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CITY OF SUNNYVALE

MASTER PLAN AND PRIMARY TREATMENT DESIGN

TECHNICAL MEMORANDUM

PRELIMINARY TREATMENT:
MASTER PLAN

FINAL
March 2014

carollo
in association with HDR

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CITY OF SUNNYVALE

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TECHNICAL MEMORANDUM

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1.0 INTRODUCTION

This technical memorandum (TM) presents an analysis and selection of process alternatives for preliminary treatment at the City of Sunnyvale's (City's) Water Pollution Control Plant (WPCP). The selected preliminary treatment processes proposed for the WPCP are based on providing the needed improvements through buildout (2035) to meet the City's goals and objectives. The recommendations presented herein are an update to and expansion of the recommendations included in the City's WPCP Strategic Infrastructure Plan (SIP).

The evaluation was completed using a two step process: (1) a one week internal peer review was held on September 9th through 12th, 2013 which was attended by process experts from the Carollo/HDR team and (2) a two-day workshop on October 14th and 15th, 2013, during which time the Carollo/HDR team presented the recommended liquid and solids treatment processes to the City staff. The key findings and recommendations developed for the preliminary treatment process are summarized in this TM, as well as in the October workshop meeting minutes and presentation slides included in Appendix A.

2.0 SUMMARY OF FINDINGS AND RECOMMENDATIONS

The key findings and recommendations for the preliminary treatment process include:

- All structures required for preliminary treatment should be designed to accommodate the 2035 peak hourly flow of 58.5 mgd. Equipment would be sized to handle the flow range between the minimum diurnal flow and the 2035 peak hourly flow. Equipment would be sized and/or installed in phases to accommodate flows as they increase. Equipment sizing and phasing would be determined during preliminary design of the Primary Treatment Facility.
- Screening:
  - Implement screening upstream of influent pumping.
  - Provide a screen clear opening of 3/8-inch.
  - Implement either chain-driven multi-rake or catenary bar screens.
  - City staff should visit installations of both types of screens to determine staff preferences. The approach for selection of screen technology would be determined during the preliminary design of the Primary Treatment Facility.
- Screenings Handling:
  - Implement a shaftless screw conveyor(s) to convey screenings from the screens to the washer/compactors.

  - Implement auger washer/compactors with sprays for screenings washing/compacting.
- Influent Pumping:
  - Implement a dual, rectangular wet well pump station with a dry pit for influent pumping (Pump Station Configuration Alternative 4).
  - Implement either vertical non-clog centrifugal pumps or non-clog dry pit submersible pumps, to be determined during the preliminary design of the Primary Treatment Facility.
- Grit Removal:
  - Implement a Eutek HeadCell® system for grit removal. Design the system for target removal of grit particles with a settling velocity greater than 0.85 cm/s.
  - The grit removal system would have a hydraulic capacity of 58.5 mgd with one unit out of service and a grit removal design capacity of 40 mgd, with all units in service. The hydraulic capacity corresponds to the projected 2035 peak hourly flow. The grit removal capacity corresponds to the projected 2035 peak day flow and is approximately twice the ultimate average design flow rate.
- Grit Handling:
  - Implement flooded-suction, recessed impeller grit pumps to convey grit from the grit removal system to the grit handling facility.
  - As part of the preliminary design of the Primary Treatment Facility, determine the level of grit particle removal that can be effectively achieved with COANDA® grit washers.
  - Implement COANDA® grit washers for grit washing/dewatering if they can provide adequate removal of the grit anticipated from the HeadCell® unit. If not, a cyclone/grit classifier would be implemented for grit washing/dewatering.
- Odor Control:
  - Provide a single, package-type bioscrubber system to treat odors collected from both the preliminary and primary treatment processes.
  - Locate the odor control system near the preliminary and primary treatment processes to minimize foul air duct runs.
  - Include the following provisions to adequately contain and exhaust odors generated at the preliminary treatment facility:
    * Cover and enclose all channels, screens, wet wells and grit basins (include provisions for corrosion protection for all covered areas).
    * Install exhaust fans to extract enough air from the covered and enclosed areas to prevent fugitive emissions and convey it to the odor control system.

* Install a ventilation system for areas that will be accessed by personnel to provide proper ventilation required for worker safety.

Table 1 summarizes how these recommendations (the Master Plan recommendations) compare with the SIP recommendations. The subsequent sections of this TM summarize the rationale for the Master Plan recommendations. These sections also include explanation as to why some SIP recommendations are no longer recommended for further consideration.

Table 1 Comparison of Master Plan and SIP Recommendations
Master Plan and Primary Treatment Design
City of Sunnyvale

Process/ Technology	Strategic Infrastructure Plan (SIP) (2011)	Master Plan (2014)
Screening	• Implement screening upstream of influent pumping • Implement screens with 3/8" openings	• Same as SIP • Same as SIP • Implement chain-driven multi-rake or catenary bar screens
Screenings Handling	• Implement a washer/compactor system that would remove organic material, reduce odors, and wash and compact the screenings	• Same as SIP
Influent Pumping	• Implement a pump station with a single, trench-style, self-cleaning wet well • Provide enough capacity to pump the projected buildout peak hourly influent flow with the largest pump out of service. • Provide variable speed pumps • Provide vertical turbine solids handling (VTSH) pumps	• Implement a dual, rectangular wet well pump station with a dry pit • Same as SIP • Same as SIP • Provide either vertical non-clog centrifugal pumps or non-clog dry pit submersible pumps. Vertical non-clog centrifugal pumps are preferred particularly if the pumps can be implemented with a single drive shaft (not a two-piece drive shaft with an intermediate bearing).
Grit Removal	• Implement new aerated grit basins to replace the existing aerated grit basins	• Implement a Eutek HeadCell® system for grit removal

Table 1	Comparison of Master Plan and SIP Recommendations Master Plan and Primary Treatment Design City of Sunnyvale	
Process/ Technology	**Strategic Infrastructure Plan (SIP) (2011)**	**Master Plan (2014)**
Grit Removal (Cont.)	• Provide enough capacity to treat the maximum day flow with one unit out of service	• Provide enough hydraulic capacity to accommodate the peak hourly flow with one unit out of service • Provide enough capacity to treat the maximum day flow with all units in service
Grit Handling	• Implement a fluidized bed grit washing/dewatering system for grit washing and dewatering	• Same a SIP • Implement COANDA® grit washers for grit washing/dewatering
Odor Control	• Provide cost allowance (based on cost model) for odor control measures at preliminary treatment process including covering and ventilating influent pump station, screening channels, and grit removal tanks and treating odorous air from the grit removal tanks.	• Contain and treat odors generated at the preliminary and primary treatment facilities with one common, package-type bioscrubber system.

3.0 SIP RECOMMENDATIONS

The SIP included the recommendation to replace the existing headworks process with a new headworks process at a new location on the existing WPCP site. The SIP recommendations for the new headworks process are summarized below and described in greater detail in the Headworks and Primary Sedimentation Upgrades Alternatives Evaluation TM of the SIP.

3.1 Screening and Screenings Handling

It was recommended the new screening and debris removal system consist of mechanically cleaned screens that remove large debris from the process and convey it to a washer compactor system. The screens would be located in deep channels upstream of the influent pump station. The screens would have a clear opening of 3/8-inch and would provide continuous and automatic removal of screenings. The washer/compactor system would remove organic matter, reduce odors, and wash and compact the screenings for disposal offsite.

3.2 Influent Pumping

It was recommended the influent pump station be a single, trench-style, self-cleaning wet well type pump station that would collect and lift the screened wastewater to the grit removal process. The pump station would include variable speed vertical turbine solids handling pumps that have the capacity to handle peak hour influent flows projected for 2035, as defined in the Flow and Loads TM of the SIP. Site space would be preserved to allow for potential expansion of the pump station with the addition of pump bays to accommodate the ultimate influent flow that would occur beyond 2035. Provisions for easy maintenance of the wet well and process equipment would be included.

3.3 Grit Removal and Grit Handling

It was recommended the new aerated grit basins be constructed to separate and collect grit material, and a fluidized bed grit washing and dewatering process be implemented to clean and dewater grit for disposal offsite. The new grit basins would be optimally configured to promote separation and collection of grit material. They would have steeply sloped floors, grit slurry pump suction pits, and be supplied with aeration air. Flooded-suction grit slurry pumps would convey grit to the grit washing/dewatering process.

It was recommended that redundant tankage and processing equipment be provided such that maximum day flow rates could be processed with one unit out of service. This design criteria is more conservative than what is typically used for grit removal facilities. Grit removal facilities must be sized to hydraulically accommodate peak hour flows with one unit out of service; however, they typically do not include a standby unit for process capacity. With a typical grit removal facility, grit removal would decrease if one unit were out of service during peak hour flows; however, the decrease would not have a significant negative impact on downstream treatment processes.

4.0 SCREENING

Screenings removal at the front end of a wastewater treatment plant greatly improves reliability and reduces maintenance of downstream facilities. Effective screenings removal will help prevent clogging of pumps and pipelines, reduce buildup of rags on mechanical equipment such as mixers and sludge collection mechanisms, reduce accumulation of materials in downstream channels, and otherwise significantly decrease many of the existing regular maintenance activities downstream of the headworks.

This section summarizes the recommended preliminary design criteria for the screening process, an evaluation of screening technology alternatives, implementation and site considerations and recommendations for the new screening process.

4.1 Background

This section summarizes the key design criteria considered and established for the screenings process in order to develop and evaluate screening technology alternatives.

4.1.1 Screening Upstream of Pumping

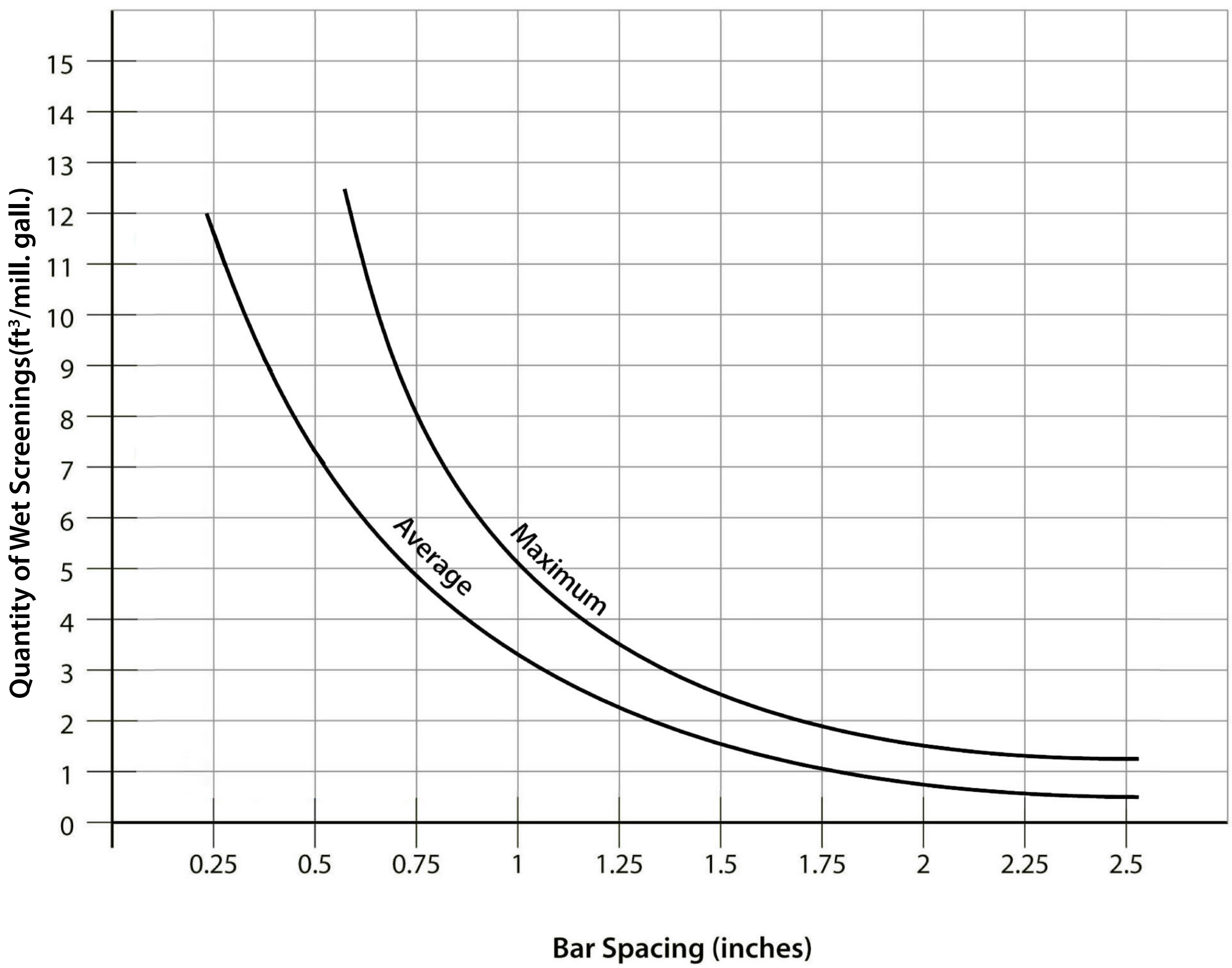
It is recommended that the screening process be located upstream of the influent pump station. This requires constructing a screening structure that is deep enough to receive the influent flow, which enters the WPCP by gravity at 30± feet below finished grade. The screens must have the ability to convey screenings up to finished grade, where they can be further processed prior to offsite disposal. Alternatively, if the screening process were located downstream of the influent pump station, the influent pump station could lift the influent flow to a screening structure located above grade.

Screening facilities are commonly located upstream of influent pump stations. Although it is more expensive to construct a deep screening structure than one located at grade, locating the screens upstream of the influent pump station protects the pumps from rags and large debris and reduces the likelihood of pump failure. Given the influent pump station is a critical facility that must function at all times, reducing the likelihood of pump failure is a significant benefit and worth the additional capital cost. The additional capital cost is also offset by reduced maintenance costs associated with the influent pumps. Providing greater protection for the pumps also provides more flexibility in the type of influent pump that can be implemented. This recommendation is consistent with numerous other similar screening installations throughout the Western U.S.

4.1.2 Screening Opening Size and Level of Capture

Selecting an opening size is important in establishing the design criteria for the screenings facilities. Screen opening size impacts screenings removal efficiency, dictates the size of screens, and affects plant hydraulics.

Figure 1 illustrates how level of screenings capture increases with smaller clear screen openings. Based on Carollo/HDR's experience, the capture rates indicated in this graph are higher than typical values for sanitary sewers in the western United States (specifically those that are separate from storm sewer systems). However, the graph correctly reflects a sharp increase in removal rates that is experienced as screen openings decrease below 3/4-inch. Table 2 describes the levels of capture normally achieved with screen bar spacing most commonly implemented at municipal wastewater treatment facilities. Smaller opening sizes (or closer bar spacing) remove more solids; however, smaller openings are more susceptible to blinding. Smaller openings also capture more organic material, which increase washing requirements and increase the risk of odor generation.



Screenings Capture

Source: Design of Municipal Wastewater Treatment Plants,
Fourth Edition, WEF Manual of Practice, Volume 2.

Figure 1
SCREENINGS REMOVAL VOLUME AS
A FUNCTION OF BAR SPACING
PRELIMINARY TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

Table 2 Screen Bar Spacing and Level of Capture Master Plan and Primary Treatment Design City of Sunnyvale		
Screen Bar Spacing, inches	**Level of Capture (1)**	**Operations and Maintenance Impacts (1)**
1/2”	• Removes rags and trash	• Less prone to blinding than finer screens
3/8”	• Removes most plastics and some disposable wipes • Removes some organics	• Some screenings washing recommended
1/4”	• Removes most plastics and disposable wipes • Removes a lot of organics	• High-level of screenings washing recommended • Screenings generate odors
Notes: (1) General guidelines. Capture and O&M impacts vary from facility to facility.		

Removing more solids provides greater protection of downstream equipment and reduces downstream maintenance. Potential reductions in maintenance include reduced ragging of downstream pumps including influent pumps, primary sludge pumps, digester mixing pumps, and heat exchangers. Removing inert material at the headworks also reduces the buildup of inert material in the digesters, reducing the frequency of digester cleaning. Removing plastic material at the headworks reduces plastic material in the solids stream and improves the quality of biosolids for reuse. Use of 1/4-inch screens does provide for greater removal of disposable wipes, which are increasingly prevalent in municipal wastewater and can clog pumps. However, these screens also remove significantly more organic material, which require larger screenings handling and odor control facilities, and increased operations and maintenance (O&M) attention at the headworks. .

The current industry trend is to install screens with 3/8-inch or 1/4-inch openings in order to capture a sufficient amount of solids at the headworks and reduce downstream maintenance costs. Table 3 summarizes the clear screen opening of screens installed at neighboring WWTPs.

It is recommended that 3/8-inch screens be implemented at the WPCP. Given the existing WPCP does not have any screens, it is anticipated that implementing 3/8-inch screens will provide a significant improvement in process performance and reduction in downstream maintenance demands, while limiting the increase in maintenance at the headworks to a reasonable level. The screens should provide removal of most plastics and rags, which can cause equipment plugging and damage.

Table 3	**Screening Installations at Northern California WWTPs Master Plan and Primary Treatment Design City of Sunnyvale**
WWTP	**Clear Screen Opening, inches**
Chico	1/4”
Dublin San Ramon	3/8”
EBMUD	1/4”
Millbrae	1/4”
Palo Alto	3/4”
Sacramento Regional	1/2”
Salem	3/8”
San Jose	3/4”
San Leandro	3/8”
SFPUC Northpoint	3/8”
SFPUC Oceanside	3/8”
West County Wastewater District	5/8”

Although screens with bar spacing less than 3/8 inch can be provided, such smaller spaced screens tend to capture a disproportionally high amount of organic material, which is not desirable. Excessive organics in screenings generate a high level of odors and require larger, more complex screenings handling systems. Such systems are higher in capital costs, more mechanically intensive, require more operator attention, and require a higher level of maintenance than screenings handling systems for larger spaced screens.

4.2 Technologies Considered

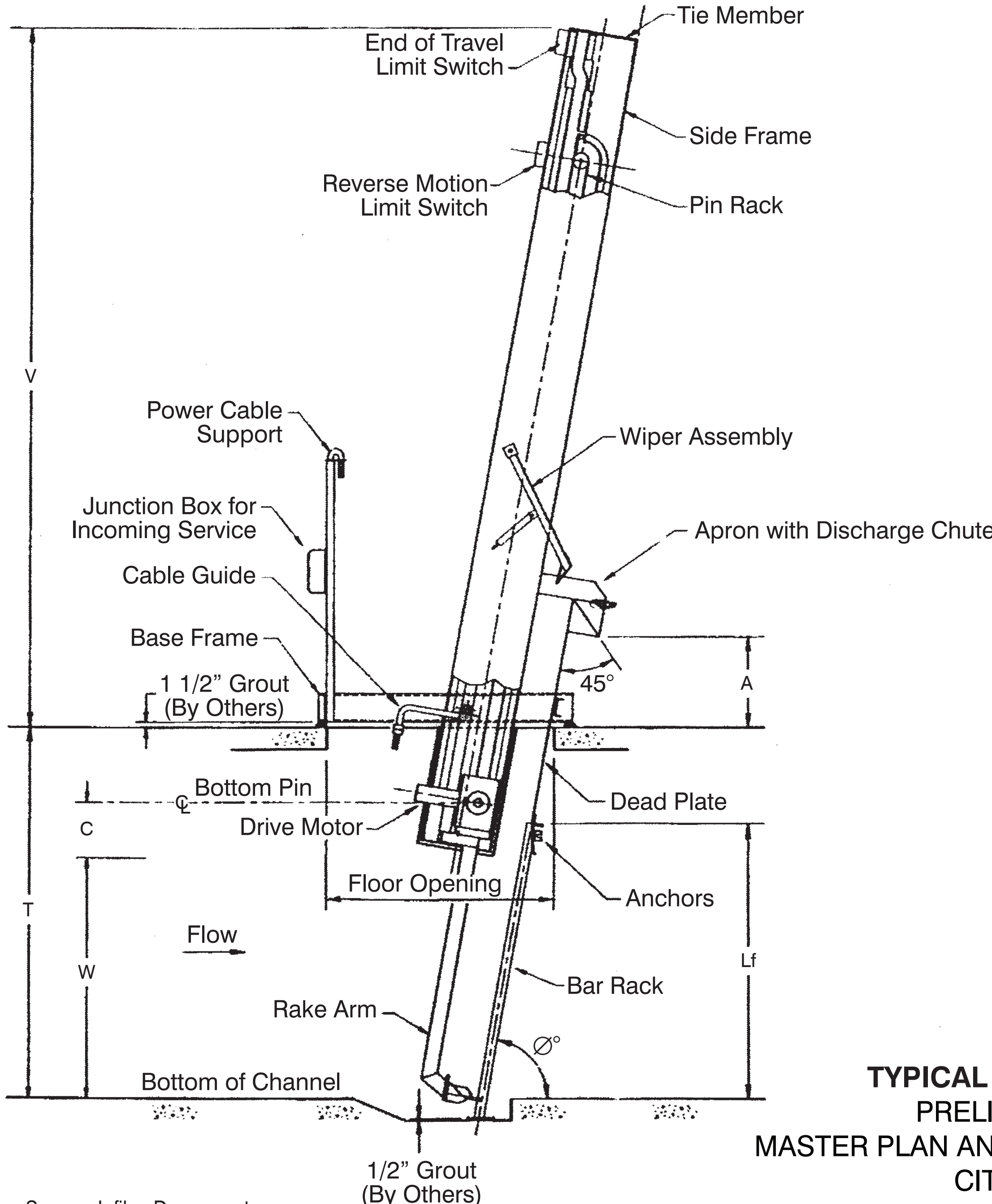
4.2.1 <u>Alternative Technologies</u>

To select the best available technology for the proposed headworks facility, a number of screening technologies were initially evaluated and discussed with City staff, including:

- Climber bar screen.
- Chain-driven multi-rake screen.
- Catenary bar screen.
- Step screen.

4.2.1.1 Climber Bar Screen

Figure 2 shows a typical climber bar screen. Climber screens have a reciprocating rake mechanism that maintains all drive components out of the flow stream under normal



Source: Infilco Degremont

Figure 2
TYPICAL CLIMBER BAR SCREEN
PRELIMINARY TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

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operating conditions. When a cleaning cycle is initiated, the cogwheels, housed in the frame of the bar screen, move down stationary pin racks, also housed in the frame. The drive assembly descends from its stopped position with the rake arm extended. When the cogwheels reach the bottom, they rotate around the bottom of the pin rack, engaging the rake teeth with the bar rack. As the cogwheels walk back up the pin racks, the screenings are carried out of the wastewater flow and are discharged to screenings conveyance equipment or bins located behind the bar screen. Climber screens are a proven and reliable technology with many successful installations.

The overall height of a climber-type bar screen is determined by both the channel depth and the height of the discharge point above the operating floor. This can result in screens that are tall and therefore more difficult to maintain. Some options to minimize the height of climber screens are to specify motors or motor housings that allow the drive to be submerged and to minimize the height of the discharge point.

The minimum recommended bar spacing for climber screens is 3/8 inch. At spacing below this dimension, the rake may experience difficulty engaging the bar rack and the rake teeth may be damaged.

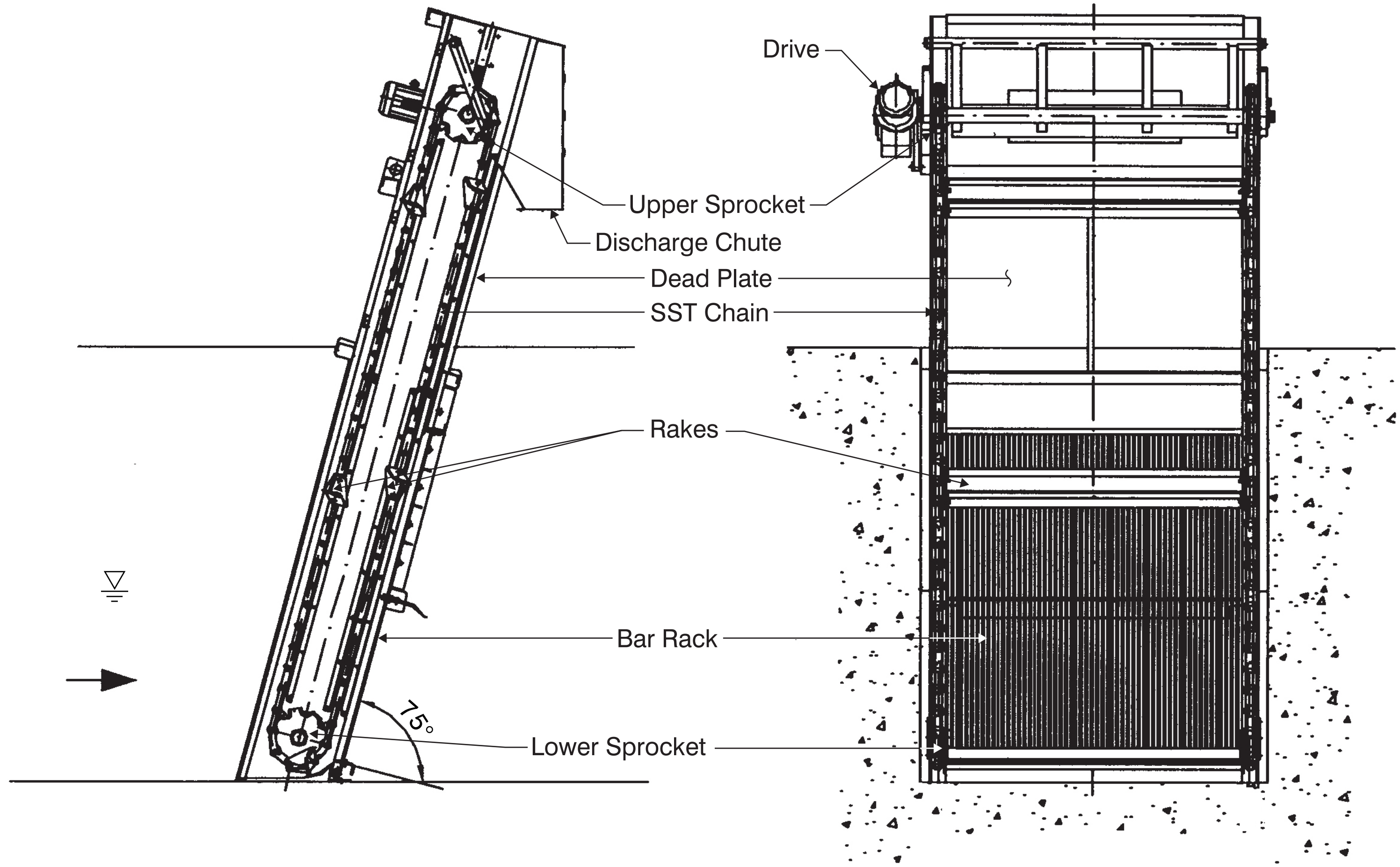
4.2.1.2 Chain-Driven Multi-Rake Screen

Figure 3 shows a typical chain-driven multi-rake screen. These screens are chain-and-sprocket-type bar screens with multiple rake bars mounted onto chains on both sides of a self-contained frame. All of the chain-driven multi-rake screen manufacturers that Carollo/HDR would recommend have a screen design that includes a lower sprocket assembly located in a recess at the bottom of the frame. The bearings for the lower sprockets are made of self-lubricating polyethylene material with a ceramic collar bonded onto the sprocket stub shaft. The all stainless steel chains are roller-type, water lubricated, and designed for continuous submerged duty.

The screens are configured so the rakes clean and return in front of the bar rack to prevent carry over of material to the downstream channel. A two-speed drive can be provided so that raking speed can be increased to accommodate high flows or high volumes of screenings in the influent flow stream. The features of this type of screen make it capable of accommodating smaller bar rack spacing (down to 1/4 inch) than climber screens.

4.2.1.3 Catenary Bar Screen

Catenary bar screens considered for this project are manufactured by a single manufacturer (Duperon). Figure 4 shows a typical Duperon FlexRake screen. Similar to chain driven multi-rake screens, this type of screen is also a front raked, front return type screen with multiple rake bars mounted onto chains on both sides of the channel. However, there are no lower sprockets and the parallel chains serve as their own frame. The chains



Source: Headworks, Inc.

Figure 3
TYPICAL CHAIN-DRIVEN MULTI-RAKE SCREEN
PRELIMINARY TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
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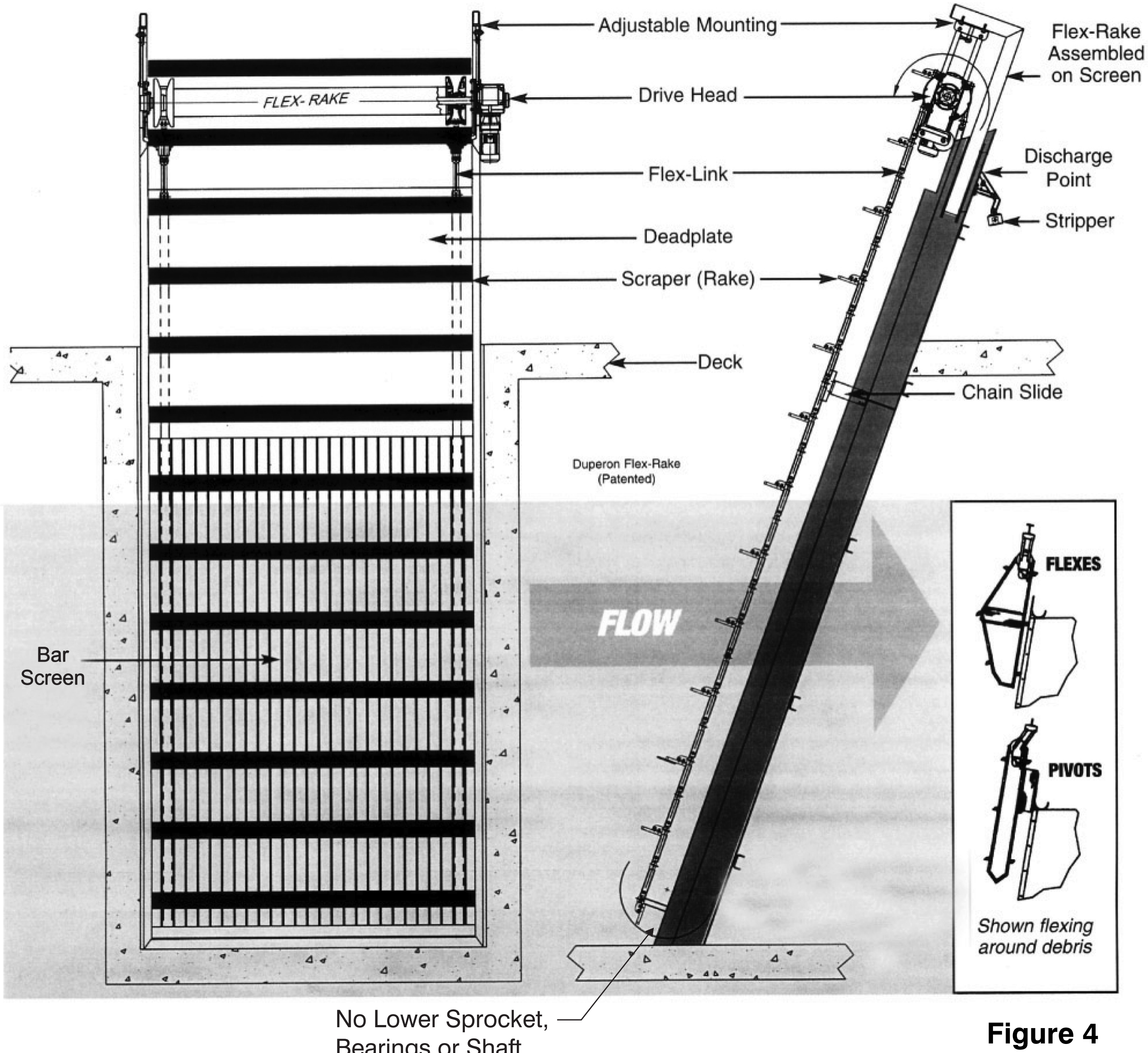

Figure 4
CATENARY BAR SCREEN - DUPERON FLEX-RAKE SCREEN
PRELIMINARY TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

Source: Duperon

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are constructed from 316 stainless steel castings that form a bar-like chain that bends in only one direction, providing both flexibility and rigidity.

4.2.1.4 Step Screen

A step screen includes a series of steps that span from the top of channel to the bottom and include a movable lamella. Figure 5 shows a typical step screen. Screenings collect on the steps and form a carpet. The moveable lamella unit is then rotated periodically to lift and transport the complete screenings carpet to the next step. Step screens can provide excellent capture of screenings, are self-cleaning, and can have opening sizes as small as 1/8-inch. They also include submerged moving parts, generate high headloss, and can be misaligned if debris catches in the lamella. Step screens are typically suitable for a maximum channel depth of about 20 feet.

4.2.2 Fatal Flaw Screening

Based on an initial pre-screening conducted during the internal peer review held in September, it was decided that climber bar screens and step screens would not be considered further for a number of reasons. Climber bar screens were eliminated because the combination of a small bar spacing and long rake cycle time is problematic for deep headworks. These screens are also taller than the other screen types and therefore more difficult to maintain and enclose for odor control. The step screens were eliminated because they are suitable for channel depths of about 20 feet and the screening facility required at the WPCP will be 30± feet deep.

The internal peer-review team recommended further evaluation of the chain-driven multi-rake screen and the catenary bar screen.

4.3 Alternative Analysis

Table 4 summarizes the key advantages and disadvantages associated with the chain-driven multi-rake bar screen and the catenary bar screen. Table 4 summarizes how each screen meets the City's evaluation criteria for the Master Plan, which is described further in the SIP Validation TM.

As summarized in Table 5, during the internal peer review in September and the workshop held in October, it was determined both types of screens are adequate. The overall design of the screening facility can easily accommodate both types of screens. Given this, it is recommended that City staff visit installations of both types of screens and further determine staff preferences. The screen technology should be selected during the preliminary design of the Primary Treatment Facility Project based on staff preferences.

Figure 5
TYPICAL STEP SCREEN
PRELIMINARY TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

Table 4 Summary of Advantages and Disadvantages of Screening Alternatives
Master Plan and Primary Treatment Design
City of Sunnyvale

Alternative	Advantages	Disadvantages
Chain Driven Multi-Rake Screens	• Most maintenance can be done above the channel • Easy to cover for odor control • Multiple rakes and two-speed drive increases screenings removal capacity. • Includes automatic jam protection system • Larger bars are more resistant to bending • Multiple manufacturers	• Bottom sprockets require occasional channel entry for inspection and maintenance
Catenary Bar Screens	• No lower sprockets in channel • Maintenance can be done above the channel • Easy to cover for odor control • Pivots around large objects (allowing screen to remain in service)	• Material hangs up on chain and drive shaft, requiring weekly cleaning • Fewer rakes with spacers and lower operating speeds decrease screenings removal capacity • Smaller bars are more prone to bending • Pivots around large objects (allowing debris to accumulate) • Sole source procurement is required • Design is still evolving for screens with openings of 1/2” or smaller

Table 5	Evaluation Summary of Screening Alternatives Master Plan and Primary Treatment Design City of Sunnyvale	
Evaluation Criteria	**Chain Driven Multi-Rake Screens (1)**	**Catenary Screens (1)**
Reliability	0	0
Ease of O&M		
Routine O&M	+	-
Confined Space Entry	-	0
Power Usage	0	0
Site Efficiency	0	0
Number of Manufacturers	+	-
Cost	0	0

Notes:
(1) Legend: + Better; 0 Neutral; - Worse.

Based on Carollo/HDR's experience, the capital and O&M cost (i.e., lifecycle cost or net present value) of both types of screens is anticipated to be about the same.

4.4 Implementation Considerations (Phasing)

The screening facility should be sized to treat the 2035 peak hourly flow, 58.5 mgd. The entire screening structure required for 2035 flows would be constructed in one phase as part of the Primary Treatment Facility Project. Carollo/HDR will review whether equipment can be installed in phases during preliminary design.

4.5 Site Considerations

The following site considerations should be considered when determining the site layout and design of the screening facility:

- The screening facility must be designed for personnel entry.
- The screening facility should include provisions for odor control, including covers for the screening channels to contain odors.
- The screening facility should include provisions for corrosion protection. For example, concrete surfaces exposed to high levels of hydrogen sulfide may be provided with a polyvinyl chloride (PVC) liner or coated with protective coatings. Recommended measures for corrosion protection will be determined in detail during the final design of the Primary Treatment Facility Project.

- Adequate truck and crane/equipment access must be provided for operations and maintenance. Screenings would be regularly loaded into a truck and hauled offsite for disposal.

4.6 Findings/Recommendations

The findings and recommendations for the screening process include:

- Implement screening upstream of influent pumping to protect the influent pumps from rags and large debris.
- Provide a screen clear opening of 3/8-inch. This size opening removes most plastics and does not typically require a high level of washing of screenings.
- Implement either chain-driven multi-rake or catenary bar screens. These screening technologies are proven, reliable, applicable for deep screening facilities, and provide high screenings removal capacity.
- City staff should visit installations of both types of screens to determine staff preferences. The approach for selection of screen technology would be determined during the preliminary design of the Primary Treatment Facility.

5.0 SCREENINGS HANDLING

The screenings handling process is comprised of screenings conveyance and screenings washing and dewatering.

This section summarizes the recommended preliminary design criteria for the screenings handling process, an evaluation of technology alternatives, implementation and site considerations, and recommendations for the new screenings handling process.

5.1 Screenings Conveyance

Screenings conveyance is required to collect screenings from the bar screens and convey them to the screenings washer/compactor system for washing and dewatering. Conveyance technologies include belt conveyors, hydraulic sluiceways and shaftless screw conveyors.

Hydraulic sluiceways are not recommended because they require a high amount of flushing water, and require use of a screenings washing technology that can handle large volumes of water. Sluiceways typically require 300 to 400 gpm of clean, chlorinated flush water to convey screenings properly. Although this flow would be used in a screening washing process, it would then need to be returned to the influent flow stream and re-routed through the plant process. By comparison, a typical washer/compactor fed by a screw or belt conveyor would consume approximately 10 to 20 percent of the volume of water needed in a sluiceway application.

Belt conveyors are a relatively simple, reliable technology and have a long successful history in this application at numerous wastewater plants. Recently however, belt conveyors have fallen out of favor due to nuisance considerations. Belt conveyors require more housekeeping by O&M staff. Screenings material placed on a conveyor belt is more difficult to contain and can spill over the sides of the conveyor. Odor control is more complex and costly for a belt conveyor as well. Given typical belt conveyors are open to the atmosphere, custom covers need to be designed to enclose the belts to contain and exhaust odors. The covers must also be designed to allow adequate access to the belts for operations and maintenance. Therefore, belt conveyors are not recommended for use at the WPCP.

Shaftless screw conveyors are recommended for screenings conveyance because the technology is relatively simple, proven, and reliable for this application. A shaftless screw conveyor, which is shown in Figure 6, consists of a hardened steel spiral installed in a stainless steel U-trough and driven by a motor and gearbox. The spiral rests on a replaceable ultra-high molecular weight polyethylene liner in the bottom of the U-trough. The screw conveyor is provided with removable stainless steel covers that completely enclose the screenings, containing the odors and preventing material from spilling out of the conveyor.

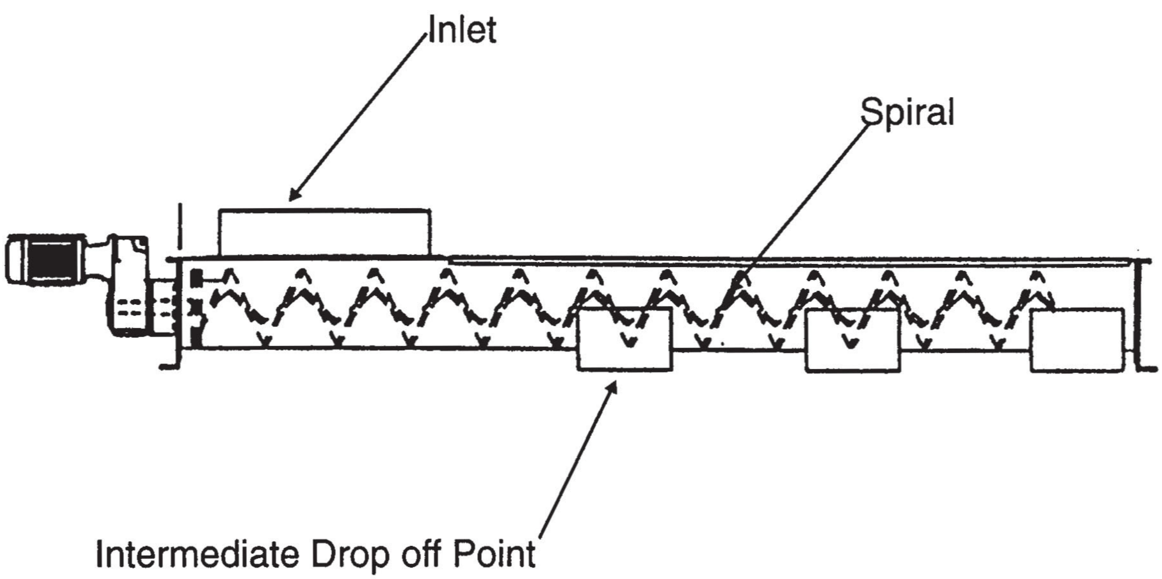
5.2 Screenings Washing/Compaction

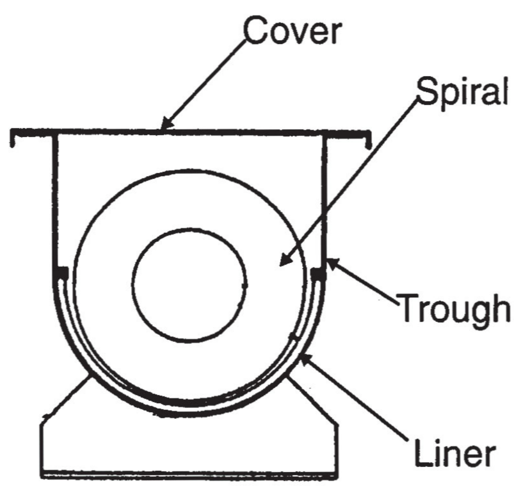
Screenings removed by the bar screens must be washed and compacted prior to being discharged into storage bins for disposal offsite. As discussed above, in addition to rags and inert material, the screens will removal fecal and other organic matter that will generate odors if this material is not adequately washed from the inert screenings and returned to the process flow. In addition to reducing odors, lowering the organic content through washing will improve dewatering and reduce the weight and volume of the solids. Dewatering is required to reduce the weight and volume of the solids to reduce hauling and disposal costs.

5.2.1 Alternative Technologies

Screenings washing and dewatering can be accomplished in a single piece of mechanical equipment called a washer/compactor. Washer/compactors are available from several manufacturers and two basic types of units were evaluated; washer/compactors with water sprays and washer/compactors with agitators. Figure 7 shows examples of both types of equipment.

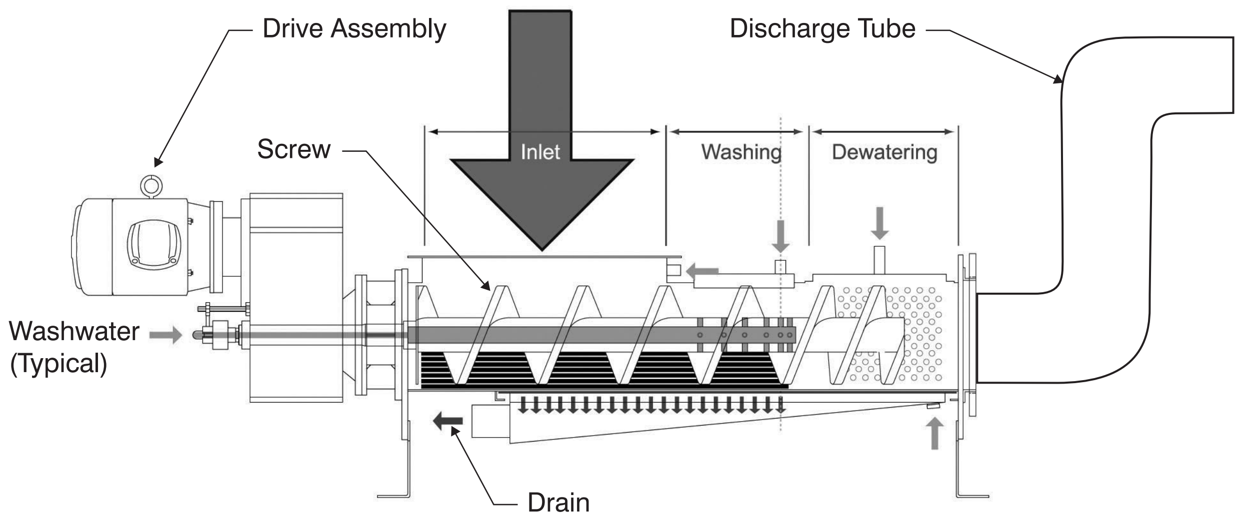
Dewatering of washed screenings in both types of units is accomplished with a screw compactor. A typical unit consists of a motor driven shafted or shaftless helical screw auger, a loading hopper, and discharge tube. Turning the auger pushes the wet screenings material from the loading hopper into the discharge tube, which is tapered for a short length. The reduction in the discharge tube diameter causes a squeezing action that removes the free water from the screenings material. The water drains out of the unit





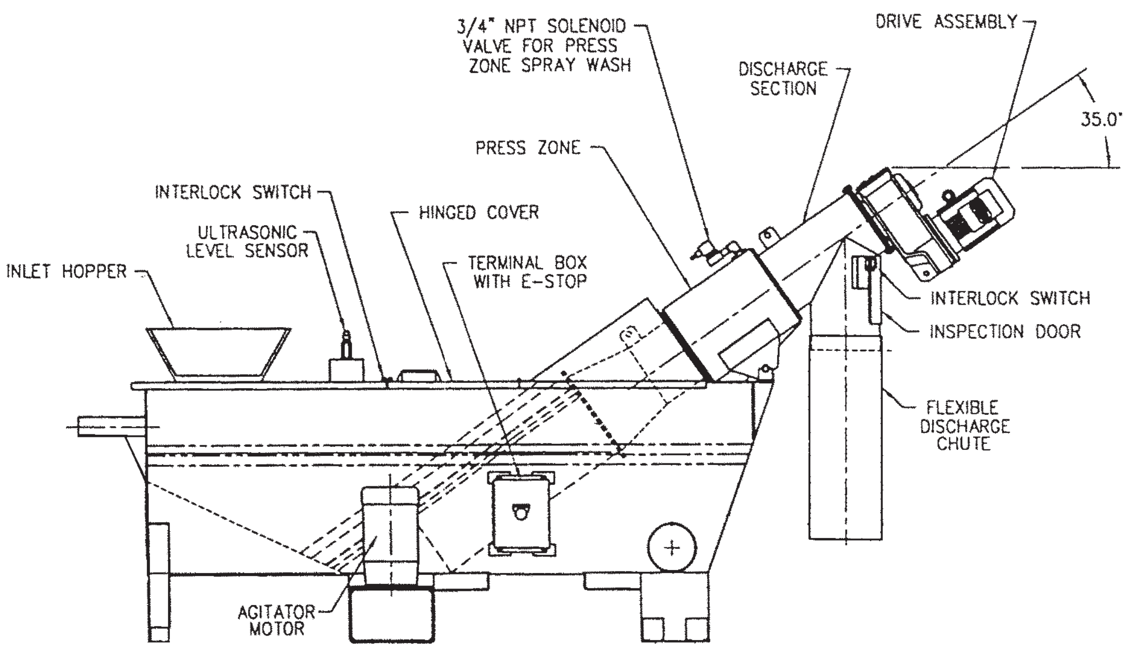
Source: American Bulk Conveying, Inc.

Figure 6
TYPICAL SHAFTLESS SCREW CONVEYOR
PRELIMINARY TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE



Washer/Compactor with Water Sprays

Source: Vulcan



Washer/Compactor with Agitator

Source: Hycor

Figure 7
TYPICAL WASHER/COMPACTORS
PRELIMINARY TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

through a perforated screen in the bottom of the unit and is returned to the flow stream for further treatment.

Washer/compactors that use water sprays typically apply high-pressure utility water to the sides of the compactor loading hopper and to the washing zone of the compaction unit. Some units also spray water from the center shaft of the auger. Water sprays have limited success in breaking up organic matter unless the washer unit also conducts a batch washing process where the auger cycles backwards and forwards a number of times to break the organic material apart. This type of equipment is capable of producing dewatered screenings material with a solids content of 30 to 40 percent.

Washer/compactors with in-tank agitators use mechanical agitation and a large volume of water to wash screenings. The loading hopper is first flooded with water in a batch process. The agitator breaks up the organic matter so that it can be carried out of the machine with the wash water through a fine perforated screen. The cleaned screenings material is then dewatered and discharged. Some of the more successful units are capable of reducing the weight and the volume of the raw screening by 50 to 80 percent and achieve a solids content in excess of 40 percent.

5.2.2 Alternative Analysis

Table 6 summarizes the key advantages and disadvantages associated with washer/compactors with water sprays and those with in-tank agitators. Table 6 summarizes how each washer/compactor meets the City’s evaluation criteria for the Master Plan, which is described further in the SIP Validation TM.

Based on the analysis summarized in Table 7, an auger washer/compactor with sprays that can operate in batch washing mode for screenings washing and dewatering is recommended. Based on our experience, the capital and O&M cost (i.e., lifecycle cost or net present value) of washer compactors with agitation washing is significantly higher than that of washer compactors with spray washing. Although washer/compactors with in-tank agitators may be able to produce cleaner screenings materials, washer/compactors with sprays are recommended because they: (1) have a lower capital cost; (2) include simpler control systems; (3) require a significantly lower degree of O&M attention; and (4) the final product is anticipated to be of good enough quality for disposal at a landfill (i.e., odors and vector attraction).

5.3 Implementation Considerations (Phasing)

The screenings handling facility should be sized to treat the 2035 maximum screenings load. This screenings load design criteria will be selected during final design of the Primary Treatment Facility Project. The entire screenings handling structure required for 2035 loads would be constructed in one phase as part of the Primary Treatment Facility Project. Carollo/HDR will review whether equipment can be installed in phases during preliminary design.

Table 6 Summary of Advantages and Disadvantages of Washer/Compactor Alternatives
Master Plan and Primary Treatment Design
City of Sunnyvale

Alternative	Advantages	Disadvantages
Washer/Compactor with Spray Washing	• Some units conduct batch washing cycle to improve washing performance • Simpler control system • Lower degree of O&M attention • Lower power usage • Lower capital cost • Multiple manufacturers	• Limited break up of organic material • Lower dewatered solids content
Washer/Compactor with Agitation Washing	• Produces cleaner, drier material • Solids content may exceed 40%	• More complicated controls • Higher degree of O&M attention • Higher capital cost • Sole source procurement may be required

Table 7 Evaluation Summary of Washer/Compactor Alternatives
Master Plan and Primary Treatment Design
City of Sunnyvale

Evaluation Criteria	Washer/Compactor with Spray Washing (Moderate Washing) (1)	Washer/Compactor with Agitation Washing (High Washing) (1)
Reliability	+	0
Ease of O&M		
Cleaner Product	-	+
Less Odors	-	+
O&M Labor and Cost	+	-
Power Usage	+	-
Site Efficiency	0	0
Number of Manufacturers	+	-
Cost	+	-

Notes:
(1) Legend: + Better; 0 Neutral; - Worse.

5.4 Site Considerations

The following site considerations should be considered when determining the site layout and design of the screening handling facility:

- The screenings handling facility would be located in close proximity to the screening facility to simplify and reduce the length of the screenings conveyor and minimize required operations and maintenance.
- The screenings handling facility would be co-located with the grit handling facility in an enclosed building with provisions for foul air collection and odor control.
- Truck access to the screenings storage bins would be provided.

5.5 Findings/Recommendations

The findings and recommendations for the screenings handling facility include:

- Implement a shaftless screw conveyor(s) to convey screenings from the screens to the washer/compactors as this technology is simple, proven, and reliable for screenings conveyance.
- Implement auger washer/compactors with sprays for screenings washing/compacting because the technology is relatively simple, low maintenance, and anticipated to provide adequate washing for material removed by 3/8-inch screens.

6.0 INFLUENT PUMPING

The influent pump station will lift screened wastewater to the grit removal process so the effluent can flow by gravity through the entire treatment process, from grit removal to disinfection and final discharge.

This section summarizes the recommended preliminary design criteria for the influent pump station, a description of pump station configurations, an evaluation of pump station configuration alternatives, implementation and site considerations, and recommendations for the new influent pump station.

6.1 Background

Regulatory considerations and implications, preliminary design criteria and the City’s general preferences on pump station configuration were established with City staff early on to develop influent pumping alternatives.

6.1.1 <u>Regulatory Considerations/Implications</u>

To avoid sewer overflows in the collection system, the WPCP must be able to accept wastewater flows on a continuous basis. The City prefers not to divert and store raw sewage under any circumstances. The headworks facility must therefore remain in service at all times – during power outages, during routine maintenance, and when equipment fails or is being replaced, etc.

6.1.2 Design Criteria

The headworks and influent pump station capacity would be designed to accommodate the flows presented in the Flow and Loads Evaluation TM. A summary of the flow rates that will be used to design the headworks and influent pump station is shown in Table 8. The facility would be designed to meet the current minimum flow conditions as well as projected Year 2035 average annual, maximum day, and peak hour flows. The influent pump station would be designed to pump the peak hourly flow with the largest pump out of service.

Table 8 Flow Projections Summary
Master Plan and Primary Treatment Design
City of Sunnyvale

Flow Parameter	Current	2025 (Phase 1 Design)	2035 (Buildout)
Peak Hour Flow, mgd (1)	39.6	50.9	58.5
Average Annual Flow, mgd (1)	13.8	17.8	20.4
Minimum Flow, mgd (1)(2)	4.8	6.2	7.1

Notes:
(1) Refer to the Flow and Loads Evaluation TM for more information on the flow projections.
(2) Estimated minimum hourly flow on minimum flow day.

6.1.3 Pump Station Configuration

The following sections summarize the wet well configuration options that were evaluated, including the use of single versus dual wet wells, the use of self-cleaning trench type wet wells versus rectangular wet wells, and the use of wet pit versus dry pit pump stations.

6.1.3.1 Single vs. Dual Wet Well

Dual wet wells that can be isolated and dewatered separately provide a level of redundancy should one wet well need to be taken off line for maintenance work such as cleaning, coating or repair of submerged piping. They also provide added flexibility for operation and maintenance staff.

Some smaller treatment plants have influent pump stations with only a single wet well. Single wet wells can be designed to have a smaller footprint than dual wet wells, and therefore lower capital cost. An argument can be made that a self-cleaning type wet well would seldom need to be taken off-line since floatables and settled solids should not accumulate in the wet well. However, there will be situations where the wet well must be taken out of service and dewatered for inspection or repair, at which times temporary bypass pumping must be provided or other accommodations must be made.

Due to the size of the WPCP, bypass pumping around the influent pump station would be a difficult and costly undertaking. Therefore, it is generally recommended that a dual wet well configuration be provided. To conduct a comprehensive pump station alternative analysis, both single and dual wet well pump station alternatives were considered in the pump station alternative analysis, which is summarized in subsequent sections.

6.1.3.2 Wet Pit vs. Dry Pit

Wet pit pump stations include pumps that are submerged in the pump station's wet well. Dry pit pump stations include pumps that are housed in a dry room that pull flow from the wet well through suction piping. By not requiring a dry basement, equipped with lighting, ventilation, gas detection, access stairs, and other requirements, wet pit pump stations generally have a lower capital cost. On the other hand, dry pit pump stations offer significant advantages and cost saving for operation and maintenance with direct access to the pumps and piping, and ability to perform most pump inspections and repairs in-house.

Both wet pit and dry pit pump station alternatives were considered in the pump station alternative analysis, which is summarized in subsequent sections.

6.1.3.3 Self-Cleaning Trench vs. Rectangular Wet Well

Two options considered for wet well design included a self-cleaning trench style wet well and a more conventional rectangular wet well. In the self-cleaning trench style wet well, the pump station undergoes regular cleaning cycles in which the normal operating level is lowered to expose an ogee ramp. This ramp increases the velocity of the inflow, creating turbulence that suspends settled solids in the wet well and allows these solids and floatable material to be pumped out. The narrow wet well limits the area where solids can circulate and accumulate. Rectangular wet wells (associated with dry-pit pump stations) can be designed to have a very compact footprint and features that minimize solids deposition. When attached to bar screen structures, the combination can make very efficient use of site space.

Both self-cleaning trench and rectangular wet well pump station alternatives were considered in the pump station alternative analysis, which is summarized in subsequent sections.

6.1.4 Types of Pumps

Four types of pumps were evaluated for the new influent pump station: 1) vertical non-clog centrifugal pumps in a dry pit; 2) submersible non-clog pumps; 3) vertical turbine solids handling (VTSH) pumps; and 4) screw centrifugal pumps. All four types of pumps are designed to handle solids bearing liquids while maintaining relatively high pump efficiencies, typically between 75 and 85 percent at their best efficiency point.

6.1.4.1 Vertical Non-Clog Centrifugal Pumps in a Dry Pit

Vertical non-clog centrifugal pumps are currently used in the City's existing influent pump station. These pumps are proven for this application and have been successfully used by the plant and at many other wastewater treatment plants (WWTPs). These pumps are available in a wide range of sizes and capacities and are available from several manufacturers including Morris Pumps, Ingersoll Dresser Pumps (Worthington), and Fairbanks Morse. Typically, these pumps have higher efficiencies than the other pump types.

Non-clog centrifugal pumps would be installed in a dry pit connected by drive shafting to motors located above the design maximum flood level. They would either be installed above the top deck of the dry pit or at an intermediate deck within the dry pit. Placing the motors above the maximum flood level would allow continued operation of the influent pump station, in the event of flooding at the WPCP.

6.1.4.2 Submersible Non-Clog Pumps

Submersible non-clog pumps are another proven technology used in many wastewater treatment applications for pumping raw sewage. Pumps are available in a wide range of sizes and capacities and are available from several manufacturers including Flygt, ABS, and KSB.

Submersible non-clog pumps can be installed in either a dry-pit or wet-pit installation. Relative to dry pit non-clog centrifugal pumps, using submersible pumps in a dry-pit installation offers the advantage of fully submerged operation, should the dry well flood. This eliminates the need for extended drive shafting. Multi-piece drive shafting can contribute to pump vibration and losses in efficiency and may require additional platform levels in the pump station to provide access to intermediate bearings and shafting joints.

Installation of submersible pumps in a wet-pit can offer substantial capital cost savings because construction of a dry-pit structure is eliminated along with the associated ventilation, access facilities, and utilities that are required to allow safe entry of personnel. A primary disadvantage of a wet-pit installation is the lack of convenient access to the pump and motor for maintenance. Regular inspection and monitoring of this type of pump would require the provision of a crane to pull the entire pump out of the wet well. Consequently, maintenance costs are typically higher for wet-pit submersible pumps than for dry-pit submersible pumps.

6.1.4.3 Vertical Turbine Solids Handling Pumps

VTSH pumps are used for pumping raw sewage, though not as frequently as non-clog centrifugal pumps or submersible non-clog pumps discussed above. VTSH pumps are often considered for installations in self-cleaning, trench type wet wells because their configuration results in a clean installation with few horizontal surfaces available to catch rags and other solids. VTSH pumps suitable for pumping raw sewage are made by several manufacturers including; Fairbanks Morse, Patterson, and Ingersoll Dresser.

VTSH pumps employ a long column pipe that supports the submerged pumping elements or pump bowls. The pump bowls are driven by an extended line shaft connected to a motor mounted at the top of the column. The pump impellers are a non-clog design that can pass wastewater solids. The column has a split discharge with an enclosed line shaft. This design allows solids to be passed into the discharge piping without being caught on intermediate shaft supports normally encountered in vertical pumps. As with submersible pumps, regular inspection and monitoring of this type of pump would require the provision of a crane to pull the entire pump out of the wet well. VTSH pump motors are, however, easily accessible since they would be exposed and located above grade. Overall, maintenance costs are expected to be higher for VTSH pumps than for pumps installed in a dry pit.

6.1.4.4 Screw Centrifugal Pumps

Screw centrifugal pumps feature an impeller with a screw section preceding a centrifugal section. The screw section creates a spiral motion that effectively passes solids, slurries and rags while maintaining efficiencies comparable to non-clog pumps. Although this type of pump has not been used in as many raw sewage pumping installations as the other pumps discussed above, a number of neighboring sewage agencies including Union Sanitary District and Vallejo Sanitation and Flood Control District have recently retrofitted some of their sewage pump stations with screw centrifugal pumps. At plants where influent pumping was located upstream of screening, this change in pump type has reportedly reduced ragging problems previously encountered at the pump stations and allowed the rags to be passed on from the pump stations to screenings facilities for removal from the flow stream.

Screw centrifugal pumps are available in submersible or dry-pit models. These pumps are available in a range of sizes from Wemco under the Hidrostal name.

6.1.5 <u>Pump Comparison</u>

Table 9 summarizes the advantages and disadvantages of each type of pump.

In terms of capacity, efficiency, and solids handling capability, each of the four types of pumps listed above are comparable. Vertical non-clog pumps would have the lowest equipment cost, followed by submersible non-clog pumps, VTSH pumps and screw centrifugal pumps.

VTSH and screw centrifugal pumps are not recommended. VTSH pumps are not recommended because they are more expensive than the other pumps and are difficult to remove for maintenance. Screw centrifugal pumps are not recommended because they are more expensive than the other pumps, require sole source procurement, and do not provide a significant benefit to justify the high cost. Although a screw centrifugal pump may pass fibrous or stringy material slightly better than the other types of pumps considered, most rags and larger inert materials should be removed by the upstream screenings facility. VTSH and screw centrifugal pumps were not considered further and were not included in the pump station alternative analysis summarized in subsequent sections.

Table 9 Summary of Advantages and Disadvantages of Pump Types
Master Plan and Primary Treatment Design
City of Sunnyvale

Alternative	Advantages	Disadvantages
Vertical Non-Clog Centrifugal Dry Pit	• Many installations • Good access for maintenance • Lowest cost	• Extended drive shaft required to keep motor dry
Non-Clog Submersible	• Many installations • Available for dry-pit and wet-pit applications	• Must pull pump for maintenance using crane if submerged • More factory maintenance may be required
Vertical Turbine Solids Handling (VTSH)	• Access to motor and mechanical seal above grade	• Few installations • Very difficult to pull for pump maintenance
Screw Centrifugal (Hidrostal)	• Reduced ragging issues (when not preceded by screens) • Passes stringy material(when not preceded by screens)	• Fewer installations • Sole source procurement • Highest cost

Vertical non-clog centrifugal dry pit and non-clog submersible pumps are preferred over the other types; however, final selection of the type of pumps cannot be accomplished independently of the selection of the wet well configuration, which has the greatest impact on both capital and O&M costs. Therefore, selection of the type of pump was incorporated into the pump station alternative analysis discussed in the subsequent sections.

6.2 Pump Station Alternatives Considered

The following pump station alternatives were considered:

- Alternative 1 – Single, self-cleaning wet well with submersible pumps.
- Alternative 2 – Single, self-cleaning wet well with dry pit pumps.
- Alternative 3 – Dual, self-cleaning wet wells with submersible pumps.
- Alternative 4 – Dual, rectangular wet wells with dry pit pumps.

Figure 8 includes a plan layout of each alternative. Section views of each alternative are included in the presentation slides in Appendix A.

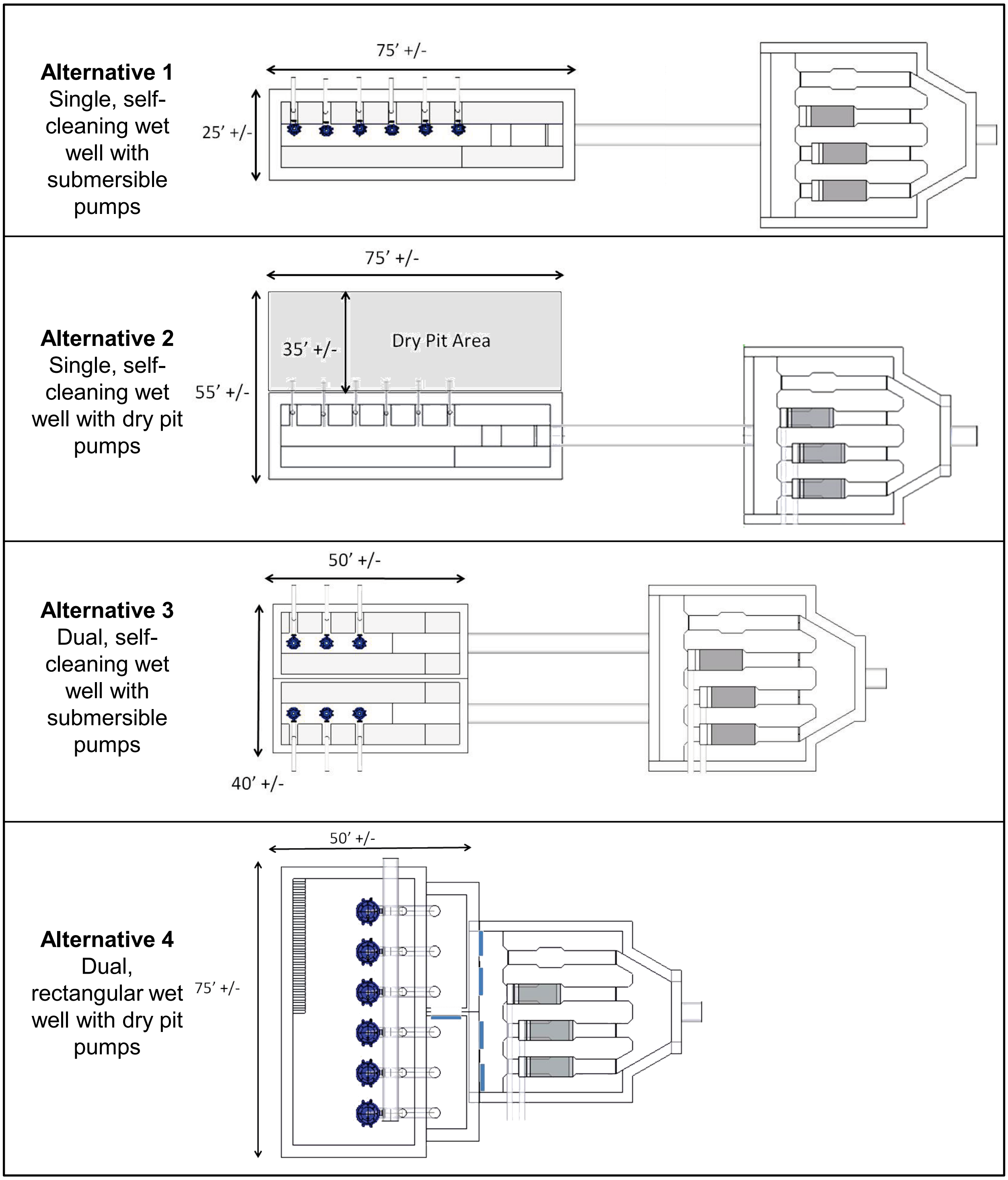


Figure 8
PUMP STATION ALTERNATIVES
PRELIMINARY TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

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6.3 Pump Station Alternative Analysis

To evaluate the pump station alternatives, both a qualitative review and net present value analysis were performed.

Table 10 summarizes the key advantages and disadvantages of each pump station alternative.

Table 10 Summary of Advantages and Disadvantages of Influent Pump Station Alternatives
Master Plan and Primary Treatment Design
City of Sunnyvale

Alternative	Advantages	Disadvantages
Alternative 1 - Single, self-cleaning wet well with submersible pumps	• Lower cost compared to wet pit/ dry pit type pump station • Less solids accumulation in wet well • Simpler control	• More difficult to access pumps for service and inspection than dry pit • Requires periodic crane rental, tall bridge crane or special equipment for submersible pump retrieval • Less redundancy and maintenance flexibility with single wet well
Alternative 2 – Single, self-cleaning wet well with dry pit pumps	• Good access to pump and motor for service and inspection • Less solids accumulation in wet well • Simpler control	• Higher cost compared to submersible pump configuration • Increased costs to provide dry pit suitable for personnel access • Less redundancy and maintenance flexibility with single wet well
Alternative 3 – Dual, self-cleaning wet wells with submersible pumps	• Lower cost compared to wet pit/ dry pit type pump station • Less solids accumulation in wet well • More redundancy and maintenance flexibility with dual wet pit design	• More difficult to access pumps for service and inspection than dry pit • Requires periodic crane rental, tall bridge crane or special equipment for submersible pump retrieval • More complicated controls to accommodate separated wet wells
Alternative 4 – Dual, rectangular wet wells with dry pit pumps	• More redundancy and maintenance flexibility with dual wet pit • Simplest control • Good access to pump and motor for service and inspection	• Higher cost to provide dry pit suitable for personnel access. • May require periodic wet well cleaning to remove accumulated solids

6.3.1 Net Present Value Analysis

Table 11 summarizes the results of the net present value analysis. The net present value analysis was based on a 20-year lifecycle cost and includes capital costs and annual O&M costs including power, maintenance and labor costs. Based on this analysis, there is not much of a cost difference between the pump station alternatives. Given this, selection of the pump station alternative is largely driven by non-economic factors such as ease of O&M and site efficiency.

Table 11 Net Present Value Analysis of Influent Pump Station Alternatives
Master Plan and Primary Treatment Design
City of Sunnyvale

Evaluation Criteria	Alt. 1 - Single, self-cleaning wet well with submersible pumps	Alt. 2 – Single, self-cleaning wet well with dry pit pumps	Alt. 3 – Dual, self-cleaning wet well with submersible pumps	Alt. 4 – Dual, rectangular wet well with dry pit pumps
Capital Cost	$7.8	$10.0	$8.2	$9.3
Annual O&M Cost	$340K	$310K	$350K	$300K
Net Present Value	$12.6M	$14.3M	$13.1M	$13.6M

Notes:
(1) All alternatives include one standby pump (largest capacity pump).
(2) Cost estimates exclude common facilities (e.g., common yard piping, odor control facilities, etc.).
(3) Capital costs include escalation to midpoint of construction (June 2016).
(4) Power costs are based on an electricity cost of $0.20/kWh.
(5) Net present value is based on a 20-year life cycle.

6.3.2 Evaluation Summary

Table 12 summarizes how each pump station alternative meets the City's evaluation criteria for the Master Plan, which is described further in the SIP Validation TM.

Based on the analysis summarized in Table 12, Alternative 4 is recommended over the other alternatives because: (1) it includes a dual wet well that provides more redundancy and flexibility for maintenance; (2) it is an efficient use of site space; (3) it includes good access for O&M; and (4) it includes simpler controls.

Given Alternative 4 is a dry well pump station, either vertical non-clog centrifugal pumps or non-clog submersible pumps could be implemented. These types of pumps are best suited for deep, dry pit pump stations.

As stated earlier, vertical non-clog centrifugal pumps are less expensive and slightly more efficient than non-clog submersible centrifugal pumps. In addition, most pump maintenance can be done onsite by City staff, which make them easier and less costly to maintain.

Table 12	Evaluation Summary of Pump Station Alternatives Master Plan and Primary Treatment Design City of Sunnyvale			
Evaluation Criteria	**Alt. 1 - Single, self-cleaning wet well with submersible pumps**	**Alt. 2 – Single, self-cleaning wet well with dry pit pumps**	**Alt. 3 – Dual, self-cleaning wet well with submersible pumps**	**Alt. 4 – Dual, rectangular wet well with dry pit pumps**
Reliability	-	-	+	+
Ease of O&M	-	0	-	+
Power Usage	0	+	0	+
Flexibility	0	0	+	+
Site Efficiency	-	-	-	+
Net Present Value	0	-	0	0

Notes:
(1) Legend: + Better; 0 Neutral; - Worse.

These pumps would require extended drive shafting to keep the motors above the maximum flood line. Depending on the dry pit design (i.e., location of the pump motors), the extended drive shafting may be comprised of a single drive shaft or a two-piece drive shaft with an intermediate bearing. A single drive shaft is preferred because it reduces system complexity and requires less capital and O&M cost.

Non-clog submersible pumps would not require extended drive shafting, but only limited maintenance could be performed by City staff onsite. The pumps would need to be shipped offsite for most maintenance.

Final pump selection would be decided during the preliminary design phase of the Primary Treatment Facility. Vertical non-clog centrifugal pumps are preferred if they could be implemented with extended drive shafting that is comprised of a single drive shaft. This type of pump is preferred because it is less expensive, more energy efficient and easier to maintain. If the extended drive shaft must be comprised of a two-piece drive shaft with an intermediate bearing, then both vertical non-clog centrifugal pumps and non-clog submersible pumps should be evaluated further during the preliminary design phase to finalize the selection of the pump type.

6.4 Implementation Considerations (Phasing)

The entire pump station structure required for 2035 flows would be constructed in one phase as part of the Primary Treatment Facility Project. Equipment would be phased in as needed to accommodate the influent flow. Equipment phasing would be determined as part of the preliminary design of the Primary Treatment Facility.

6.5 Site Considerations

The following site considerations should be considered when determining the site layout and design of the influent pump station:

- It is not recommended that the pump station be contained within a building. A canopy may be required to protect any equipment installed above the top deck of the pump station (i.e., pump motors). Electrical equipment such as VFDs and MCCs would be housed in a new at-grade electrical building, located near the pump station. It is recommended the electrical equipment be contained in a building to protect it from the elements and extend its useful life.

- The dry pit must be designed for personnel entry.

- Include provisions for odor control, including containment and ventilation of areas where foul air is generated (e.g., the wet well).

- Include provisions for corrosion protection. For example, concrete surfaces exposed to high levels of hydrogen sulfide may be provided with a polyvinyl chloride (PVC) liner or coated with protective coatings. Recommended measures for corrosion protection will be determined in detail during the final design of the Primary Treatment Facility Project.

- Include provisions that protect the pump motor from flooding. This may require installing the pump motors above the top deck of the pump station or including an intermediate deck within the dry well, where operators could access the pump motors. In both cases, all entrances or openings associated with this critical pump station must be located above the design flood level. Alternatively, consider using non-clog submersible dry-pit pumps.

- Pumps will need to be retrieved with a fixed crane or rental equipment. Adequate truck/crane access must be provided to load and haul equipment offsite.

6.6 Findings/Recommendations

The findings and recommendations for influent pumping include:

- Implement a dual, rectangular wet well pump station with a dry pit for influent pumping (Pump Station Configuration Alternative 4). This alternative provides more redundancy and flexibility for maintenance, is an efficient use of site space, includes good access for O&M, and results in simpler controls.

- Implement either vertical non-clog centrifugal pumps or non-clog dry pit submersible pumps. These types of pumps are best suited for deep, dry pit pump stations. The pump type should be finalized during preliminary design of the Primary Treatment Facility.

7.0 GRIT REMOVAL

The primary purpose of grit removal at a wastewater treatment plant is to reduce maintenance of downstream facilities. Benefits of grit removal include reducing accumulation in downstream channels, basins, and digesters and reducing wear in mechanical equipment such as pumps, valves and sludge collection mechanisms.

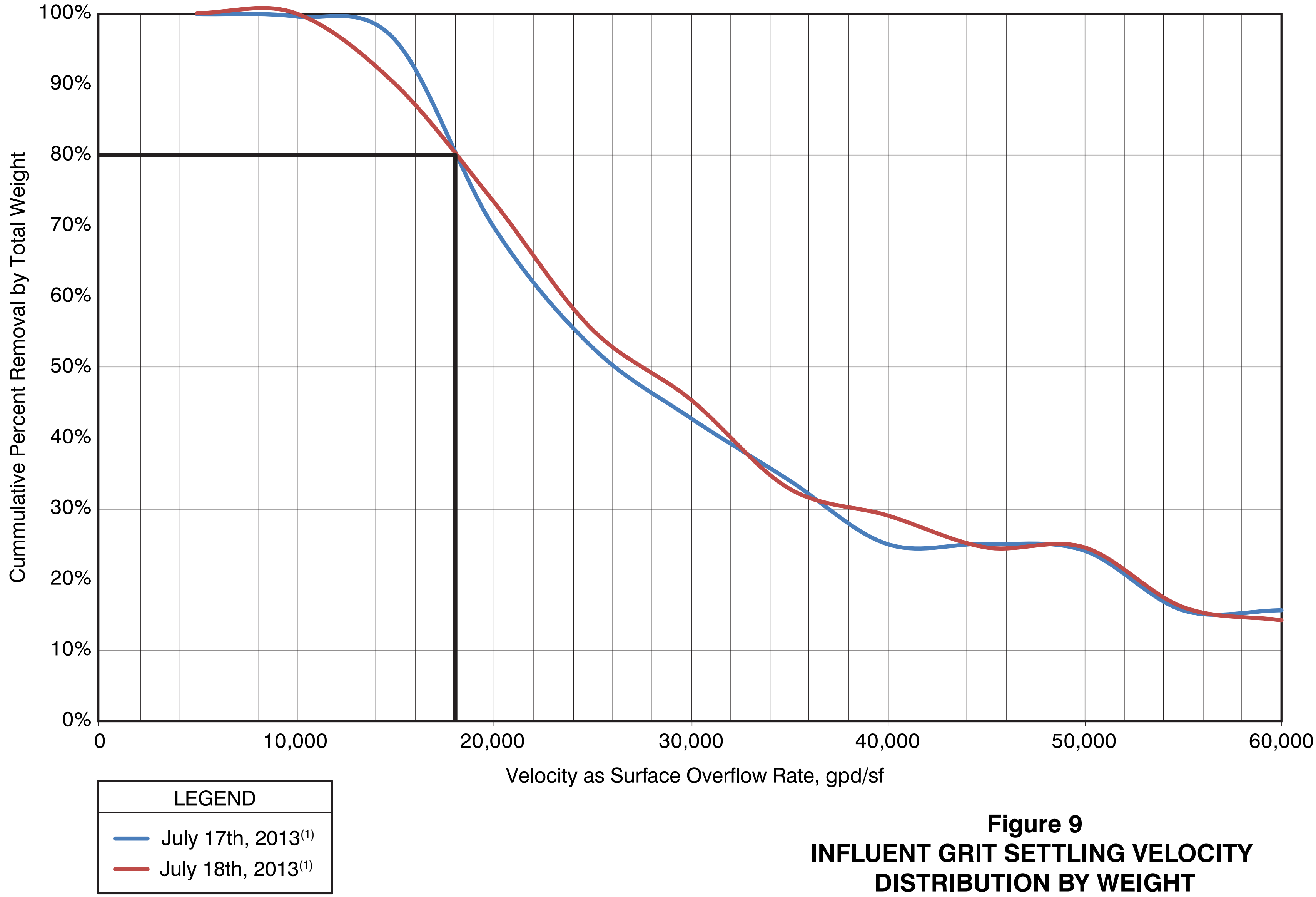
This section summarizes the grit characterization testing that was performed at the WPCP, the recommended preliminary design criteria for the grit removal process, an evaluation of grit removal technologies, implementation and site considerations, and recommendations for the new grit removal process.

7.1 Grit Testing Results

A grit characterization study was performed in July 2013 to assess the amount of grit in the influent to the WPCP, characterize the grit by size and weight distribution, and determine the settleability of the grit. The results of the grit characterization study were used to develop and evaluate grit removal technology alternatives.

The study is summarized in the Grit Characterization Study TM. The key findings and recommendations of the study include:

- The influent grit is larger and settles slower than grit typically found in grit sampling/testing at other plants.
- The existing grit removal system removes about 20 percent of the influent grit.
- The moisture content of the removed grit is approximately 65 percent and its organic content is approximately 20 to 25 percent. Implementing a new grit handling system could result in drier and cleaner grit (i.e., grit with lower moisture and organic content). Drier grit is less costly to haul/dispose of and cleaner grit generates less odors.
- To significantly increase grit removal, it is recommended the grit removal system be designed to remove grit settling faster than 0.85 cm/s, which corresponds to a design surface overflow rate of about 18,000 gpd/sf. Based on the influent grit settling characteristics that are presented in Figure 9, this would result in a theoretical removal of about 80 percent by weight of the grit entering the WPCP and an expected practical removal in the range of 40 to 60 percent at the design flow.



NOTE:
(1) Grit characterization testing performed at Sunnyvale WPCP on July 17th and 18th, 2013.

Figure 9
INFLUENT GRIT SETTLING VELOCITY DISTRIBUTION BY WEIGHT
PRELIMINARY TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

7.2 Technologies Considered

7.2.1 Alternative Technologies

Two grit separation technologies used in wastewater treatment are aerated grit basins and vortex grit basins. Vortex grit removal technologies include mechanically induced vortex grit removal as well as free vortex grit removal. The following grit removal technologies were initially evaluated and discussed with City staff, including:

- Aerated grit basins.
- Mechanically-induced vortex grit basins.
- Free vortex grit removal system (i.e., HeadCell® multi-tray vortex system).

7.2.2 Aerated Grit Basins

Aerated grit basins use a specific velocity of roll or agitation to keep organics in suspension while settling the grit out of the wastewater. Compressed air is typically discharged into the rectangular grit chamber along the bottom of one side of the tank creating a rising air column that causes the flow to rotate. The air rate can be adjusted to create a low enough velocity near the floor to allow the grit to settle to the bottom of the basin and into collection hoppers. If the velocity is properly adjusted, in a well-designed basin, the aerated grit process can capture fine, slow settling grit.

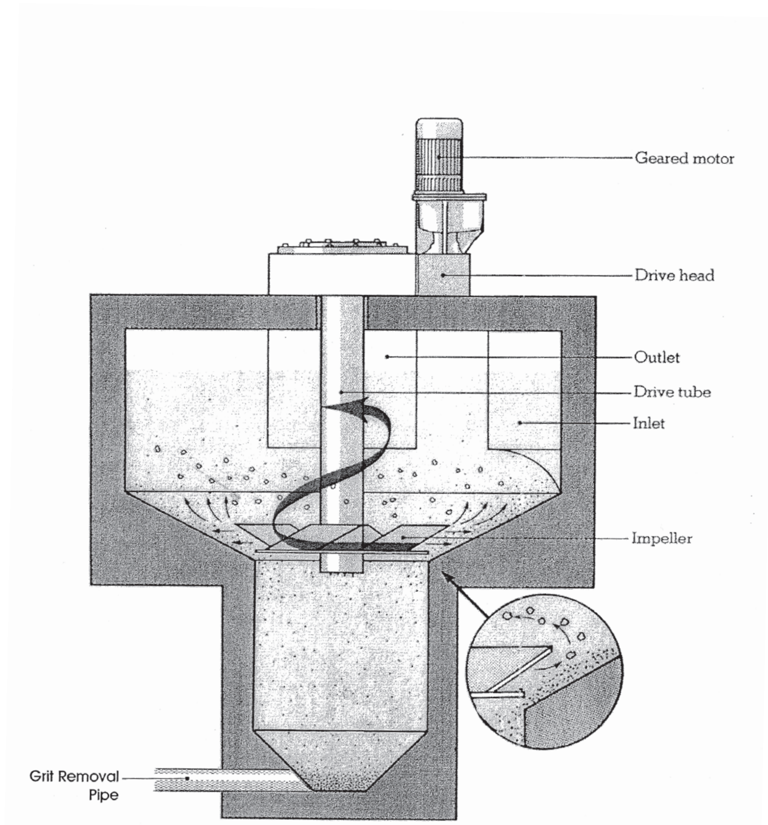
Although aerated grit basins are an effective grit removal technology, they are operationally more complicated than vortex grit basins and have higher capital and O&M costs. Aerated grit chambers have a larger overall footprint than vortex systems and require multiple grit slurry pumps, aeration blowers, aeration piping, and coarse bubble diffusers, which increases the overall capital cost. The air introduced into an aerated grit basin is typically collected and treated in a foul air treatment system.

7.2.3 Vortex Grit Removal

The vortex grit removal process provides a simpler, less mechanically intensive method of grit removal in a smaller footprint than aerated grit removal.

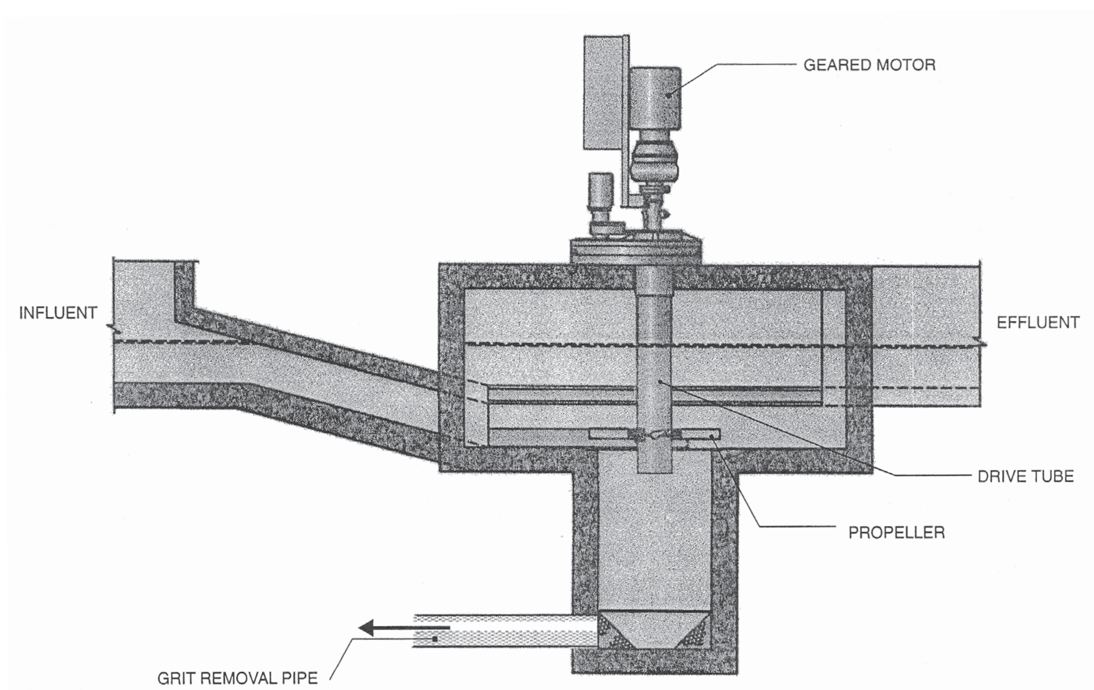
7.2.3.1 Mechanically-Induced Vortex Grit Basins

Mechanically induced vortex grit basins work on the principles of gravity and centrifugal action to capture grit in the center hopper of a circular tank. Figure 10 shows the two primary types of mechanically-induced vortex grit basins – a sloped bottom grit basin and a flat bottom grit basin. The influent enters at a tangent to the outside of the basin producing a spiraling doughnut-shaped flow pattern. The flow pattern in the circular basin pushes the heavier grit particles to the outside where travel times are longer, providing more time for the grit to settle below the “lip” of the outlet opening thus “trapping” it. Impellers at the



Sloped Bottom Vortex Grit Basin

Source: Jones & Attwood



Flat Bottom Vortex Grit Basin

Source: Smith & Loveless

Figure 10
MECHANICALLY INDUCED
VORTEX GRIT BASINS
PRELIMINARY TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

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center of the basins cause a lifting action that suspends and lifts the lighter organic material that is then passed out of the basin through the effluent channel.

Vortex grit basins have been used by many WWTPs in the United States to remove grit from the influent flow stream. They have a smaller footprint and significantly lower capital cost than aerated grit systems; however, it is Carollo's and HDR's experience that the forced vortex grit basin technology has not been as effective in removing slow settling grit particles.

7.2.3.2 Multi-tray Vortex System

The Eutek HeadCell® is a modular, multiple-tray settleable solids concentrator that can be designed to remove fine grit with low settling velocity. Figure 11 shows a Eutek HeadCell® system. A flow distribution header evenly distributes the influent flow over multiple conical trays. The tangential feed establishes a vortex flow pattern where solids settle into a boundary layer on each tray and are swept down to the center underflow collection chamber. The settled solids are continuously pumped to a grit separation, classification, and dewatering system. Additional information on the Eutek HeadCell® system that was developed by the manufacturer is included in Appendix B.

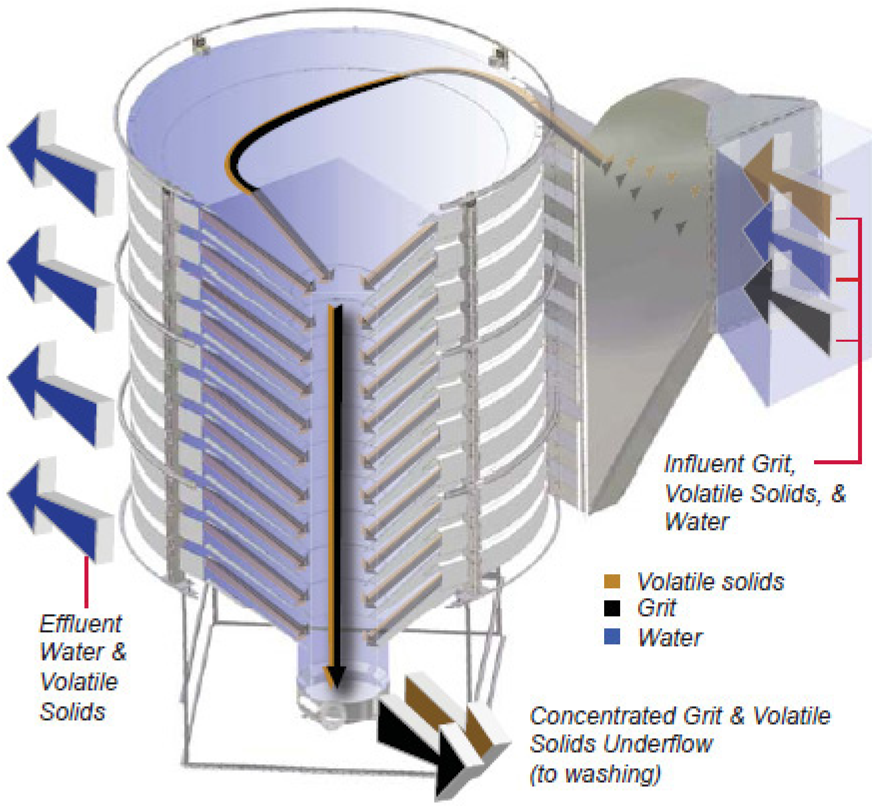
The Eutek HeadCell® System is a relatively new and proprietary technology. It has been implemented in the United States for over 8 years and has been implemented at over 80 United States WWTPs. The Eutek HeadCell® systems have a smaller footprint than aerated grit systems and require less mechanical equipment for operation, resulting in a lower capital cost. Eutek HeadCell® systems are also anticipated to provide higher removal of fine (i.e., slow-settling) grit than aerated grit basins and mechanically-induced vortex grit basins. Given these systems are comprised of several trays stacked on top of each other, they are more difficult to inspect than aerated grit systems. Based on Carollo/HDR's experience, a Eutek HeadCell® system is anticipated to perform well at the WPCP; however, special attention to operation and maintenance considerations should be included in final design of this technology.

7.2.4 <u>Fatal Flaw Screening</u>

Based on an initial pre-screening conducted during the internal peer review held in September, it was decided the forced vortex grit basin technology should not be implemented at the WPCP given the influent grit is largely comprised of slow settling grit. Based on Carollo's and HDR's experience, this technology has not been effective in removing slow settling grit particles.

7.3 Alternative Analysis

To evaluate an aerated grit system against a HeadCell® system both a qualitative review and net present value analysis were performed. Preliminary design criteria were established to conduct the net present value.



Source: Eutek

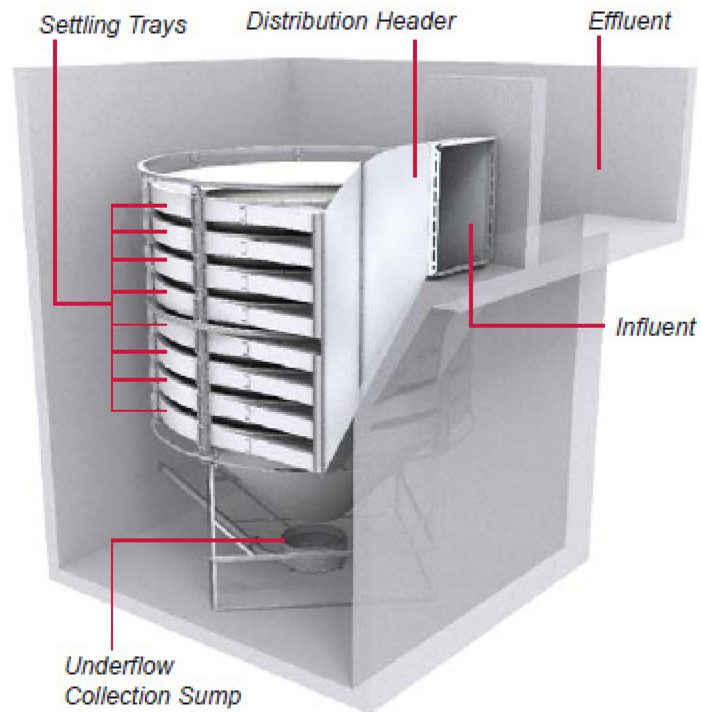


Figure 11
EUTEK HEADCELL® MULTI-TRAY VORTEX SYSTEM
PRELIMINARY TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

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Table 13 summarizes the key advantages and disadvantages of each grit removal alternative.

Table 13 Summary of Advantages and Disadvantages of Grit Removal Technology Alternatives
Master Plan and Primary Treatment Design
City of Sunnyvale

Alternative	Advantages	Disadvantages
Aerated Grit	• Can be sized for virtually any flow • Potential improved flocculation of light solids which is good for the primary sedimentation process performance • More control of removal	• Energy intensive • Increased O&M attention • Larger footprint • More foul air to treat • Higher Cost
HeadCell®	• High turndown ratios • No moving parts or blowers • Small footprint • Capable of removing more fine particles than aerated grit	• Relatively new in the market • Screening requirements (≤ ¾”) • More difficult to inspect • Potentially higher headloss than aerated grit • Sole-source required

7.3.1 Preliminary Design Criteria and Net Present Value Analysis

It is recommended the grit removal facility have a hydraulic capacity of 58.5 mgd with one basin out of service. At this hydraulic capacity, the grit removal facility would be able to pass the 2035 peak hourly flow.

To minimize costs, it is recommended the grit removal facility have a grit removal design capacity of 40 mgd (in lieu of designing for the peak hourly flow). This design capacity is equivalent to the 2035 peak day flow and is about twice the projected 2035 average flow of 20.4 mgd. At flows above 40 mgd, grit removal efficiency will be reduced; however, it is expected this reduction in efficiency may be offset by the fact that grit received during high flows is expected to be relatively heavy. At high flows, high velocities in the sewers flush heavy, already-settled grit from the collection system to the WPCP and the fraction of easily settable grit is higher than during normal flow conditions.

As noted earlier, as part of the grit characterization study it was recommended the grit removal system be designed to have a maximum surface overflow rate of 18,000 gpd/sf.

7.3.2 Net Present Value Analysis

Table 14 summarizes the preliminary design criteria and the results of the net present value analysis. The net present value analysis was based on a 20-year lifecycle cost and includes capital costs and annual O&M costs including power, maintenance and labor costs. As shown in Table 14, a HeadCell® system has a lower net present value than an aerated grit system. This is largely due to the compactness and simplicity of the HeadCell® System. The HeadCell® system requires less concrete and less mechanical equipment.

Table 14 Net Present Value Analysis of Grit Removal Alternatives
Master Plan and Primary Treatment Design
City of Sunnyvale

Evaluation Criteria	Aerated Grit	HeadCell®
Design Flow, mgd	40	40
No. of Basins (1)	3	3
Basin Sizing (2)	800 SF/basin	Nine – 12 foot diameter trays
Capital Cost	$8.8M	$6.6M
Annual O&M Cost	$230K	$120K
Net Present Value	$11.6M	$7.9M

Notes:
(1) Assumes an hydraulic capacity of 58.5 mgd with one basin out of service and a grit removal design capacity of 40 mgd with all units in service.
(2) Based on 18,000 gpd/SF overflow rate.
(3) Cost estimates exclude common facilities (e.g., common yard piping, odor control facilities, etc.).
(4) Capital costs include escalation to midpoint of construction (June 2016).
(5) Power costs are based on an electricity cost of $0.20/kWh.
(6) Net present value is based on a 20-year life cycle.

7.3.3 Evaluation Summary

Table 15 summarizes how each grit removal technology meets the City's evaluation criteria for the Master Plan, which is described further in the SIP Validation TM.

Based on the analysis summarized in Table 15, the HeadCell® alternative is recommended over the aerated grit alternative because: (1) it is a simpler grit system with fewer mechanical components; (2) it should be effective at removing the slower settling grit found at the WPCP; (3) it has a lower net present value; and (4) it has a small, space efficient footprint when compared against aerated grit.

7.4 Implementation Considerations (Phasing)

The entire grit removal facility required for 2035 flows would be constructed in one phase as part of the Primary Treatment Facility Project.

Table 15	**Evaluation Summary of Grit Removal Alternatives Master Plan and Primary Treatment Design City of Sunnyvale**	
Evaluation Criteria	**Aerated Grit**	**HeadCell®**
Reliability	+	0
Ease of O&M		
O&M Attention	-	+
Ease of inspection	+	-
Power Usage	-	+
Flexibility	0	0
Site Efficiency	-	+
Net Present Value	-	+

Notes:
(1) Legend: + Better; 0 Neutral; - Worse.

7.5 Site Considerations

The following site considerations should be considered when determining the site layout and design of the grit removal facility:

- Enclose and provide odor control for the grit removal system.
- Include provisions for corrosion protection. For example, concrete surfaces exposed to high levels of hydrogen sulfide may be provided with a polyvinyl chloride (PVC) liner or coated with protective coatings. Recommended measures for corrosion protection will be determined in detail during the final design of the Primary Treatment Facility Project.
- Provide sufficient space for O&M access considerations.

7.6 Findings/Recommendations

The findings and recommendations for grit removal include:

- Implement a Eutek HeadCell® system for grit removal because it is a simpler grit removal system that should effectively remove the WPCP grit, has a lower 20-year life cycle cost than aerated grit, and has a small, space efficient footprint. Design the system for target removal of grit particles with a settling velocity greater than 0.85 cm/s.

- The grit removal system would have a hydraulic capacity of 58.5 mgd with one unit out of service and a grit removal design capacity of 40 mgd, with all units in service. The hydraulic capacity corresponds to the projected 2035 peak hourly flow. The grit removal capacity corresponds to the projected 2035 peak day flow and is approximately twice the ultimate average design flow rate.

8.0 GRIT HANDLING

The grit handling process is comprised of grit withdrawal and grit washing and dewatering.

This section summarizes the recommended preliminary design criteria for the grit handling process, an evaluation of technology alternatives, implementation and site considerations and recommendations for the new grit handling process.

8.1 Grit Withdrawal

Settled grit must be removed from the bottom of the HeadCell® grit basins and transferred to grit dewatering equipment. This is typically accomplished using heavy-duty pumps with hardened wear components that can handle abrasive materials, which settle in the grit basins.

Recessed impeller pumps located at grade next to the grit basins are recommended for this application. These pumps have a successful, long track record in grit pumping applications and are very durable and reliable. The pump impellers are located out of the main flow path and the pump can pass solids almost as large in diameter as the inlet of the pump. Based on the hydraulic grade line at the grit basins, these pumps will have a flooded suction, which is required for proper operation.

8.2 Grit Washing and Dewatering

Grit washing separates grit from organic solids and grit dewatering removes the free water from the material in preparation for disposal. A lower organic content in grit reduces odors and vector attraction while dewatering reduces the weight, volume, and cost of materials hauled.

8.2.1 Alternative Technologies

The following grit removal technologies were initially evaluated and discussed with City staff, including:

- Eutek Slurry Cup/Grit Snail™.
- Cyclone and grit classifier.
- Huber COANDA® Grit Washer.

8.2.1.1 Slurrycup/Grit Snail™

The Eutek Slurrycup™ /Grit Snail™ is a proprietary system (manufactured by Eutek Systems). The Eutek Slurrycup™ uses a combination of an open free vortex and the boundary layer effect to capture, classify, and remove fine grit, sugar sand, snail shells, and high density fixed solids from grit slurries. The grit underflow from the Eutek Slurrycup™ is discharged into the Eutek Grit Snail™ clarifier, where the grit and fine abrasives settle onto slow-moving stepped cleats. Degritted water flows out of the clarifier via an overflow weir and is returned to the treatment plant. Dewatering begins as the grit and fine abrasives are quiescently raised from the clarifier pool to retain fine grit. The dewatered abrasives are carried to the top of the Eutek Grit Snail™, where they are discharged into a dumpster. Instead of utilizing an auger to dewater the grit, the Snail™ lifts the settled grit to the discharge point with a stepped belt conveyor.

In comparison to other grit washing/dewatering technologies, Carollo's experience is that the Slurrycup™/Snail™ system can be very maintenance-intensive and prone to frequent plugging. For this reason, this system will not be considered further for this project.

8.2.1.2 Cyclone and Grit Classifier

Cyclone/classifier systems can be supplied by several manufacturers and have a long history of successful operation at municipal WWTPs. Figure 12 illustrates the cyclone/classifier grit dewatering system.

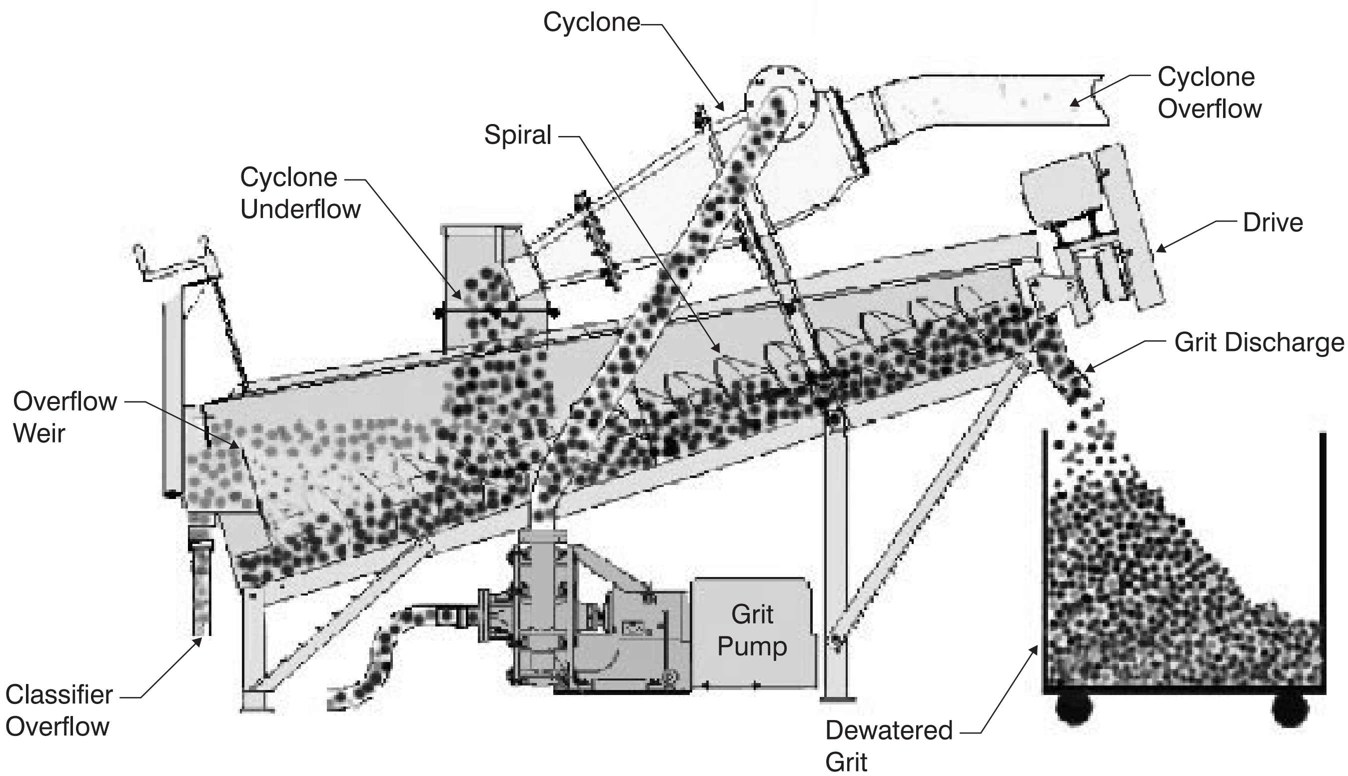
In this system, grit slurry withdrawn from the grit basin hopper is pumped to the cyclone, which is mounted on top of the classifier. When the pressurized grit flow enters the cyclone, the energy furnished by the pump is converted into a rotational motion, similar to a cyclone, which causes the grit to be pushed to the outer walls by centrifugal force. The cyclone uses this centrifugal force to concentrate the grit to as little as five percent of the total incoming flow, while draining the remaining water and some organic material back to the plant influent. The concentrated cyclone underflow discharges into the classifier below. Grit settles to the bottom of the classifier and is removed with a short helical auger. The remaining water and suspended organics discharge over a weir at the back of the classifier.

Cyclone/classifier units have a lower capital cost than other technologies; however they have potential to produce a lower quality grit that contains more organics and is more odorous.

8.2.1.3 COANDA® Grit Washer

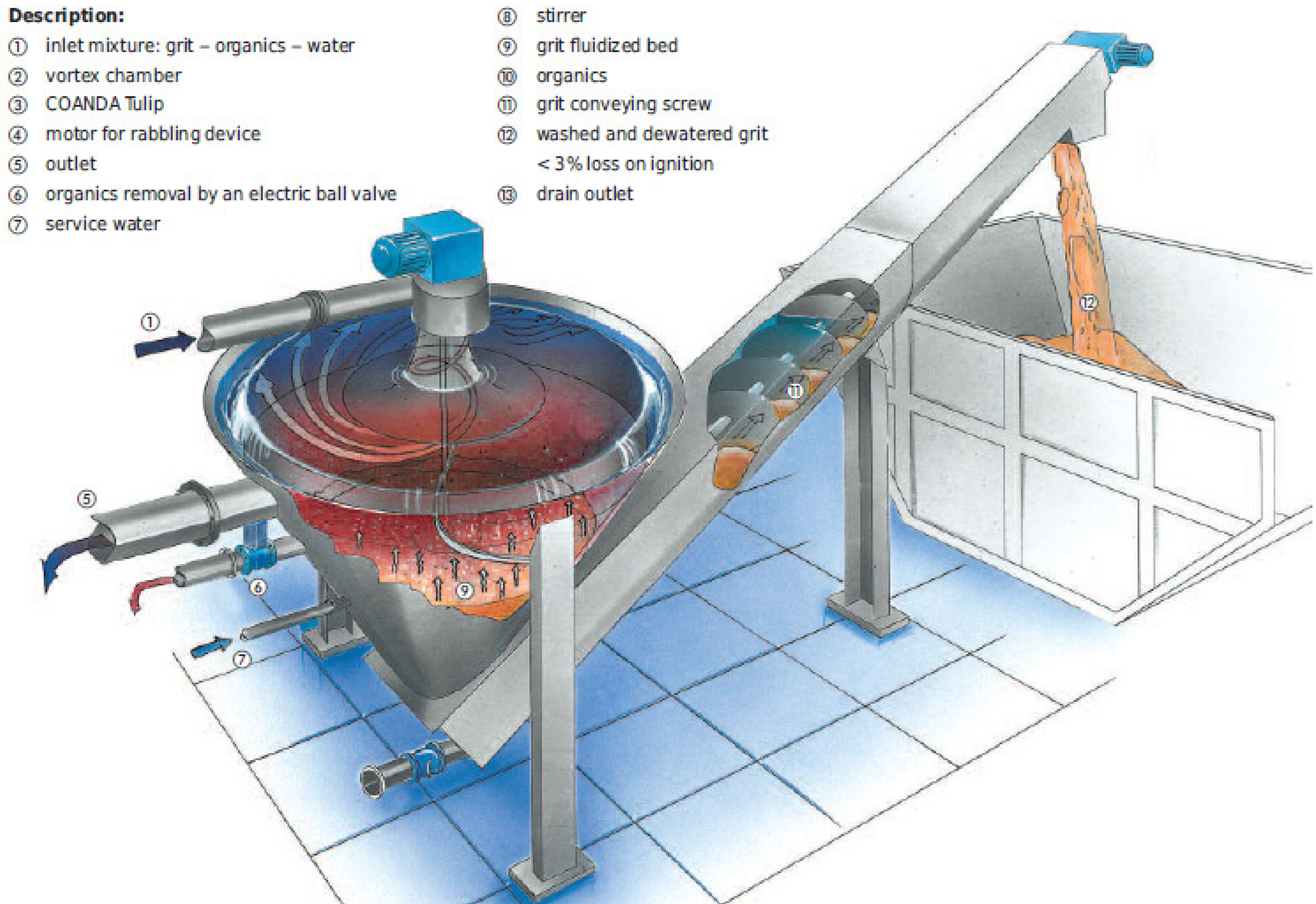
The COANDA® grit washer is a proprietary grit washing/dewatering system (manufactured by Huber) that typically produces cleaner and drier grit than other systems. Figure 13 illustrates the COANDA® grit washing/dewatering system.

In this system, grit slurry is fed through a vortex chamber where a spinning rotational motion is generated. The slurry then flows down through a trumpet-shaped segment into



Source: Wemco

Figure 12
TYPICAL GRIT CYCLONE/CLASSIFIER
PRELIMINARY TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE



Source: Huber Technology

Figure 13
COANDA GRIT WASHER RoSF4
PRELIMINARY TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

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the washing/separation unit. The flow is diverted along the curved inner surface of the trumpet-shaped segment by the COANDA® effect that a liquid flow adheres to the contour of a curved surface. The flow is diverted smoothly, without generation of eddies, from a fast rotating vertical direction to a gradually slower rotating horizontal direction. The water flows evenly in a relatively thin layer below the water surface towards a circumferential overflow weir.

The combined forces of gravity and inertia cause grit and heavier organics particles to settle out of the flow. The separated grit is then washed, which takes place in the bottom portion of the grit washer where a fluidized grit bed is generated. Wash water is fed into a bottom chamber to create a fluidized bed. The vertical flow of water carries the removed low-density organics upwards towards the overflow weir while the heavier grit remains within the fluidized bed. Washed grit is periodically removed through the bottom of the unit. The grit drops into the inclined screw and is conveyed above the water level in the grit washer and drained by gravity. The washed and dewatered grit drops from the conveyor into a dumpster. Additional information on the COANDA® grit washer that was developed by the manufacturer is included in Appendix C.

The COANDA® grit washer is a relatively new and proprietary technology. It has been implemented in the United States for approximately 10 years and has been implemented at over 40 U.S. WWTPs. The equipment cost of a COANDA® grit washer system is anticipated to be greater than a cyclone/classifier system. However, based on our experience with other facilities, the O&M and lifecycle cost is anticipated to be about the same or lower because the COANDA® grit washer produces significantly drier, cleaner, less odorous grit, which results in lower hauling cost and less foul air to treat. Since the grit characterization study at the WPCP revealed that most of the influent grit settles like fine sand, a closer evaluation of the COANDA® technology with respect to capture rate should be completed as part of preliminary design, to confirm the selection.

8.2.2 Fatal Flaw Screening

Carollo's experience with the Slurrycup™/Snail™ system is that it can be very maintenance-intensive and prone to frequent plugging. For this reason, this system is not recommended for this project.

8.2.3 Alternative Analysis

Table 16 summarizes the key advantages and disadvantages associated with the cyclone and grit classifier and the COANDA® grit washer. Table 16 summarizes how each technology meets the City's evaluation criteria for the Master Plan, which is described further in the SIP Validation TM.

Based on the analysis summarized in Table 17, the COANDA® grit washer is preferred over the cyclone/grit classifier because it produces a less odorous product that is drier, cleaner and less odorous product. Based on field test results, it is anticipated the proposed

HeadCell® grit basins will capture the slow settling grit in the plant influent with settling velocities as identified by the grit characterization study. The COANDA® grit washer's capture efficiency of fine grit with similar settling velocities must be confirmed during preliminary design. If Huber can furnish satisfactory data and references to demonstrate this, then COANDA® grit washers would be the recommended grit washing/dewatering technology. If not, then cyclone/ grit classifier units would be used.

Table 16 Summary of Advantages and Disadvantages of Grit Washing/Dewatering Alternatives
Master Plan and Primary Treatment Design
City of Sunnyvale

Alternative	Advantages	Disadvantages
Cyclone/ Grit Classifier	• Extensive successful experience in similar applications • Wide range of hydraulic capacity applicable to medium and large plants • Produces adequate product • Moderate capital cost	• Provides limited washing of grit
COANDA® Grit Washer	• Produces cleaner, drier, less odorous product • Reduces hauling cost	• High capital cost • Sole-source required

Table 17 Evaluation Summary of Grit Washing/Dewatering Alternatives
Master Plan and Primary Treatment Design
City of Sunnyvale

Evaluation Criteria	Cyclone/Classifier	COANDA® Grit Washer
Reliability		
Capture of fines	+	0
Ease of O&M		
Cleaner Product	-	+
Less Odor	-	+
Hauling Cost	-	+
Power Usage	0	0
Flexibility	0	0
Site Efficiency	0	0
Number of Manufacturers	+	-
Cost	0	0

Notes:
(1) Legend: + Better; 0 Neutral; - Worse.

As stated above, based on previous experience, the lifecycle cost (i.e., net present value) of a COANDA® grit washer system is anticipated to be about the same or lower than that of a cyclone/classifier system. This is largely due to savings associated with odor control and grit hauling costs.

8.3 Implementation Considerations (Phasing)

The grit handling facility should be sized to treat the 2035 maximum grit load. The entire grit removal facility required for 2035 flows would be constructed in one phase as part of the Primary Treatment Facility Project. If equipment can be installed in phases, will be determined during preliminary design.

8.4 Site Considerations

The following site considerations should be considered when determining the site layout and design of the grit handling process:

- The grit handling facility should be located close to the grit removal facility to reduce grit piping runs and minimize the operations and maintenance demands of the grit conveyance system.
- The grit handling facility should be co-located with the screenings handling facility.
- The grit handling facility should be located in a building with provisions for odor control.
- Truck access to the grit disposal bins should be provided.

8.5 Findings/Recommendations

The findings and recommendations for grit handling include:

- Implement flood-suction recessed impeller grit pumps to convey grit from the grit basins to the grit handling facility.
- As part of the preliminary design of the Primary Treatment Facility, confirm COANDA's removal efficiency of grit particles having settling velocities similar to the values measured during the July 17th and 18th, 2013 field testing at the WPCP..
- Implement COANDA® grit washers for grit washing/dewatering if they can provide adequate removal of the grit anticipated from the HeadCell® unit. If not, a cyclone/grit classifier would be implemented for grit washing/dewatering.

9.0 ODOR CONTROL

Preliminary treatment processes typically generate a high level of odors. As a result, most preliminary treatment facilities require some level of odor control to reduce odors onsite and prevent noticeable odors from spreading beyond the plant boundaries and affecting the area surrounding the WPCP.

This section summarizes odor regulations, odor testing that was conducted at the WPCP, an evaluation of odor control technologies, and recommendations for odor control at the preliminary treatment facilities.

9.1 Regulations

In the State of California, odors are regulated by CH&S code Section 41700 which states, “A person shall not discharge from any source whatsoever such quantities of air contaminants or other material which cause injury, detriment, nuisance or annoyance to any considerable number of people.” There is no regulation on how odor violations are determined.

The Bay Area Air Quality Management District (BAAQMD) has regulations to address certain odorous substances (e.g., hydrogen sulfide, sulfur dioxide). The limits are not applicable, however, unless a sufficient number of odor complaints are received.

The City has not received odor complaints for the current wastewater operations at the WPCP. Although the City has not received odor complaints, the City would like to develop a proactive approach in addressing odors as part of the long-term planning for the WPCP.

9.2 Onsite Odor Testing

In order to evaluate the odor generation potential at the WPCP, odor testing was performed at the WPCP on September 9th through 11th, 2013. The odor testing identified which odorous compounds are being emitted from each source and in what concentrations. This information was used to evaluate where odor control should be implemented as well as the use of potential odor technologies.

The methodology and results of the study are summarized in the Odor Testing Report TM. The key findings and recommendations of the study, as they relate to the preliminary treatment process include:

- The headworks and primary facilities have relatively high H_2S concentrations.
- The headworks and primary clarifier odors were not overpowering during the testing, but they were certainly noticeable and capable of being detected off-site depending on the wind direction.

- Given the new processes will be similar to the current processes, it is highly probable the new processes will have similar odor generation potential. Therefore, provisions for odor containment and treatment should be provided. Specific areas to be addressed include the following: (1) screening and screenings handling areas; (2) influent wetwell; (3) grit removal and grit handling areas; (4) primary sedimentation tank (PST) influent/effluent channels and (5) PST launder area. Further details will be developed during the preliminary design phase.

- Given odors generated at the headworks and primary clarifiers are similar, it is recommended that a common odor control system be provided for the headworks and primary clarifiers. This will reduce site space required for odor control and the overall cost of the odor control system.

9.3 Technologies Considered

The following odor control technologies are commonly used for odor control at WWTPs and were evaluated for treating odors generated by the preliminary treatment process:

- Activated sludge diffusion – diffusion of the odors into the aeration basins where they are oxidized

- Bioscrubber – a biological treatment process in which synthetic media is placed inside a vertical tower and odors are removed biologically

- Biofilter – a biological treatment process in which odors are removed biologically using organic or inorganic media, typically inside a custom built structure

All three technologies have been utilized successfully for many years and provide adequate odor control. However, since the secondary process will not be in operation until 2023 and due to some recent process control issues associated activated sludge diffusion, activated sludge diffusion is not considered a viable alternative. Biofilters are a cost effective alternative, but typically require a significantly larger footprint than bioscrubbers. Based on a preliminary sizing analysis, use of biofilters is not practical due to the space limitations at the WPCP. Like biofilters, bioscrubbers require no chemical usage (if non-chlorinated plant effluent water is used in the system), utilize less site space and can be expanded to provide two-stage treatment of odors should more stringent odor control be necessary in the future. Given these advantages, package-type bioscrubber systems are recommended for scrubbing odors generated at the preliminary process. Further details will be provided during preliminary design.

9.4 Recommendations and Site Considerations

The findings and recommendations for odor control include:

- Provide a single, package-type bioscrubber system to treat odors collected from both the preliminary and primary treatment process areas.

- Locate the odor control system near the preliminary and primary treatment processes to simplify the odor ducting design.

- Include the following provisions to adequately contain and exhaust odors generated at the preliminary treatment facility:
  - Cover and enclose all channels, screens, wet wells and grit basins. Include provisions for corrosion protection for all covered areas (e.g., use of stainless steel and concrete coatings).
  - Install exhaust fans to extract enough air from the covered and enclosed areas to prevent fugitive emissions and convey it to the odor control system.
  - Install a ventilation system for areas that will be accessed by personnel to provide proper ventilation required for worker safety.

Further details for the containment, ventilation, and treatment of odors, will be provided as part of the preliminary design effort for the Primary Treatment Facility.

APPENDIX A – PROCESS ALTERNATIVES REVIEW WORKSHOP MINUTES AND SLIDES – OCTOBER 15TH, 2013

Engineers...Working Wonders With Water™

CONFERENCE MEMORANDUM

Project:	Master Plan and Primary Treatment Design	**Conf. Date:**	October 15, 2013
Client:	City of Sunnyvale	**Issue Date:**	October 31, 2013
Location:	West Conference Room		

Attendees:

City:
John Stufflebean
Kent Steffens
Craig Mobeck
Bhavani Yerrapotu
Bryan Berdeen
Dan Hammons
Melody Tovar
Manuel Pineda
Mansour Nasser
Alo Kauravlla

SCVWD:
Hossein Ashktorab
Luis Jaimes

Carollo/HDR/Subconsultants:
Jim Hagstrom
Jamel Demir
Jan Davel
Katy Rogers
Anne Conklin
Daniel Cheng
Scott Parker
Walid Karam
James Wickstrom

Boris Pastushenko
David Jenkins
Alex Ekster
J.B. Neethling

Dana Hunt
Hany Gerges
June Leng

Ray Goebel

Purpose: Process Alternatives Review Workshop (Workshop 2)

Distribution: Attendees **File:** 9265A.00

Discussion:
The following is our understanding of the subject matter covered in this conference. If this differs with your understanding, please notify us.

1. **FILTRATION**
   a. **Discussion**
      1) Regulatory Considerations and Implications
         a) The Basin Plan does not explicitly require filtration, but cites the use of filtration as a factor by which the South Bay treatment plants provide "equivalent protection" and hence qualify for an exception to the Basin Plan

prohibition on “shallow water” discharges. After some discussion, it was noted that the Master Plan will assume a filtration requirement for Bay discharge.

   b) At the moment, Apple’s recycled water quality requirements are very stringent, sometimes more than potable water requirements. However, they seemed open to adjusting their requirements during negotiations with SCVWD. It was agreed to move forward with the assumption to provide Title 22 quality recycled water to Apple.
   c) Some questions regarding TDS levels in WPCP influent. Overall water supply TDS is low. The City has discovered a pipe that is introducing Bay water to the collection system. The flow is estimated to be around 0.5 mgd and contributes 2,600 mg/l of TDS. The City is currently working to seal the leak, which should lower the influent TDS to the WPCP.
2) Long Term Alternatives
   a) Analysis indicates that it is viable to continue use of the existing dual media filters.
   b) A filter re-rating study should be perform to allow production of Title 22 quality water at higher filter loading rates (precedent set for this).
   c) The analysis of alternatives indicates that supplementing with potable water is the lowest NPV option.
   d) There was discussion on how peak flows would affect filter operation. It was noted that San Jose has loaded their filters at 9 gpm/sf during peak flows, and that the main considerations of peak flow loading is the exceedances of Title 22 filtration rate limits and a shortened filter run time.
   e) It was noted that potable water blending will provide additional reliability to the recycled water system.
3) Short Term Alternatives
   a) The existing chlorine contact basins can be modified to allow for a dedicated recycled water channel (eliminates batch operation).
   b) With this modification, the existing filters, supplemented by potable water, could meet the near-term recycled water demands.
   c) It was noted that the interim filtration requirements would need to be refined to consider the split treatment scenario.
   d) While MBR and UF were only presented as short term solutions, there was interest in determining how much these facilities would impact the future secondary treatment costs.
4) SCVWD staff indicated that their Board has just approved funding for an indirect potable reuse (IPR) study. Therefore, the City should include IPR in the future MP process planning considerations. It was noted that the decision for the secondary processes will need to be made in the spring of 2014. Therefore, SCVWD will need to provide a clear direction for IPR prior to that. All agreed that the consideration of IPR will impact the short and long term recommendations for the filtration process.

5) **It is recommended that the existing filter facilities continue to be utilized for both Bay discharge and recycled water needs.**

b. **<u>Decisions</u>**

1) Final decision on filtration approach will be pending SCVWD's IPR evaluation.

c. **<u>Action Items</u>**

1) Carollo needs to determine impacts of peak flows on the final recommendation.

2) A separate meeting will be scheduled between the City and the master plan team to discuss possible impacts of IPR.

2. **DISINFECTION**.

a. **<u>Discussion</u>**

1) Regulatory Considerations and Implications

a) Current disinfection requirements include effluent limits for total coliform (for recycled water) and enterococcus (for Bay discharge). CECs, THMs and NDMA are future long-term considerations.

2) Alternatives

a) Based on near-term Bay discharge and recycled water demands, continue transition from gaseous chlorine to HOCl disinfection.

(1) Dedicate three chlorine contact tanks (CCTs) to Bay discharge and one CCT to recycled water.

(2) Identified need to add aqueous ammonia feed station to disinfect fully nitrified AS effluent. This avoids break-point chlorination to maintain the required chlorine residual (and also mitigates THM formation). THMs will continue to be monitored.

(3) UV could become an alternative when NDMA and THMs are regulated (long-term issue).

(4) Ozone would be an effective AOP for CECs (whether added to HOCl or UV or as a standalone single treatment technology).

b) There was a discussion on whether or not to add ammonia to free chlorine after the new secondary process comes online. Carollo/HDR recommended that the Master Plan analysis assume that ammonia addition is needed for chloramination. When TN limits become a reality, one option is to evaluate a dual disinfection process – chloramination followed by free chlorine. This is currently done in LA County.

c) The group noted that CEC's could be a direct concern if IPR is implemented.

d) Two ideas were proposed to mitigate THM formation:

(1) Perform breakpoint chlorination to mitigate NDMA. It was noted that free chlorine would not be effective for NDMA control.

(2) Add ozone prior to the filters, which allows the filters to more effectively remove precursors for THMs.

e) Carollo/HDR concluded that building an MBR for the near term recycled water demands alone is not a cost effective option.

f) **Carollo/HDR recommended that master planning site space be reviewed and potentially allocated at the WPCP for not only the HOCl and aqueous ammonia facilities, but for potential UV and ozone facilities.**

3) Layouts

a) Based on accommodating potential IPR needs, It was noted that an 8,000 sf RO facility will most likely not fit on the WPCP site if conventional AS is selected (MBRs provide space for an RO facility.

b. **Decisions**

1) Continue with the conversion to HOCl disinfection.

2) In future, once the NAS system is operational, add aqueous ammonia to chloraminate.

3) If NDMA limits precludes the continued addition of aqueous ammonia, monitor THM formation. If THMs become an issue, consider conversion to UV.

4) Once CECs become regulated, consider installation of an ozone system.

c. **Action Items**

1) Carollo to evaluate additional disinfection alternative to minimize THM production – chloramination followed by free chlorine disinfection.

HEADWORKS

a. **Summary of Recommendations**

1) Provide bar screens before pumping.

2) Build headworks structure for build-out flows. Analyze the phasing of mechanical equipment based on flow requirements.

3) Provide odor control for entire headworks facility.

4) Pump station

a) Rectangular wetwell.

b) Dual wetwell configuration

c) Dry-pit pumps

d) Vertical non-clog or submersible non-clog pumps

5) Screening

a) 3/8-inch bar spacing.

b) 3 duty screens, 1 standby screen, 1 bypass channel.

c) Multiple-rake or catenary screen (Duperon).

6) Screenings Conveyance

a) Shaftless screw conveyors.

7) Screenings Washing

a) Auger with Spray Washing.

8) Grit Removal

a) Eutek HeadCell.

b) Two duty plus one standby unit with hydraulic capacity for peak hourly flow, and treatment capacity for peak day flow.

9) Grit Washing

a) Huber Coanda.

b) One standby unit.

b. **<u>Discussion</u>**

1) Influent Pumping

a) There was concern regarding the long shafts inherent to dry pit non-clog pumps. The meeting participants agreed that dry pit submersible pumps should be further evaluated since they do not have associated long shafts.

b) It was noted that the cleaning requirements for the wetwells will be minimal since daily flows should provide sufficient scour.

c) The Master Plan team noted the difficulty of expanding headworks structures. After some discussion, there was general consensus that the headworks structure should be constructed for the buildout flows during the upcoming design, whereas the equipment will be phased in as flows increase.

2) Screening

a) Question raised about getting screenings out (30 foot depth) – sufficient experience noted for this approach. Should be focus of next rounds of field trips.

b) The selection of screen spacing was discussed (trade off of finer materials capture vs. effective organics separation. It was noted to the City that once the new headworks is constructed, the plant will be faced with a new reality – dealing with screenings at the front end of the plant (and not downstream in places like the digesters).

c) The SIP showed that the screenings washing/compacting facility will be housed in a canopy. However, the current assumption is that the screenings washing/compacting facilities will be housed in a masonry building for odor control. There was general agreement regarding this approach.

d) The screens will lift rags and solids above grade, eliminating the need for an angled screw conveyor between the screens and the washer/compactor.

3) Grit Removal

a) The grit study found that the grit at Sunnyvale is larger than typical grit found at similar plants. However, the grit settles slower than typical grit of similar size. The result is that the required grit facilities (Headcell or aerated grit basin) would need to be 60% larger than an equivalently sized facility at a typical treatment plant.

b) The NPV analysis recommends the selection of the HeadCell technology based on cost and footprint. However, it was noted that inspection and maintenance considerations will need to be further refined.

4) Grit Washing

   a) There was general agreement that even though Coanda is 25 – 30% more expensive than a cyclone, it produces higher quality grit and should be selected.

   b) The City expressed the desire to have a standby Coanda unit. Carollo/HDR recommend having a standby unit.

c. **Decisions**

1) Provide screens ahead of influent pumping.
2) Select 3/8" bar spacing.
3) Build headworks structure for buildout flows but phase in additional equipment as flows increase.
4) Provide odor control at the headworks.
5) Provide a pump station with a rectangular, dual, dry-pit configuration.
6) Provide shaftless screw conveyors for screenings conveyance.
7) Provide auger with spray washing for screenings washing/compaction.
8) Provide a building to house the screening and grit handling equipment.
9) Provide HeadCell for grit removal.
10) Provide Coanda for grit washing and dewatering.

d. **Action Items**

1) Schedule site visits to influent pump stations that are configured with a rectangular dry pit.
2) Resolve pump selection as part of pre-design
3) Carollo to identify potential sole-source equipment issues associated with the headworks implementation.

3. **THICKENING**

a. **Summary of Recommendations**

1) Based on analysis of alternatives, rotating drum thickeners (RDTs) are the recommended technology for thickening of WAS only
2) Could be used for co-thickening if that is desired
3) Could be co-located with dewatering facility

b. **Discussion**

1) Odor control will need to be provided as part of this facility.

c. **Decisions**

1) Provide RDTs to thicken WAS.

d. **Action Items**

1) City to visit some RDT facilities.

4. **DIGESTION**

   a. **Summary of Recommendations**

      1) Modify to allow all digester to operate as primary units.
      2) Potential need identified for two additional digesters (needs to be evaluated after AS plant comes on-line). New digesters would be the same size as Digester No. 4.
      3) Provide space for either pre-process or post-processing technologies.

   b. **Discussion**

      1) Regulatory Considerations and Implications.
         a) No current or near-term drivers for Class A sludge
         b) 503 regs drive HRT detention time (minimum of 15 days), but criteria used is typically more like 20 days. Analysis of future digester needs is based on 20 days.
      2) It was noted that space should be left for pre-processing (sonication) and post-processing (drying) because industry trends indicate that these technologies will gain traction in the future.
      3) Brought up the possibility of producing green waste pellets. It was noted that SRCSD tried a pelletizing operation, but discovered that it was costing $350/ton to operate, which is very expensive.
      4) Co-thickening primary sludge and WAS can bring the sludge up between 5%-6% prior to digestion (determine sensitivity on future digester needs).
      5) Regarding the possibility of receiving FOG, Carollo/HDR's experience is that projected FOG loadings are typically double the actual amounts generated. It was also noted that the City's SMaRT station will be rebuilt around 2021/2022, and any food/FOG waste can be considered as part of that renewal effort.

   c. **Decisions**

      1) Provide space for primary sludge screening.
      2) Provide space for two additional digesters with the same capacity as Digester No. 4.
      3) Provide space for possible FOG station to receive FOG and liquefied food waste.

   d. **Action Items**

      1) Carollo/HDR to show the impact of FOG and food waste in digester gas projections during the plant energy balance exercise.
      2) Carollo/HDR to determine sensitivity of digester capacity as a function of sludge thickness.

5. **DEWATERING**

   a. **Summary of Recommendations**

1) Centrifuges were lowest NPV alternative – but screw presses still under consideration.

b. **Discussion**

1) The group discussed the O&M requirements between screw presses and centrifuges. It was noted that centrifuges are more labor intensive but screw presses are more costly. Operations staff felt that screw presses could be operated with less attention.

2) Implementing centrifuges or screw presses are both viable options for sludge dewatering. The decision is largely dependent on O&M preferences.

c. **Decisions**

1) Delay the decision of sludge dewatering technology, until City staff visits screw press and centrifuge dewatering facilities and determines technology preferences.

d. **Action Items**

1) Carollo to organize site visits to screw press and centrifuge dewatering facilities with City staff.

6. **ODOR CONTROL**

a. Summary of Recommendations

1) Provide bioscrubbers for odor control

2) Near Term – Implement odor control at headworks and primary sedimentation tanks.

3) Long Term – Implement odor control at thickening/dewatering facilities.

b. Discussion

1) Odor testing at the plant site revealed that there are no major issues with RSC and VOCs.

2) Field testing work indicated odor issues associated with the existing headworks/primary sedimentation tanks.

c. Decision Log

1) Provide odor control at the headworks and primary sedimentation tanks as part of the Phase 1 project.

d. Action Items

1) None

Prepared By:

Daniel Cheng

DC:JD:dc

This workshop module will be a success if …

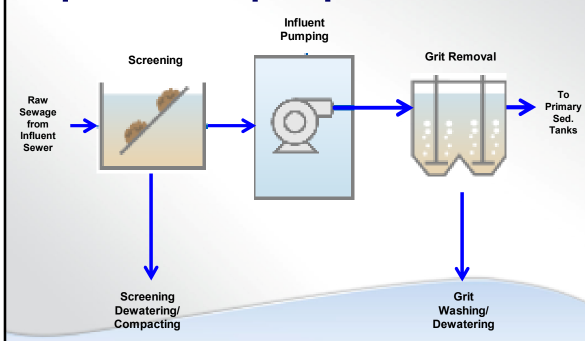
- ✓ Establish location of pumps relative to screens
- ✓ Establish wet well configuration
- ✓ Establish technology, preferred manufacturers and design criteria
  - ✓ Screening
  - ✓ Screenings handling
  - ✓ Grit removal
  - ✓ Grit washing

Agenda

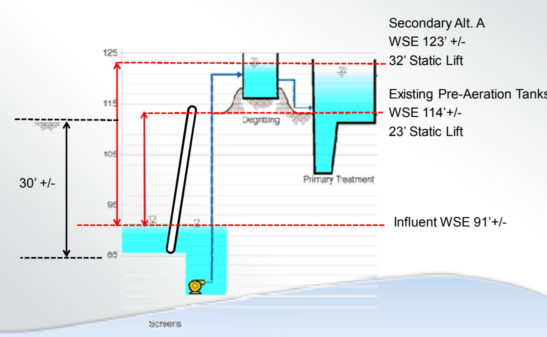
- ✓ Location of pumps relative to screens
- ✓ Wet well configuration and pump type
- ✓ Screening
- ✓ Screenings handling
- ✓ Grit removal
- ✓ Grit washing

Location of Pumps Relative to Screens

SIP recommended screening upstream of pumps



Screenings will need to be lifted about 30 feet to grade



Recommend screening upstream of pumps

- Screens remove rags and protect the pumps (higher reliability)
- 30-foot deep screens are feasible and proven
- Provides more flexibility for pump technology

Wet Well Configuration and Pump Type

Key Topics – Wet Well Configuration and Pump Type

- SIP Recommendations
- Design criteria
- Single vs. dual wetwell
- Wet pit vs. dry pit
- Self cleaning trench vs. rectangular wet wells
- Types of pumps
- Wet well configuration alternatives
- Recommendations
- Next Steps

SIP Recommendations – Wet Well Configuration and Pump Type

- Provide safe, single, self-cleaning wet well
- Easy maintenance for pump equipment and drivers
- Vertical turbine solids handling (VTSH) pumps

Design Criteria - Flows

Parameter	Current	Phase 1 Design	2035 (Buildout)
Peak Hour Flow, mgd	39.6	50.9	58.5
Average Annual Flow, mgd	13.8	17	20.4
Min Flow, mgd	3.3	4.3	4.9

- Recommend facility design accommodate 2035 (buildout) flows
- Potential to phase equipment to meet interim flows

Single vs. Dual Wet Well

Single Wet Well

- No redundancy
- Smaller footprint
- Lower cost

Dual Wet Well

- Improved redundancy at low flows
- Larger footprint
- Higher cost

Wet Pit vs. Dry Pit

Wet Pit Pumps (e.g. Submersible Pumps)

- Smaller footprint (if trench-type)
- Lower cost
- Regular maintenance more difficult

Dry Pit Pumps

- Larger footprint
- Higher cost
- Regular maintenance easier

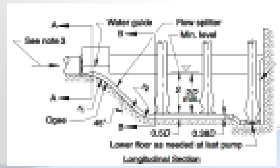
Self-Cleaning Trench vs. Rectangular Wet Well

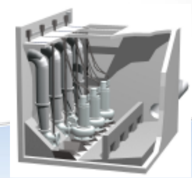
Self-Cleaning Trench

- Less solids accumulation in wet wells
- Less efficient use of site space with upstream screening facility

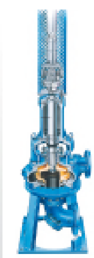
Rectangular Approach

- Higher potential for solids accumulation in wet well
- More efficient layout with upstream screening facility





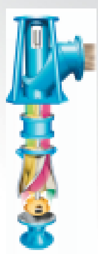
Types of Pumps



Vertical Non-Clog Centrifugal

Screw Centrifugal

Non-Clog Submersible



Vertical Turbine Solids Handling (VTSH)

Dry Pit Pumps ← → (Vertical Non-Clog Centrifugal, Screw Centrifugal, Non-Clog Submersible)

Wet Pit Pumps ← → (Non-Clog Submersible, VTSH)

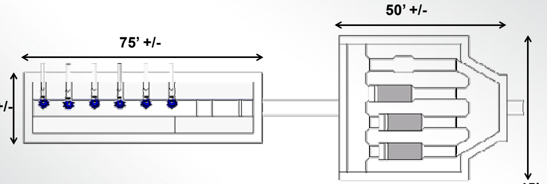
Types of Pumps

Type	Pros	Cons
Vertical Non-Clog Centrifugal (Dry Pit)	- Many installations - Good access for maintenance	- Extended drive shaft required to keep motor dry
Non-Clog Submersible	- Many installations	- Must pull pump for maintenance using crane - More factory maintenance may be required
Screw Centrifugal (Hidrostal)	- Reduced ragging issues - Passes stringy material	- Fewer installations - Limited models and manufacturers
VTSH	- Access to motor and mechanical seal above grade	- Fewer installations - Very difficult to pull pump for maintenance

Wet Well Configuration Alternatives

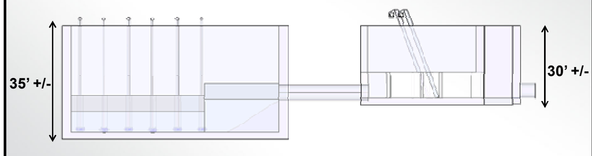
Alternative	Description
1	Single, self-cleaning wet well, with submersible pumps
2	Single, self-cleaning wet well, with dry pit pumps
3	Dual, self-cleaning wet well, with submersible pumps
4	Dual, rectangular wet well, with dry pit pumps

Alt 1 – Single, self-cleaning wet well, with submersible pumps



Bottom Plan

Alt 1 – Single, self-cleaning wet well, with submersible pumps

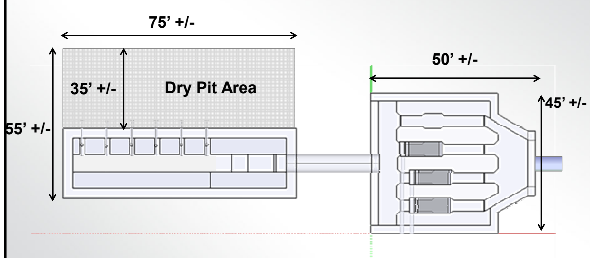


Section

Alt 1 – Single, self-cleaning wet well, with submersible pumps

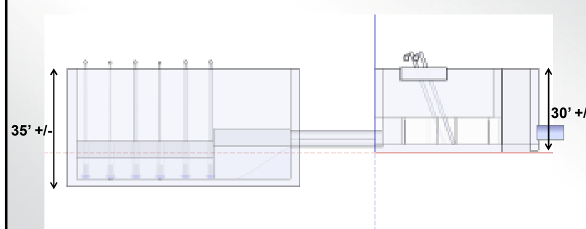
Pros	Cons
Lower cost compared to wet pit/ dry pit configuration	More difficult to access pumps for service and inspection than dry pit
Less solids accumulation in wet well	Requires periodic crane rental, tall bridge crane or special equipment for submersible pump retrieval
Simpler control	Less redundancy and maintenance flexibility with single wet well

Alt 2 - Single, self-cleaning wet well, with dry pit



Bottom Plan

Alt 2 - Single, self-cleaning wet well, with dry pit

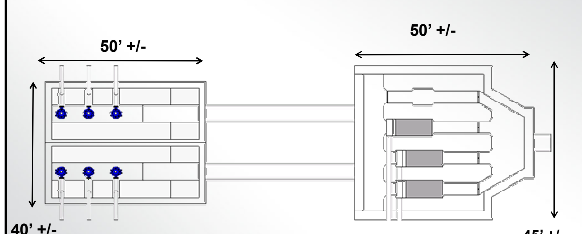


Section

Alt 2 - Single, self-cleaning wet well, with dry pit

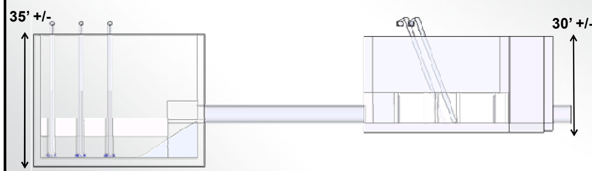
Pros	Cons
Good access to pump and motor for service and inspection	Higher cost compared to submersible pump configuration
Less solids accumulation in wet well	Increased costs to provide dry pit suitable for personnel access
Simpler control	Less redundancy and maintenance flexibility with single wet well

Alt 3 - Dual, self-cleaning wet well, with submersible pumps



Bottom Plan

Alt 3 - Dual, self-cleaning wet well, with submersible pumps

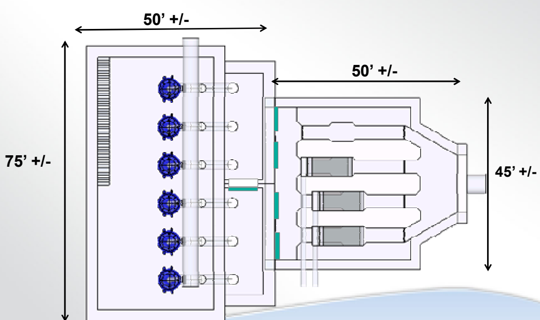


Section

Alt 3 - Dual, self-cleaning wet well, with submersible pumps

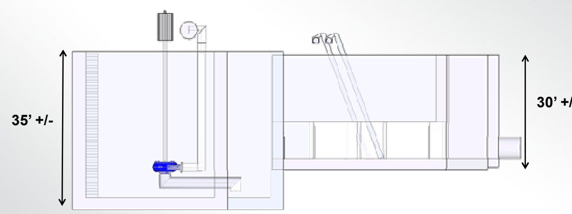
Pros	Cons
Lower cost compared to wet pit/ dry pit configuration	More difficult to access pumps for service and inspection than dry pit
Less solids accumulation in wet well	Requires periodic crane rental, tall bridge crane or special equipment for submersible pump retrieval
More redundancy and maintenance flexibility with dual wet pit design	More complicated controls to accommodate separated wet wells

Alternative 4 – Dual, rectangular wet well, with dry pit pumps



Bottom Plan

Alternative 4 – Dual, rectangular wet well, with dry pit pumps



Section

Alternative 4 – Dual, rectangular wet well, with dry pit pumps

Pros	Cons
More redundancy and maintenance flexibility with dual wet pit	Higher cost. Increased costs to provide dry pit suitable for personnel access.
Simplest control	May require periodic wet well cleaning to remove accumulated solids
Good access to pump and motor for service and inspection	

Capital Cost Summary

Alt.	Description	Capital Cost
1	Single, self-cleaning wet well, with submersible pumps	$7.8M ±
2	Single, self-cleaning wet well, with dry pit	$10.0M ±
3	Dual, self-cleaning wet well, with submersible pumps	$8.2M ±
4	Dual, rectangular wet well, with dry pit	$9.3M ±

Note: Excludes common facilities (e.g., screening facility)

Evaluation of Alternatives

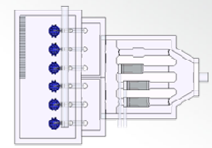
	1 Single self-cleaning wet well sub. pumps	2 Single self-cleaning wet well dry pit pumps	3 Dual self-cleaning wet well sub. pumps	4 Dual rectangular wet well dry pit pumps
Reliability	-	-	+	+
Ease of O&M	-	+	-	+
Power Usage	0	+	0	+
Flexibility	0	0	+	+
Site Efficiency	-	-	-	+
Capital Cost	$7.8M ±	$10.0M ±	$8.2M ±	$9.3M ±
Annual O&M	$250K ±	$220K ±	$250K ±	$220K ±
Net Present Value	$11.3M ±	$13.1M ±	$11.7M ±	$12.3M ±

Note: Excludes common facilities

+ Better	0 Neutral	- Worse

Recommend Alternative 4

- More redundancy and maintenance flexibility with dual wet well
- Efficient use of site space
- Good access for O&M
- Simpler control



Dual, rectangular wet well, with dry pit

Considerations of implementing Alternative 4

- 30 feet deep +/- screens
- 35 feet deep +/- pump station
- Covered channels and equipment for odor control
- Dry well designed for personnel entry
- Exposed pump motors (no building over deck)
- Long shafting (intermediate bearing?)
- Pump retrieval via fixed crane or rental equipment

Next Steps

- Tour installations
  - Dry Pit
    - OCSD Plant 1 or Plant 2
  - Self Cleaning
    - Orange County Sanitation District (OCSD), CA. Bitter Point Pump Station (40 mgd)
  - Submersible
    - City of Salem, OR
- Use Alternative 4 for master planning purposes

Screening

Key Topics – Screening

- SIP Recommendations
- Size of opening/ screenings capture
- Screening alternatives
- Recommendations
- Next Steps

SIP Recommendations – Screening

- Mechanical screening
- 3/8″ opening
- Continuous, automatic removal of screenings

Size of Screen Opening and Screenings Capture

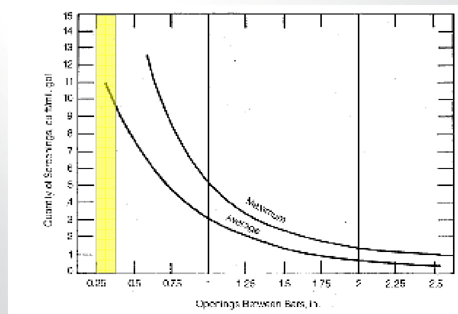
Clear Opening	Level of Capture	Comments
1/2″	- Removal of rags and trash	- Less prone to blinding than finer screens
3/8″	- Removes most plastics and some disposable wipes - Removes some organics	- Some washing recommended
1/4″	- Removes most plastics and disposable wipes - Removes lots of organics	- Screenings generate odors - High level of washing recommended

Note: General guidelines. Capture varies from facility to facility.

Screening Installations at Similar Facilities

Facility	Screen Clear Opening
Chico	1/4″
Dublin San Ramon	3/8″
EBMUD	1/4″
Millbrae	1/4″
Palo Alto	3/4″
Sacramento Regional	1/2″
Salem	3/8″
San Jose	3/4″
San Leandro	3/8″
SFPUC Northpoint	3/8″
SFPUC Oceanside	3/8″
West County Wastewater District	5/8″

As screen opening gets smaller capture increases significantly



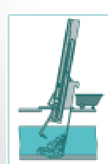
Source: WEF Manual of Practice 8

Recommend implementing 3/8″ screens

Clear Opening	Level of Capture	Comments
1/2″	- Removal of rags and trash	- Less prone to blinding than finer screens
3/8″	- Removes most plastics and some disposable wipes - Removes some organics	- Some washing recommended
1/4″	- Removes most plastics and disposable wipes - Removes lots of organics	- Screenings generate odors - High level of washing recommended

Note: General guidelines. Capture varies from facility to facility.

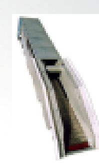
Screening Technology Alternatives



Climber Bar Screen

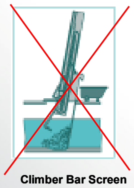
Chain Driven Multi Rake Bar Screen

Catenary Bar Screen



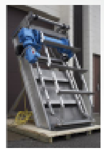
Step Screen

Screening Technology Alternatives



Climber Bar Screen

Chain Driven Multi Rake Bar Screen



Catenary Bar Screen

Step Screen

Eliminated:
- More difficult to enclose
- Combination of small bar spacing and long rake cycle time is problematic for deep headworks

Eliminated:
- Depth limitations

Screening Technology Alternatives

Chain Driven Multi Rake Bar Screen

Catenary Bar Screen

Chain Driven Multi-Rake Screen Advantages and Disadvantages

Advantages	Disadvantages
Most maintenance can be done above the channel	Bottom sprockets require occasional inspection and maintenance (channel entry)
Multiple rakes and two speeds increases screenings removal capacity	
Easy to cover for odor control	
Larger bars, more resistant to bending	
Automatic jam protection system	
Multiple Manufacturers	

Catenary Screen Advantages and Disadvantages

Advantages	Disadvantages
No lower sprocket in channel	Material hangs up on chain and drive shaft, requiring weekly cleaning
Maintenance can be done above the channel	Fewer rakes with spacers and lower operating speeds decrease screenings removal capacity
Easy to cover for odor control	Smaller bars, more prone to bending
Pivots around large objects	Pivots around large objects
	Requires sole-source procurement
	Evolving design for ½” and smaller

Evaluation of Alternatives

	Chain-Driven Multi Rake	Catenary
Reliability	0	0
Ease of O&M		
Routine O&M	+	-
Confined space entry	-	0
Power Usage	0	0
Site Efficiency	0	0
Number of Manufacturers	+	-
Cost	0	0

+ Better	0 Neutral	- Worse

Screenings facility recommendations

- Screen clear opening = 3/8”
  - Removes most plastics
  - Doesn’t require high level of washing
- Screen technology to be considered for preliminary design:
  - Chain-driven multi rake
  - Catenary
- Provide 1 standby screen
- Provide 1 emergency bypass channel

Next Steps

- Tour installations (≤½" bar spacing)
  - Multi-rake bar screen
    - San Francisco Oceanside
    - Chico
    - Dublin San Ramon
    - City of Los Angeles (Tillman)
    - City of Salem, Oregon
  - Catenary bar screen
    - EBMUD
    - El Dorado Irrigation District (Deer Creek WWTP)

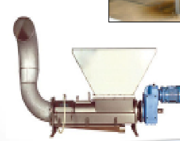
Screenings Handling

Key Topics – Screenings Handling

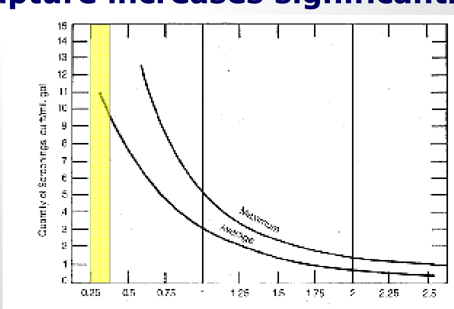
- SIP Recommendations
- Expected screenings removal
- Screenings handling alternatives
  - Conveyance
  - Washing
- Recommendations

SIP Recommendations – Screening

- Provide screenings debris transport
- Provide screenings washing to remove fecal matter
- Provide dewatering and compacting for offsite disposal



As screen opening gets smaller capture increases significantly

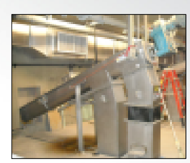


Source: WEF Manual of Practice 8

Screenings Conveyance Alternatives

Belt Conveyors

Hydraulic Sluiceways



Shaftless Screw Conveyors

- Requires compactor with high hydraulic capacity
- Requires higher redundancy in compactor equipment

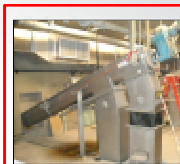
Belt Conveyor

- Difficult to effectively cover for odor control.
- Can be messy.

Screenings Conveyance Alternatives

Belt Conveyors

Hydraulic Sluiceways



Shaftless Screw Conveyors

- Reliable
- Clean
- Easy to cover for odors

Screenings Washing and Dewatering Alternatives

Auger with Spray Washing

(Moderate washing)

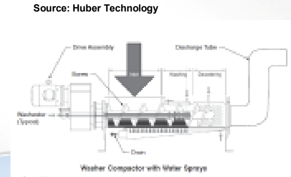
Auger with Agitation Washing

(High level of washing)

Auger With Spray Washing

- Limited break up of organic material
- Some units conduct batch washing cycle to improve washing performance
- Dewatered solids content is typically 30-40%
- Moderate capital cost
- Manufacturers:
  - Huber WAP
  - Vulcan EWP
  - Others

Source: Huber Technology



Source: Vulcan Industries

Auger With Agitation Washing

- Produces cleaner material
- Higher degree of O&M attention
- More complicated controls
- Solids content may exceed 40%
- Higher capital cost
- Sole source may be required
- Manufacturers:
  - Huber WAP/SL

Huber

Evaluation of Alternatives

	Auger With Sprays (Moderate Washing)	Auger With Agitation (High Washing)
Reliability	+	0
Ease of O&M		
-Cleaner product	-	+
-Less odors	-	+
-O&M labor and cost	+	-
Power Usage	+	-
Site Efficiency	0	0
Cost	+	-

+ Better	0 Neutral	- Worse

Screenings Handling Recommendations

- Shaftless screw conveyor for transport
- Auger washer compactor with sprays
  - Simple
  - Lower maintenance
  - Adequate washing for solids removed by 3/8” screen

Next Steps

- Tour installations
  - Washer Compactors w/ Sprays
    - SOCWA (Latham Plant, Dana Point,CA) – Vulcan EWP
    - SOCWA (Joint Regional Plant, Laguna Niguel,CA) – Vulcan EWP
    - City of Livermore, CA – Vulcan EWP
    - West County Wastewater District, Richmond, CA
  - Washer Compactors w/ Agitator
    - Fairfield Suisun Sewer District – Huber WAP-SL
    - City of Santa Barbara – Huber WAP-SL

Grit Removal

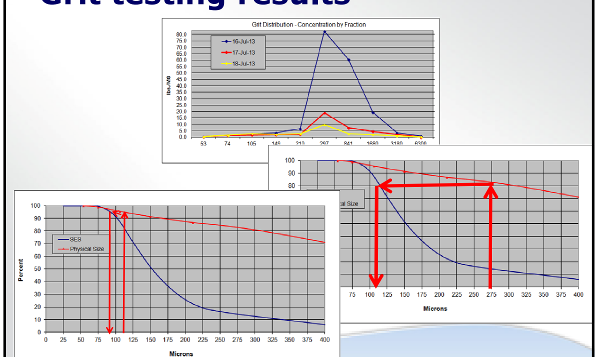
Key Topics – Grit Removal

- SIP Recommendations
- Summary of grit analysis
- Grit removal alternatives
- Recommendations
- Next Steps

SIP Recommendations – Grit Removal

- Sloped, pre-aeration grit removal tanks
- In-tank separation of organics and inert material

Grit testing results



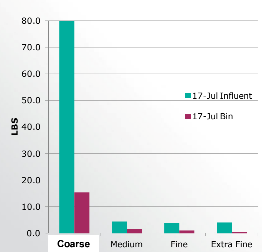
Grit Characterization Study Conclusions:

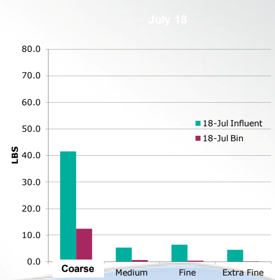
- Influent grit data for July 16 is anomalous and should not be used in the analysis
- Influent grit is larger and settles slower than is typically found in grit sampling/testing at other plants
- The existing grit removal system removes about 20% of the influent grit
- To significantly increase grit removal, the grit settling faster than 0.85 cm/s would have to be targeted (18,300 gpd/sf)

Grit Characterization Study Conclusions:

- The moisture content of removed grit is approximately 65% and its organic content is approximately 25%. A good grit handling system can improve these values considerably.

Grit Fixed Solids

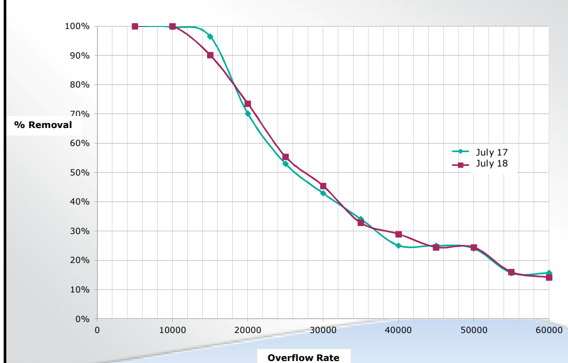




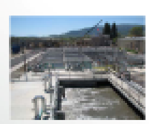
Test Results

Test Date	Grit In (lb FS/mg)	Grit In (lb FS)	Grit Removed (lb FS)	% Removal
July 16	181	417	26	6
July 17	41	93	19	20
July 18	25	58	13	22

Predictive Removal

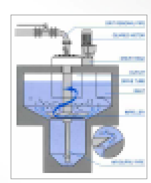


Grit Removal Alternatives



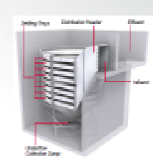
Aerated Grit Basins

- Large footprint
- Mechanically intensive
- Higher energy use



Mechanically Induced Vortex Grit Basins

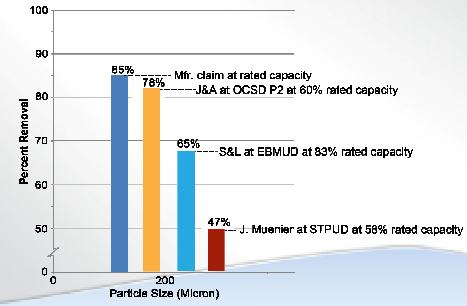
- Small footprint
- Few moving parts



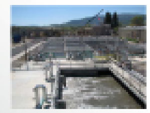
Multi-Tray Vortex (Headcell)

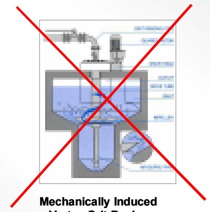
- Small footprint
- No moving parts
- Sole-source

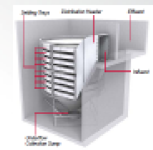
Operational experience shows that vortex basins do not perform as advertised



Grit Removal Alternatives


Aerated Grit Basins


Mechanically Induced Vortex Grit Basins

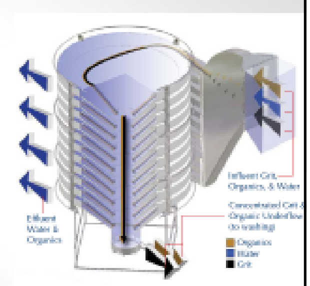

Multi-Tray Vortex (Headcell)

Aerated Grit Chambers

- Can be sized for virtually any flow
- Potential improved flocculation of light solids which is good for PST performance
- More control of removal
- Energy intensive
- Increased O&M attention
- Larger footprint
- More foul air to treat
- Higher cost

Eutek Headcell™

- High turndown ratios
- No moving parts or blowers
- Small footprint
- Capable of removing more fine particles than aerated grit
- Relatively new in the market
- Screening requirements (<¾")
- Sole-source required
- More difficult to inspect
- Need to address potential loss of pumping



Design Criteria

Parameter	Current	Phase 1	2035 (Buildout)
Peak Hour Flow, mgd	39.6	50.9	58.5
Peak Day Flow, mgd	27.1	34.8	40.0
Average Dry Weather Flow, mgd	13.2	17.0	19.5
Min Flow, mgd	3.3	4.3	4.9

- System should <u>hydraulically</u> pass the peak hourly flow (~60 mgd) with one grit basin out of service
- At flows above 40 mgd, grit is expected to be relatively heavy due to higher velocities in sewers

Alternative Configurations

	Aerated Grit Basins 40-mgd	HeadCell 40-mgd
Design Flow, mgd	40	40
No. of Basins	3	3
Basin Dimensions	800 SF/basin	12' diameter 9 trays
Capital Cost	$8.8M ±	$6.6M ±
Annual O&M	$190K ±	$120K ±
Net Present Value	$11.1M ±	$7.9M ±

Evaluation of Alternatives

	Aerated Grit (40 mgd)	HeadCell (40 mgd)
Reliability	+	0
Ease of O&M		
- O&M labor and cost	-	+
- Ease of inspection	+	-
Power Usage	-	+
Flexibility	0	0
Site Efficiency	-	+
Net Present Value (NPV)	$11.1M ±	$7.9M ±

+ Better	0 Neutral	- Worse

Grit Removal Recommendations

- Eutek Headcell System
- 60 mgd hydraulic capacity with one unit out of service
- 40 mgd design capacity for grit removal
  - Corresponds to the design peak day flow
  - About twice the ultimate design average flow (19.5 mgd)
  - At flows above 40 mgd, grit is expected to be relatively heavy due to higher velocities in sewers

Next Steps

- Tour installations
  - HeadCell
    - Littleton-Englewood, CO
  - Aerated Grit Chambers
    - Clark County Sanitation District, Las Vegas
- Meet with Purchasing
  - Sole-source procurement

Grit Washing

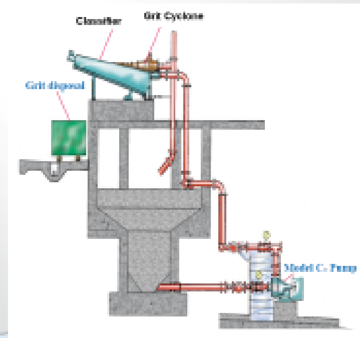
Key Topics – Grit Washing

- SIP Recommendations
- Types of technology
- Recommendations
- Next Steps

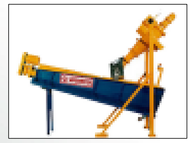
SIP Recommendations – Grit Washing/Dewatering

- Grit slurry pump flooded-suction pumps
- Fluidized bed grit washing/dewatering units

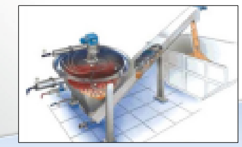
Flooded suction grit pumps recommended



Grit Washing and Dewatering Technologies

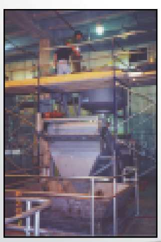
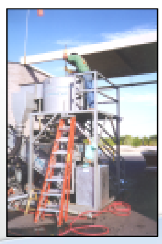

Cyclone & Grit Classifier


Eutek SlurryCup/Grit Snail

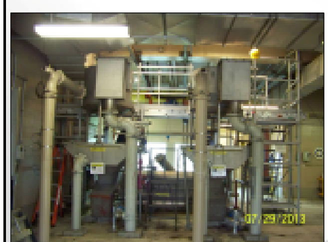

Huber Coanda

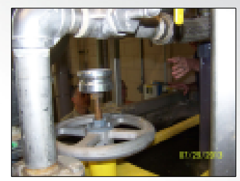
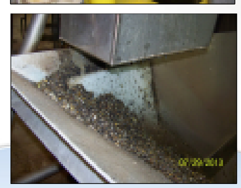
SlurryCup/Snail

- Maintenance-intensive
- Frequent plugging problems

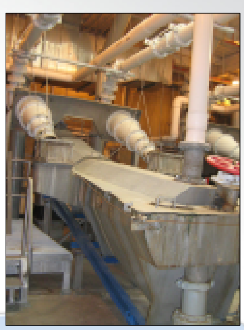

SlurryCup/Grit Snail, Englewood, CO



Cyclone and Grit Classifier

- Extensive successful experience in similar applications (Sunnyvale)
- Wide range of hydraulic capacity applicable to medium/ large plants
- Produces adequate product
- Provides limited washing of grit
- Moderate capital cost
- Manufacturers:
  - Wemco

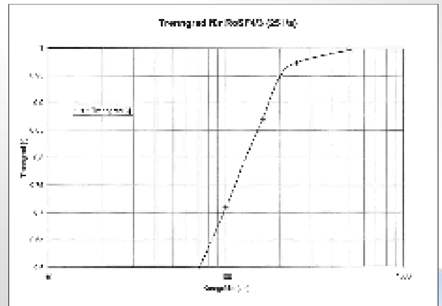


Cyclone and Classifier Typical Product

COANDA Grit Washing Equipment

- Produces a cleaner, drier, less odorous product
- Reduces hauling cost
- Higher capital cost
- Sole source required
- Manufacturers:
  - Huber (Coanda)

COANDA Grit Washer Performance Curve



Coanda Grit Product from Magna, UT

Evaluation of Alternatives

	Cyclone/ Grit Classifier	Coanda
Reliability		
-Capture of fines	+	0
Ease of O&M		
-Cleaner product	-	+
-Less odor	-	+
-Hauling cost	-	+
Power Usage	0	0
Flexibility	0	0
Site Efficiency	0	0
Number of Manufacturers	+	-
Cost	+	-

+ Better	0 Neutral	- Worse

Recommendations

- Tentative recommendation is to use Coanda units
  - Confirm performance of Coanda configuration for fine sand capture
  - Sole-source procurement required
- Default to cyclone classifier if Coanda fine sand removal cannot be achieved
- 1 standby unit

Next Steps

- Tour installations
  - Coanda
    - Denver Metro, CO
    - City of Henderson, NV
  - Cyclone/grit classifier
    - Clark County Sanitation District, Las Vegas
    - Orange County Sanitation District, CA
    - Fairfield-Suisun Sewer District, CA
- Meet with Purchasing
  - Sole-source procurement

Cost Comparison with SIP

Headworks Capital Cost Comparison – June 2014

Description	SIP	Facility Plan Cost
Headworks Facilities Described in SIP	$14.7M	
Electrical and Instrumentation	$3.2M	
Subtotal	**$17.9M**	
Dual Wet Well/Dry Pit PS	+$1.5M	
Standby Screen and Bypass Channel	+$1.6M	
60 mgd Pumping Capacity Installed Instead of 50 mgd	+$0.3M	
Facility 3-5 Feet Deeper	+$0.5M	
CMU Building for Screenings and Grit Bins	+$0.5M	
Account for Slow Settling Grit	+$0.7M	
Recycle Flows Pump Station	+$1.0M	
Total	**$24.0M±**	**$24.5M±**

This Workshop module will be a success if …

- ✓ Establish location of pumps relative to screens
- ✓ Establish wet well configuration
- ✓ Establish technology, preferred manufacturers and design criteria
  - ✓ Screening
  - ✓ Screenings handling
  - ✓ Grit removal
  - ✓ Grit washing

End

APPENDIX B – EUTEK HEADCELL® GRIT REMOVAL SYSTEM

Eutek HeadCell®

Advanced Stacked Tray Grit Separation

Water & Wastewater Solutions
Grit Removal at its Finest...™

Eutek HeadCell® - Stacked Tray Grit Separation

The Eutek HeadCell® is the ideal grit separator for both new and retrofit applications. The Eutek HeadCell® is a multiple tray separator that can be sized to remove fine grit over a wide range of flows with less than a foot of headloss. The Eutek HeadCell® provides high performance with a small footprint.

Applications

- New wastewater treatment plants
- Treatment plant retrofits
- Sediment removal pretreatment for potable water
- Grit removal for industrial effluent
- Pre-treatment for MBR and many other process upgrades

Advantages

- Large surface area in a small footprint
- No moving parts or external power source
- Less than a foot of headloss to operate
- Double treatment capacity in the same footprint as existing equipment
- Economical to own and operate
- Accommodates high turndown ratios

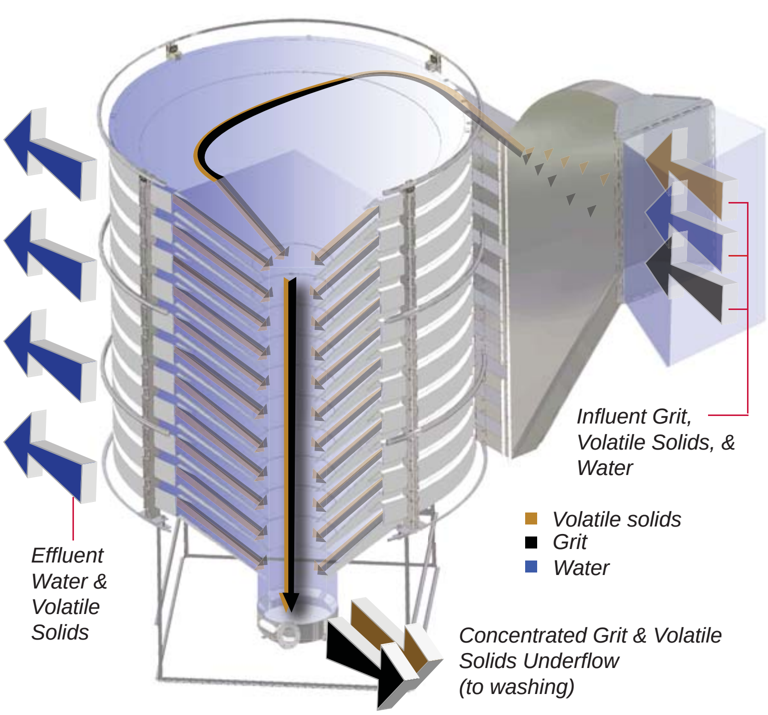
How it Works

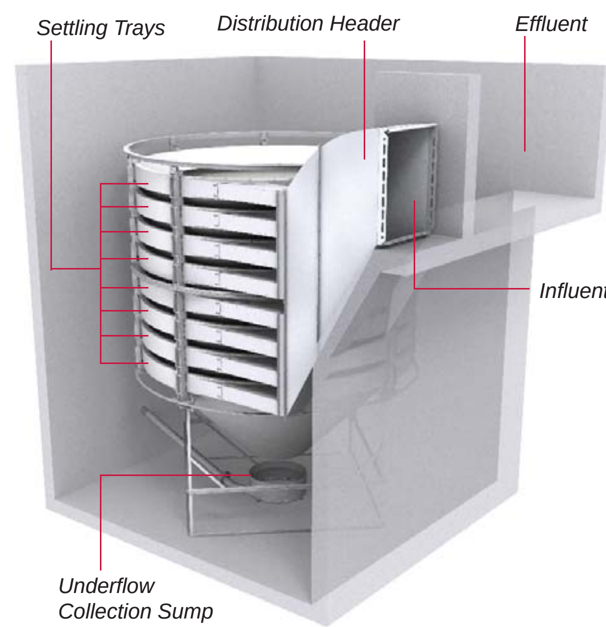
The stack of hydraulically independent polyethylene trays are submerged in a concrete chamber. Screened sewage enters the influent duct and passes into the grit chamber. The influent duct directs the flow into the high efficiency distribution header to evenly distribute the influent tangentially into the modular multiple-tray system.

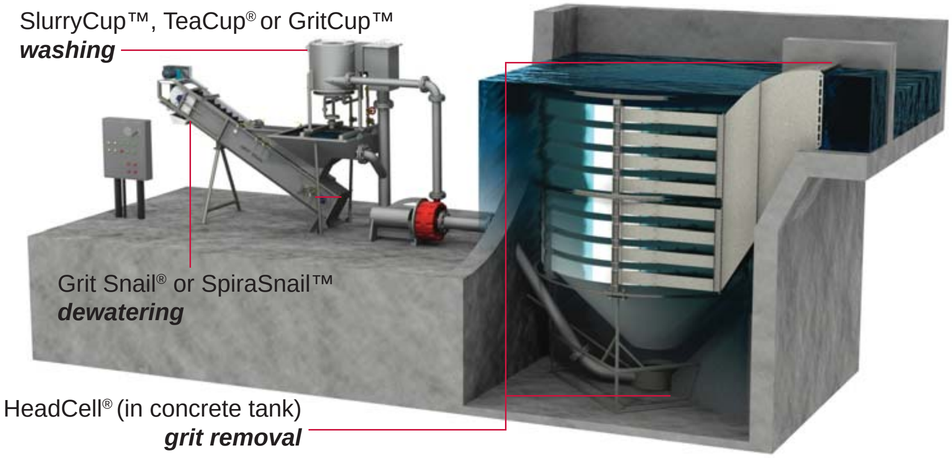
Tangential feed establishes a vortex flow pattern causing solids to fall into a boundary layer on each tray. Grit settles out by gravity along the sloped surface of each tray and then solids are swept to the center opening which allows them to fall to a common collection sump.

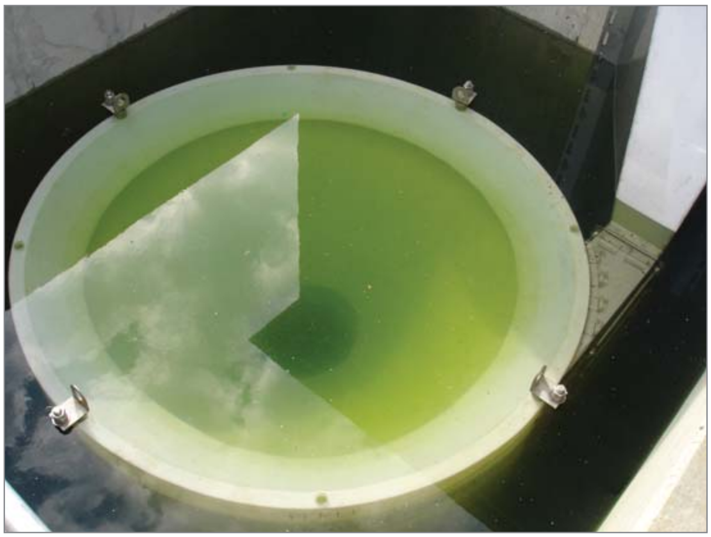
Degritted effluent flows out of the trays, over a weir and into an effluent trough. The HeadCell® typically requires less than 12 inches of headloss.

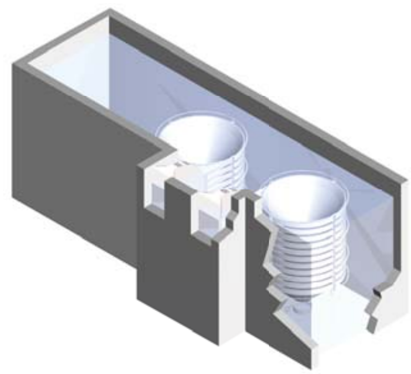
Often, the settled solids are continuously pumped from the grit sump to a Eutek SlurryCup™ or Eutek TeaCup® grit washing system and then dewatered by a Eutek Grit Snail® dewatering escalator, depending on grit load.











Two Eutek HeadCell® Units Retrofitted Into An Existing Grit Basin

Configurations

The Eutek HeadCell® fits into existing structures and uses existing channels, which significantly reduces concrete costs during installation. A retrofitted Eutek HeadCell® system can increase flow capacity and still capture finer grit in the same footprint. Inlet and outlet orientation and location can be configured to meet many design requirements.

Eutek HeadCell® Performance

- Removes 95% of particles equal to or greater than 75 microns at the design flow rate when used with Hydro washing and dewatering equipment
- Typically less than 12” inches headloss at peak flow
- Less than 15% volatile solids and greater than 60% total solids

Design Notes

- Short settling distances eliminate inefficiency and increase grit capture
- Large surface area effectively uses plant space
- Evenly split flows eliminate short circuiting
- Continuous boundary layer flows over hydrophobic surfaces, minimizes grease buildup and keeps trays clean
- All-hydraulic design with no moving parts ensures a long product life

Capacity

- Sized for peak flow at peak grit loads
- Virtually no turndown ratio limits
- Modular and expandable combinations to fit any size plant

APPENDIX C – HUBER COANDA® GRIT WASHER

COANDA Grit Washer RoSF 4

Grit separation, washing, dewatering in one system

- Reduced disposal costs
- Utilisation of the Coanda effect ensures high grit removal efficiency.
- Less than 3 % organic content
- High solids throughput
- More than 1300 installations worldwide

The situation

Grit from grit traps of wastewater treatment plants

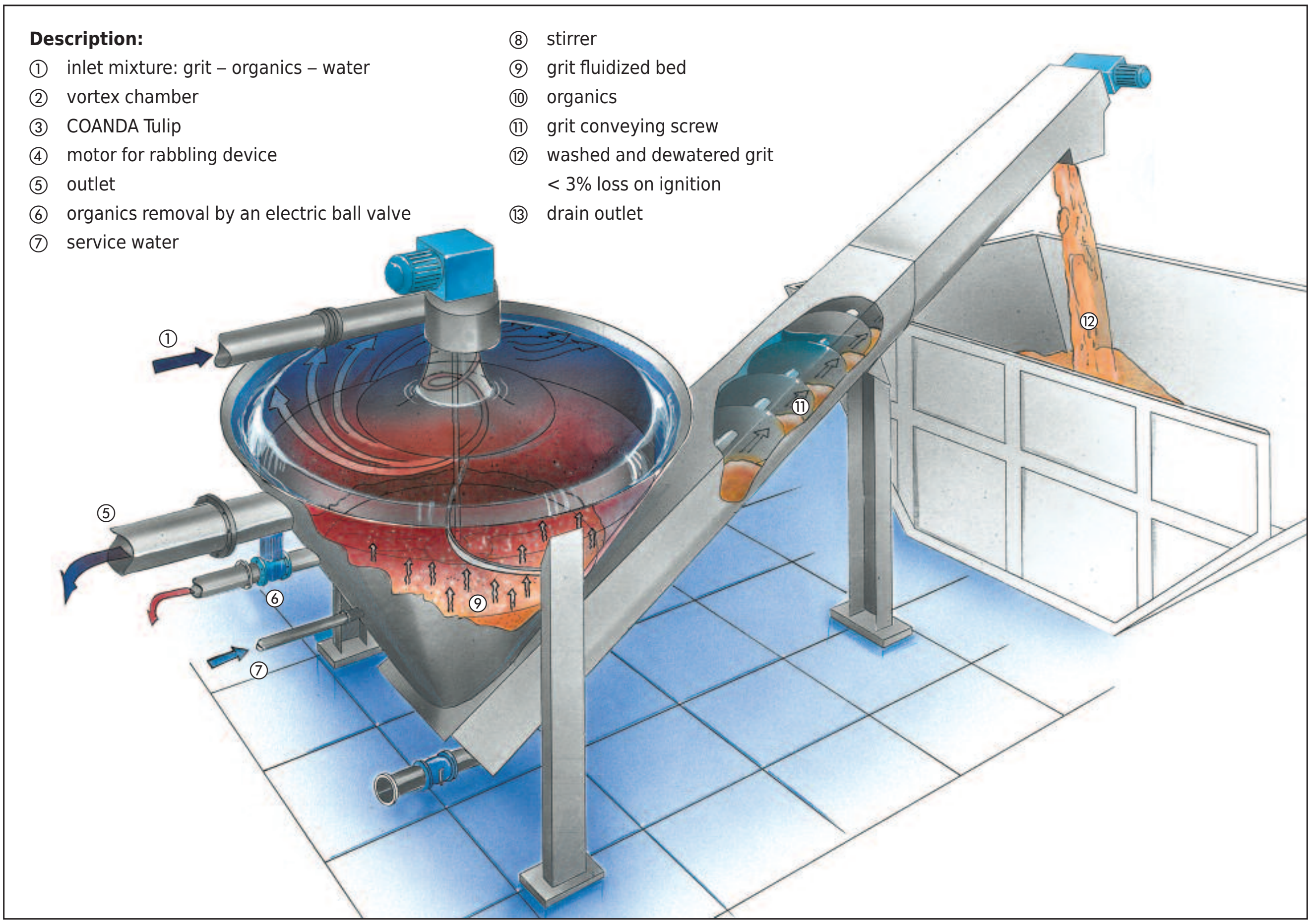
The grit contained in the wastewater is usually removed in grit traps by gravity or centrifugal force to protect downstream equipment. Various different grit trap systems are available for this purpose which however separate not only the grit but frequently also many of the organic particles, dependent upon the hydraulic load (inflow). The separated particles are then pumped from the grit trap to a grit classifying unit (screw or pilgrim step classifier) which remove the solids from the flow without any differentiation. As a result, the loss on ignition of the classified grit trap material varies from 10 % to 80 % depending on the screen bar spacing and inflow. The water content of the grit trap material is accordingly high (50 - 80 %).

The result are inevitably high costs for removal, transport and disposal, and in addition very bad hygienic conditions.

Grit from sewer systems, gully waste, road refuse

These raw materials are more or less contaminated with organics (sludge, leaves, etc.), but they contain also foreign matter that is similar to domestic waste (such as cans, screenings, stones, etc.), and a considerable amount of water. Additionally, the individual raw materials (grit, organics, foreign matter) vary seasonally so that their loss on ignition will range from 5 % to 80 % and their water content from 40 % to 90 %.

This results in inevitably high costs for dewatering, removal, transport and disposal.



Flow diagram of a COANDA Grit Washer RoSF 4

Design and function

Classifying and washing in one system

The COANDA Grit Washer combines grit classifying and grit washing in a single and compact unit. By using the COANDA effect the process of classifying can be combined with the process of sorting to ensure a continuously high separation efficiency and outstanding washing performance.

COANDA effect for excellent grit classifying

A mixture of grit, organics and water is fed through a vortex chamber where a fast spinning rotational movement is generated. The mixture then flows down through a trumpet-shaped COANDA Tulip.

The flow is diverted along the curved inner surface of the COANDA Tulip by the COANDA effect that a liquid flow is adhering to the contour of a curved surface. The flow is thus smoothly, without generation of eddies, diverted from a fast rotating vertical direction to a gradually slower rotating horizontal direction. The diagram shows the high flow velocity (red vectors) along the inner surface of the COANDA Tulip, the moderate radial velocity (green vectors) underneath the water surface and the again high velocity at the weir. The solids contained in the flow (grit particles, organic material) are then separated due to the flow diversion combined with flow velocity reduction, dependent upon the particle settling velocity, and sink down to the bottom portion of the tank. The excellent flow pattern in the COANDA Grit Washer leads to a > 95 % separation of 0.20 – 0.25 mm diameter grit particles.

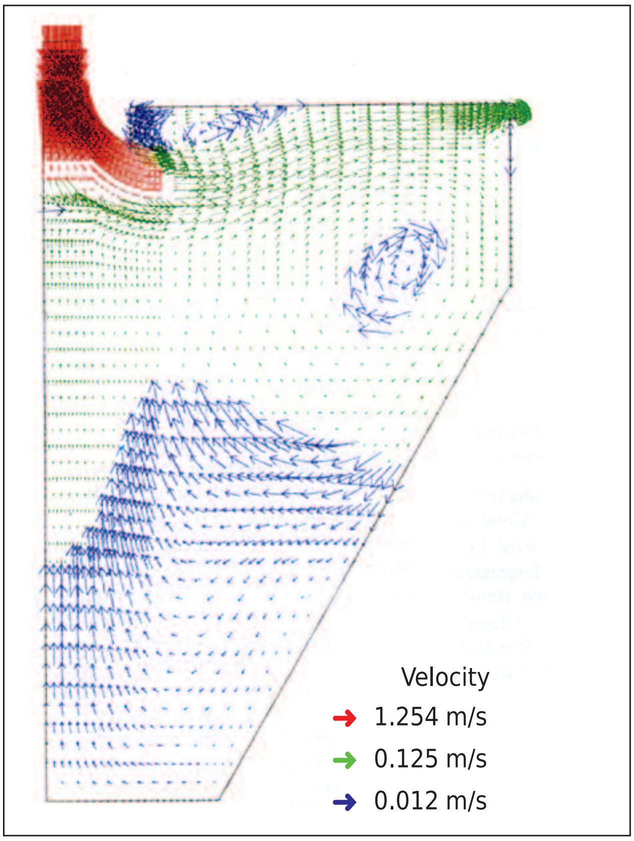
The separation degree depends on the settling velocity of the solids to be separated (due to the influence of particle density and size) so that also organic material will be separated.

Fluidised bed for outstanding grit washing

The separated grit is then washed, i.e. attached organic matter is separated from the mineral grit particles. This takes place in the bottom portion of the COANDA Grit Washer where a fluidised grit bed is generated. Wash water is fed into a bottom chamber that is separated from the grit washer tank by a perforated plate and a perforated rubber diaphragm. The wash water flows upwards through the diaphragm and is evenly distributed over the bottom of the tank thus generating a fluidised grit bed. Within the fluidised bed the grit particles rub against each other thus removing organics from their surfaces. This process is supported by the central stirrer keeping the particles in motion.

After removal of the organic material the clean grit is removed through a classifying screw, statically dewatered and discharged into a container.

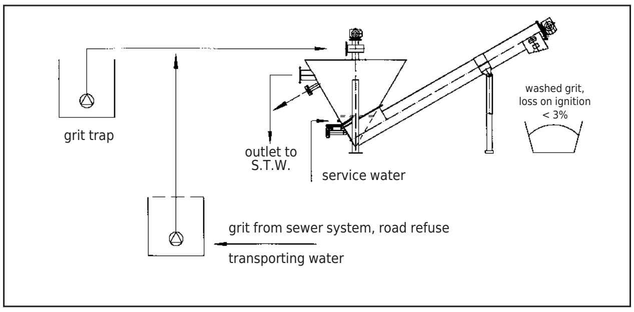
The organic material left in the COANDA Grit Washer is removed from the plant also automatically but discontinuously, depending on the entire process, so that a defined separation capacity is constantly available.



Flow velocities in the COANDA Grit Washer RoSF 4 (measured by TU Munich)

Washed grit removed at a wastewater treatment plant

Options for grit washing processes



- Reduced disposal costs
- 95% capture rate of 0.20 – 0.25 mm diameter grit particles due to the COANDA Effect and low surface overflow rate
- Organic content reduction to < 3% loss on ignition
- Dewatering of washed grit to approx. 90% dry residue

The user's benefits

- No additional preceding screening required (e.g. < 4 mm)
- High grit and gravel yield
- Suitable for treatment of grit from sewers, gully waste, road sweepings
- No crushing of stones and gravel inside the plant
- The screw is supported on both ends for minimised wear.
- Optional grit removal even during grit feeding due to on-line grit level measurement
- Encapsulated, odour-free plant
- Separate organics discharge allows for separate further treatment of organics
- Large diameter screws for a high solids throughput
- Stainless steel stirrer and screw
- More than 1300 installations worldwide give proof of customer satisfaction
- Easy to integrate into complete treatment processes

Installation examples

Innovative technology: COANDA Grit Washer RoSF 4 size III with frost protection for outdoor installation

Reduced disposal costs and improved hygienic conditions with the COANDA Grit Washer

HUBER SE

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COANDA Grit Washer RoSF 4