure Nos. 1 and 2
Core Sample Location Plans — Figure Nos. 3 and 4
LML Report No. 5060

Photographic Documentation
Traverse City Wastewater Treatment Plant Concrete Evaluation
G2 Project No. 200895



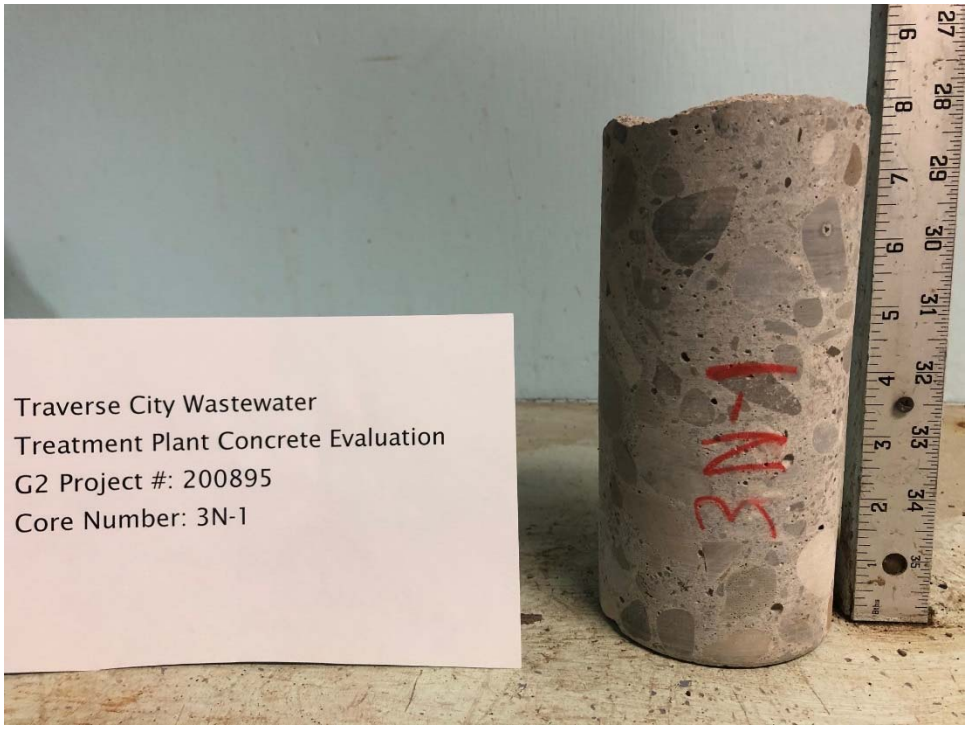
Concrete Core: 1S-1



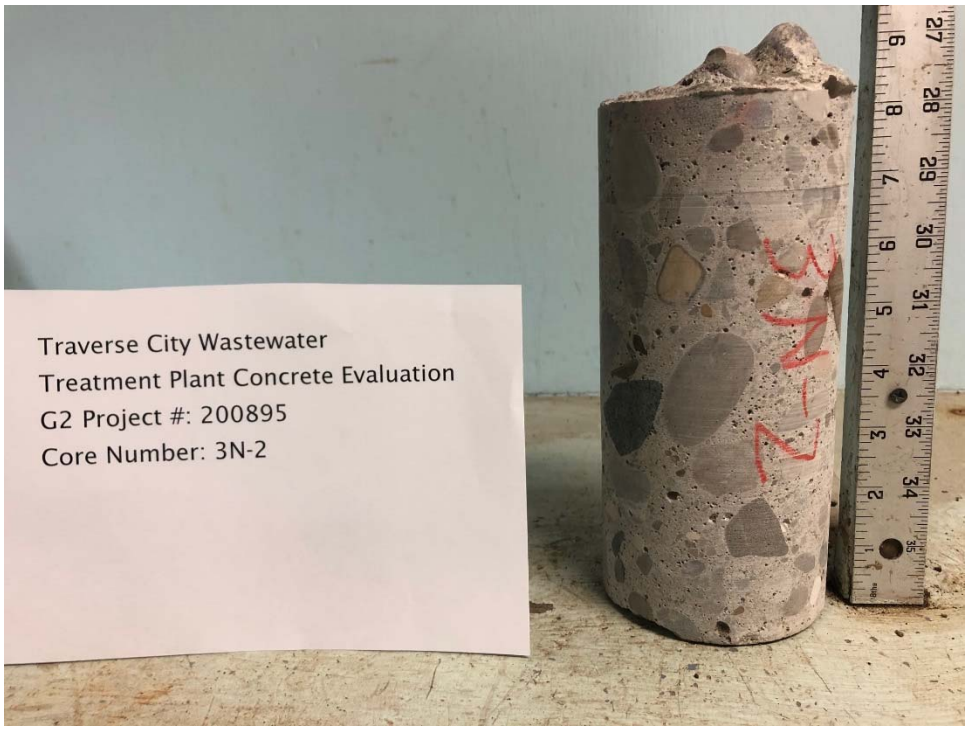
Concrete Core 2S-1

Figure No. 1

Photographic Documentation
Traverse City Wastewater Treatment Plant Concrete Evaluation
G2 Project No. 200895

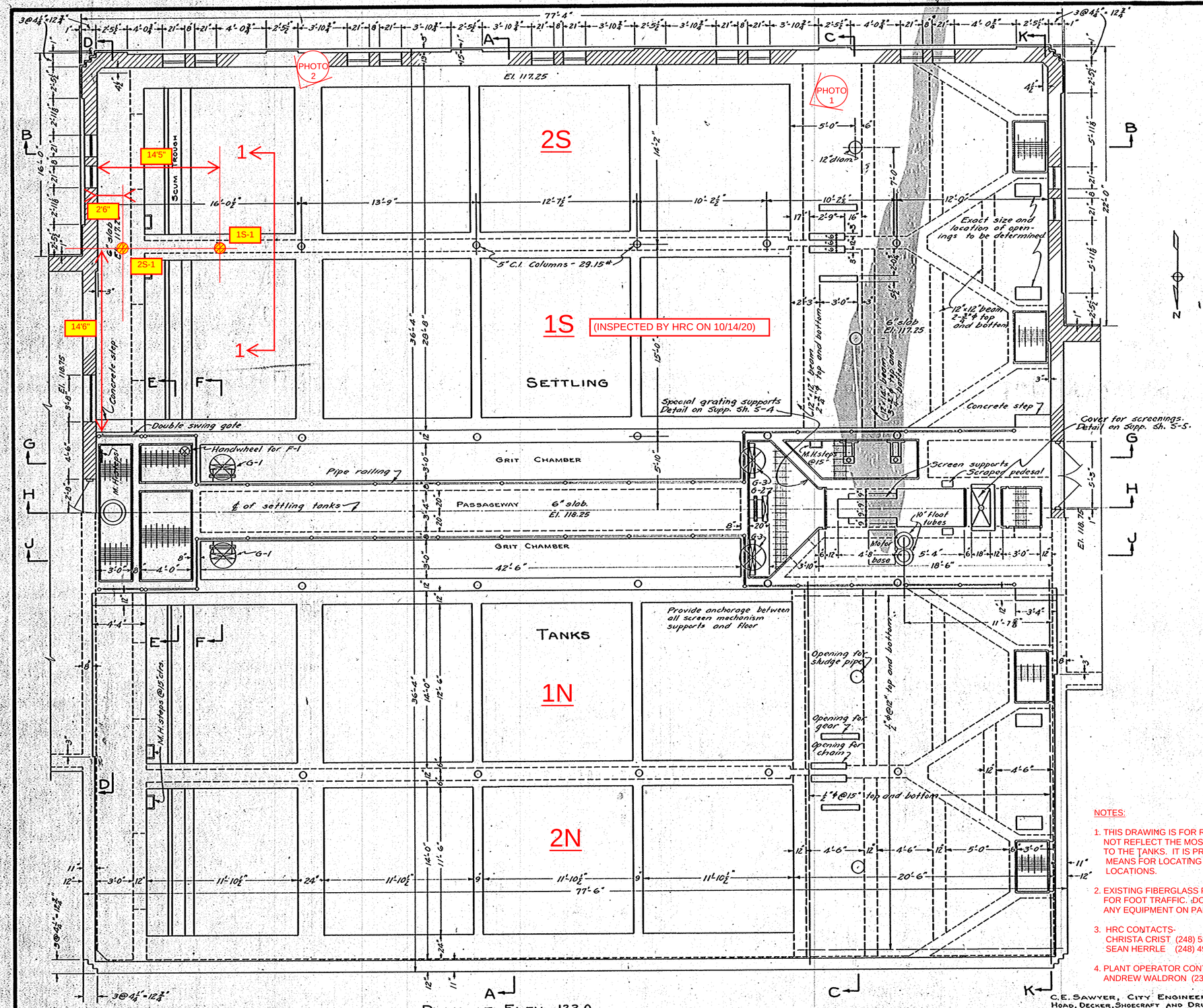


Concrete Core: 3N-1



Concrete Core 3N-2

Figure No. 2



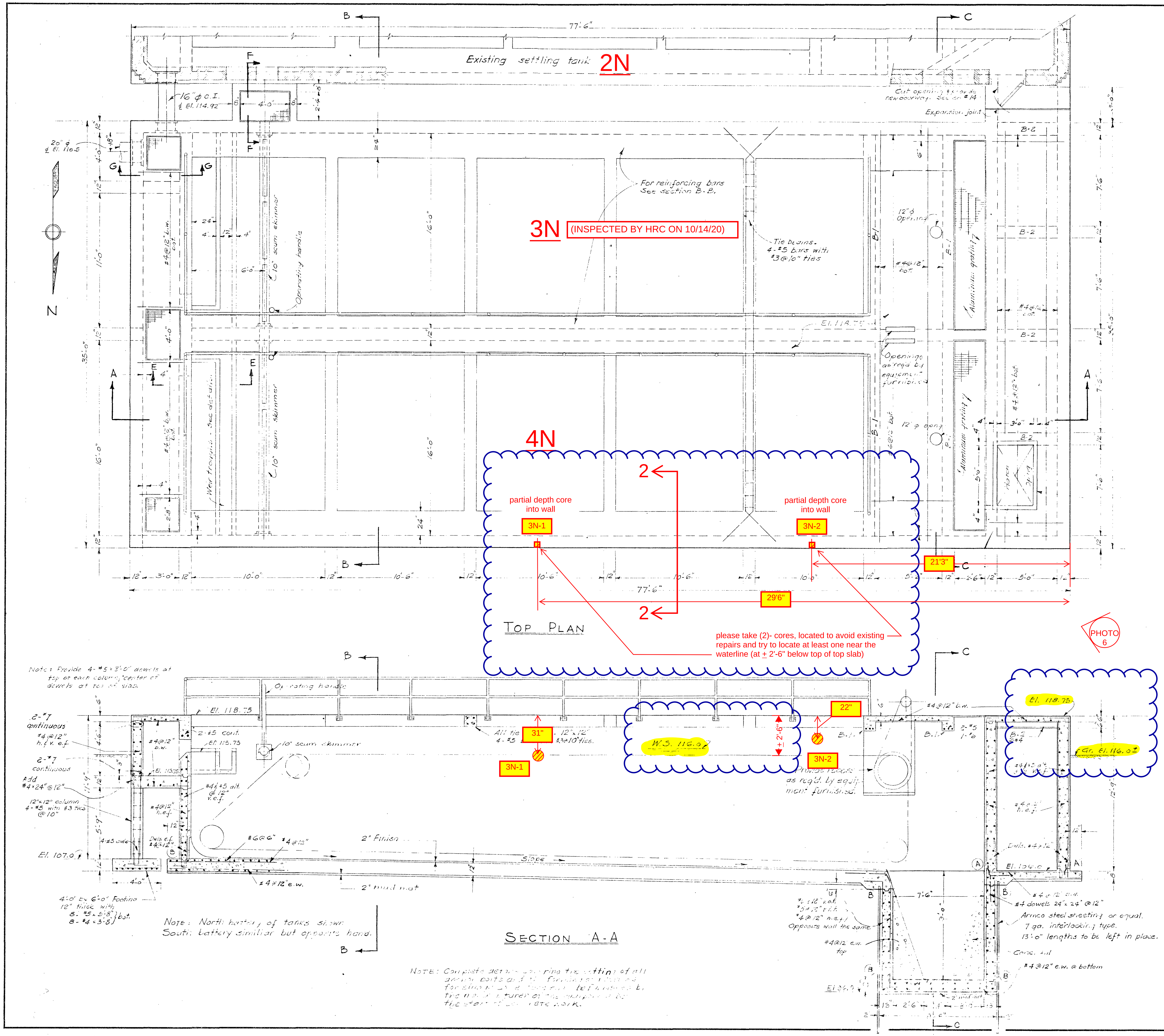
NOTES:

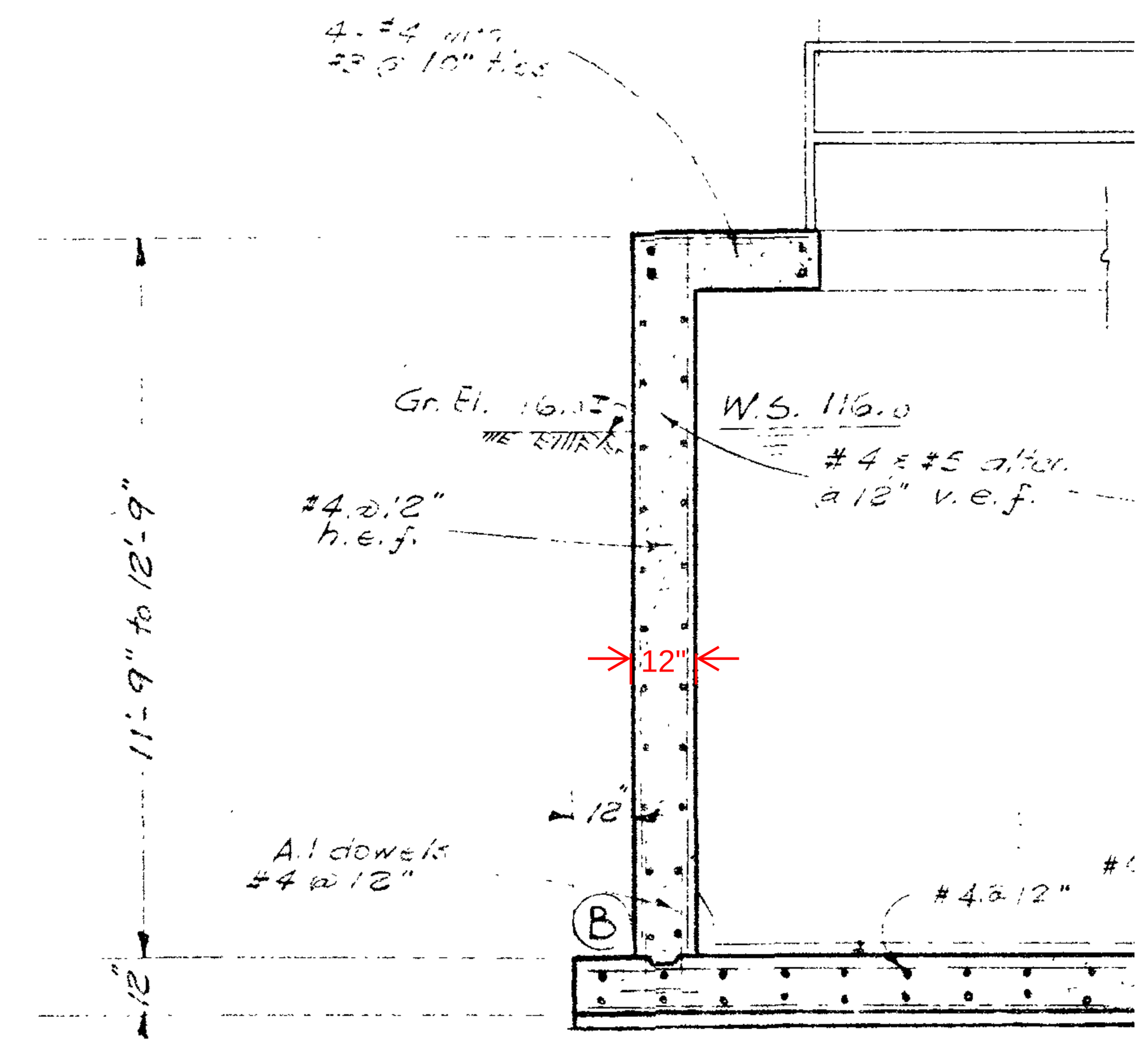
1. THIS DRAWING IS FOR REFERENCE ONLY AND DOES NOT REFLECT THE MOST RECENT MODIFICATIONS TO THE TANKS. IT IS PROVIDED AS A SUFFICIENT MEANS FOR LOCATING THE CONCRETE SAMPLE LOCATIONS.
2. EXISTING FIBERGLASS PANELS ARE NOT RATED FOR FOOT TRAFFIC. DO NOT STAND ON OR PLACE ANY EQUIPMENT ON PANELS.
3. HRC CONTACTS-
   CHRISTA CRIST (248) 535-1027 (CELL)
   SEAN HERRLE (248) 496-8064 (CELL)
4. PLANT OPERATOR CONTACT (JACOBS)-
   ANDREW WALDRON (231) 409-2842

C.E. SAWYER, CITY ENGINEER.
HOAD, DECKER, SHOECRAFT AND DRURY, CONSULTING ENGINEERS.
FRY AND KASURIN, CONSULTING ARCHITECTS.

TRAVERSE CITY, MICHIGAN
SEWAGE DISPOSAL SYSTEM
SEWAGE TREATMENT PLANT
SETTLING TANKS – FLOOR PLAN
SCALE IN FEET
0 1 2 3 4 5 6 7 8
FEBRUARY 1932
9

Figure Nos. 3





SECTION 2-2

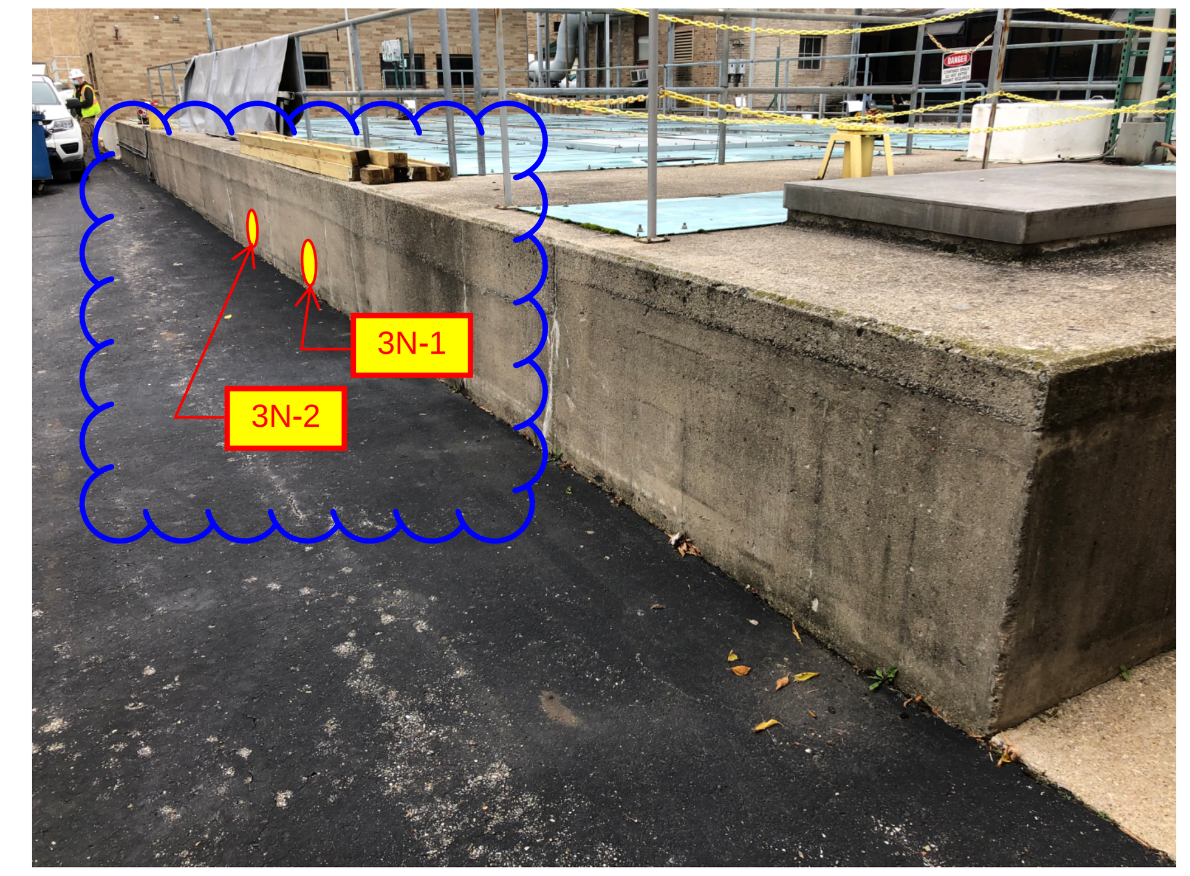


PHOTO 6

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2. EXISTING FIBERGLASS PANELS ARE NOT RATED FOR FOOT TRAFFIC. DO NOT STAND ON OR PLACE ANY EQUIPMENT ON PANELS.
3. EXACT LOCATION OF SAMPLES 3N-1 & 3N-2 MAY BE FIELD ADJUSTED TO AVOID EXISTING CRACK REPAIR AREAS.

Figure No. 4

McNAMEE, PORTER AND SEELEY
CONSULTING ENGINEERS
ANN ARBOR, MICHIGAN

Traverse City, Michigan
Sewage Treatment Plant Additions

Settling Tanks
Plan and Section

ISSUE	NATURE OF REVISION	DATE
	As constructed	3/4/59

Issued Sept. 1957 — Contract 1 — Sheet 5

REPORT NO. 5060

ON

PETROGRAPHIC EXAMINATION OF TWO CONCRETE CORE SAMPLES TAKEN AT A WASTE WATER TREATMENT FACILITY IN TRAVERSE CITY, MI.

TO

G2 CONSULTING GROUP
TROY, MICHIGAN|
(G2 PROJECT NO. 200895)

DECEMBER 14, 2020

DR. DAVID LANKARD
LANKARD MATERIALS LABORATORY
COLUMBUS, OHIO

LML REPORT NO. 5060

CONTENTS

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INTRODUCTION

On November 20, 2020, I received two concrete cores from James Berry, Project Manager of G2 Consulting Group in Troy, Michigan. The cores were taken from reinforced concrete tank structures at the Traverse City Michigan Waste Water Treatment Plant.

Following their inspection of the tank structures in October 2020, personnel of Hubbell, Roth, and Clark Consulting Engineers (Bloomfield Hills, MI) are proceeding with the concept that the concrete structures can be retained with relatively minor upgrades and repairs. As a confirmation and backup to the results of their visual inspection of the tanks, HRC has requested a qualitative evaluation of representative samples of the concrete from the tanks. G2 Engineering is assisting HRC in this effort. To this end, I was requested by Mr. Berry to conduct a petrographic examination of the cited cores. The objectives of my examination are (1) to provide a characterization of the overall quality and the current condition of the core concretes, and (2) to provide an assessment of the prospects for future service.

DESCRIPTION OF THE TANK STRUCTURES AND SAMPLING SITES

Of the four rectangular tanks at the facility, two, the largest were constructed in the 1960s. The two smaller tanks were built in the 1930s. One of the cores sent to me (Core 1S-1) was taken from one of the 1930s tanks, the other (Core 3N-1) from one of the 1960s tanks. Figure 1 shows current views of the cited tank structures.

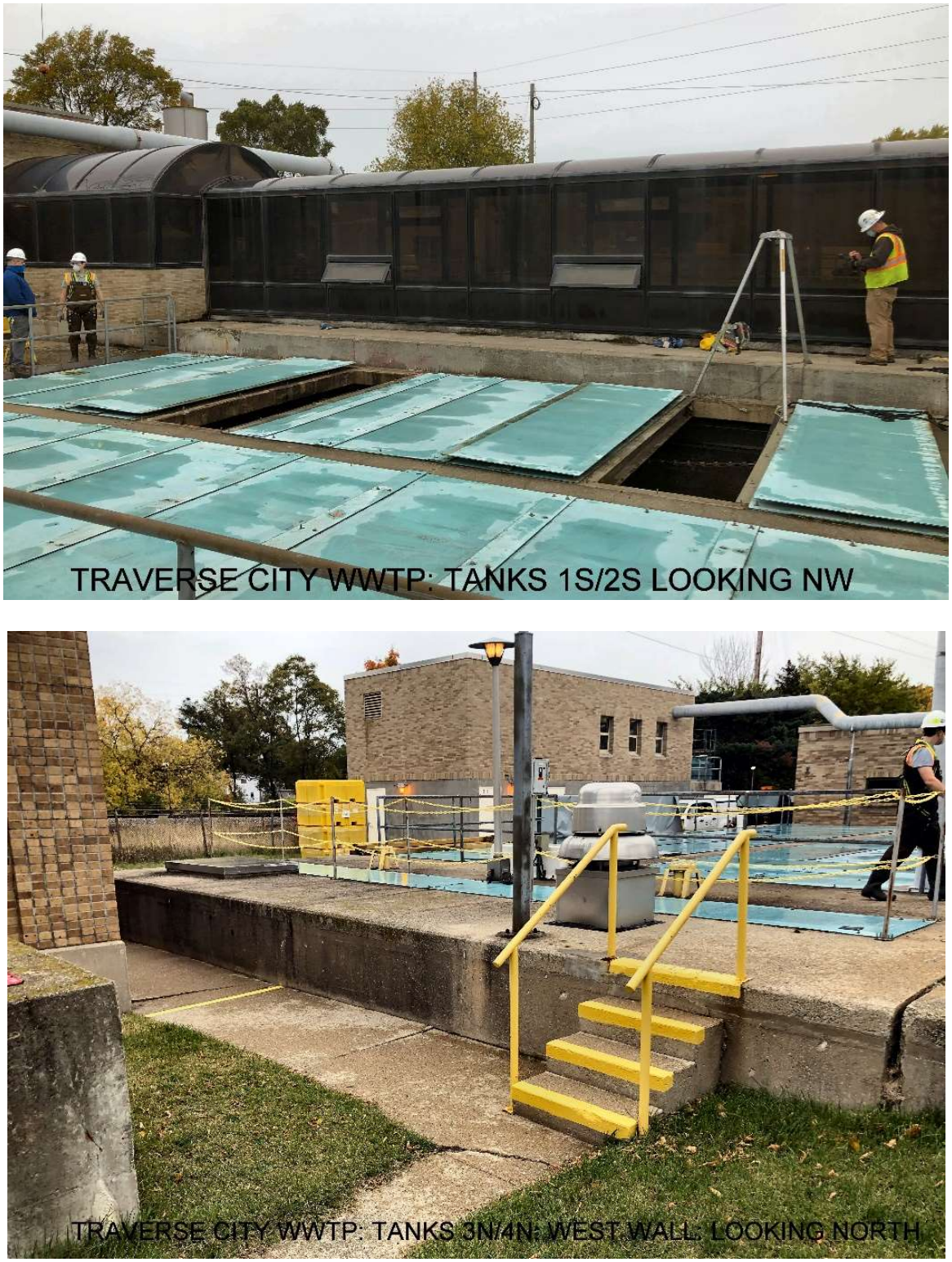


Figure 1. Views of the Traverse City WWTP facility in October 2014. The top view shows the tanks labeled 1S and 2S. Core 1S-1 was taken from the vertical wall separating Chamber 1S from 2S (1930s construction). The bottom view shows Tanks 3N and 4N. Core 3N-1 was taken from Tank 3N, which was constructed in the 1960s.

DESCRIPTION OF THE CORES

Core 3N-1, shown in Figure 2 as received at LML, has a diameter of 3.7 in. and a length of 7.8 in. This core was taken horizontally through the exposed vertical exterior surface of the outer 12 in. thick wall of Tank 3N/4N. The wall surface is above grade and is not in contact with the tank water. A companion core (3N-2) was taken for a compressive strength test.

Core 1S-1 (photograph taken at G2), has a diameter of 3.7 in. and a length of around 7.5 in. The core was taken from the top surface of the 12 in. thick vertical wall, which separates Chambers 1S and 2S. The wall surface is above grade and is not in contact with the tank water. The core was tested for compressive strength at G2, and the fracture pieces were provided to LML for the petrographic examination.

Figure 2. Cores 3N-1 and 1S-1 provided for the petrographic examination. Core 3N-1 was received intact. Core 1S-1 was tested for compressive strength at G2, following which the fracture pieces were provided for the petrographic examination.

CORE EXAMINATION PROCEDURES

My examination was conducted in accordance with relevant guidelines of ASTM C856, the Standard Practice for Petrographic Examination of Hardened Concrete.

Examination of the Cores in the As-Received Condition

The as-received concrete samples were examined visually and microscopically. An Olympus SZX-16 stereomicroscope was used on fracture surfaces and cored-surfaces. Observations were made and noted on (1) the mode of fracture in the strength test for Core 1S-1 (aggregate pull-out or fracture), and on (2) the presence or absence of secondary deposits and distress features.

Further Examination of the Cores

Following the preliminary examination, the cores were saw-cut for further examinations and tests. Core 3N-1 was saw-cut as shown in Figure 3.

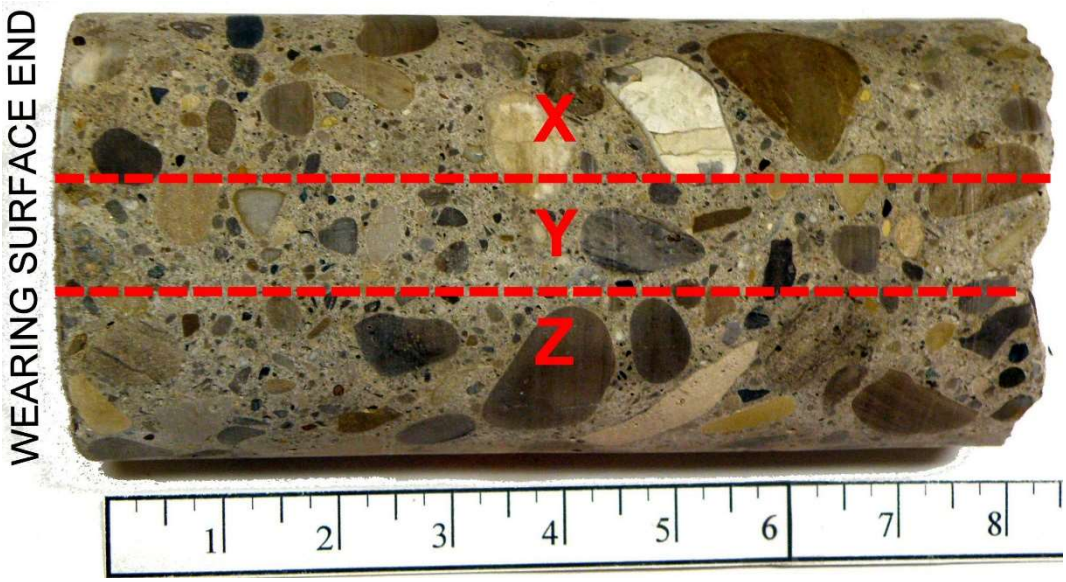


Figure 3. The dashed lines show where saw-cuts were made on Core 3N-1. Features of interest are discussed below.

Features of Interest in Figure 3

1. Sample Piece Y is a 1 in. thick slab. Both saw-cut surfaces of the piece are lapped (polished) for subsequent reflected light microscope examinations. Observations made and tests conducted during the examination provide (1) an identification of the cementitious and aggregate constituents of the concretes, (2) an estimate of the water-cement ratio (w/c) of the cementitious phase, (3) a characterization of the size and distribution of air voids and other types of voids, (4) information on the quality of the cement paste/aggregate bond, and (5) an opportunity to identify evidence of distress in the concrete.

Features of Interest in Figure 3 (Cont'd)

2. The fresh saw-cut surface of Core Piece X is sprayed with a pH indicating solution (phenolphthalein) to assess the presence and extent of carbonation of the concrete. Following this step, the piece is used to measure the density of the concrete, using relevant procedures of ASTM C642, the Standard Test Method for Specific Gravity, Absorption, and Voids in Hardened Concrete.

3. A fresh fracture surface is created in Core Piece Z using a modification of ASTM C496, the splitting tensile strength test. The examination of the newly-created fracture surface provides additional information on (1) the cement paste/aggregate bond strength, (2) the quality of the cement paste phase, and (3) the presence of distress features that could otherwise be missed.

Core 1S-1 was received in pieces and could not be saw-cut as shown in Figure 3. Saw-cuts were made in the pieces to provide for the preparation of lapped surfaces, for the assessment of carbonation, and for a density measurement.

Secondary Deposits

Particular attention was paid to the question of the presence and extent of secondary deposits in the core concretes. The search for secondary deposits was done on as-received surfaces, lapped surfaces, and newly-created fracture surfaces of the cores. What are secondary deposits and why are they important?

During wetting and drying episodes, water moves from one location to another in hardened concrete in service. It is an inevitable occurrence that soluble constituents located at an original site are transported and deposited at a new site. Such deposits are referred to as secondary deposits. The most common internal sites for their deposition are in air void cavities and along any pre-existing fracture surfaces. Two of the most common secondary deposits are calcium hydroxide and ettringite (a hydrous calcium sulfoaluminate mineral). The presence of secondary deposits is a innocuous diagnostic feature which confirms that there has been moisture movement into and out and through the concrete. An abundance of secondary deposits confirms that there has been extensive moisture cycling. This condition can (1) lead to freeze/thaw damage if the concrete is not adequately air entrained, or (2) lead to destructive cement/aggregate reactions if such aggregates are present.

On the other hand, the absence or dearth of secondary products confirms that the examined concrete did not experience any significant episodes of moisture cycling.

The findings of the examination and tests of the cores follow.

CORE 3N-1: EXAMINATION AND TEST RESULTS

Core 3N-1 represents the concrete that was used in the 1960s construction of the tanks at the Traverse City WWTP facility. The core, with a diameter of 3.7 in. and a length of 7.8 in. was taken horizontally (parallel to grade) through an exposed vertical exterior surface of the outer wall of Tank 3N. Figure 4 shows a lapped surface of the core.

Figure 4. This lapped surface of Core 3N-1 shows the appearance of the concrete. Features and properties of the core concrete are described below.

Cementitious Constituent (Core 3N-1)

The cementitious phase is composed solely of well hydrated portland cement. There is no standard test procedure for measuring the water-cement ratio (w/c) of hardened concrete. The water-cement ratio is estimated by qualified petrographers through observations and measurements of features and properties of the cement paste that are affected by w/c, including color, hardness, rate of water absorption, and abundance of residual cement grains. For the Core 3N-1 concrete, the w/c is estimated at 0.42, and is uniform from top to bottom in the core.

Carbonation of the Cement Paste (Core 3N-1)

A pH indicating solution (phenolphthalein) was sprayed on a fresh saw-cut surface of the core, with the result shown in Figure 5.

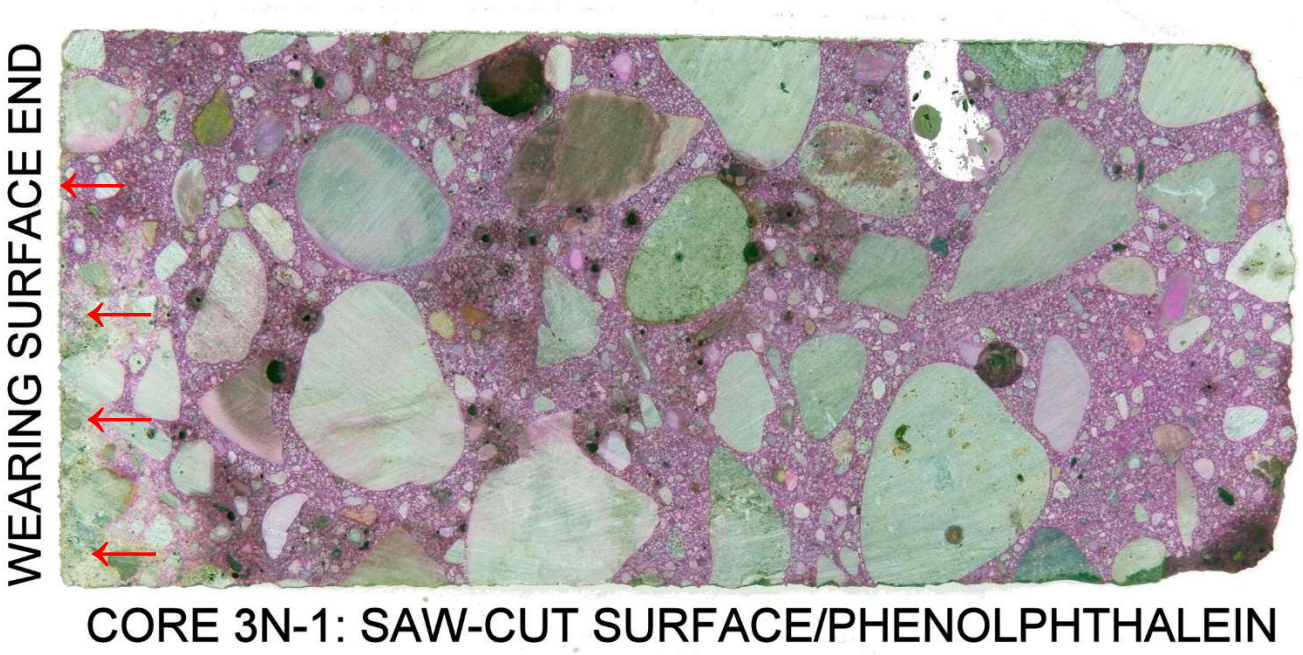


Figure 5. This view shows the appearance of a saw-cut surface of Core 3N-1 following the application of phenolphthalein solution. Features of interest are described below.

Features of Interest in Figure 5

1. The red coloration shows the area on the concrete that is not carbonated. When phenolphthalein contacts a carbonated concrete surface (pH below 10) there is no color change.

2. The only carbonation is a thin layer of the concrete at the wearing surface (where there is contact with the atmosphere). In this 2-dimensional view, a portion of the wearing surface layer shows 0 to 0.5 mm depth of carbonation (no color). Below this region in the figure, the depth of carbonation (indicated by the arrows) is 6 mm to 8 mm. A minor degree of incomplete consolidation has contributed to the carbonation in this region. There is no other carbonation in the core concrete.

3. The absence of any significant carbonation of the concrete at this sampling site after 60 years of service is attributed in large part to the good quality of the cement paste phase (low w/c, low permeability).

Fine and Coarse Aggregates (Core 3N-1)

The aggregate constituent in the core concrete is from a single sand/gravel source type, and is composed of both limestone and siliceous/silicate rock and mineral types.

Coarse Aggregate

The dominant coarse aggregate rock type is limestone, which includes finely-crystalline limestone, with smaller amount of micritic limestone and finely crystalline dolomitic limestone.

The limestone rock types comprise an estimated 80 to 90 percent of the coarse aggregate constituent. Within the category of limestone rocks, these limestone particles are hard and dense, and show a low rate of water absorption. The remainder of the coarse aggregate suite includes particles of quartz, quartzites, chert, igneous rock types, and occasional shale.

The particle size of the coarse aggregate constituent best fits the grading requirements of the ASTM C33, No. 57 classification (The Standard Specification for Concrete Aggregates). In this classification 90 to 100 % of the particles pass the 1 in. sieve. As seen in Figures 4 and 5, the rounded gravel particles range from roughly equiaxed to elongate and bladed in shape.

Fine Aggregate

The ASTM C33 gradation for fine aggregate shows 95 to 100 percent passing the No. 4 sieve (4.75 mm) and 0 to 10 percent passing the No. 100 sieve (0.15 mm). The fine aggregate in the Core 3N-1 concrete is a natural sand composed of the same siliceous and limestone rock and mineral types as the coarse aggregate. Quartz particles in the range of 0.05 mm to 0.5 mm form an estimated 70 to 80 percent of the sand, along with small amounts of sand-sized limestone particles, chert, igneous lithics, and trace amounts of shale. Figure 6 shows the dominance of small, clear quartz particles in the fine aggregate in the core concrete.

Figure 6. Photograph, taken at a magnification of 16X, on an acid-etched lapped surface of Core 3N-1. The arrows point to several of the small, clear quartz particles, which form an estimated 70 to 80 percent of the fine aggregate constituent. The darker particles include limestones and igneous rock constituents.

Cement Paste/Aggregate Bond (Core 3N-1)

Microscopic examinations made on lapped surfaces of Core 3N-1 reveal a tight, uninterrupted cement paste/aggregate bond. The examination of intentionally created fracture surfaces in pieces of the core confirm this condition as shown in Figure 7.

Figure 7. This view shows the appearance of the fracture surface that was intentionally created in Piece Z of Core 3N-1, in the ASTM C496 splitting tensile test. All of the coarse aggregate particles (dots on several) in the view fractured in the test, rather than pulling out intact. The red dot is on a chert aggregate particle that shows evidence of ASR activity (discussed in a later section). Other features of interest are discussed below.

Features of Interest in Figure 7

1. All of the coarse aggregate particles and many of the largest fine aggregate particles fractured in the test. This confirms (1) the good quality and strength of the cement paste/aggregate bond, and (2) the good quality of the cement paste phase (low w/c, low level of porosity, good strength).

2. The mode of failure predicts a high level of compressive strength for the core concrete. A companion core to Core 3N-1, Core 3N-2 had a measured compressive strength of 8420 psi, when tested by G2.

Cement/Aggregate Reactions (Core 3N-1)

There is a low level of alkali-silica reaction activity (ASR) associated with the chert aggregate particles in the coarse and fine aggregates. This condition is discussed in detail in a later section of the report

Air Voids and Consolidation (Core 3N-1)

The concrete represented by Core 3N-1 is non-air entrained, with an entrapped air void content estimated at 2 percent to 3 percent. The air voids typically range in size from a low value of 0.2 mm to a high value of 2 mm.

As can be seen on the lapped surface of Core 3N-1 in Figure 4, the core concrete is well consolidated. The only evidence of incomplete consolidation is in isolated, discrete and small regions of mortar at the wearing surface elevation (to a depth into the wearing surface of around 6 mm. This condition has not affected the performance or durability of the core concrete.

Core 3N-1 represents around an 8 in. thickness of the 12 in. thick tank wall, with the wearing surface being the exterior surface of the wall. The wall is not in contact with the tank water. The access of water in the form of precipitation is from the top and vertical side of the wall. Virtually all of the entrapped air void cavities are either free of any secondary deposits, or contain minute amounts. The overall dearth of secondary deposits confirms a low level of water ingress and moisture cycling episodes over the 60 years of service of the wall.

Core Concrete Density (Core 3N-1)

The density of pieces of Core 3N-1 was measured following a 48-hour water soaking period at room temperature (per relevant procedures of ASTM C642). A density measurement made on water-saturated hardened concrete is expected to correlate reasonably well with the original unit weight of the fresh concrete. The measured water-saturated density of the Core 3N-1 concrete is 151.9 lb/ft^3, which is in the range of expected values for non-air entrained concrete containing a good quality sand/gravel aggregate.

Core Concrete Compressive Strength (Cores 3N-1 and 3N-2)

Core 3N-2, the companion core to 3N-1, was tested for compressive strength at G2, with a measured value of 8420 psi. The mode of intentional failure of the Core 3N-1 concrete in the present study indicates a similar level of strength.

Current Condition of the Core 3N-1 Concrete

The Core 3N-1 concrete is in excellent condition following 60 years in an exposed freeze/thaw environment. There has been a minor amount of cement paste lost from the exposed wearing surface of the wall (a normal expectation), and low-level ASR activity that has not been destructive. Beyond these features, there is no evidence of distress of any type from any source exhibited by the core concrete.

A characterization of the ASR activity in the Core 3N-1 concrete is discussed in detail in a later section of the report.

CORE 1S-1: EXAMINATION AND TEST RESULTS

Core 1S-1 represents the concrete used in the 1930s construction of the tanks. As taken, the core had a diameter of 3.7 in. and a length of around 7.5 in. The core was taken (top down) in the middle of the 12 in. wide vertical wall separating the two tank chambers S1 and S2. After a compressive strength test at G2, the core pieces were provided for the petrographic examination. Figure 8 shows a lapped surface of one of the pieces of Core 1S-1 from the strength test.

Figure 8. This view shows a lapped surface of one of the Core 1S-1 pieces from the compressive strength test. Features and properties of the core concrete are described below.

Cementitious Constituents (Core 1S-1)

The cementitious phase is composed solely of well-hydrated portland cement. The water-cement ratio (w/c) is estimated at 0.42 and is reasonably uniform as observed on the fracture surfaces and lapped surfaces of the core pieces.

Carbonation of the Cement Paste (Core 1S-1)

A phenolphthalein solution was sprayed onto fresh saw-cut surfaces of the core pieces with the result shown in Figure 9.

Figure 9. This view shows the appearance of saw-cut surfaces of two pieces of Core 1S-1, following the application of phenolphthalein solution. Features of interest are described below.

Features of Interest in Figure 9

1. Virtually the entire saw-cut surface area of the core pieces shows the red coloration, confirming no carbonation of the concrete. The only carbonation is at the wearing surface end of the right-hand core piece in the figure, where the maximum thickness of no color change (carbonation) is 0.5 mm.

2. The shallow depth of carbonation at this sampling site after 90 years of service is attributed in large part to the good quality of the cement paste phase (low w/c, low permeability).

Fine and Coarse Aggregates (Core 1S-1)

The fine and coarse aggregate in the core concrete are from a single sand/gravel source type, and is composed of both limestone and siliceous/silicate rock and mineral types. The aggregate in this 1930s concrete is very similar to the sand/gravel aggregate in the 1960s concrete represented by Core 3N-1.

Coarse Aggregate (Core 1S-1)

The particle size of the coarse aggregate best fits the grading requirements of the ASTM C33 No. 67 classification. In this classification 100 percent of the particles pass the 1 in. sieve, with 95 to 100 percent passing the 0.75 in. sieve.

The dominant coarse aggregate rock type is finely-crystalline limestone, with small amount of micritic limestone and finely crystalline dolomitic limestone. Within the category of limestone rocks, these coarse aggregate particles are very hard and dense, and show a very low rate of water absorption. The limestone rock types comprise an estimated 80 to 90 percent of the coarse aggregate constituent. The remainder of the coarse aggregate suite includes quartz, quartzites, chert, igneous rock types, and shale.

Fine Aggregate (Core 1S-1)

The fine aggregate in the Core 1S-1 concrete is a natural sand composed of both siliceous and limestone rock and mineral types. Quartz particles in the range of 0.1 mm to 0.5 mm form an estimated 70 to 80 percent of the sand, along with small amounts of sand-sized limestone particles, chert, igneous lithics, and trace amounts of shale. Figure 10 shows the dominance of small quartz particles in the fine aggregate in the core concrete.

Figure 10. Photograph, taken at a magnification of 16X, on an acid-etched lapped surface of Core 3N-1. The arrows point to several of the small clear quartz particles, which form an estimated 70 to 80 percent of the fine aggregate.

Cement Paste/Aggregate Bond (Core 1S-1)

Microscopic examinations made on lapped surfaces of Core 1S-1 reveal a tight, uninterrupted cement paste/aggregate bond. The examination of the fracture surfaces created in the compressive strength test of Core 1S-1 confirm this condition as shown in Figure 11.

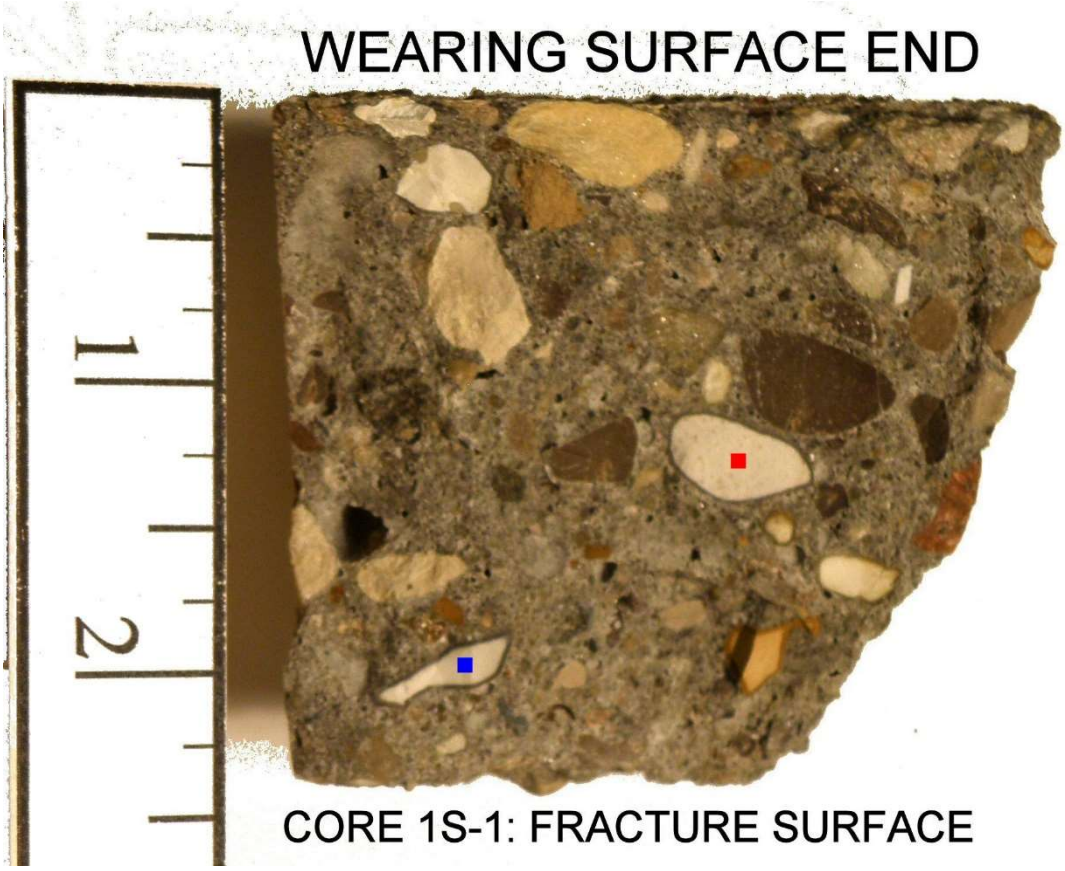


Figure 11. This view shows the appearance of a fracture surface that was created in the compressive strength test of Core 1S-1. All of the coarse aggregate particles in the view fractured in the test, confirming the good paste/aggregate bond, and the quality of the cement paste phase (low w/c, good level of strength). The colored dots are on chert coarse aggregate particles that show evidence of ASR activity (to be discussed).

Cement/Aggregate Reactions (Core 1S-1)

There is a low level of alkali-silica reaction activity (ASR) associated with the chert particles (8 % to 10 % of total aggregate count) in the core concrete.

Air Voids and Consolidation (Core 1S-1)

The concrete represented by Core 1S-1 is non-air entrained. The entrapped air content is estimated at 2 to 3 percent, which includes spherical entrapped air voids, and irregularly-shaped voids resulting from incomplete consolidation. Examples of the consolidation-related voids are shown in Figure 12.

Figure 12. Photograph, taken at a magnification of 7X, on a lapped surface of Core 1S-1, showing two of the consolidation voids that are present in a minor amount in the core. Other than these innocuous artifacts, the core concrete is well-consolidated.

As discussed previously for the Core 3N-1 concrete, the air voids and other voids in Core 1S-1 are either free of secondary deposits, or contain only a very light coating or small, spotty deposits.

Core Concrete Density (Core 1S-1)

The water-saturated density (ASTM C642) of the Core 1S-1 concrete is 149.9 lb/ft^3, which is in the expected value range for non-air entrained concrete containing a good quality sand/gravel aggregate.

Core Concrete Compressive Strength (Core 1S-10

The compressive strength of Core 1S-1 was measured at G2, resulting in a value of 8260 psi.

Current Condition of the Core 1S-1 Concrete

The Core 1S-1 concrete is in excellent condition following 90 years in an exposed freeze/thaw environment. There has been a minor amount of cement paste lost from the exposed wearing surface (a normal expectation), and isolated ASR activity that has not been destructive. Beyond these features, there is no evidence of distress of any type from any source exhibited by the core concrete.

Additional detail on the ASR activity in Cores 1S-1 and 3N-1 is presented next.

ALKALI-SILICA REACTION ACTIVITY IN THE CORE CONCRETES

Core 1S-1 was taken from a concrete tank that was constructed at the Traverse City waste water treatment plant in the 1930s. Core 3N-1 was taken from a concrete tank that was constructed at the same facility in the 1960s.

Despite the 30-year difference in construction dates, the sand/gravel aggregate in the core concretes is either from the same source, or from a similar source in the area. The sand/gravel aggregate contains both limestone rock types and silica/silicate rock types and minerals. A minor constituent of this aggregate is a microcrystalline form of quartz known as chert. Chert is present in small amounts in both the fine and coarse aggregate fractions of both cores.

Chert is one of the silica-based rock types that is prone to participation in alkali-silica reactions in portland cement concretes. In many historical cases, the ASR activity is non-destructive, creating no distress in the affected concrete. In other cases, the ASR activity is destructive, with the degree of distress ranging from insignificant to threatening the satisfactory performance and service life of the affected concrete.

The factors influencing the onset and severity of ASR activity in any given case include, (1) the alkali content of the portland cement used in the concrete, (2) the form and amount of chert (or other reactive aggregate) in the concrete, and (3) the degree of water saturation and moisture cycling in the concrete.

For the cores examined here, the form of ASR activity is the destructive form, but the degree of distress is of the insignificant variety. Examples from both core concretes are shown and discussed below.

ASR Activity in the Core 3N-1 Concrete

Core 3N-1 was taken horizontally through the exposed vertical exterior surface of the outer wall of Tank 3N/4N. As such, it was not a surface on which precipitation water would be expected to accumulate and pond.

Chert particles account for an estimated 3 to 4 percent of the total aggregate particle count in the core concrete. The diagnostic features of ASR activity include (1) a darkened rim around the perimeter of the reacting aggregate particle, where it is in contact with the cement paste, (2) the presence of white ASR gel reaction product in cracks, or in air void cavities adjacent to the reacting aggregate particle, (3) cracks in the reacting aggregate, which can extend into the adjacent mortar and nearby aggregate particles.

Figure 13 shows enlarged view of a lapped surface of Core 3N-1, which shows these features of interest. The reacting chert aggregate particle is located around 7 in. below the exposed tank wall surface.

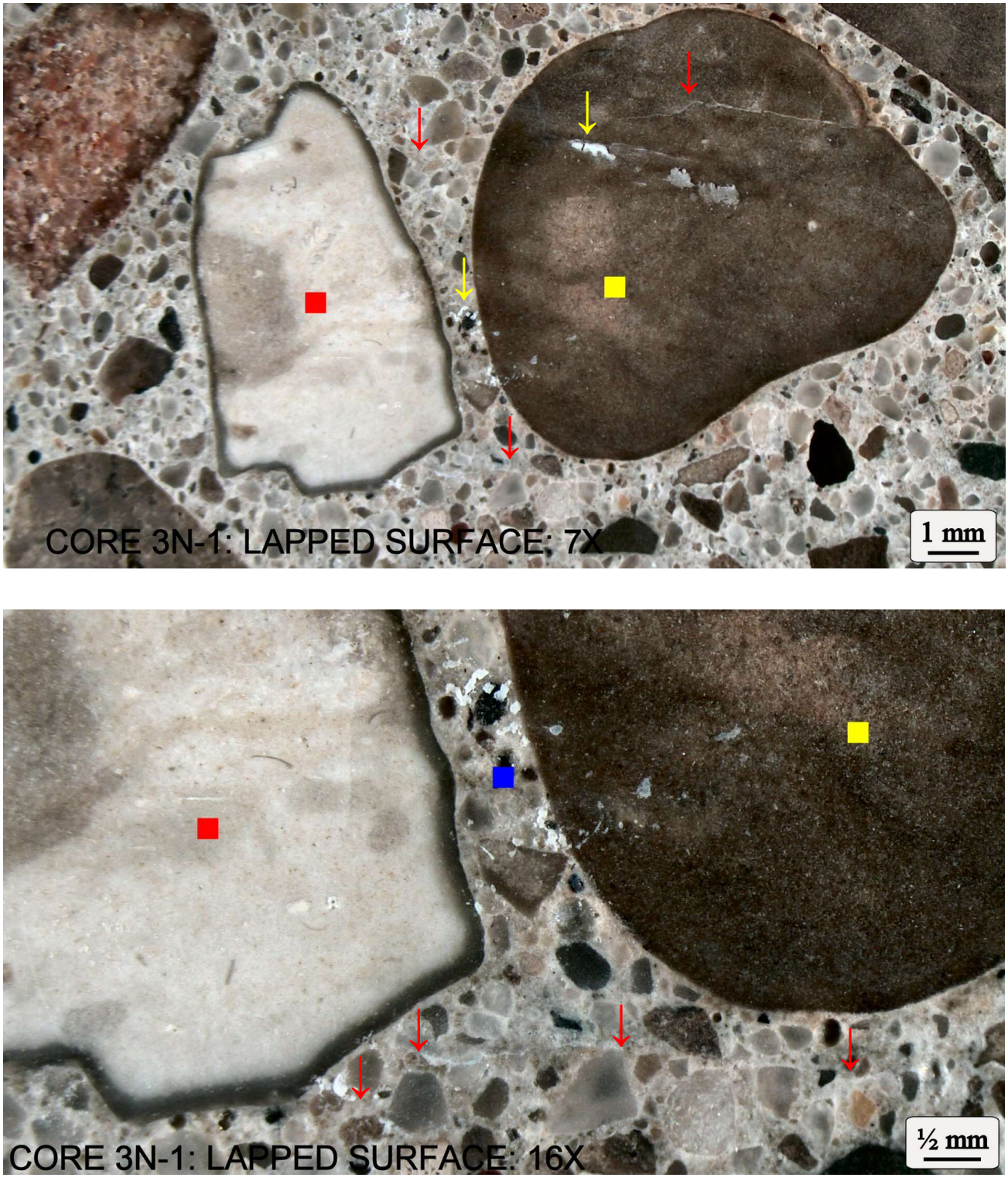


Figure 13. These are photographs, taken at a magnification of 7X and 16X, on a lapped surface of Core 3N-1. The red arrows point to ASR-related microcracks. Features of interest are discussed below.

Features of Interest in Figure 13

1. Reaction Rim: ASR Gel: Microcracks: The red dot is on a chert coarse aggregate particle that shows evidence of ASR activity. The evidence is in the form of (1) a darkened reaction rim around the perimeter of the particle, (2) the presence of ASR gel, and (3) microcracks emanating from the particle into the adjacent mortar and an adjacent limestone aggregate particle.

2. ASR-Related Cracks: The red arrows point to the microcracks, which emanate from the reacted chert particle and pass into the adjacent mortars. The cracks are very tight and are difficult to see even under the microscope. The filling of the cracks with white ASR gel renders them visible.

3. ASR Gel: The white material on the limestone particle (yellow arrow) is ASR gel, which exuded onto the lapped surface following the drying-out period after the lapping step. ASR gel also exudes from the cement paste adjacent to the reacted chert particle (blue dot)

4. Destructive and Non-Destructive ASR: When the cracking is confined to the reacting aggregate particle, the distress is characterized as "non-destructive ASR". When the cracks pass into the adjacent mortar, the distress is characterized as "destructive ASR".

5. Degrees of Destructive ASR: In the example shown for Core 3N-1 in Figure 13, the microcracks are very tight and extend into the adjacent mortar and aggregate particle a short distance (a few millimeters). In this 60-year old concrete this condition has probably prevailed for decades. The cracking distress shown in this example of the 1960s concrete at the WWTP is insignificant as related to the durability and performance of the concrete. In historical worst-case situations, destructive ASR activity has resulted in expansive stresses and cracking that required removal and replacement of the concrete.

6. The chert particle shown in Figure 13 is 7 in. below the exterior wearing surface in this view. The estimated percent of chert particles in the Core 3N-1 concrete is 3 to 4 percent of the total aggregate particle count. The majority of chert particles that could be seen on lapped surfaces and fracture surfaces show only a reaction rim (non-destructive ASR activity) and gel. There is no evidence of any significant destructive ASR activity in the Core 3N-1 concrete

ASR Activity in the Core 1S-1 Concrete

Chert particles account for an estimated 8 to 10 percent of the total aggregate particle count in the Core 1S-1 concrete. Reacted chert coarse aggregate particles are exposed on the fracture surfaces from the compressive strength test (8260 psi) of Core 1S-1, as shown in the example in Figure 14.

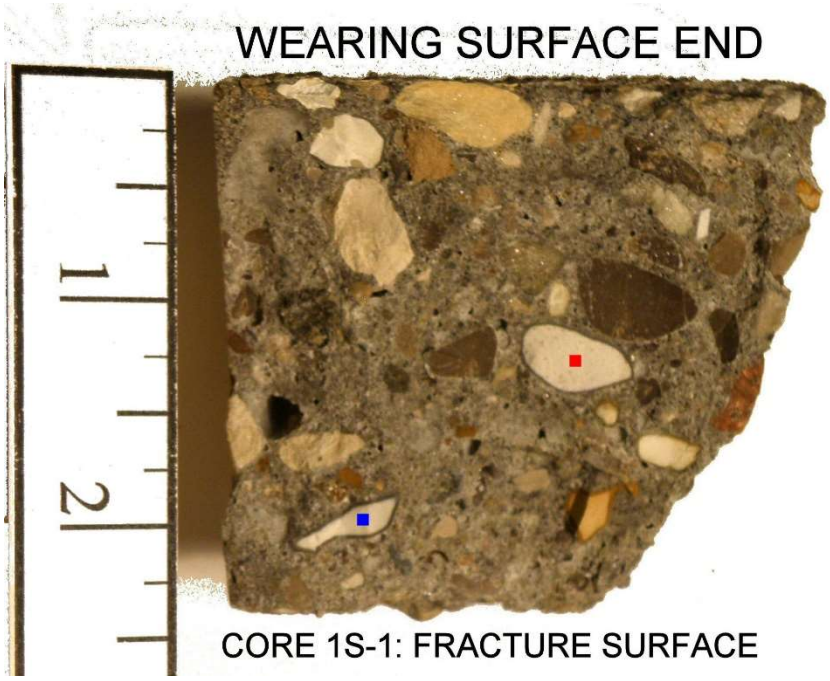


Figure 14. This view shows a fracture surface of Core 1S-1 resulting from the compressive strength test. All of the coarse aggregate particles exposed on the surface are fractured. The dots are on two chert particles that have evidence of ASR activity.

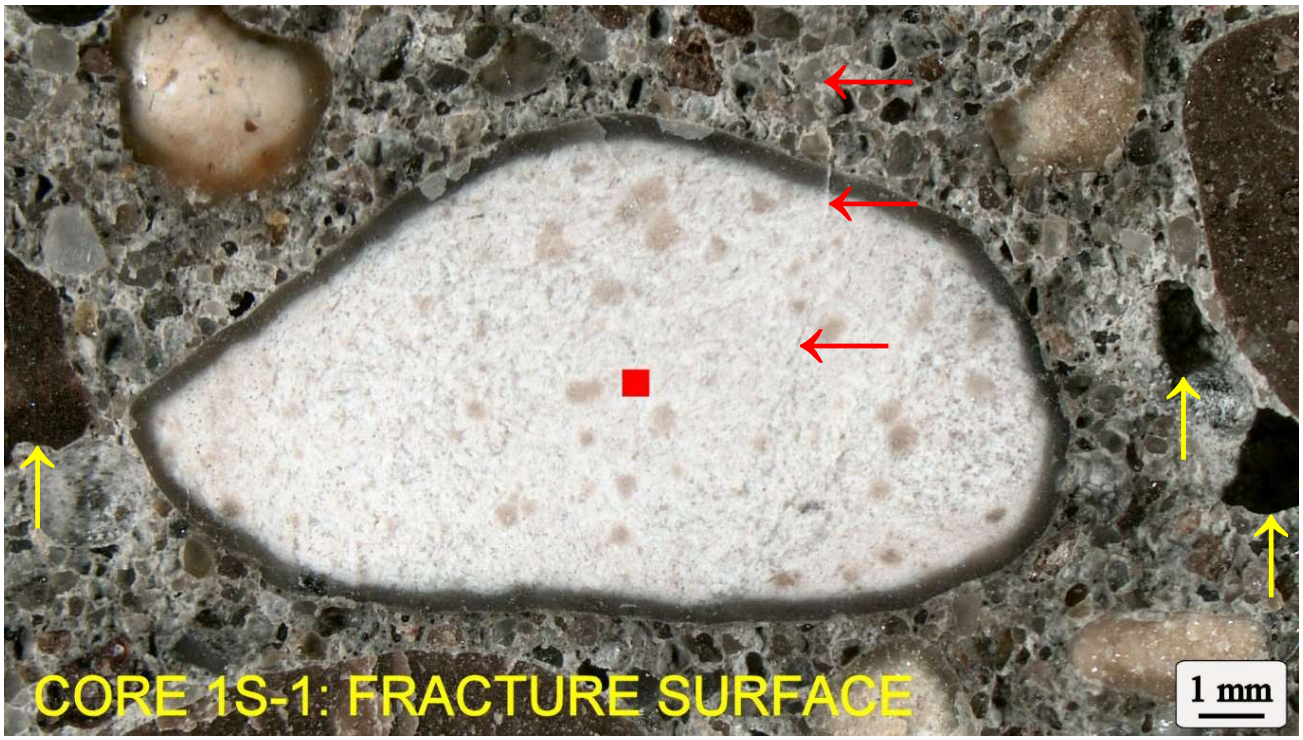
Enlarged views of the reacted chert particles shown in Figure 14 are shown in Figure 15. Features of interest in Figure 15 are discussed below.

Features of Interest in Figure 15

1. Both chert aggregate particles show darkened reaction rims, confirming the ASR activity.

2. The red arrows point to microcracks emanating from the chert particles that pass into the adjacent mortar. The microcracks are tight and travel only a few millimeters into the mortar.

3. The yellow arrows point to air voids, which are virtually free of any secondary deposits. This condition indicates that there has been very little moisture access or moisture cycling in the concrete. The scenario has implications for the performance of the tank concretes.



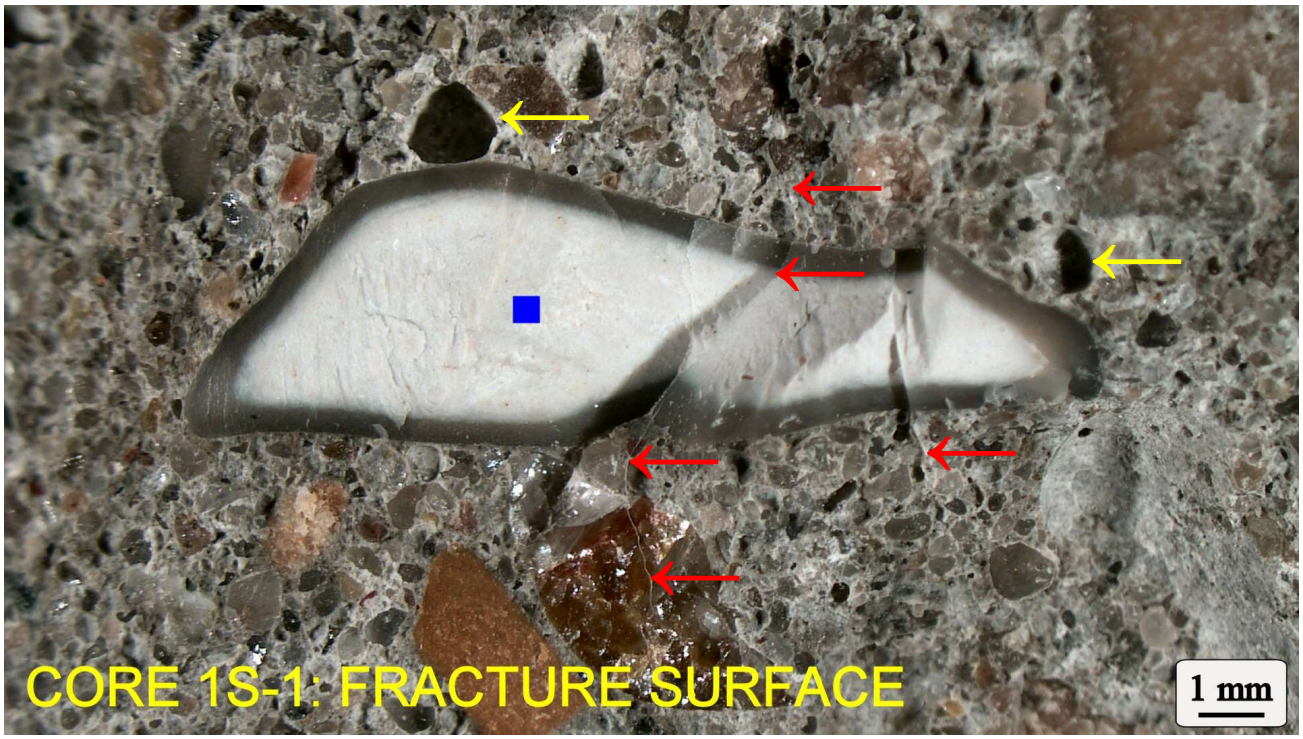


Figure 15. Photographs, taken at a magnification of 7X, on the fracture surface of Core 1S-1 shown in Figure 14. These views show the reacted chert coarse aggregate particles that are cited in Figure 14. The particles are 1 to 2 in. below the wearing surface. Features of interest in Figure 15 are discussed on Page 21.

Other examples of the ASR activity associated with the chert aggregate particles in the Core 1S-1 concrete are shown in Figure 16, which are enlarged views of a lapped surface of the core.

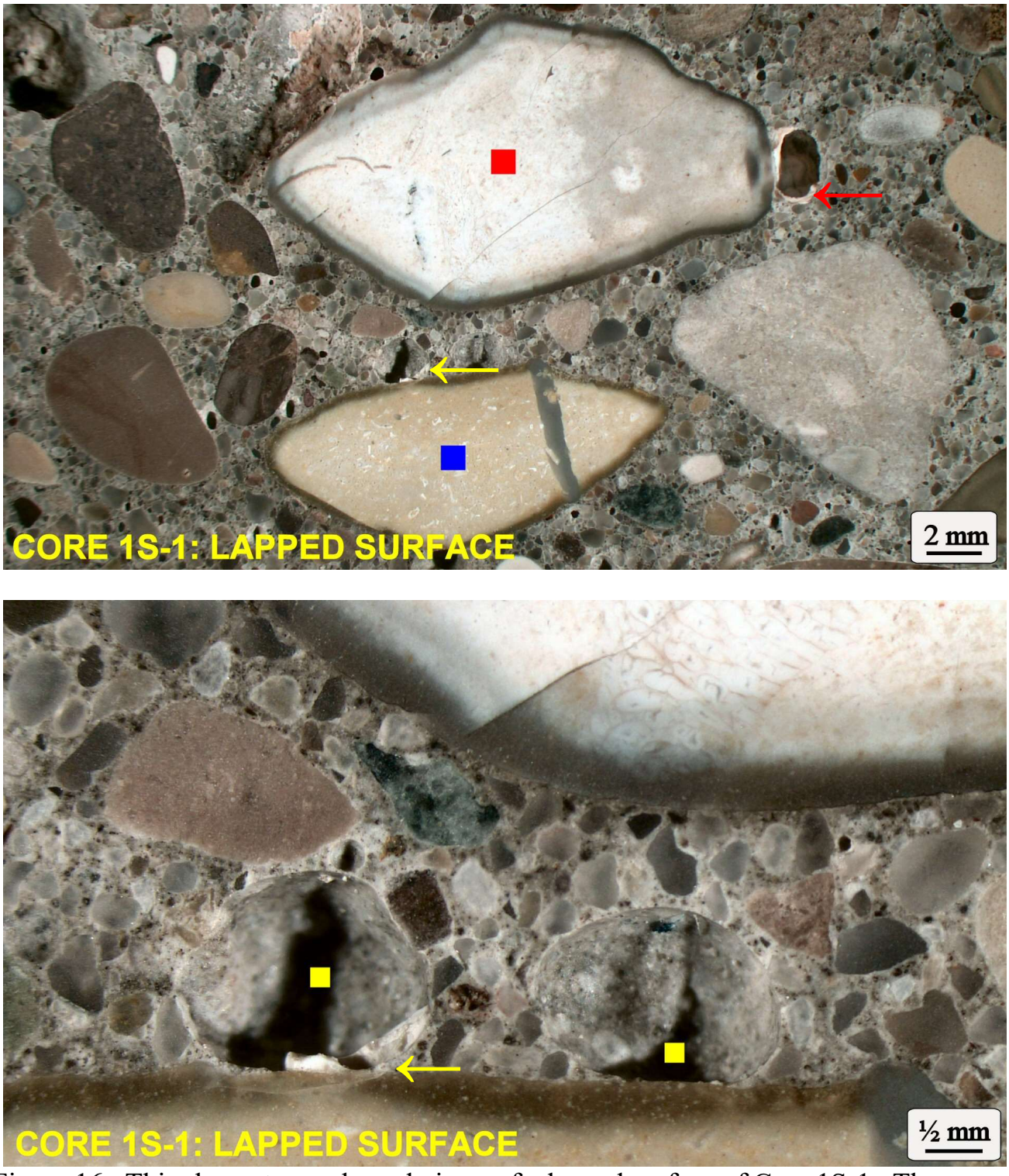


Figure 16. This shows two enlarged views of a lapped surface of Core 1S-1. The photographs were taken at magnifications of 3.5X (top) and 16X. Features of interest are discussed below.

Features of Interest in Figure 16

1. The dots are on reacted chert aggregate particles, which show reaction rims.

2. The arrows in the top photograph point to air voids, which contain a small amount of white ASR gel.

3. The yellow arrow in the bottom photograph points to the same feature of interest as the yellow arrow in the top photograph. This is a short microcrack in the reaction rim of the blue dot particle, along which is a tiny deposit of white ASR gel.

4. Of particular interest in the bottom photograph is that, with the exception of the tiny ASR gel deposit cited in Point 3 above, the air void cavities are empty; free of any other secondary deposits. As discussed previously, this condition confirms that there has been very little moisture access or moisture cycling in the concrete at this sampling site. The scenario has implications for the performance of the tank concretes as discussed in the next section of the report.

THE ROLE OF WATER IN THE PERFORMANCE OF THE CONCRETES

Water plays a key role in the creation of distress in exposed concrete is service including creation of the potential for distress associated with alkali-silica reaction activity (ASR), and the potential for distress associated with freeze/thaw cycling. The 1930s and the 1960s tank concretes at the Traverse City waste water treatment plant are candidates for both of these forms of distress.

Chert, an ASR-prone form of quartz is a minor constituent of the sand/gravel aggregate in the concretes. Neither concrete has a satisfactory entrained air void system, making them vulnerable to freeze/thaw damage. Despite these scenarios, the concretes represented by the cores examined here show no evidence of freeze/thaw damage, and no significant damage from destructive ASR activity. These outcomes are attributed in large part to the fact that water-saturation and water cycling episodes have not occurred with any great frequency in the concrete at these sampling sites.

The relatively dry condition of the concrete at the 1S-1 and 3N-1 sampling sites is somewhat puzzling, as the walls from which the cores were taken have been exposed to the elements for 90 years and 60 years respectively. Water has not penetrated deeply into the concrete at these locations. There are several factors that could be playing a role in this outcome.

Factors Affecting the Relatively Dry Condition of the Core Concretes

1. The concrete walls from which the cores were taken (1) are above grade, and (2) are not in contact with the water in the tanks. The primary source of water is precipitation in contact with the top surface of the walls and the vertical wall surfaces. Water can accumulate on the top surface of the walls, but not on the vertical side surfaces. There has been some loss of a few millimeter thickness of cement paste from the wearing surfaces of both cores, revealing the tops of fine aggregate particles and a few coarse aggregate particles. Beyond this expected weathering outcome there is no evidence of any near-surface distress in either core.
2. For water to enter the concrete it has to pass through the hardened cement paste phase. In both cores examined here the water-cement ratio is estimated at 0.42. At this low level of w/c, the expected permeability of the cement paste is quite low, as shown in Figure 17.

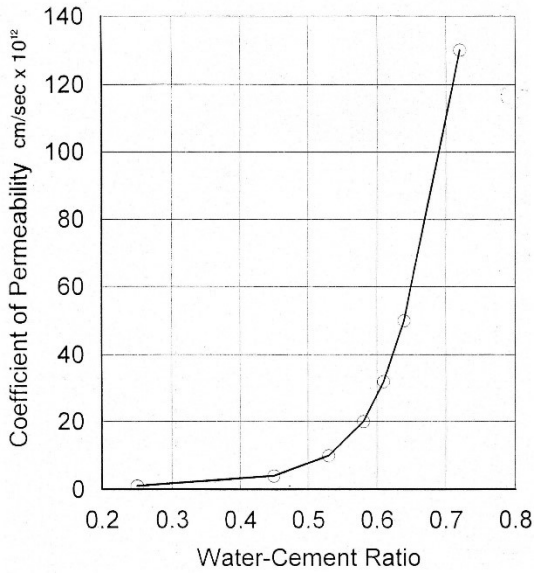


Figure 17. Cement paste permeability as a function of water-cement ratio. (T.C. Powers & R.A. Helmuth, Proceedings of the Highway Research Board, 32nd Annual Meeting, 1953).

3. Although the water in the tanks is not intentionally heated, it is reportedly generally above freezing temperature. With the tanks buried approximately 12 ft. deep, this condition may have helped to limit the freezing episodes of the concrete above grade.

SUMMARY AND CONCLUSIONS

Reinforced concrete tanks at the Traverse City, Michigan waste water treatment plant have been in service for around 60 to 90 years. Following their inspection of the tanks in October 2020, Hubbell, Roth, and Clark Consulting Engineers believe the structures can remain in service with minor upgrades and repairs. As a confirmation of the visual inspection, HRC has requested an evaluation of representative samples of concrete from the tanks. G2 Consulting Group is working with HRC in this effort. To this end, on November 20, 2020 I was provided with two tank concrete cores by G2 for petrographic examinations. The findings of the examinations, discussed in this report, provide a characterization of the overall quality and the current condition of the core concretes, and provide an assessment of the prospects for future service.

Description of the Cores

Of the four concrete tanks at the WWTP facility, two were constructed in the 1930s and two in the 1960s. I received one core from one of the 1930s tanks (Core 1S-1) and one from a 1960s tank (Core 3N-1). The cores, with a diameter of 3.7 in. and a length of around 8 in., were taken in above-grade walls of the tanks. One end surface of the cores is the exterior exposed wearing surface of the walls. The other end surface is a fresh fracture surface, made in sound concrete as a planned break-off point during coring.

Core Examination Procedures

Visual and microscopic examinations were conducted in accordance with relevant guidelines of ASTM C856, the Standard Practice for Petrographic Examination of Hardened Concrete. A pH indicating solution (phenolphthalein) was used to assess the presence and extent of carbonation. A density measurement was made following relevant procedures of ASTM C642, the Standard Test Method for Specific Gravity, Absorption, and Voids in Hardened Concrete.

Reporting Protocol

The coring sites for the examined cores were selected to be representative of the tank concretes. However, the finding of the present investigation can be strictly applied only to the concretes represented by the examined cores.

Characterization of the Core Concretes

Despite a 30-year difference in construction dates, the constituents, as well as many features and properties of the core concretes share much in common. A summary is provided below.

Core Concrete Description and Constituents

These are non-air entrained portland cement concretes, containing a natural sand/gravel fine and coarse aggregate. The cement paste phase is of good quality, with a water-cement ratio estimated at 0.42.

The aggregate is composed of both limestone and siliceous rock and mineral types. The aggregates in the two core concretes either came from the same source or from similar source types. The aggregates are of good quality based on the criteria of hardness, rate of water absorption, soundness, and current condition. In the 1930s concrete (Core 1S-1), the coarse aggregate gradation falls within the ASTM C33 classification of No. 67 (3/4 in. to No. 4 sieve). The 1960s aggregate is coarser, falling within the gradation-requirements of ASTM C33 No. 57 (1 in. to No. 4). Chert, a microcrystalline form of quartz, is present as a minor phase of the aggregate in both core concretes.

The core concretes are not air entrained. The entrapped air content is estimated at 2 to 3 percent. Reflecting the low air void content, the water saturated density is 150 lb/ft^3 in the Core 1S-1 concrete, and 152 lb/ft^3 in the Core 3N-1 concrete.

Core compressive strength measurements made on single cores at G2 showed 8260 psi for the 1930s concrete, and 8420 psi for the 1960s concrete.

Viewed from the perspective of the above characterization, the lack of an adequate entrained air void system, and the presence of an aggregate constituent that is potentially prone to alkali-silica reaction activity (chert), raise warning flags as regards the durability of the concrete in service. However, neither of these conditions have had any adverse effect on the durability of the core concretes to date.

Current Condition of the Core Concretes

Both of the cores examined here were retrieved intact and in sound condition (as can be seen in Figure 2). The subsequent petrographic examinations revealed no evidence of any distress related to the effects of freeze/thaw cycling.

The examinations did reveal the presence of ASR activity associated with the chert aggregate particles in both the 1930s concrete and the 1960s concrete. However, as described in detail in the report, the presence of ASR activity is not necessarily a death sentence for concrete.

Most of the reacted chert particles in the core concretes show what is characterized as “non-destructive ASR activity”. In a minority of the particles there is evidence of “destructive ASR activity”, which on a scale of “insignificant” to “life-threatening”, is characterized as “insignificant” for the core concretes.

As discussed in detail in the report, a condition of water-saturation, and well as frequent episodes of water cycling in the concrete is a requirement for both freeze/thaw-related damage, and for high levels of destructive ASR activity. The petrographic evidence confirms that neither of these conditions was in play for the core concretes. The possible reasons for this positive outcome are discussed in the report, and include an expected low value of permeability of the concretes due to the low water-cement ratio.

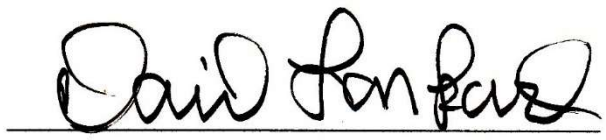
In summary, the core concretes are in sound condition and are of good quality based on the criteria of (1) the quality of the cementitious phase (a low water-cement ratio, (2) the absence of any significant regions of carbonation, (3) the quality of the aggregates, and (4) the quality of the cement paste/aggregate bond.

Future Service Outlook

It is prudent here to reiterate the caveat that the findings of the present study can be strictly applied only to the concretes represented by the two cores examined here. However, it is reasonable to expect that exposed tank concrete that shows, in a site survey, the same visual appearance and sound condition as that seen at the coring sites, will show similar features to those described here for the core concretes.

The most compelling argument supporting a claim of continued satisfactory performance is the 60-year and 90-year satisfactory performance of the tank concretes to date. This assumes that none of the modifications planned for the facility will increase the accessibility of water to the concrete.

Finally, if there is any of the tank concrete that currently does show cracking or spalling damage, the logical suspects would be either freeze/thaw damage, or a more destructive form of ASR activity.



Dr. David Lankard, President & Petrographer

Traverse City Regional Wastewater Treatment Plant