

DATE: June 5, 2019

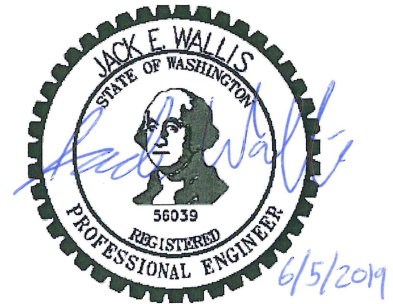
TO: Leana Johnson, City of Stevenson
Eric Hansen, City of Stevenson

CC: Steve Ogle, Washington State Department of Ecology

FROM: Jack Wallis, PE, Wallis Engineering

RE: Immediate Improvements Evaluation

EXHIBITS: Exhibit A – Cost Estimates
Exhibit B – Process Audit of the Stevenson Wastewater Treatment Facility
Exhibit C – Conceptual Layouts
Exhibit D – Manufacturer’s Literature



SECTION 1: PROJECT PURPOSE AND INTRODUCTION

The City of Stevenson wastewater treatment plant (WWTP) was last upgraded in 1992, and in recent years influent biological oxygen demand (BOD) and total suspended solids (TSS) loads have grown beyond the WWTP’s design capacity. Although the WWTP typically meets the discharge requirements of its NPDES permit, the high loads cause occasional effluent violations.

The City retained Wallis Engineering to complete design of the WWTP improvements identified in the General Sewer Plan/Facility Plan (GSP/FP), which will increase WWTP capacity for existing and future flows and loads. Design is currently underway, and is expected to be complete by Spring 2020, with construction complete by Autumn 2022. Because the WWTP will be operating beyond its design capacity in this interim period, the City therefore desires immediate improvement options that can be implemented quickly to prevent effluent violations prior to the full WWTP upgrade. Immediate improvements consist of portions of the full upgrade project that can be fast-tracked to improve performance.

The purpose of this memorandum is to identify and evaluate immediate wastewater treatment plant (WWTP) improvement options that can be fast-tracked to reduce the quantity and severity of effluent violations prior to the full WWTP upgrade. This memorandum is organized in the following sections:

Section 1: Project Purpose and Introduction1

Section 2: Summary of Recommendations2

Section 3: Wastewater Treatment Plant Performance3

Section 4: Immediate Improvement Evaluation5

Section 5: Conclusions and Next Steps.....9

SECTION 2: SUMMARY OF RECOMMENDATIONS

Immediate improvements were evaluated on the basis of cost and ability to improve WWTP performance. A summary of the recommended improvements is shown below in Table 1, grouped by priority.

Table 1. Recommended Improvement Summary

Immediate Improvement	Benefit	Cost ^a
High Priority		
Oxidation ditch DO sensor	<ul style="list-style-type: none"> Operators can view and respond to online DO measurements. Additional data for design. 	\$12,940 ^b
RAS metering	<ul style="list-style-type: none"> Operators can balance RAS flow from each clarifier, improving performance. 	\$21,320
Influent pH sensor	<ul style="list-style-type: none"> Operators can view and respond to instantaneous pH measurements. Additional data for design. 	\$4,880 ^b
Relocate influent Parshall flume level sensor	<ul style="list-style-type: none"> Improves the accuracy of the influent flow meter. 	\$5,590
Total Cost:		\$44,730
Medium Priority		
Base SCADA system	<ul style="list-style-type: none"> Reduces operator time necessary to record measurements and improves access to controls. 	\$5,140
Data Logging (requires base SCADA system)	<ul style="list-style-type: none"> Reduces operator time necessary to record DO measurements. Improves visibility of online DO measurements, allowing operators to respond more quickly. 	\$2,730
Automate aeration control (requires base SCADA system)	<ul style="list-style-type: none"> Reduces operator time necessary to respond to DO variations. 	-- ^c
Automatic RAS pump control	<ul style="list-style-type: none"> Reduces operator time needed to adjust RAS pump flow rates manually. 	\$2,080
Total Cost:		\$9,950
Low Priority		
Clarifier Stamford baffles	<ul style="list-style-type: none"> Improves TSS removal performance 	\$58,500
Level clarifier effluent weirs	<ul style="list-style-type: none"> Improves TSS removal performance 	\$11,180
Total Cost:		\$69,680

- a) Costs include procurement of materials and construction only (engineering and construction management cost is included in the current scope of work).
- b) Cost assumes that the City will install conduit between the oxidation ditch and the RAS building.
- c) There are no additional construction costs for this item (engineering cost necessary to modify the existing PLC is included in the current scope of work).

The following section describe the evaluation process by which these improvements were identified and defined in sufficient detail to provide a basis of design moving forward. Detailed cost estimates are included as Exhibit A.

SECTION 3: WASTEWATER TREATMENT PLANT PERFORMANCE

Wastewater treatment plant performance data for the past year was reviewed to identify specific performance problems. This review focuses on 5-day biological oxygen demand (BOD) and total suspended solids (TSS) measurements, as these constituents were previously identified as the primary capacity issue at the WWTP.

3.1 Biological Oxygen Demand and Total Suspended Solids

As shown below in **Figure 1**, over the last year influent BOD loads were significantly higher than the permit limit of 612 pounds per day (lb/d), with a maximum of 1,439 lb/d in September 2018. Influent TSS loads were lower than BOD loads but were also above the permit limit (612 lb/d) for most months.

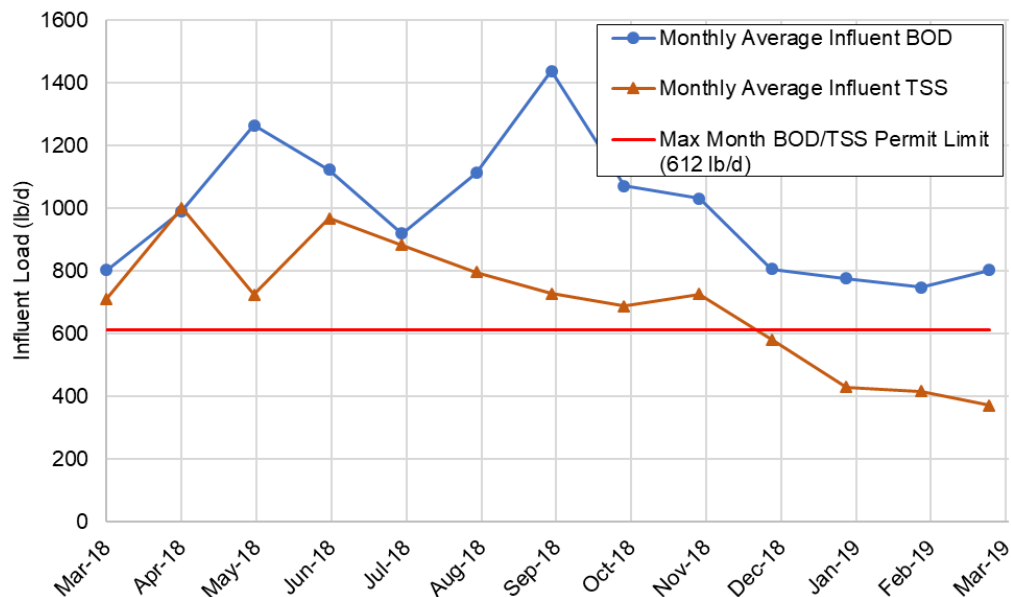


Figure 1. Influent BOD load, March 2018 to April 2019

Despite the high influent loads, the WWTP typically met its NPDES permit requirements for effluent BOD and TSS during summer and autumn months, as shown in **Figure 2** and **Figure 3**. This indicates that the existing WWTP has sufficient aeration capacity and biomass to remove the high influent BOD loads during these months (although it is unlikely that the WWTP meets redundancy requirements for aeration equipment).

In winter and spring months the WWTP discharged effluent with BOD and TSS concentrations significantly higher than permit limits, although influent BOD and TSS for these months was lower than in the summer months. The BOD violations only occurred along with TSS violations, indicating that the BOD discharged was, in part, particulate BOD contained in the suspended solids. These effluent violations appear to have been caused by a failure of the secondary clarifiers, rather than inadequate biological treatment in the oxidation ditch; although lower influent wastewater temperatures during the winter would also cause the BOD removal to be less efficient and could contribute partially to soluble BOD in the effluent. Secondary clarifier failure was likely caused by multiple factors, including the following:

1. Sludge settleability is poor, with SVI values averaging over 200. Sludge settleability is likely impacted by cold weather, high/low pH, and slug loads from industrial users.
2. The WWTP currently operates with a MLSS concentration of approximately 4,000 mg/L (compared to the design value of 3,000 mg/L), resulting in a clarifier solids loading rate higher than design capacity during wet weather months.
3. RAS flow rate control is inadequate, with no method available for operators to determine the RAS flow rate from each clarifier independently. This likely results in unequal overflow rates from each clarifier.

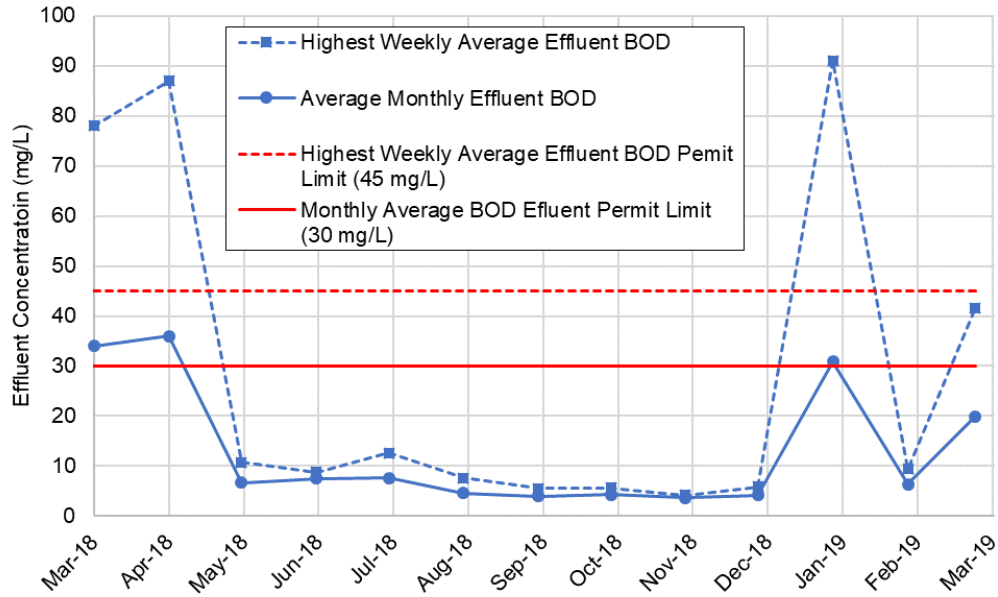


Figure 2. Effluent BOD concentration, March 2018 to April 2019

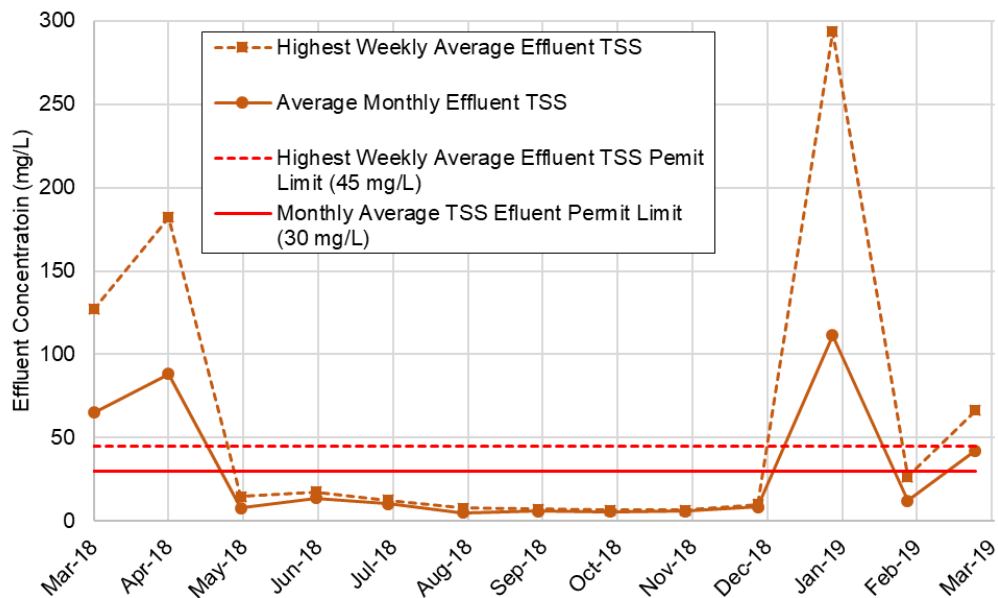


Figure 3. Effluent TSS concentration, March 2018 to April 2019

3.2 Influent and Effluent pH

As shown in **Figure 4**, influent pH exhibits extreme variations from a minimum of 4.6 standard units (S.U.) to a maximum of 12.3 S.U. Effluent pH is generally stable, although two low pH effluent violations occurred over the last year, both in summer months when the beverage industries are more active. It is very likely that effluent pH violations are caused by industrial discharges, possibly of acidic cleaning chemicals. Alkalinity is also consumed during biological treatment (nitrification), and this also contributes to the overall lower effluent pH.

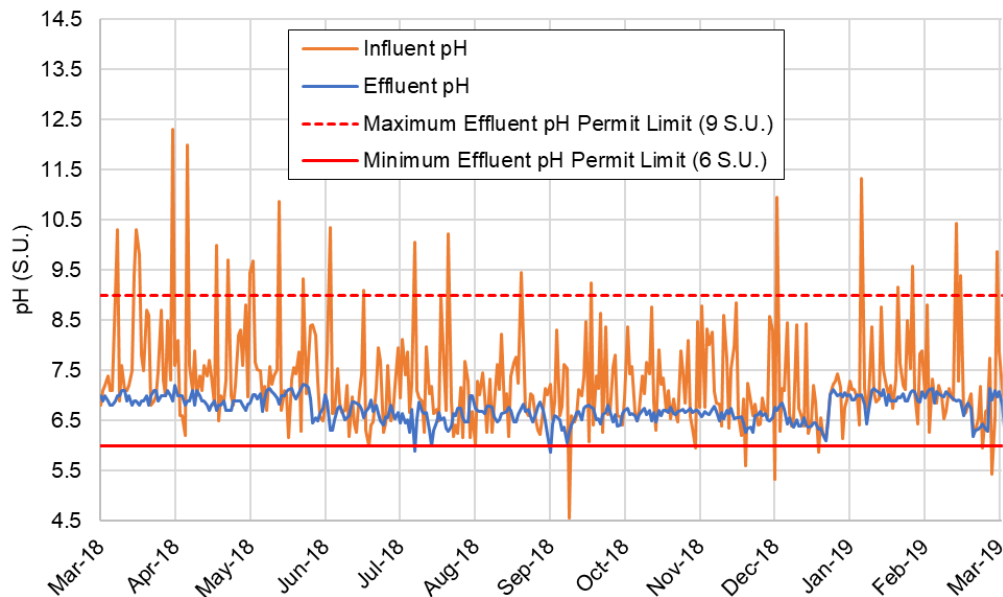


Figure 4. Influent and effluent pH, March 2018 to April 2019

3.3 Summary of WWTP Performance

Based on this performance data review, the following conclusions can be drawn:

1. The influent BOD and TSS loading remain above the WWTP design capacity, although the TSS loading dropped below the design capacity from December 2018 through March 2019.
2. Despite the high loads, the aeration basin appears to be able to treat the influent BOD adequately from May 2018 through December 2018, although there is likely no redundancy.
3. Effluent BOD and TSS violations appear to be caused, in part, by secondary clarifier failure.
4. Influent pH varies significantly, likely due to industrial discharges. Effluent pH violations occur occasionally.

Immediate improvements that may improve process control and clarifier performance are discussed below.

SECTION 4: IMMEDIATE IMPROVEMENT EVALUATION

In 2018, the City retained Water Solutions Inc. (WSI) to perform a process audit of the WWTP (Process Audit), included as Exhibit B. The Process Audit identified improvements and process changes that could improve the performance of the existing WWTP. These improvements are evaluated in detail below, along with additional improvements that were identified in the course of this work. All improvements are

evaluated on the basis of cost and expected benefit to the WWTP performance, and to ensure that the improvements fit within the long-term improvements.

4.1 Oxidation Ditch Improvements

The Process Audit recommended four oxidation ditch improvements:

1. Installation of an online DO sensor
2. Repair of the aerator High Speed setting
3. MLSS polymer addition
4. Installation of a selector basin

Since the Process Audit was completed, the High Speed setting has been repaired and a polymer addition system has been installed. Installation of a selector basin is not evaluated for inclusion as an immediate improvement due to the high cost, which makes fast-tracked construction infeasible at this time. Based on the performance data review, we identified one additional immediate improvement option: installation of online pH sensors on the raw wastewater influent channel, which would allow operators to respond to low/high pH occurrences and assist in implementing industrial pretreatment. Dissolved oxygen sensors and pH sensor improvements are evaluated below.

Dissolved Oxygen Sensors

Over the last year, oxidation ditch DO concentration measurements have varied from 0.1 to 5.6 mg/L, with an average of 1.7 mg/L. These DO concentrations were measured using handheld probes one to three times per day. It is likely that even greater variations occur throughout the day due to diurnal flow and loading variations, as well as high BOD slug loads from industrial users. The current measurement method does not allow the operators to view diurnal DO variations, nor does it allow operators to respond adequately to varying DO concentrations.

The full WWTP upgrade will include a permanent DO sensor, which will likely be used to automate oxidation ditch aeration. The DO sensor could be fast-tracked as an immediate improvement, which will allow operators to view and respond to DO variations throughout the day. This could be particularly useful during high BOD slug loads from industrial users, as operators could increase aeration as DO concentrations drop. Additional dissolved oxygen data would also be useful to inform design of the full WWTP upgrade.

This improvement would include a single DO sensor upstream of the first aerator, as shown on Exhibit C. The DO sensor would be connected to a local controller, which would allow the operator to view DO concentrations and would also send DO data to the SCADA system when installed. Dissolved oxygen sensor and controller manufacturer's literature is included as Exhibit D. Due to the relatively low cost and high value of this improvement, this is considered high priority.

Influent pH Sensor

Over the last year, influent wastewater pH measurements have varied from 4.6 to 12.3, with an average of 7.3. These pH values were measured on grab samples from the influent channel one to three times per day. Similar to DO concentrations, it is likely that variations in pH are even greater throughout the day due to industrial discharges, which often have very high or low pH from cleaning chemicals. The high and low pH values have the potential to negatively impact the biological process and reduce sludge settleability.

Continuous pH measurement would allow operators to see the extent of pH variations in the WWTP influent. This could allow the City to determine the effect of industrial slug loads on the WWTP, and could aid in determining pretreatment requirements for industries.

This improvement would include a single pH sensor placed in the influent channel just downstream of the Parshall flume, where there is standing water (see Exhibit C). The pH sensor would be connected to the same local controller as the DO sensor. Manufacturer's literature for pH sensors is included as Exhibit D. Due to the relatively low cost and high value of this improvement, this is considered high priority.

Influent Parshall Flume Modifications

The existing level sensor for the influent Parshall flume is located several feet upstream of the recommended location. Relocating the level sensor to the recommended location would improve the accuracy of influent flow meter readings. The existing and recommended sensor locations are shown on Exhibit C. Due to the low cost and high value of this improvement, this is considered high priority.

4.2 Clarifier Improvements

The Process Audit recommended three clarifier improvements:

1. RAS metering for each clarifier
2. Stamford baffles
3. Weir leveling

No additional clarifier improvements were identified in this evaluation of potential immediate improvements. The three recommendations are evaluated below.

RAS Pump Flow Meters

The existing RAS pumps discharge into a common header with a single flow meter measuring the combined RAS from both clarifiers. Due to the age of the RAS pumps, it is unlikely that each pump conveys the same flow rate when operating at the same speed. Operators attempt to balance flow by adjusting the speed of each RAS pump manually, looking at check valve arm height and wastewater flow over the clarifier weirs. There is no method to accurately determine flow rate from each RAS pump independently.

If the two RAS pumps are operating at different flow rates, each clarifier operates at different overflow rates (assuming equal flow splitting from the oxidation ditch). Therefore, the clarifier with a greater overflow rate is more likely to fail under high load conditions. This hypothesis is corroborated by the fact that washouts tend to occur more often in the south clarifier than the north clarifier. Balancing the RAS flow would allow each clarifier to operate at the same overflow rate, and thus improve performance and reliability.

This improvement would include installation of two new electromagnetic flow meters on the 6-inch discharge pipe from each RAS pump, as shown on Exhibit C. Four-inch flow meters are recommended to ensure that flow velocities are within the recommended range. A local readout would be mounted on each flow meter, allowing operators to view the flow rate when adjusting pump speed to balance RAS flow. Because this improvement would greatly improve process control, this is considered high priority.

Clarifier Stamford Baffles

Stamford baffles are typically installed on new clarifiers to improve TSS removal performance. These baffles are installed below the effluent launders, and serve to redirect density currents downward, preventing solids from running up the sidewall and over the weirs. Stamford baffles have the potential to

reduce effluent TSS by up to 70%, and improve wet weather treatment. However, Stamford baffles are not expected to significantly improve performance when clarifiers are failing and solids are washing out.

This improvement would require taking the clarifiers offline and draining them while the baffles are installed. The baffles consist of prefabricated fiberglass panels with stainless steel mounting hardware, and would be mounted on the bottom corner of the effluent launder. The lead time for Stamford baffles is 12 to 20 weeks. Due to the high cost, long lead-time, and limited performance improvement expected, this is considered a low priority improvement.

Level Clarifier Effluent Weirs

The existing effluent weirs in the secondary clarifiers are not level, resulting in uneven hydraulics throughout the clarifiers. This can cause in greater overflow rates in specific portions of the clarifiers, resulting in worse TSS removal in those locations. Leveling the effluent weirs would evenly distribute flow throughout the clarifiers, which could improve performance. However, performance improvements are not expected to be significant.

This improvement would require taking the clarifier offline while the weirs are adjusted. Due to this requirement, and the limited performance improvement expected, this is considered a low priority improvement.

4.3 SCADA Improvements

The WWTP currently has no SCADA system other than local chart recorders and alarm annunciation at the PLC control panel. Part of the WWTP upgrades will involve installing a plant-wide SCADA system that will control all aspects of the treatment plant. The first phase of the SCADA system can be fast-tracked and installed as part of the immediate improvements. This would provide a single location for data logging and trending, and could allow the operator easier access to process controls for RAS pumps and aeration control. The first phase of SCADA improvements would consist of the base SCADA system, along with one of several SCADA improvements that could be implemented, including:

1. Data logging
2. Automated aeration control
3. Automated RAS control

These improvements are discussed below.

Base SCADA System

The base SCADA system would include a desktop computer with SCADA software installed. An ethernet cable would be run through existing conduit to the RAS building and connected to the existing PLC. This would allow for access to any inputs or process control data logged by the PLC. The benefits of the base SCADA system are associated with the additional improvements described below.

Data Logging

Connecting the influent flow meter, effluent flow meter, and DO and pH sensors to the SCADA system would allow for logging and trending of this data. This would reduce the operator's time collecting data and would improve the visibility of measurements – thus allowing the operator to respond more quickly to process changes.

This improvement would require connecting the DO and pH sensors to the existing PLC, which would be connected to the SCADA computer. To save costs, the City could install conduit from the oxidation ditch to the RAS building. This improvement is considered medium priority.

Automatic Aeration Control

If the DO and pH sensors are connected to the SCADA system, the existing PLC can be modified to automatically control the aerators based upon the dissolved oxygen concentration. Each aerator has two speed settings, which results in a total of four levels of aeration power available:

1. One aerator on low
2. Two aerators on low
3. One aerator on low, one aerator on high
4. Two aerators on high

The PLC would be programmed to increase or decrease aeration power to maintain a minimum and maximum DO concentration in the oxidation ditch. Dissolved oxygen setpoints would be adjustable on the SCADA computer. This improvement is considered medium priority.

Automatic RAS Pump Control

To improve RAS control, the existing PLC could be modified to automatically adjust the pump speed based upon a flow setpoint. This would reduce the operator attention required to set and balance RAS flow rates. This improvement would require connecting the effluent flow meter and each RAS flow meter to the existing PLC, and minor programming modifications to the existing PLC. This improvement is considered medium priority.

SECTION 5: CONCLUSIONS AND NEXT STEPS

5.1 Conclusions

Based on our evaluation of existing plant deficiencies, future planned improvements, and past audit work, we recommend that the City make immediate improvements to their WWTP to reduce the likelihood and frequency of effluent violations prior to construction of full improvements to the plant. We have listed recommended immediate improvements in Table 1, Section 1, along with estimated construction costs.

The City has limited funds for construction of these improvements, and may not have sufficient funds to construct all of them. Therefore, we have organized immediate improvements into three separate packages, listed in the table above in order of priority. It is our opinion that construction of the highest priority package will provide the greatest benefits for a limited cost, but that construction of all of the identified improvements will have the greatest reduction of effluent violations. The City will be pursuing multiple funding opportunities to construct all the recommended improvements. Should funds not be available to construct all of these, we recommend that they construct them in order of priority.

5.2 Next Steps

This technical memorandum recommends changes to the existing WWTP's processes, and will therefore be reviewed by the Department of Ecology (DOE) prior to implementing improvements. As modified by DOE comments, the design team will move forward with final design of the recommended immediate improvements. Depending on funding, the City hopes to construct these improvements in early fall, in order to coincide with typical low levels of industrial BOD loads and low flows.

Preliminary design of the full WWTP improvements will be continuing on a parallel path to design of immediate improvements.

Exhibit A
Stevenson Wastewater Treatment Plant Improvements
Immediate Improvements Construction Cost Estimates
Draft Technical Memorandum RE: Immediate Improvements Evaluation

Oxidation Ditch Improvements

Prepared by: Wallis Engineering, JW
Industrial Systems, MW

5/23/2019
WE #1477A

Oxidation Ditch Dissolved Oxygen Sensor

Item Description	Quantity	Unit	Unit Cost	Total Cost
DO Sensor (Hach LDO Model 2)	1	EA	\$ 2,100	\$ 2,100
Sensor Mounting Kit	1	EA	\$ 650	\$ 650
Controller (Hach SC-200)	1	EA	\$ 2,100	\$ 2,100
Conduit and Wiring, Materials and Installation	1	LS	\$ 2,600	\$ 2,600
Installation of DO Sensor and Controller	1	LS	\$ 2,500	\$ 2,500
<i>Construction Subtotal</i>				\$ 9,950
Contingency (30%)				\$ 2,990
Total Construction Cost				\$ 12,940

Influent pH Sensor

Item Description	Quantity	Unit	Unit Cost	Total Cost
pH Sensor (Hach Digital pHD)	1	EA	\$ 1,000	\$ 1,000
Sensor Mounting Kit	1	EA	\$ 600	\$ 650
Installation of pH Sensor	1	LS	\$ 2,200	\$ 2,100
<i>Construction Subtotal</i>				\$ 3,750
Contingency (30%)				\$ 1,130
Total Construction Cost				\$ 4,880

Cost Estimate Notes and Assumptions:

1. The pH sensor will be connected to the controller installed for the DO sensor.

Relocate Parshall Flume Level Sensor

Item Description	Quantity	Unit	Unit Cost	Total Cost
Installation and Minor Materials	1	EA	\$ 4,200	\$ 4,300
<i>Construction Subtotal</i>				\$ 4,300
Contingency (30%)				\$ 1,290
Total Construction Cost				\$ 5,590

Cost Estimate Notes and Assumptions:

1. Cost assumes that the existing ultrasonic transducer will be reused.

Exhibit A
Stevenson Wastewater Treatment Plant Improvements
Immediate Improvements Construction Cost Estimates
Draft Technical Memorandum RE: Immediate Improvements Evaluation

Clarifier Improvements

Prepared by: Wallis Engineering, JW
Industrial Systems, MW

5/23/2019
WE #1477A

RAS Flow Meters

Item Description	Quantity	Unit	Unit Cost	Total Cost
4" Flow Meter (Siemens SITRANS F M MAG 5100 W)	2	EA	\$ 2,600	\$ 5,200
Flow Meter Grounding Rings	2	EA	\$ 200	\$ 400
Conduit and Wiring, Materials and Installation	1	LS	\$ 1,200	\$ 1,200
Pipe and Fittings, Materials and Installation	1	LS	\$ 7,600	\$ 9,600
Construction Subtotal				\$ 16,400
Contingency (30%)				\$ 4,920
Total Construction Cost				\$ 21,320

Clarifier Stamford Baffles

Item Description	Quantity	Unit	Unit Cost	Total Cost
Stamford Baffles (NEFCO Stamford Baffle 2.0)	2	EA	\$ 16,000	\$ 32,000
Installation	1	LS	\$ 13,000	\$ 13,000
Construction Subtotal				\$ 45,000
Contingency (30%)				\$ 13,500
Total Construction Cost				\$ 58,500

Level Clarifier Weirs

Item Description	Quantity	Unit	Unit Cost	Total Cost
Installation and Minor Materials	1	LS	\$ 8,600	\$ 8,600
Construction Subtotal				\$ 8,600
Contingency (30%)				\$ 2,580
Total Construction Cost				\$ 11,180

Exhibit A
Stevenson Wastewater Treatment Plant Improvements
Immediate Improvements Construction Cost Estimates
Draft Technical Memorandum RE: Immediate Improvements Evaluation

SCADA Improvements

Prepared by: Wallis Engineering, JW
Industrial Systems, MW

5/23/2019
WE #1477A

Base SCADA System

Item Description	Quantity	Unit	Unit Cost	Total Cost
Computer Workstation	1	EA	\$ 1,150	\$ 1,150
SCADA Software (Wonderware Intouch 2017 Runtime 500 Tag)	1	EA	\$ 2,800	\$ 2,800
<i>Construction Subtotal</i>				\$ 3,950
Contingency (30%)				\$ 1,190
Total Construction Cost				\$ 5,140

Data Logging

Item Description	Quantity	Unit	Unit Cost	Total Cost
Run pH and DO Signals to RAS Building	1	LS	\$ 2,100	\$ 2,100
<i>Construction Subtotal</i>				\$ 2,100
Contingency (30%)				\$ 630
Total Construction Cost				\$ 2,730

Cost Estimate Notes and Assumptions:

1. Cost assumes that the City will install conduit between the oxidation ditch and the RAS building for pH and DO sensor signal wiring.

Automate RAS Pumps

Item Description	Quantity	Unit	Unit Cost	Total Cost
Effluent Flow Meter Signal Wiring	1	LS	\$ 800	\$ 800
RAS Pump VFD to PLC Wiring	1	LS	\$ 800	\$ 800
<i>Construction Subtotal</i>				\$ 1,600
Contingency (30%)				\$ 480
Total Construction Cost				\$ 2,080

14 June 2018

Technical Memorandum

To: Eric Hansen – Public Works Director

From: Brad Musick – Wastewater Solutions, Inc.

Subject: Process Audit of the Stevenson Wastewater Treatment Facility

Section 1. Project Description

Wastewater Solutions, Inc. (WSI) was contracted by the City of Stevenson, WA to provide a process and operational audit of the wastewater treatment facility. The goal was to determine if operational changes could improve plant performance and/or gain capacity from now through an upcoming facility upgrade.

A site visit was conducted May 21-22, 2018. The site visit included a field evaluation. Prior to the onsite work, WSI evaluated plant operating and design data, permit, studies, drawings, and other information.

Jacobs/CH₂M is a contract operations company hired by the City to care for, operate, and maintain the treatment facility. The Jacobs' operator tasked with operating and running the plant is Andy Gates. Andy has been a plant operator about 3 years, is a Class II Operator, and has been the person in responsible charge of the facility for approximately 5 months. Andy also attended Linn Benton Community College, studying wastewater.

Andy Gates actively participated in the exchange of ideas and information. Andy seemed to know the plant equipment and had a good understanding of operations. Staff seemed willing to implement most recommended changes. The consultant relied heavily on the outstanding plant-specific knowledge of the utility staff.

Section 2. Plant Description

The City of Stevenson Wastewater Treatment Plant (Stevenson WWTP) is located on the banks of Rock Creek, on the west end of Stevenson. The plant is designed for a peak-hour flow of 1.5 million gallons per day (mgd). It uses a singular oxidation ditch for treatment and discharges treated and disinfected effluent to the Bonneville Pool of the Columbia River.

The Stevenson WWTP was constructed in 1971 and originally consisted of a Smith and Loveless Oxygest package treatment plant ("donut") with a chlorine contact tank for disinfection and a sludge lagoon.

In 1992, the original plant was upgraded with largely new current facilities, including the oxidation ditch, secondary clarifiers, and UV disinfection facility. Some components from the original plant were kept as back-up to the new facilities or for solids handling.

2.1 Treatment Processes

Wastewater enters the Rock Creek Pump Station (serving portions of the City east of the WWTP) and Fairgrounds Pump Station (serving portions of the City west of the WWTP). These serve as the WWTP's current influent pump stations.

The following are the systems and processes comprising the treatment plant:

- Headworks

The combined force main from the influent pump stations discharges to the headworks facility. The combined raw wastewater flows are typically discharged to the south channel of the headworks, which features a mechanical bar screen to remove screenings entering the plant.

- Secondary Treatment
 - Oxidation Ditch
 - Secondary Clarifiers
 - RAS and WAS

Screened wastewater flows by gravity to the oxidation ditch, which is aerated by one or two brush rotors. In the aeration basin, bacteria consume organic BOD and inorganic ammonia. The bacteria responsible for BOD removal build floc which is then settled in the secondary clarifiers.

In the clarifiers, the biologically treated wastewater is separated from the biomass. The treated wastewater flows to UV disinfection. Most of the microbes are returned back to the oxidation ditch using RAS pumps. The excess microbes are wasted to the digester/solids holding.

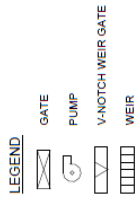
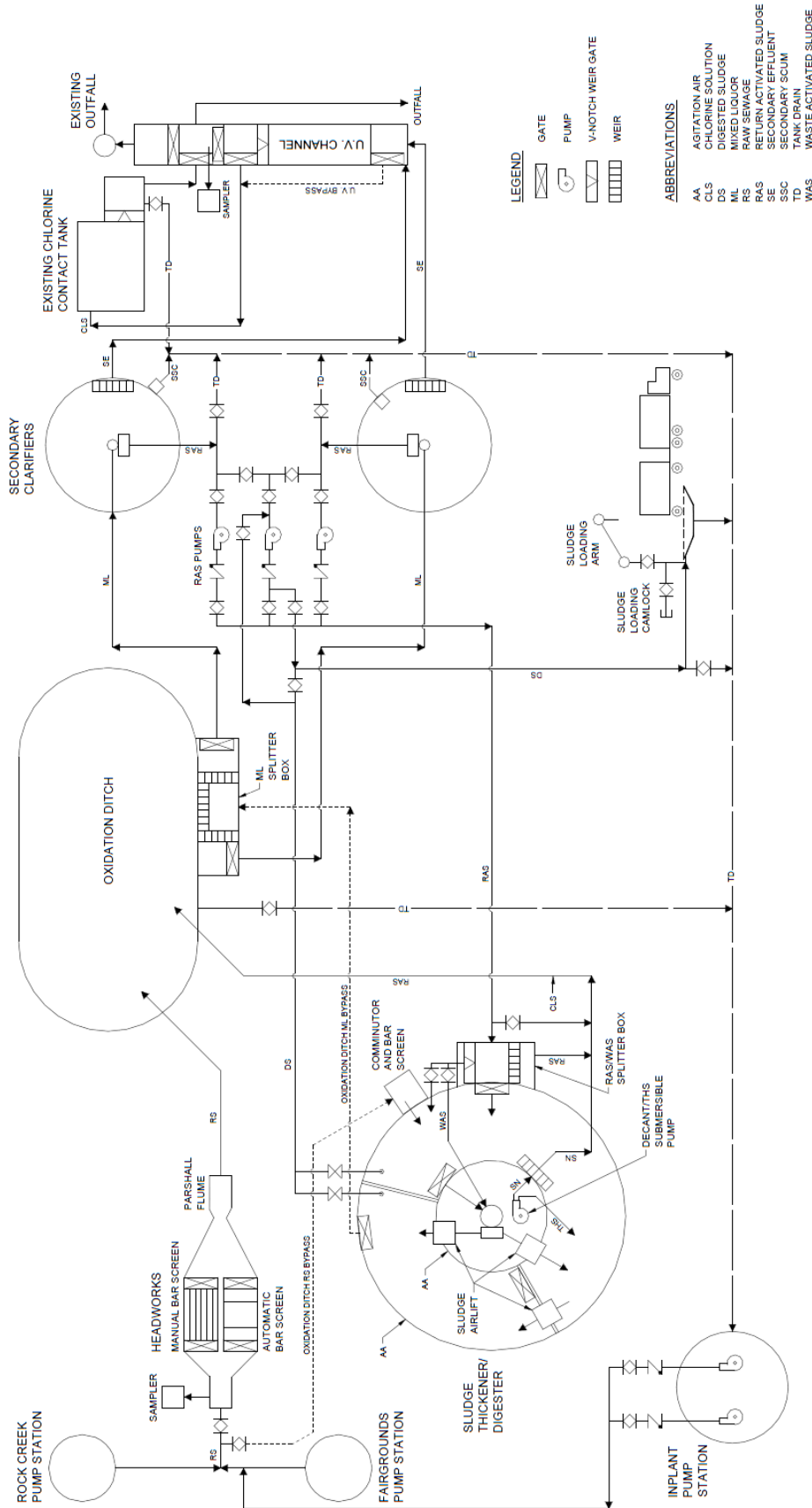
- Disinfection

The treated wastewater is made safe for discharge to the public waterway by Ultraviolet (UV) disinfection. The disinfection process kills pathogenic bacteria.

- Solids Handling

A pump station located between the secondary clarifiers pumps return activated sludge (RAS) and waste activated sludge (WAS) from the clarifiers to the RAS/WAS splitter box at the sludge holding tank. RAS flows to the oxidation ditch, and WAS flows to the solids holding tank.

The biosolids are hauled offsite in tanker trucks to other treatment facilities for further treatment.



ABBREVIATIONS

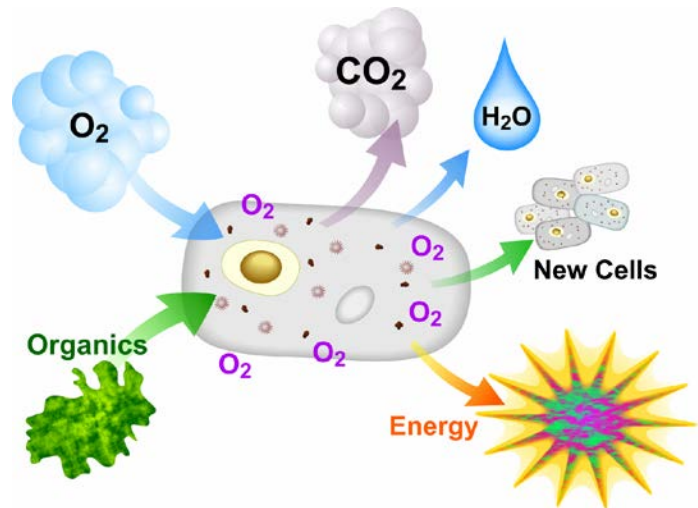
AA	AGITATION AIR
CLS	CHLORINE SOLUTION
DS	DIGESTED SLUDGE
ML	MIXED LIQUOR
RS	RAW SEWAGE
RAS	RETURN ACTIVATED SLUDGE
SE	SECONDARY EFFLUENT
SSC	SECONDARY SCUM
TD	TANK DRAIN
WAS	WASTE ACTIVATED SLUDGE

Section 3. Statement of the Issue(s)

The waste water plant experiences solids and BOD permit violations. The violations generally result from slug loads of high BOD waste from industry. BOD loadings higher than permit are recorded routinely. The highly soluble (dissolved) industrial waste slug load overwhelms the oxidation ditch's ability to deliver sufficient dissolved oxygen (DO) to the bacteria.

When bacteria are presented with soluble BOD, they take the food (BOD) material up through their cell wall. A biochemical reaction occurs and the BOD is converted into energy, water, new bacterial cells, and carbon dioxide. The rate at which the bacteria convert soluble BOD into solids (new cells) is dependent on the amount of food present, time, dissolved oxygen, and other growth pressures.

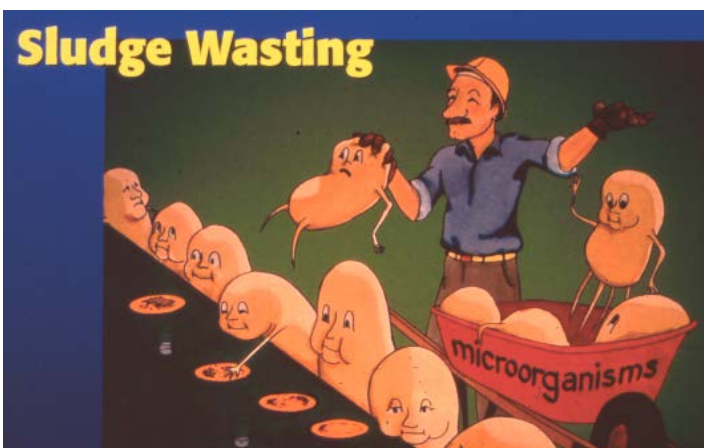
Given the right conditions, the heterotrophic bacteria that oxidize BOD can split in half and form new cells every 10-15 minutes. When a BOD slug enters the plant, there is a rapid rate of new cell development (log growth). If the bacteria have insufficient oxygen to oxidize the stored food, then the bacteria basically can't do anything else in the oxidation ditch. The bacteria travel, full of food, to the secondary clarifier. In most activated sludge facilities, it is important that the bacteria coming back from the clarifier (as RAS) to the oxidation ditches be hungry and ready to eat more BOD. This does not happen at Stevenson during a BOD slug load.



When experiencing a BOD slug load to the plant, the Stevenson bacteria do not come back hungry in the RAS to the ditch and are thus not readily available to consume BOD. Any solids lost from the clarifier are also full of BOD. The slugs come in quite often.

Typically in an oxidation ditch activated sludge system, the waste sludge produced (called sludge yield), is about 0.25-0.5 pounds of WAS sludge per pound of BOD in the influent. Because of the BOD slugs and low dissolved oxygen, the Stevenson sludge yield is closer to about 0.5 to 0.8 – roughly 2x the mass of secondary sludge is being produced compared to

other similar plants. So Stevenson must waste more sludge and handle more biosolids than other extended aeration plants.



When not experiencing the high BOD load, the plant tends to run fairly well and stays within compliance. On days without the high BOD load, the plant does a very good job of both BOD and ammonia oxidation. This shows it has capacity for the base loads, just not the slugs.

Section 4. Findings and Recommendations

The finding and recommendations are broken down into the following categories:

1. General Findings and Recommendations
2. Quick Benefit Recommendations
3. Long Term Recommendations

The information has been compiled into the following tables to reduce read time and make for easier reference. Note that the number # does not signify priority.

General (No specific order)

#	General Findings and Recommendations	Comments
1	Housekeeping	The contract operations firm has operated the facility since 1992. It was clean and all liquid treatment processes were new and in good order. Not sure much in terms of housekeeping has been performed since 1992. The contractor is responsible for cleaning as per the contract.
2	Maintenance	There is no High Speed on the ditch aeration equipment. They have not worked in years (as per operator). This is especially important since the plant experiences low DO during the BOD slugs. Repair of the aeration delivery equipment is very important. The blower(s) for the aerobic digester/holding and diffusers are also not fully functional. This too is a priority item.
3	Staffing	The half-time operator schedule may not be sufficient to perform all necessary tasks. That said, it does not relieve them of any housekeeping nor maintenance items. Some have been issues for years.
4	Micro Exam Performed	Findings from the micro exam are as follows: <ul style="list-style-type: none"> a. Open floc b. Filaments common c. Predominance of Stalked Ciliates d. Lots of Testate Amoeba e. Worms Shows varying F/M with both young and old.
5	Diluted Settleable Solids Test	The test showed that sludge settling is hindered by mass and reducing MLSS would improve settling in the clarifier.
6	O&M Manual last Updated 1992	Needs updated. Needs SOPs specific to dealing with high BOD slugs.
7	Staff Training	Contract staff has had little process training from Jacobs/CH2M.



Quick Benefit Recommendations

(No specific order)

#	Quick Benefit Recommendations	Comments
1	Online DO Probe Needed	The handheld DO probe does not show staff the diurnal DO in the ditch. Need to see BOD slugs and allow action when needed.
2	RAS Metering Needed	There is no RAS metering. Not sure the percentage of flow that they use really has any meaning. RAS is one of 3 controls on activated sludge (RAS, DO, and WAS). Need good info on all three to control the plant.
3	Reduce RAS Rate	The RAS rate is 110% of plant flow. This is too high. The RAS should be 3-5 x MLSS, but is currently only about 1.5 x. The high RAS robs capacity and dilutes waste sludge increasing the volume to pump. The reduced hydraulic load through the ditch will improve BOD treatment and also reduce the solids push to the clarifier. See Benefits of Lower RAS in Tech Memo.
4	Reduce MLSS Inventory	The plant has more than enough microbes to eat BOD under normal conditions. The diluted settleable solids showed improved setting with a lower mixed liquor concentration. Suggest around 3000-3500 mg/L. See Diluted Settle info in Tech Memo.
5	Repair and Run Both Ditch Rotors- High on at least one (once functional)	Due to the sporadic nature of the BOD slug loads, it is recommended that the staff run high DO's in the ditch to help meet the demand when the slugs occur. Repairing the rotors to run on HIGH speed will help with BOD treatment,
6	Add Polymer to RAS or MLSS	Add polymer to the RAS and/or the MLSS discharge to enhance solids capture. Especially recommended during BOD slugs or high flow situations.
7	Industrial Waste Equalization and pH Adjustment	Have the industry add flow equalization and pH adjustment. It would be advantageous if the BOD could be metered in at night when the plant experiences lighter loading.
8	Keep ditch weir level at max to help with oxygen transfer. Automate gate during upgrade IF they don't go with diffused air.	While using the mechanical rotor mixers, the gate weir should be at its highest to maximize DO transfer.



Intermediate to Long Term Recommendations

#	Intermediate to Long Term Findings and Recommendations	Comments
1	Add Stamford Baffles to Clarifiers	These pre-fab baffles help redirect flow and velocity and reduce clarifier solids in discharge.
2	Add Full Time Operator	Need more attention at the plant. Need to protect the City assets.
3	RAS Reaeration to Gain Aerobic Capacity	BEFORE UPGRADE. Consider gaining aerobic capacity by adding reaeration of the RAS. This could be done in the old contact tank, a banker box, or possibly in the existing solids handling. This would be an interim capacity gain until the upgrade is complete.
4	Level Weirs on Secondary Clarifiers	The weirs on the secondary clarifiers are not level. This causes higher flows over the lower weirs – pulling more solids over than necessary. Should be fixed during upgrade.
5	Selector Activated Sludge	It is important the upgrade have a biological selector to select for desirable floc formers. The type of selector (anoxic or anaerobic) should be based on the type of filaments they currently tend to grow, future permit considerations, etc.
6	SCADA	Need a SCADA system with the upgrade..

Some of the items in the tables above are discussed in more detail in the information that follows.

Stamford Baffles

The addition of Stamford baffles to the existing clarifiers and to the new one under consideration would be money well-spent. The purpose is to re-direct the current or velocity of the water in the clarifier as the flow tends to run up the sidewall and over the weirs. The Stamford baffle redirects that energy back toward the center of the clarifier, reducing the hydraulic impact on solids loss. Literature from Stamford states solids reduction up to 70% and improved wet weather treatment.

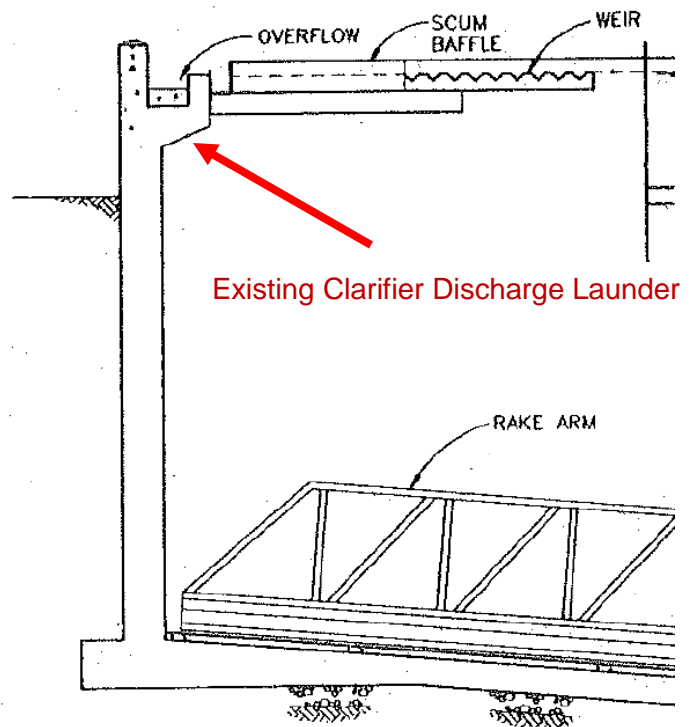


The existing clarifiers have a peripheral discharge launder. There was some discussion regarding the bottom of the launder and whether or not it acts as a density current baffle.

As the section drawing at right shows, the upward-angled launder bottom slope would be relatively ineffective redirecting the flow energy.

The design allows less dense solids to be carried up the sidewall and roll over the weir much more easily than a flow redirected by a downward- angled Stamford baffle shown in the above picture.

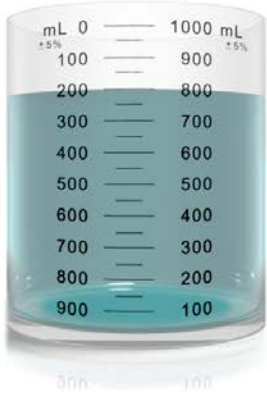
It is believed that Stamford baffles would be beneficial to the existing clarifiers. A conversation with the manufacturer would be beneficial to determine the true applicability of adding these to the clarifiers and what solids reduction would be expected.



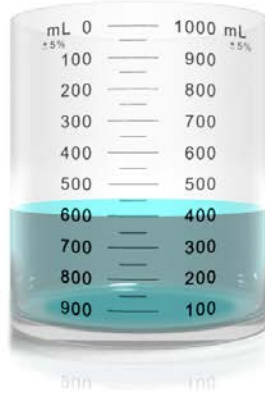


Reduced MLSS Inventory and the Diluted Settle Solids Test

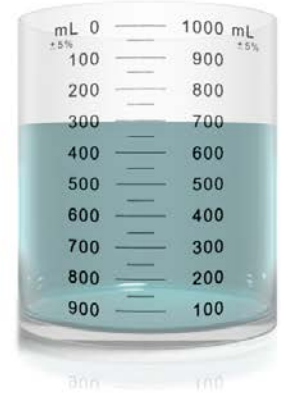
A diluted settleable solids test was performed to see the impact on filaments on the poor settling Stevenson sludge. The diluted settleable test illustrates how much of the settling problem is due to poor sludge **QUALITY** and how much of it is due to sludge **QUANTITY**.



Normal SS Test
SSV - 800

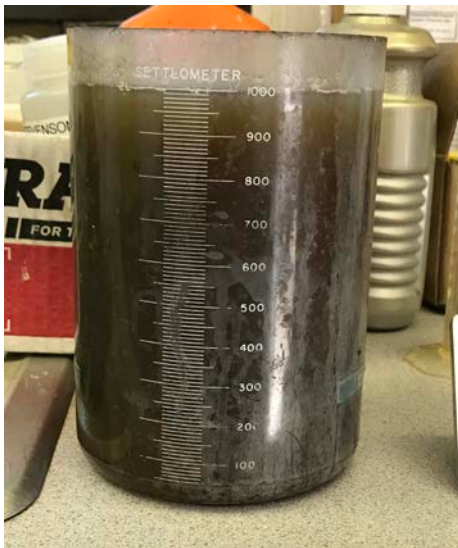


Diluted SS Test
SSV - 400
Quantity - Increase WAS

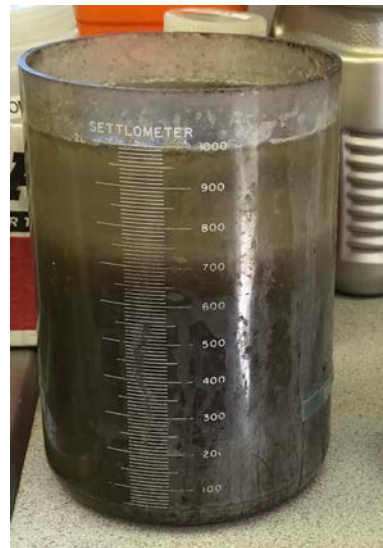


Diluted SS Test
SSV - 700
Quality - Filament Problem
Growth Pressure

At the Stevenson facility, the mixed liquor barely settled at all in the 30 minute settleable test.



Normal 30 Minute Stevenson Settleable



Diluted 30 Minute Settleable

Though the filaments were in the “common” range in terms of numbers, they appear to have less impact on the settleability than the MLSS concentration. So, the settling issue has more to do with too many solids (Quantity) vs. the Quality of the sludge produced.

Reducing the MLSS will have a positive impact on solids settling

Benefits of Reduced RAS Rates

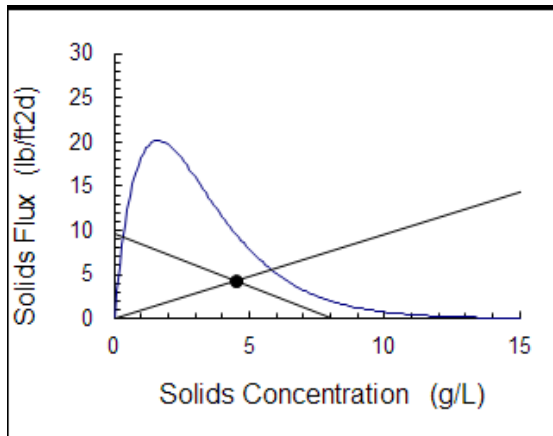
Based on a daily flow of 0.20 MGD

SVI of 211 Used Based on Historical Information

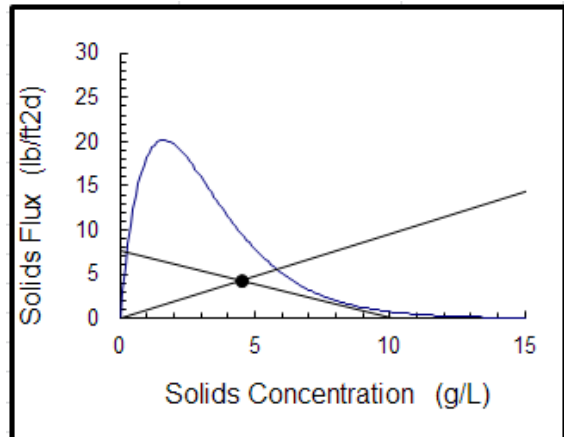
Comparing 110% RAS to 80% RAS	Total AB MGD RAS+RAW	RAS Flow MGD	RAS Conc. mg/L	WAS Sludge to Digester
Current RAS RATE @ 110% of RAW Flow	0.42	0.22	8000	
More optimized RAS RATE @ 80% of RAW FLOW	0.38	0.16	10125	
Reductions (-) or Gains (+)	(-) 10%	(-) 0.121	(+) 21%	(-) 21%

Benefits

- * Pumping Energy Savings
- * Better Settling in Clarifier
- * 21% (approx) Reduction in WAS Sludge Volume
- * 10% Reduction in Total Flow to AB
- * 20% Improvement on Detention Time
- * Increased digester sludge storage capacity (21%)
- * Less "supeing" labor



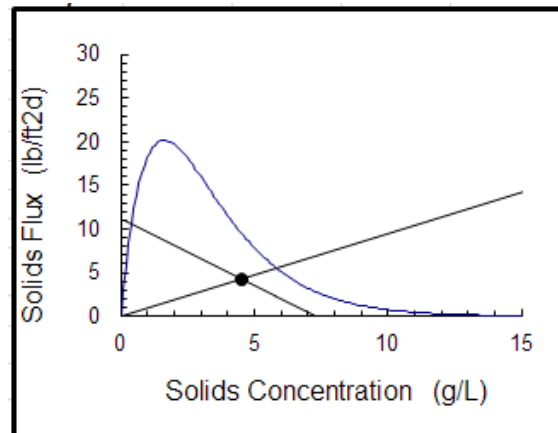
Stated Clarifier Conditions based on 110% RAS
(The RAS is NOT this concentrated in real life)



Optimized RAS rate of 80%

The RAS RATE may be higher than plant staff thought. To get SP to more closely match the plant data, the StatePoint RAS rate had to be brought up to 190% of plant flow, instead of the guesstimate of 110%. Note the lack of flow measure on RAS is an issue discussed elsewhere in the Tech Memo.

That said, if the RAS rate is higher than the 110%, then that makes the potential savings and performance gains much more substantial than stated in the table above.



Possible Current Clarifier Conditions Based on 159% RAS

The table below shows the comparison of the State Point current RAS rate vs. a more optimized RAS rate.

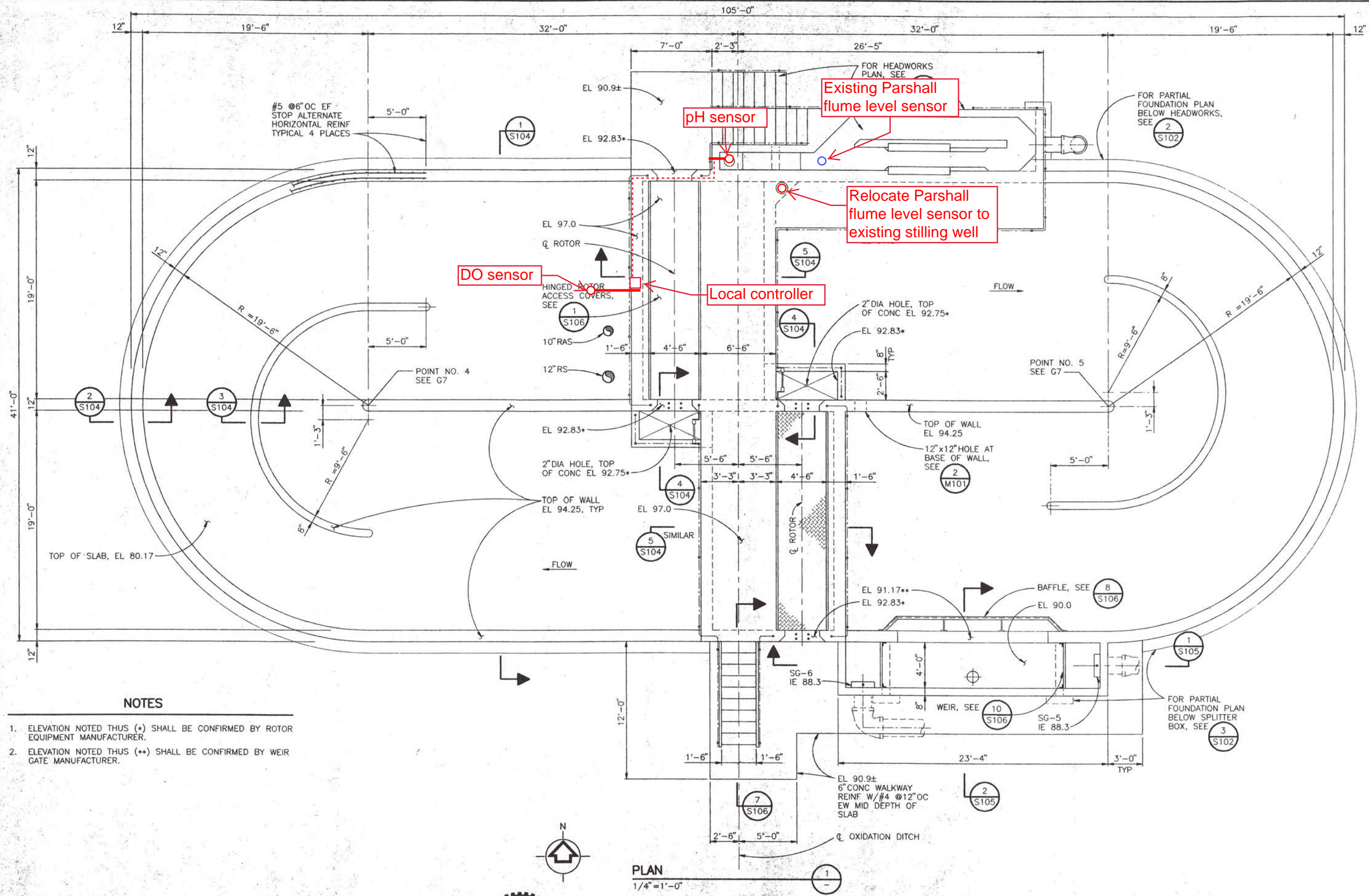
Comparing 190% RAS to 80% RAS	Total AB MGD RAS + RAW	RAS Flow MGD	RAS Conc. mg/L	WAS Sludge (V) to Digester
Based on Calculated 190% Current RAS flow	0.6	0.38	6800	
More optimized RAS RATE @ 80% of RAW FLOW	0.36	0.16	10125	
Reductions (-) or Gains (+)	(-) 40%	(-) 0.25	(+) 33%	(-) 33%

Section 5. Conclusion

The plant tends to meet permit during normal loads. However, when the BOD is beyond the design capacity, the plant can experience solids and BOD issues for a couple of days.

In terms of summarizing and prioritizing the short-term recommendations, they are as follows:

1. It is very important that the rotors on the ditch be repaired to allow them to operate on the HIGH setting. Since the BOD slugs cannot be predicted, it is important that the DO be maintained higher than normal to try to minimize the impact of the load. The ditch weir should also be run at or near its highest level to maximize oxygen transfer.
2. Reducing the mixed liquor solids concentration is needed to improve settling in the clarifier. It is recommended that the solids inventory be dropped from 4500 mg/L down to between 3,000-3,500 mg/L.
3. Optimizing the RAS rate will go a long way in improving both the aeration and the clarifier performance. It will also reduce the volume of sludge needed to waste by 20-30% and improve sludge storage by a comparable percentage.
4. Fixing the digester blowers and diffusers will help digest the sludge instead of allowing it to sit and ferment. The fermented decant could be adding organic acids. Coupled with the organic acids from the brewery, they are a food source for non-desirable filamentous bacteria. In addition, aerating the digester may reduce mass to be hauled.
5. Clean the plant.



NOTES

1. ELEVATION NOTED THUS (*) SHALL BE CONFIRMED BY ROTOR EQUIPMENT MANUFACTURER.
2. ELEVATION NOTED THUS (**) SHALL BE CONFIRMED BY WEIR GATE MANUFACTURER.

PLAN
1/4" = 1'-0"

KCM Kramer, Chin & Mayo, Inc.
7080 SW Fir Loop
Portland, Oregon 97223

date	designed by	WGG
JUNE 92	drawn by	RJM/JLF
scale	checked by	JAS
AS NOTED	approved by	MCD



revisions

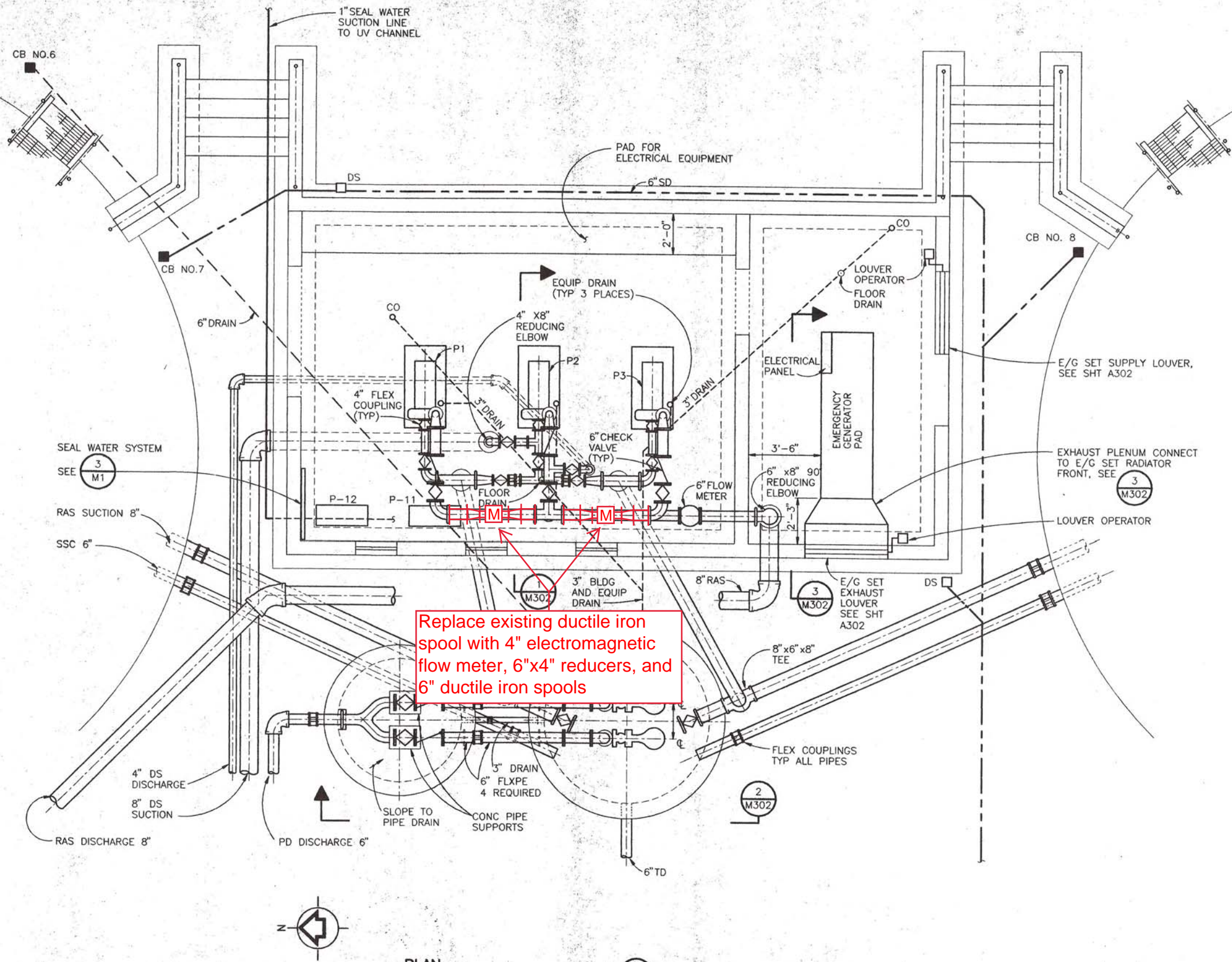
WASTEWATER FACILITIES IMPROVEMENTS
CITY OF STEVENSON, WASHINGTON

OXIDATION DITCH
TOP PLAN

drawing number
S101
sheet number
25 of 75

3252501R 1=48 3252-04-6/18F

This drawing is full size when 22" x 34" or is reduced to half size when 11" x 17"



Replace existing ductile iron spool with 4" electromagnetic flow meter, 6"x4" reducers, and 6" ductile iron spools

PLAN
3/8" = 1'-0"

date	designed by	BJB
JUNE 92	drawn by	DV/JLF
scale	checked by	JAS
AS NOTED	approved by	MCD



revisions	1
-----------	---

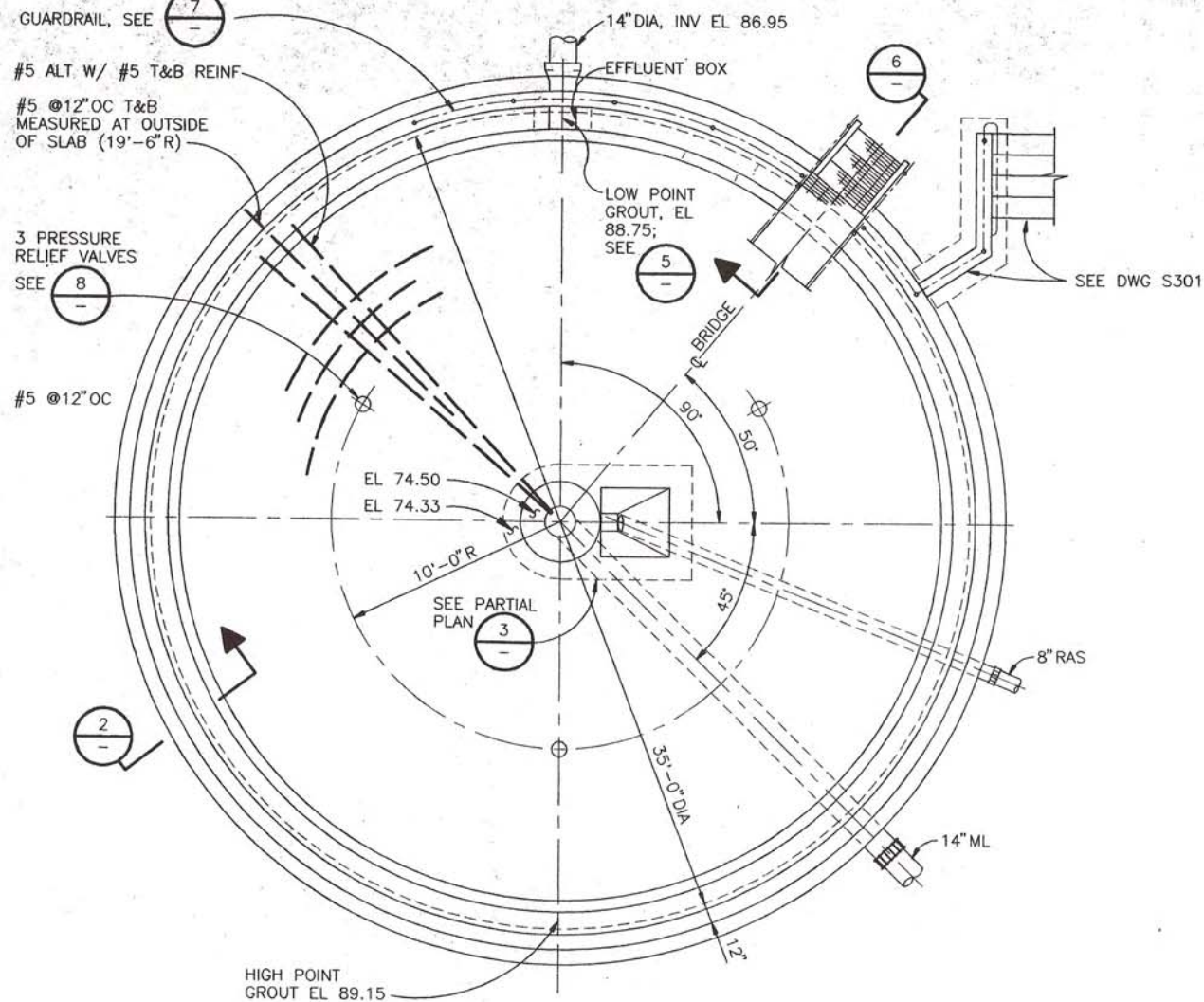
WASTEWATER FACILITIES IMPROVEMENTS
CITY OF STEVENSON, WASHINGTON

PUMP BUILDING AND IN-PLANT PUMP STATION
PLANS AND DETAILS

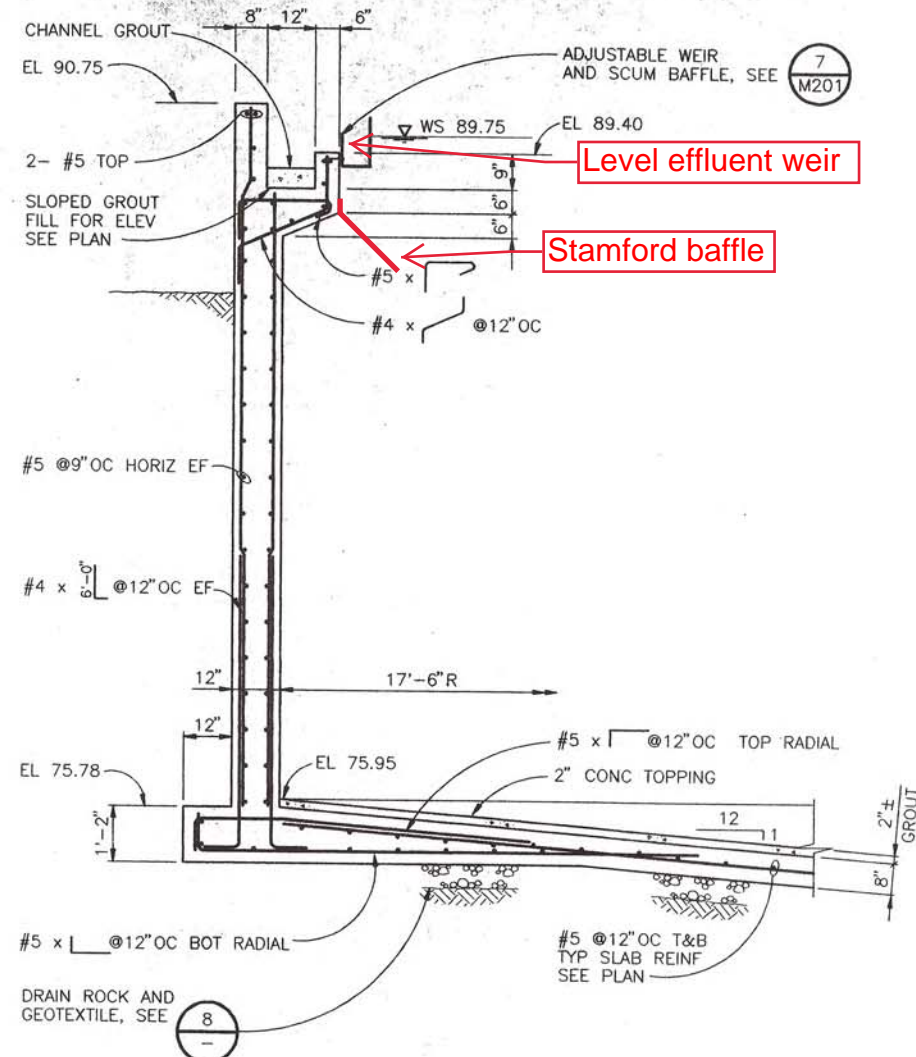
drawing number	M301
sheet number	38 of 75

3252M31V 1=32 3/8"=1'-0" 6/22A

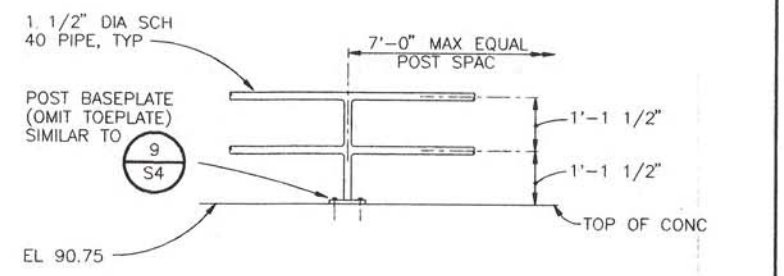
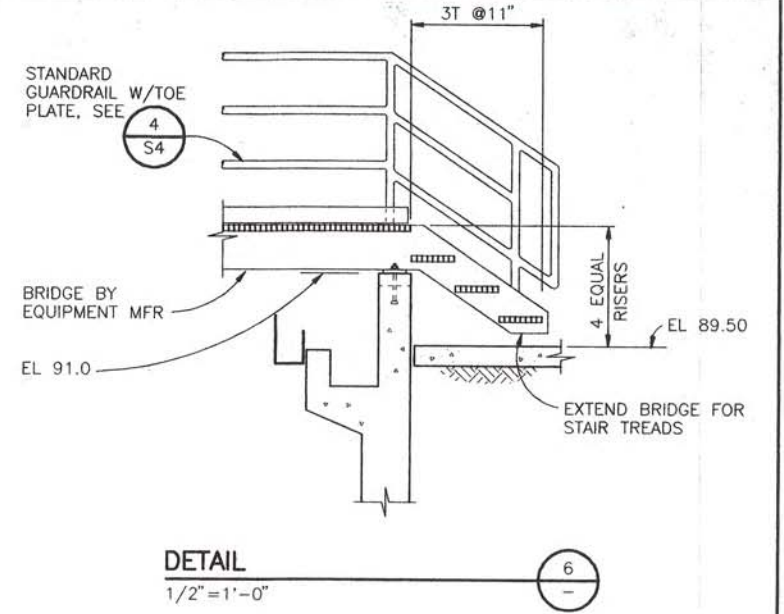
This drawing is full size when 22" x 34" or is reduced to half size when 11" x 17"



CLARIFIER NO. 1 AS SHOWN
 CLARIFIER NO. 2 OPPOSITE HAND
PLAN
 1/4" = 1'-0"

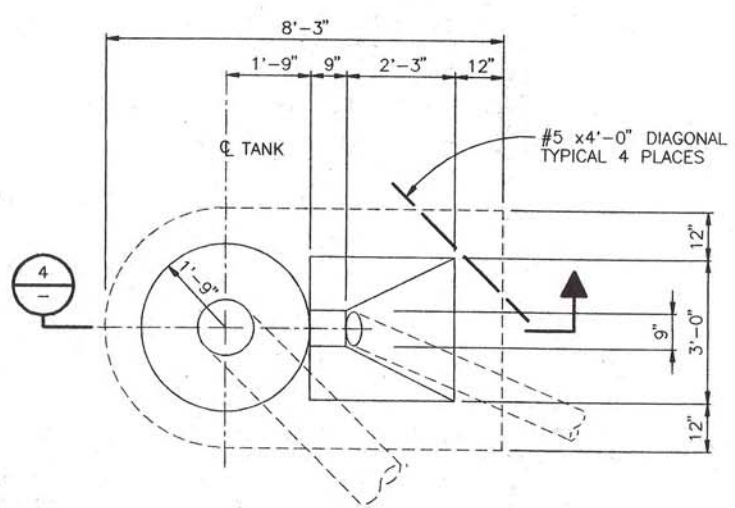


TYPICAL SECTION
 1/2" = 1'-0"

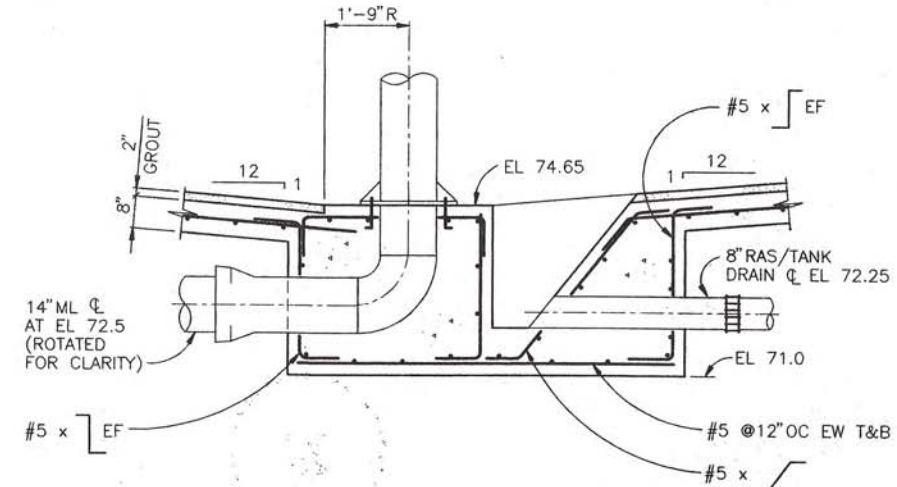


NOTE:
 1. PROVIDE GUARDRAIL AS SHOWN ON SECONDARY CLARIFIER, TYPICAL 2 PLACES.
 2. PROVIDE GUARDRAIL ON TOP OF EXISTING CHLORINE CONTACT TANK, APPROX 75 LINEAR FEET.

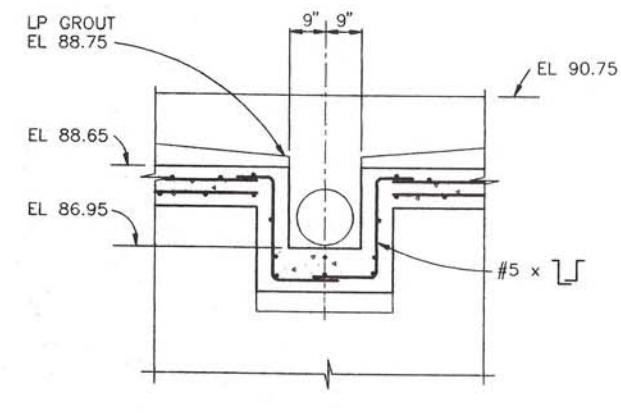
GUARDRAIL
 1/2" = 1'-0" 7



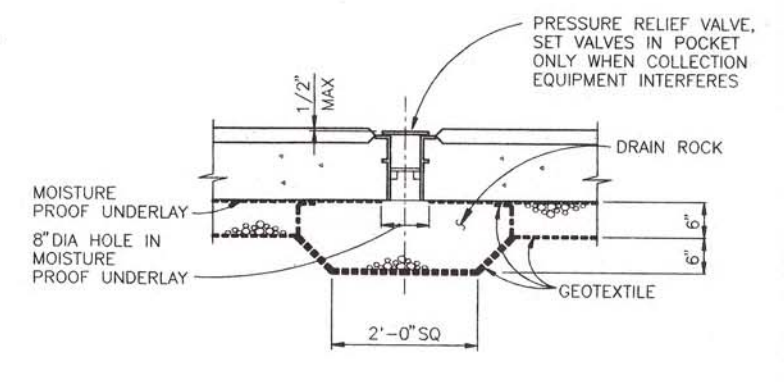
PARTIAL PLAN
 1/2" = 1'-0" 3



PARTIAL PLAN
 1/2" = 1'-0" 4



DETAIL
 1/2" = 1'-0" 5



PRESSURE RELIEF VALVE
 NO SCALE 8

KCM Kramer, Chin & Mayo, Inc.
 7080 SW Fir Loop
 Portland, Oregon 97223

date	designed by	GCB
JUNE 92	drawn by	JLF
scale	checked by	JAS
AS NOTED	approved by	MCD



revisions	
-----------	--

WASTEWATER FACILITIES IMPROVEMENTS
 CITY OF STEVENSON, WASHINGTON

SECONDARY CLARIFIER
 PLAN AND SECTIONS

drawing number	S201
sheet number	33 of 75

This drawing is full size when 22" x 34" or is reduced to half size when 11" x 17"

DISSOLVED OXYGEN: HACH LDO® PROBE, MODEL 2

Applications

- Wastewater
- Industrial Water
- Drinking Water



Take “No” for an answer when measuring dissolved oxygen with the next generation Hach LDO probe.

No Calibration Required

The Hach LDO probe is ready to work in your process right out of the box with no calibration required for the entire 2-year life of the sensor cap.

No Membranes to Replace

There is virtually no maintenance with Hach's breakthrough luminescent technology. There are no membranes to replace, no electrolyte solution to replenish, and no anode or cathode to clean.

No Missed Cleaning Cycles

Customizable service indicators trigger a service message so that a cleaning cycle is never missed.

No Drift

A cutting-edge, 3D calibration procedure at the factory makes oxygen measurement with the Hach LDO probe more accurate than ever before.

No Complications

A robust new design gives the Hach LDO enhanced durability and reduced size for easier handling.

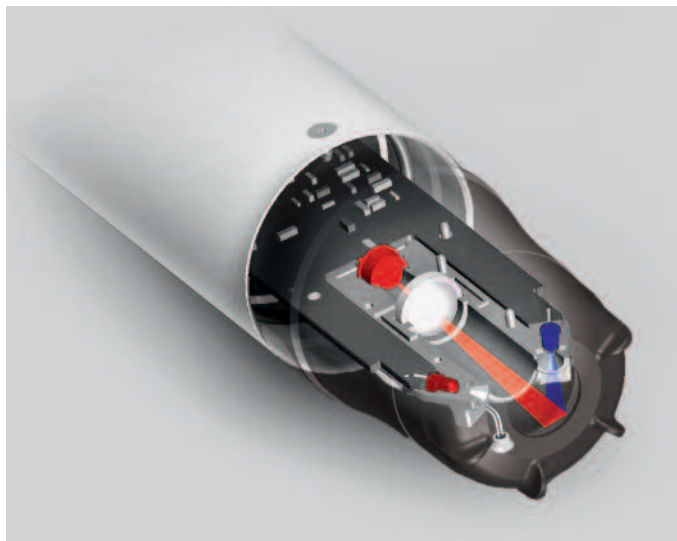
Specifications*

Range	0 to 20.00 ppm 0 to 20.0 mg/L (or ppm) 0 to 200 % air saturation	Flow Rate	None required
Accuracy	± 0.05 ppm below 1 ppm ± 0.1 ppm below 5 ppm ± 0.2 ppm above 5 ppm	Sensor Immersion Depth	Down to 345 kPa 345 kPa (50 psi), maximum; accuracy may not be maintained at this depth
Response Time	$T_{95} < 60$ s $T_{90} < 40$ s	Transmission Distance	1000 m (3280 ft.) maximum when used with a termination box
Resolution	0.01 ppm DO 0.1% saturation	Cable Length	10 m (options with 30m, 60m, 100m)
Repeatability	± 0.1 (mg/L) ppm	Dimensions (D x L)	1.9 in x 10 in (48.25 mm x 254 mm)
		Weight	2.2 lbs. (1 kg), probe only <i>*Subject to change without notice.</i>

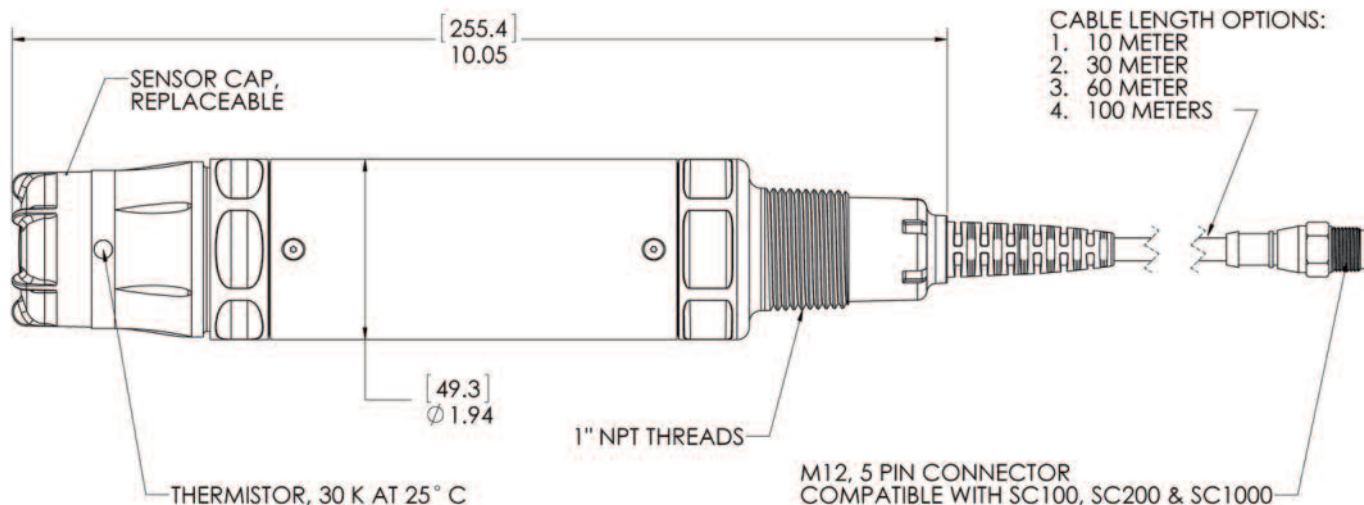
Principle of Operation

The HACH LDO sensor is coated with a luminescent material. Blue light from an LED is transmitted to the sensor surface. The blue light excites the luminescent material. As the material relaxes it emits red light. The time it takes for the red light to be emitted is measured. Between the flashes of blue light, a red LED is flashed on the sensor and used as an internal reference.

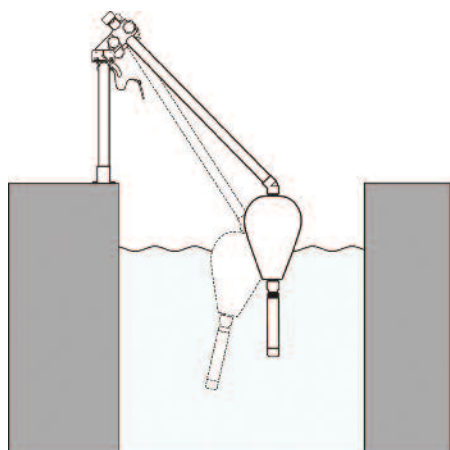
Increased oxygen in the sample decreases the time it takes for the red light to be emitted. The time measurements correlate to the oxygen concentration.



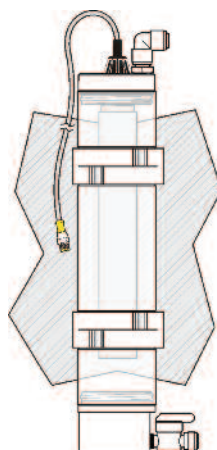
Dimensions



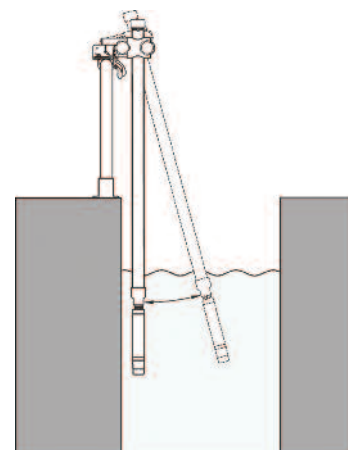
Installation / Mounting



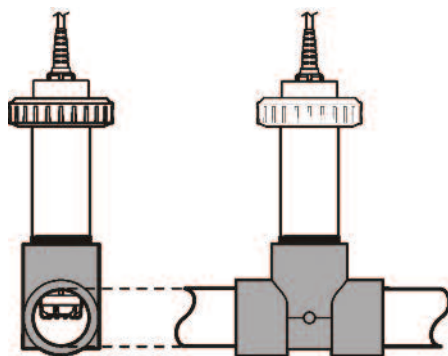
Float Mount Kit



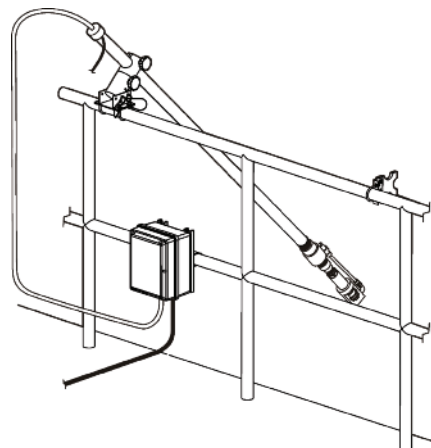
Flow Cell



Pole Mount Kit



Union Mount Kit



Air Blast Cleaning System

Ordering Information

9020000	Hach LDO Model 2 Probe
9020000-UPGRADE	LDO Probe, Mounting Conversion Adapter
9020000-SC200	LDO Probe, Mounting Conversion Adapter, sc200 controller with 2 channels

Accessories

5867000	Digital Termination Box
5796000	Digital Extension Cable, 7.7 m (25 ft.)
5796100	Digital Extension Cable, 15 m (50 ft.)
5796200	Digital Extension Cable, 31 m (100 ft.)
6860000	High Output Air Blast Cleaning System, 115 Vac
6860100	High Output Air Blast Cleaning System, 230 Vac
9253500	Air Blast Hardware Components

Replacement Parts

9021100	LDO Model 2 Sensor Cap Replacement Kit
----------------	--

Mounting Kits

9253000	Pole Mount Kit, PVC
9253100	Ball Float Mount Kit, PVC
9257000	Union Mount Kit, PVC
9253400	Mounting Conversion Adapter, LDO Model 1 to LDO Model 2
7300800	1 NPT sc Sensors Flow Cell

Controllers

sc200 Digital Controllers

LXV404.99.00552	sc200 controller, 2 channel, digital
LXV404.99.00542	sc200 controller, 2 channel, digital & mA input
LXV404.99.00502	sc200 controller, 1 channel, digital
LXV404.99.00512	sc200 controller, 2 channel, digital & pH/DO
LXV404.99.00522	sc200 controller, 2 channel, digital & Conductivity
LXV404.99.00532	sc200 controller, 2 channel, digital & Flow

sc1000 Digital Controllers

LXV402.99.00002	sc1000 Display Module
LXV400.99.1R572	sc1000 Probe Module, 4 sensors, 4 mA Out, 4 mA In, 4 Relays, 110-230V
LXV400.99.1B572	sc1000 Probe Module, 4 sensors, 4 mA Out, 4 mA In, 4 Relays, Modbus RS485, 110-230V
LXV400.99.1F572	sc1000 Probe Module, 4 sensors, 4 mA Out, 4 mA In, 4 Relays, PROFIBUS DP, 110-230V
LXV400.99.1R582	sc1000 Probe Module, 6 sensors, 4 mA Out, 4 mA In, 4 Relays, 110-230V



HACH COMPANY World Headquarters: Loveland, Colorado USA

United States:	800-227-4224 tel	970-669-2932 fax	orders@hach.com
Outside United States:	970-669-3050 tel	970-461-3939 fax	int@hach.com
hach.com			

LIT2455 Rev 3

A14 Printed in U.S.A.

©Hach Company, 2014. All rights reserved.

In the interest of improving and updating its equipment,

Hach Company reserves the right to alter specifications to equipment at any time.



Be Right™

sc200™ UNIVERSAL CONTROLLER

Applications

- Drinking Water
- Wastewater
- Industrial Water
- Power



One Controller for the Broadest Range of Sensors.

Choose from 30 digital and analog sensor families for up to 17 different parameters.

Maximum Versatility

The sc200 controller allows the use of digital and analog sensors, either alone or in combination, to provide compatibility with Hach's broad range of sensors, eliminating the need for dedicated, parameter-specific controllers.

Ease of Use and Confidence in Results

Large, high-resolution, transreflective display provides optimal viewing resolution in any lighting condition. Guided calibration procedures in 19 languages minimize complexity and reduce operator error. Password-protected SD card reader offers a simple solution for data download and transfer. Visual warning system provides critical alerts.

Wide Variety of Communication Options

Utilize two to five analog outputs to transmit primary and secondary values for each sensor, or integrate Hach sensors and analyzers into MODBUS RS232/RS485, Profibus® DP, and HART networks.



Password protected SD card reader offers a simple solution for data download and transfer, and sc200 and digital sensor configuration file duplication and backup.



Be Right™

Controller Comparison



Features	Previous Models		sc200™ Controller	Benefits
	sc100™ Controller	GLI53 Controller		
Display	64 x 128 pixels 33 x 66 mm (1.3 x 2.6 in.)	64 x 128 pixels 33 x 66 mm (1.3 x 2.6 in.)	160 x 240 pixels 48 x 68 mm (1.89 x 2.67 in.) Transreflective	<ul style="list-style-type: none"> Improved user interface—50% bigger Easier to read in daylight and sunlight
Data Management	irDA Port/PDA Service Cable	N/A	SD Card Service Cable	<ul style="list-style-type: none"> Simplifies data transfer Standardized accessories/ max compatibility
Sensor Inputs	2 Max Direct Digital Analog via External Gateway	2 Max Analog Depending on Parameter	2 Max Digital and/or Analog with Sensor Card	<ul style="list-style-type: none"> Simplifies analog sensor connections Works with analog and digital sensors
Analog Inputs	N/A	N/A	1 Analog Input Signal Analog 4-20mA Card	<ul style="list-style-type: none"> Enables non-sc analyzer monitoring Accepts mA signals from other analyzers for local display Consolidates analog mA signals to a digital output
4-20 mA Outputs	2 Standard	2 Standard	2 Standard Optional 3 Additional	<ul style="list-style-type: none"> Total of five (5) 4-20 mA outputs allows multiple mA outputs per sensor input
Digital Communication	MODBUS RS232/RS485 Profibus DP V1.0	HART	MODBUS RS232/RS485 Profibus DP V1.0 HART 7.2	<ul style="list-style-type: none"> Unprecedented combination of sensor breadth and digital communication options

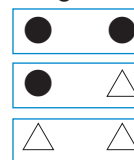
Choose from Hach's Broad Range of Digital and Analog Sensors

Parameter	Sensor	Digital or Analog
Ammonia	AMTAX™ sc, NH4D sc, AISE sc, AN-ISE sc	●
Chlorine	CLF10 sc, CLT10 sc, 9184 sc	●
Chlorine Dioxide	9185 sc	●
Conductivity	GLI 3400 Contacting, GLI 3700 Inductive	△
Dissolved Oxygen	LDO® Model 2, 5740 sc	●
Dissolved Oxygen	5500	△
Flow	U53, F53 Sensors	△
Nitrate	NITRATAX™ sc, NO3D sc, NISE sc, AN-ISE sc	●
Oil in Water	FP360 sc	●
Organics	UVAS sc	●
Ozone	9187 sc	●
pH/ORP	pHD	●
pH/ORP	pHD, pH Combination, LCP	△
Phosphate	PHOSPHAX™ sc	●
Sludge Level	SONATAX™ sc	●
Suspended Solids	SOLITAX™ sc, TSS sc	●
Turbidity	1720E, FT660 sc, SS7 sc, ULTRATURB sc, SOLITAX sc, TSS sc	●
Ultra Pure Conductivity	8310, 8311, 8312, 8315, 8316, 8317 Contacting	△
Ultra Pure pH/ORP	8362	△

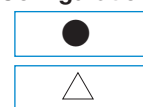
● = Digital △ = Analog

Connect up to two of any of the sensors listed above, in any combination, to meet your application needs. The diagrams below demonstrate the potential configurations. Operation of analog sensors requires the controller to be equipped with the appropriate sensor module. Contact Hach Technical Support for help with selecting the appropriate module.

2 Channel Configurations



1 Channel Configurations



Specifications*

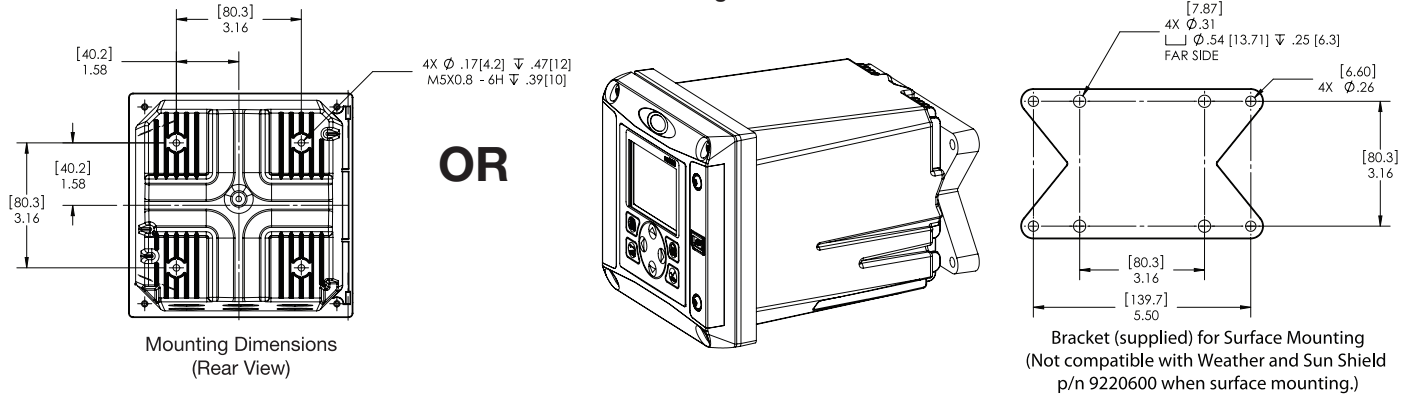
Dimensions (H x W x D)	5.7 in x 5.7 in x 7.1 in (144 mm x 144 mm x 181 mm)
Display	Graphic dot matrix LCD with LED backlighting, transreflective
Display Size	1.9 x 2.7 in. (48 mm x 68 mm)
Display Resolution	240 x 160 pixels
Weight	3.75 lbs. (1.70 kg)
Power Requirements (Voltage)	100 - 240 V AC, 24 V DC
Power Requirements (Hz)	50/60 Hz
Operating Temperature Range	-20 to 60 °C , 0 to 95% RH non-condensing
Analog Outputs	Two (Five with optional expansion module) to isolated current outputs, max 550 Ω , Accuracy: ± 0.1% of FS (20mA) at 25 °C, ± 0.5% of FS over -20 °C to 60 °C range Operational Mode: measurement or calculated value
Analog Output Functional Mode	Linear, Logarithmic, Bi-linear, PID
Security Levels	2 password-protected levels
Mounting Configurations	Wall, pole, and panel mounting
Enclosure Rating	NEMA 4X/IP66
Conduit Openings	1/2 in NPT Conduit
Relay: Operational Mode	Primary or secondary measurement, calculated value (dual channel only) or timer

Relay Functions	Scheduler (Timer), Alarm, Feeder Control, Event Control, Pulse Width Modulation, Frequency Control, and Warning
Relays	Four electromechanical SPDT (Form C) contacts, 1200 W, 5 A
Communication	MODBUS RS232/RS485, PROFIBUS DPV1, or HART 7.2 optional
Memory Backup	Flash memory
Electrical Certifications	EMC CE compliant for conducted and radiated emissions: - CISPR 11 (Class A limits) - EMC Immunity EN 61326-1 (Industrial limits) Safety cETLus safety mark for: - General Locations per ANSI/UL 61010-1 & CAN/CSA C22.2. No. 61010-1 - Hazardous Location Class I, Division 2, Groups A,B,C & D (Zone 2, Group IIC) per FM 3600 / FM 3611 & CSA C22.2 No. 213 M1987 with approved options and appropriately rated Class I, Division 2 or Zone 2 sensors cULus safety mark - General Locations per UL 61010-1 & CAN/CSA C22.2. No. 61010-1

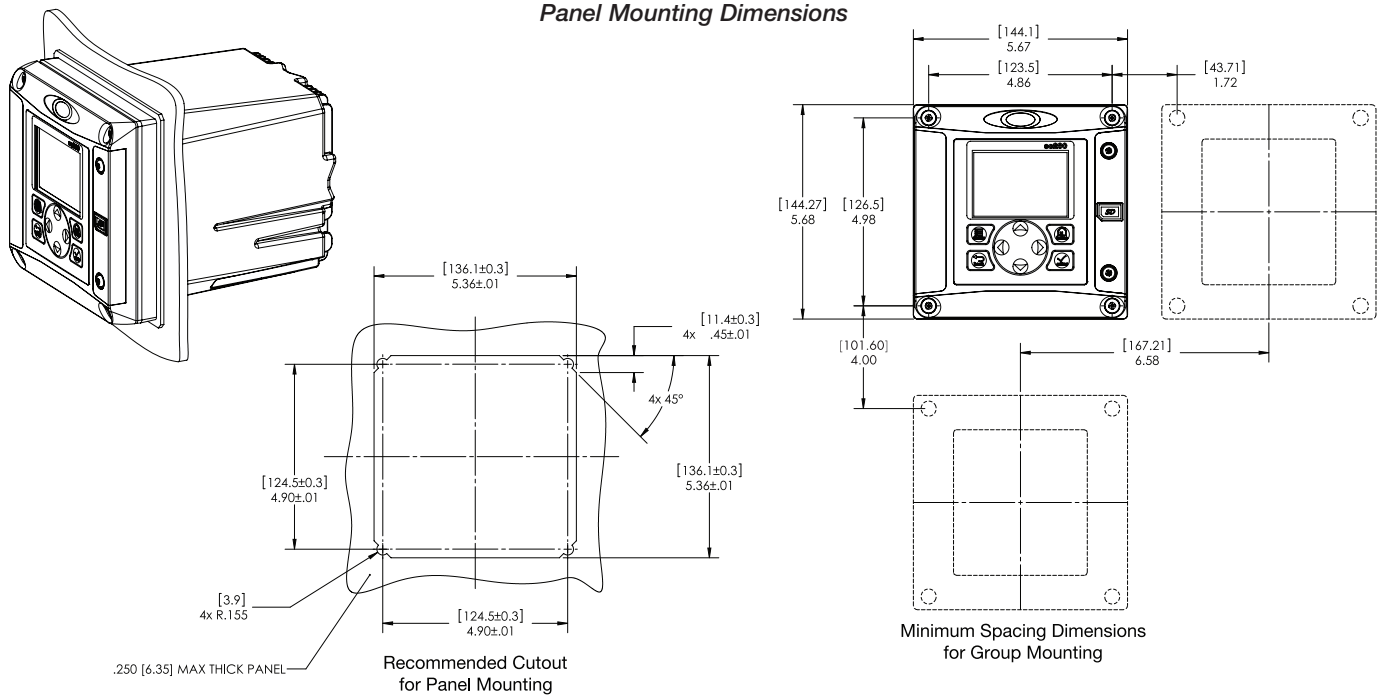
*Subject to change without notice.

Dimensions

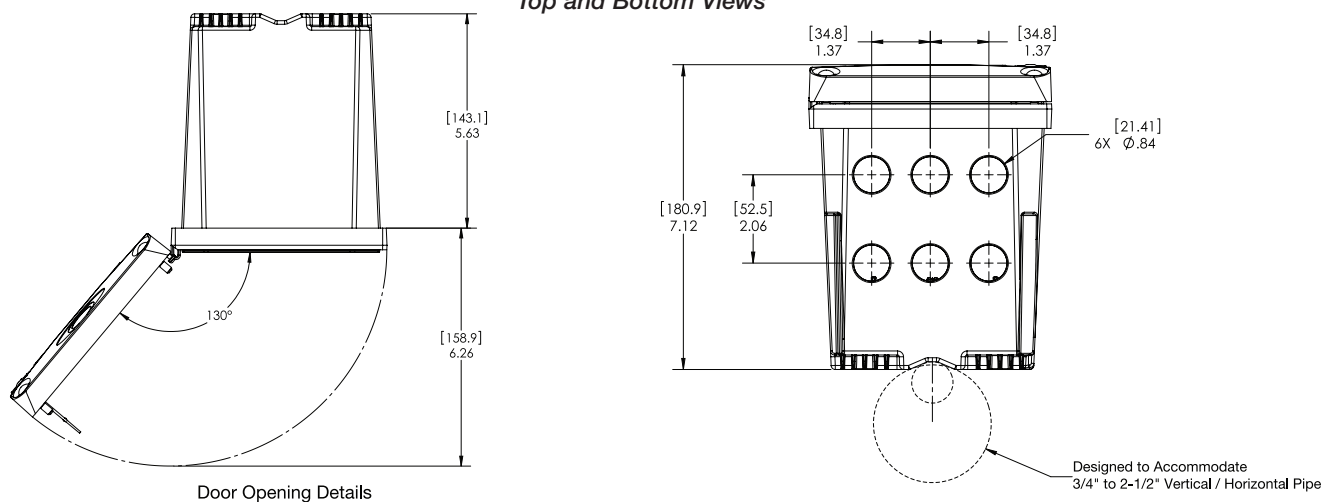
Surface Mounting Dimensions



Panel Mounting Dimensions



Top and Bottom Views



Ordering Information

sc200 for Hach Digital and Analog Sensors

LXV404.99.00552	sc200 controller, 2 channels, digital
LXV404.99.00502	sc200 controller, 1 channel, digital
LXV404.99.00102	sc200 controller, 1 channel, pH/DO
LXV404.99.00202	sc200 controller, 1 channel, Conductivity
LXV404.99.01552	sc200 controller, 2 channels, digital, Modbus RS232/RS485
LXV404.99.00112	sc200 controller, 2 channel, pH/DO

Note: Other Sensor combinations are available. Please contact Hach Technical Support or your Hach representative.

Note: Communication options (MODBUS, Profibus DPV1, and HART) are available. Please contact Hach Technical Support or your Hach representative.

sc200 for Ultrapure Sensors

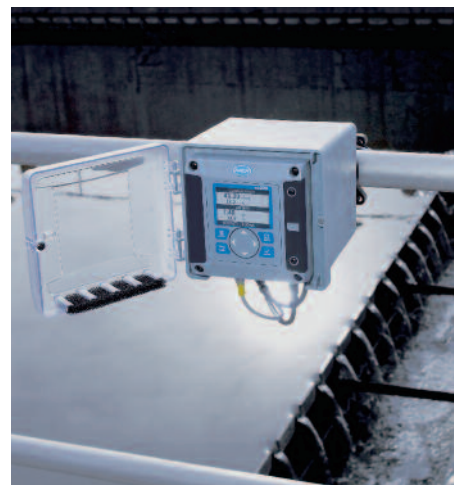
9500.99.00602	sc200 controller, 1 channel, ultrapure conductivity
9500.99.00702	sc200 controller, 1 channel, ultrapure pH
9500.99.00662	sc200 controller, 2 channel, ultrapure conductivity
9500.99.00772	sc200 controller, 2 channel, ultrapure pH

Sensor and Communication Modules

9012900	Analog pH/ORP and DO module for GLI Sensors
9013000	Analog Conductivity module for GLI Sensors
9012700	Flow module
9012800	4-20 mA Input Module
9525700	Analog pH/ORP Module for Polymetron Sensors
9525800	Analog Conductivity Module for Polymetron Sensors
9013200	Modbus 232/485 Module
9173900	Profibus DP Module
9328100	HART Module
9334600	4-20 mA Output Module (Provides 3 additional mA Outputs)

Accessories

9220600	sc200 Weather and Sun Shield with UV Protection Screen
8809200	sc200 UV Protection Screen
9218200	SD card reader (USB) for connection to PC
9218100	4 GB SD card



HACH COMPANY World Headquarters: Loveland, Colorado USA

United States: 800-227-4224 tel 970-669-2932 fax orders@hach.com
 Outside United States: 970-669-3050 tel 970-461-3939 fax int@hach.com
hach.com

LIT2665 Rev 7
 K13 Printed in U.S.A.

©Hach Company, 2013. All rights reserved.
 In the interest of improving and updating its equipment,

Hach Company reserves the right to alter specifications to equipment at any time.



DIFFERENTIAL pH AND ORP SENSORS

Applications

- Drinking Water
- Wastewater
- Industrial Water
- Power



Wide range pH glass
(HF resistant glass also available)



The smart choice for accurate, reliable, and dependable pH/ORP measurement.

Hach Digital pHD sc sensors are available in convertible (PEEK® or Ryton®), insertion, and sanitary body styles. Three electrodes are used in these sensors to increase measurement accuracy and eliminate sensor ground loops.

Differential Electrode Measurement Technique

This field-proven technique uses three electrodes instead of the two normally used in conventional pH sensors. Process and reference electrodes measure the pH differentially with respect to a third ground electrode. The end result is unsurpassed measurement accuracy, reduced reference junction potential, and elimination of sensor ground loops. These sensors provide greater reliability, resulting in less downtime and maintenance.

Patented Technology

The former GLI, now a Hach Company brand, invented the Differential Electrode Technique for pH measurement in 1970. The pHDTM sensor series (U.S. Patent Number 6395158B1, May 28, 2002) takes this field-proven technology to a new level.

Replaceable Salt Bridge/Protector

The unique, replaceable salt bridge holds an extraordinary volume of buffer to extend the working life of the sensor by protecting the reference electrode from harsh process conditions.

Built-in Encapsulated Preamp

Encapsulated construction protects the sensor's built-in preamp from moisture and humidity, ensuring reliable sensor operation. The preamp in the pHD analog sensor produces a strong signal, enabling the sensor to be located up to 1000 m (3280 ft.) from the analyzer.

Durable Body Materials

Both the digital and analog pH and ORP differential sensors feature a durable PEEK® body for chemical compatibility with most process solutions. For less aggressive solutions, Hach offers a Ryton® sensor in a convertible style for pH and ORP measurement. A sensor with a stainless steel body is available for immersion applications.

Versatile Mounting Styles

Sensors are available in four mounting styles—convertible, insertion, immersion, and sanitary.

Differential Sensor Warranty

Hach Company offers an outstanding warranty on its differential sensors. We will replace any differential sensor that fails due to defects in materials or workmanship within one year from the date of shipment, and up to 30 months on a prorated basis for any failure.

Specifications*

pH Sensors

Some industrial applications require accurate measurement and control below 2 or above 12 pH. In these special cases, please contact Hach Technical Support for further details.

Measuring Range	-2 to 14 pH
Sensitivity	±0.01 pH
Stability	0.03 pH per 24 hours, non-cumulative
Operating Temperature	Digital Sensor: -5 to 70°C (23 to 158°F) Analog Sensor with Digital Gateway: 5 to 105°C (23 to 221°F) Immersion Sensor: 0 to 50°C (32 to 122°F)
Flow Rate	3 m (10 ft.) per second, maximum
Sensor Pressure/ Temperature Limits	Digital: 6.9 bar at 70°C (100 psi at 158°F) Analog: 6.9 bar at 105°C (100 psi at 221°F)
Built-in Temperature Element	NTC 300 ohm thermistor for automatic temperature compensation and analyzer temperature readout
Transmission Distance	100 m (328 ft.), maximum 1000 m (3280 ft.), maximum when used with a termination box
Sensor Cable (integral)	4 conductor cable with one shield and polyurethane jacket; rated to 105°C (221°F); 10 m (33 ft.) standard length
Wetted Materials	PEEK® or Ryton® (PVDF), salt bridge of matching material with Kynar® junction, glass process electrode, titanium ground electrode, and Viton® O-ring seals (Please contact Hach Technical Support for available wetted O-ring materials.)

ORP (Redox) Sensors

For best ORP measuring results in solutions containing zinc, cyanide, cadmium or nickel, Hach recommends using the pHD sc ORP sensor equipped with an optional gold electrode.

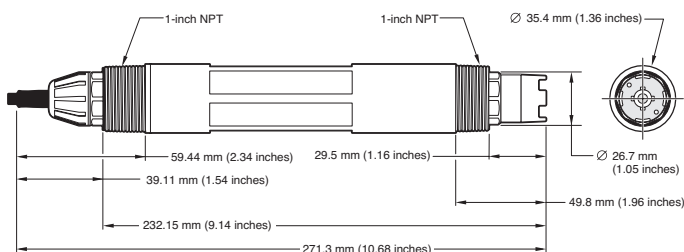
Measuring Range	-1500 to +1500 mV
Sensitivity	±0.5 mV
Stability	2 mV per 24 hours, non-cumulative
Operating Temperature	Digital Sensor: -5 to 70°C (23 to 158°F) Analog Sensor with Digital Gateway: -5 to 105°C (23 to 221°F) Immersion Sensor: 0 to 50°C (32 to 122°F)
Flow Rate	3 m (10 ft.) per second, maximum
Sensor Pressure/ Temperature Limits	Digital: 6.9 bar at 70°C (100 psi at 158°F) Analog: 6.9 bar at 105°C (100 psi at 221°F)
Built-in Temperature Element	NTC 300 ohm thermistor for analyzer temperature readout only—no automatic temperature compensation necessary for ORP measurement
Transmission Distance	100 m (328 ft.), maximum 1000 m (3280 ft.), maximum when used with a termination box
Sensor Cable (integral)	4 conductor cable with one shield and polyurethane jacket; rated to 105°C (221°F); 10 m (33 ft.) standard length
Wetted Materials	PEEK® or Ryton® (PVDF), salt bridge of matching material with Kynar® junction, glass and platinum (or plastic and gold) process electrode, titanium ground electrode, and Viton® O-ring seals

*Subject to change without notice.

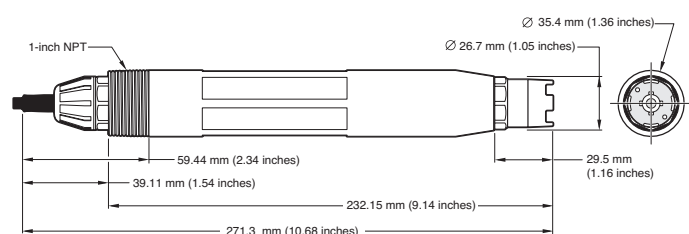
PEEK® is a registered trademark of ICI Americas, Inc.; Ryton® is a registered trademark of Phillips 66 Co.; Kynar® is a registered trademark of Pennwalt Corp.; Viton® is a registered trademark of E.I. DuPont de Nemours + Co.

Dimensions

Convertible Style

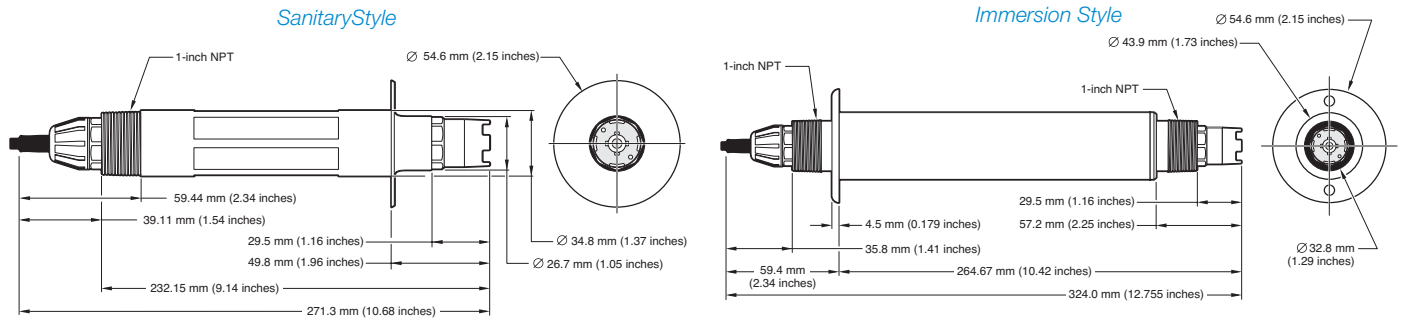


Insertion Style



Continued on next page.

Dimensions *continued*



Ordering Information

pHD sc Digital Differential pH/ORP Sensors

All digital sensors include built-in digital electronics and integral 10 m (33 ft.) cable terminated with connector for the Hach SC Digital Controllers.

pH Sensors

Prod. No.	Body Material	Body Style*	Electrode Material	Max Temp
DPD1P1	PEEK ¹	Convertible	Glass, General Purpose	70°C (158°F)
DPD1P3	PEEK ¹	Convertible	Glass, HF-resistant	70°C (158°F)
DPD2P1	PEEK ¹	Insertion	Glass, General Purpose	70°C (158°F)
DPD3P1	PEEK ¹	Sanitary	Glass, General Purpose	70°C (158°F)
DPD1R1	Ryton ²	Convertible	Glass, General Purpose	70°C (158°F)
DPD1R3	Ryton ²	Convertible	Glass, HF-resistant	70°C (158°F)
DPS1	Stainless Steel	Immersion	Glass, General Purpose	50°C (122°F)

¹Polyetheretherketone ²Polyphenylene Sulfide

ORP Sensors

Prod. No.	Body Material	Body Style*	Electrode Material	Max Temp
DRD1P5	PEEK ¹	Convertible	Platinum	70°C (158°F)
DRD1P6	PEEK ¹	Convertible	Gold	70°C (158°F)
DRD2P5	PEEK ¹	Insertion	Platinum	70°C (158°F)
DRD1R5	Ryton ²	Convertible	Platinum	70°C (158°F)
DRD1R6	Ryton ²	Convertible	Gold	70°C (158°F)
DRS5	Stainless Steel	Immersion	Platinum	50°C (122°F)

¹Polyetheretherketone ²Polyphenylene Sulfide

Digital Gateway

6120500 Digital Gateway, convert pHD analog sensors to digital output for connecting to SC1000 digital controller

pHD Analog Sensors

All analog sensors include built-in preamplifier and integral 4.5 m (15 ft.) cable terminated with stripped and tinned wires.

pH Sensors

Prod. No.	Body Material	Body Style*	Electrode Material	Max Temp
PD1P1	PEEK ¹	Convertible	Glass, General Purpose	95°C (203°F)
PD1P3	PEEK ¹	Convertible	Glass, HF-resistant	95°C (203°F)
PD2P1	PEEK ¹	Insertion	Glass, General Purpose	95°C (203°F)
PD3P1	PEEK ¹	Sanitary	Glass, General Purpose	95°C (203°F)
PD1R1	Ryton ²	Convertible	Glass, General Purpose	95°C (203°F)
PD1R3	Ryton ²	Convertible	Glass, HF-resistant	95°C (203°F)

¹Polyetheretherketone ²Polyphenylene Sulfide

ORP Sensors

Prod. No.	Body Material	Body Style*	Electrode Material	Max Temp
RD1P5	PEEK ¹	Convertible	Platinum	95°C (203°F)
RD1P6	PEEK ¹	Convertible	Gold	95°C (203°F)
RD2P5	PEEK ¹	Insertion	Platinum	95°C (203°F)
RD1R5	Ryton ²	Convertible	Platinum	95°C (203°F)
RD1R6	Ryton ²	Convertible	Gold	95°C (203°F)

¹Polyetheretherketone ²Polyphenylene Sulfide

*Definitions of body styles:

- Convertible – 1-inch NPT threads at both ends, designed for tee-mounting or other flow through mountings, and pipe mounting for immersion
- Insertion – no threads on the electrode end, designed for use with insertion valve assembly
- Sanitary – 2-inch flange for a tri-clover style fitting
- Immersion – used with chain mounting or pipe mounting

Continued on next page.

Ordering Information *continued***pHD sc Digital and pHD Analog Sensor Accessories****Cables**

Extension cables are used only with digital sensors or digital gateways when connecting to an SC Digital Controller.

6122400	Digital Extension Cable, 1 m (3.2 ft.)
5796000	Digital Extension Cable, 7.7 m (25 ft.)
5796100	Digital Extension Cable, 15 m (50 ft.)
5796200	Digital Extension Cable, 31 m (100 ft.)

Interconnect cables are used only with analog sensors, junction box, and controller.

1W1100	Analog Interconnect Cable, order per foot
---------------	---

Digital Termination Box

Required when the cable between the sensor/gateway and SC Digital Controller is 100 m (328 ft.) to 1000 m (3280 ft.)

5867000	Digital Termination Box
----------------	-------------------------

Analog Junction Box

Required when the cable between the analog sensor and controller is greater than standard sensor cable. Includes terminal strip and gasket.

60A2053	Junction Box, Surface-mount, aluminum (includes mounting hardware)
60A9944	Junction Box, Pipe-mount, PVC (for 1/2-inch diameter pipe, includes mounting hardware)
60G2052	Junction Box, Pipe-mount, PVC (for 1-inch diameter pipe, includes mounting hardware)
76A4010-001	Junction Box, NEMA 4X (no mounting hardware included)

Salt Bridges

The double junction salt bridge on the standard cell of all Hach pHD sensors is field-replaceable.

SB-P1SV	PEEK Sensor and Salt Bridge Body, Kynar (PVDF) Outer Junction
SB-P2SV	PEEK Sensor and Salt Bridge Body, Ceramic Outer Junction
SB-P1SP¹	PEEK Sensor and Salt Bridge Body, Kynar (PVDF) Outer Junction
SB-R1SV	Ryton Sensor and Salt Bridge Body, Kynar (PVDF) Outer Junction

¹Special perfluoroelastomer O-ring in place of the Viton® O-ring

pHD Sensor Reagents and Standards

25M1A1025-115	Standard Cell Solution, 500 mL
25M8A1002-101	Gel Powder, for high temperature applications, 2 g

pH Buffers

2283549	pH 7, 500 mL (1 pint)
2283449	pH 4, 500 mL (1 pint)
2283649	pH 10, 500 mL (1 pint)

ORP Reference Solutions (in resealable plastic bottles)

25M2A1001-115	200 mV 500 mL (1 pint)
25M2A1002-115	600 mV 500 mL (1 pint)

Mounting Hardware for pHD sc Differential Sensors**Sanitary Mount**

MH018S8SZ 316 SS
Includes 2-inch sanitary tee and heavy-duty clamp. Cap and EPDM compound gasket supplied with sensor; can be ordered separately.

Union Mount

6131300 CPVC
6131400 316 SS
Includes standard 1-1/2 inch tee, union pipe with adapter, sealing hub, and lock ring and Viton® O-ring.

Flow-through Mount

MH334N4NZ CPVC
MH314N4MZ 316 SS
Includes a standard 1-inch tee in respective material.

Insertion Mount

<i>Digital</i>		<i>Analog</i>	
5646300	CPVC	5646400	CPVC
5646350	316 SS	5646450	316 SS

Includes a 1-1/2 inch ball valve, 1-1/2 inch NPT close nipple, sensor adapter with two Viton® O-rings and wiper, extension pipe, pipe adapter, back tube, and lock ring.

Immersion Mount**Standard Hardware**

<i>Digital</i>		<i>Analog</i>	
6136400	CPVC	MH434A00B	CPVC
6136500	316 SS	MH414A00B	316 SS

Includes 1-inch by 4 ft. pipe and 1-inch x 1-inch NPT coupling. (Pipe-mount junction box with terminal strip included in analog hardware.)

Handrail Hardware

MH236B00Z CPVC
Includes 1-1/2 inch by 7.5 ft. CPVC pipe, and swivel/pivot/ pipe clamp assembly.

Chain Mount Hardware

2881900 316 ss
Includes stainless steel bail, nuts, and washers. Does not include chain. To be used with stainless steel immersion sensor only.

Ball Float Hardware

6131000 CPVC
Includes 1-1/2 inch by 7.5 ft. CPVC pipe, ball float assembly, and swivel/pivot/ pipe clamp assembly.

HACH COMPANY World Headquarters: Loveland, Colorado USA

United States:	800-227-4224 tel	970-669-2932 fax	orders@hach.com
Outside United States:	970-669-3050 tel	970-461-3939 fax	int@hach.com

hach.com

LIT2467 Rev 3

A13 Printed in U.S.A.

©Hach Company, 2013. All rights reserved.

In the interest of improving and updating its equipment,

Hach Company reserves the right to alter specifications to equipment at any time.



Be Right™