West Basin Facility Plan Project 7054

TECHNICAL MEMORANDUM 3

Rock Creek Grit Removal Alternatives Analysis

FINAL / August 2025

Produced by: carollo

Clean Water Services

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66976
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JAN. 1, 2002
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EXPIRES: 12/31/24

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Abbreviations

ADW	average dry weather
CAMP®	concentrated, accelerated, motivated, problem-solving
Carollo	Carollo Engineers, Inc.
District	Clean Water Services
fps	feet per second
gpd/sf	gallons per day per square foot
gpm	gallons per minute
MDDW	maximum day dry weather
MDWW	maximum day wet weather
mgd	million gallons per day
O&M	operations and maintenance
PHF	peak hour flow
ppd	pounds per day
SOR	surface overflow rate
TDH	total dynamic head
WRRF	Water Resource Recovery Facility

TM 3 ROCK CREEK GRIT REMOVAL ALTERNATIVES ANALYSIS

3.1 Executive Summary

The existing Rock Creek Water Resource Recovery Facility (WRRF) grit removal system is comprised of primary clarifiers, sludge pumps, primary sludge degritting, and grit storage hoppers. Primary sludge is degritted by two Slurry Cup/Snail grit washers. The Slurry Cup/Snail grit washers were originally configured for 650 gallons per minute (gpm) in a one duty one standby configuration, but WRRF operations staff have found that the equipment is most reliable and produces the best quality grit at a throughput of 450 gpm. Higher flow rates result in more frequent plugging issues and lower quality grit while the necessary vortex for grit separation is not stable at lower flow rates.

The Slurry Cup/Snail grit washers were installed in 2002. Operations staff have reported maintenance issues with the existing grit handling system. The system requires frequent maintenance due to plugging primarily of the units' hydraulic valve. Operations staff has reported plugging of the Slurry Cup/Snail up to several times a week. Modifications to reduce plugging also reduce the grit quality. The current firm capacity is insufficient for the projected primary sludge flows and loads. Typically, one roll-off dumpster load of grit is hauled per week. Carollo Engineers, Inc. (Carollo) experience in the industry suggests that plugging is a common maintenance issue with this type of equipment.

The capacity of the degritting system is set by the primary sludge flow rate, which will increase over time as growth occurs. The primary sludge flow rate is currently 430 gpm for average day and 760 gpm for maximum day. The firm capacity of the degritting system is 450 gpm, which is slightly higher than the current average daily sludge flow rate, but lower than the current maximum day flow rate. By 2045, the average daily primary sludge flow rate will exceed the firm capacity of the existing system. Capacity must be expanded to meet projected sludge flows, and improvements are also recommended to address reported maintenance issues.

The planning team evaluated three alternatives to increase the capacity and improve the performance of the existing system. For each alternative, it was assumed that the existing degritting equipment, which is close to the end of its service life, would be replaced. Alternative 1 assumes the system is expanded by replacing the two existing Slurry Cup/Snails in kind and installing a third, equally sized unit. Alternative 2 assumes installing two cyclone hydrogritters. Alternative 3 assumes installing three Coanda systems.

The alternatives were compared based on cost and non-cost factors. The analysis concluded that the cost of the degritting equipment would be similar for Alternatives 2 and 3, while Alternative 1 was significantly higher. The cost of installation will vary for each alternative, with Alternative 2 being the easiest to install and therefore having the lowest installation cost. Alternative 2 also scored the highest on non-cost factors, and is expected to produce a grit quality that is similar to the existing system.

Based on this analysis, Alternative 2 - Cyclones/Classifiers is recommended. The planning team noted that Alternative 3 - Cyclones/Coanda may have a distinct advantage with respect to grit quality. The system produces a cleaner, dryer grit product that could significantly reduce the cost of grit hauling in the future.

However, grit hauling is not currently a significant expense for the Rock Creek WRRF, and the performance of Coanda is not proven for degritting primary sludge. If Clean Water Services (District) is interested in further evaluating Coanda in the interest of producing a cleaner, drier grit product, additional evaluation and pilot testing is recommended.

3.2 Background

During initial discussions with District operations staff about the current Slurry Cup/Snail degritting equipment it was determined that the system has insufficient capacity for future loads and requires frequent maintenance to meet performance expectations. The equipment has also been in operation for over 20 years and is nearing the end of its service life. Based on these factors, the planning team considered alternatives to replace the existing system as described in this technical memorandum.

The current and projected primary sludge flows and loads are shown in Table 3.1. These projected flows and loads are based on a primary sludge concentration of 1.5 percent. The current average dry weather (ADW) flow rate is 430 gpm which is just below the 450 gpm firm capacity of the existing system. The current system's firm capacity is insufficient for the 2023 maximum day dry weather (MDDW) flow and maximum day wet weather (MDWW) flow, which are 720 gpm and 760 gpm respectively. By 2045 the projected average day primary sludge flow rate will exceed the existing system's firm capacity. New equipment will need to be implemented to handle the 2045 flow rates. A firm capacity of 1,000 gpm is needed to handle the 2045 MDDW scenario.

From an operations and maintenance standpoint, the Slurry Cup/Snail grit washers offer low reliability and excessive maintenance. The primary challenges raised by District operations staff have been maintenance related and not the grit quality. However, the grit quality has declined over time due to modifications to the equipment intended to reduce plugging in the Slurry Cup/Snail grit washers. The maintenance issues that are occurring are not uncommon for the Slurry Cup/Snail system and are well documented in similar systems.

Table 3.1 Projected Primary Sludge Flow and Loads

Year	Scenario	Influent Flow Rate (mgd)	Primary Sludge Load (ppd)	Primary Sludge Flow(1) (gpm)	Flow Velocity in 6-inch Pipe (fps)
2023	ADW	34	77,200(2)	430	4.9
	MDDW	60	130,600(3)	720	8.2
	MDWW	127	136,300(3)	760	8.6
2045	ADW	50	103,100(2)	570	6.5
	MDDW	87	177,700(3)	990	11.2
	MDWW	157	182,900(3)	1,020	11.5
Buildout	ADW	65	140,300(2)	780	8.9
	MDDW	119	243,400(3)	1,350	15.3
	MDWW	199	249,400(3)	1,380	15.7

Notes:
(1) Based on primary sludge concentration of 1.5 percent.
(2) Using PC total suspended solids removal model (average).
(3) Using PC total suspended solids removal model (upper limit).
fps - feet per second; mgd - million gallons per day; ppd - pounds per day.

3.2.1 Existing Degritting System Overview

Flow enters the Rock Creek WRRF through the influent pump station where seven raw sewage pumps lift the raw sewage so it can flow to downstream processes. The sewage then flows through bar screens to remove large debris before splitting to one or more of three primary clarifiers. The grit and sludge precipitated in these clarifiers is then pumped to the Slurry Cup/Snail grit washers from one of the four primary sludge pumps. The washed, dewatered grit is conveyed to a hopper for storage before it is dumped into a roll-off bin for disposal at the landfill. A capacity summary of the existing grit removal equipment in use at the Rock Creek WRRF is summarized in Table 3.2.

Table 3.2 Component Capacity

Component	Number of Units	Capacity
Bar Screens	▪ 4 Total: » 2 at 100 mgd (each). » 2 at 50 mgd (each).	▪ Firm Capacity: 200 mgd.
Primary Clarifiers	▪ 3 existing, plus 1 under construction (all 140-foot diameter)	▪ 15.3 mgd ADW (each) at 990 gpd/sf SOR. ▪ 57.6 mgd PHF (each) at 3,740 gpd/sf SOR ▪ 44.6 mgd MDWW (each) at 2,900 gpd/sf SOR
Primary Sludge Pumps	▪ 5 Total: » 1 per existing PC + 1 standby +1 for PC under construction.	▪ 200 gpm at 70 feet TDH (each).
Slurry Cup/Snail Grit Washers	▪ 2 Total: » 1 duty + 1 standby.	▪ Firm Capacity: 450 gpm(1) ▪ Originally configured for 650 gpm (each).

Notes:
(1) WRRF operations staff have found that the equipment is most reliable and produces the best quality grit at a throughput of 450 gpm despite a nameplate capacity of 650 gpm.
gpd/sf - gallons per day per square foot; PHF - peak hour flow; SOR - surface overflow rate; TDH - total dynamic head.

3.2.2 Degritting System Condition

As part of the initial grit system evaluation Carollo performed a site walk and interviewed treatment plant staff about the condition of existing equipment as summarized below:

- **Bar Screens:** The bar screens are in good condition. District staff normally only use bar screen channels 2 and 5 which are the 100 mgd capacity fine screens installed in 2015. Due to this, grit is backing up in front of the isolation gates for the other channels. This backup was the only issue that was brought up by District staff in regard to the bar screens.
- **Primary Clarifiers:** All primary clarifiers are in serviceable condition, but some corrosion damage has been identified. The primary clarifiers have Westech mechanisms with spiral-arm sludge collectors and a sludge "ring" at the bottom of the clarifier. Primary clarifier No. 3 has seen high torque and other minor issues on start-up. District staff assume this is due to grit accumulation in the basin. A fourth primary clarifier is currently under construction with anticipated completion in 2025.
- **Primary Sludge Pumps:** The sludge from the primary clarifiers flows into the sludge pump suction header where each primary clarifier has its own sludge pump. In total there are four sludge pumps to cover the three existing primary clarifiers and one as a standby pump. An additional primary sludge pump will be added as part of the ongoing Primary Clarifier 4 project. The primary sludge pumps can

send the sludge to the sludge screens or grit removal directly. The District staff did not have complaints about the sludge pumps' performance and note that the pumps are in good condition.

- **Grit Removal:** The Slurry Cup/Snail grit washers require frequent attention and maintenance particularly the bottom valves, which are often found leaking, damaged, or plugged. The bottom of the Slurry Cup also wears out, causing frequent maintenance. It was also noted that the grit conveyance from the "Snail" to the hopper is problematic. The conveyor's bearings must be serviced or replaced every two years and the belts need to be replaced every eight years. This piece of equipment is roughly 20 years old and is nearing the end of its service life.

3.2.3 Degritting System Performance

The existing degritting system produces acceptable grit quality when the equipment is operating near its most efficient loading point of 450 gpm. However, District staff report that that the equipment is difficult or sensitive to operate and requires frequent maintenance in order to reliably meet performance expectations. As such, the current system is unreliable because of its temperamental operation and high maintenance demand. Upstream of the Slurry Cup/Snails, District staff report that grit has been accumulating in the raw sewage piping between the influent pump station and headworks facilities. After inspection, it is suspected that grit is accumulating in the influent force main riser sections and the screening facility influent channels.

3.2.4 Degritting System Capacity

The Degritting system capacity was evaluated for 2023, 2045, and the buildout scenario. For each scenario the total and reliable capacity was evaluated based on the existing and an expanded system. Two Slurry Cup/Snail grit washers represent the existing system while three Slurry Cup/Snail grit washers represent the expanded system.

The primary sludge flows, represented by the red lines in Figure 3.1, are projected to increase. Rock Creek's existing system capacity does not meet the MDDW primary sludge flow for the 2045 scenario. The existing system capacity would not reliably be able to meet the average day primary sludge flow for the 2045 scenario. If the system was expanded the capacity would be able to reliably handle the average day primary sludge flow for all scenarios. The total capacity for the expanded system would be able to handle the MDWW primary sludge flow for all scenarios.

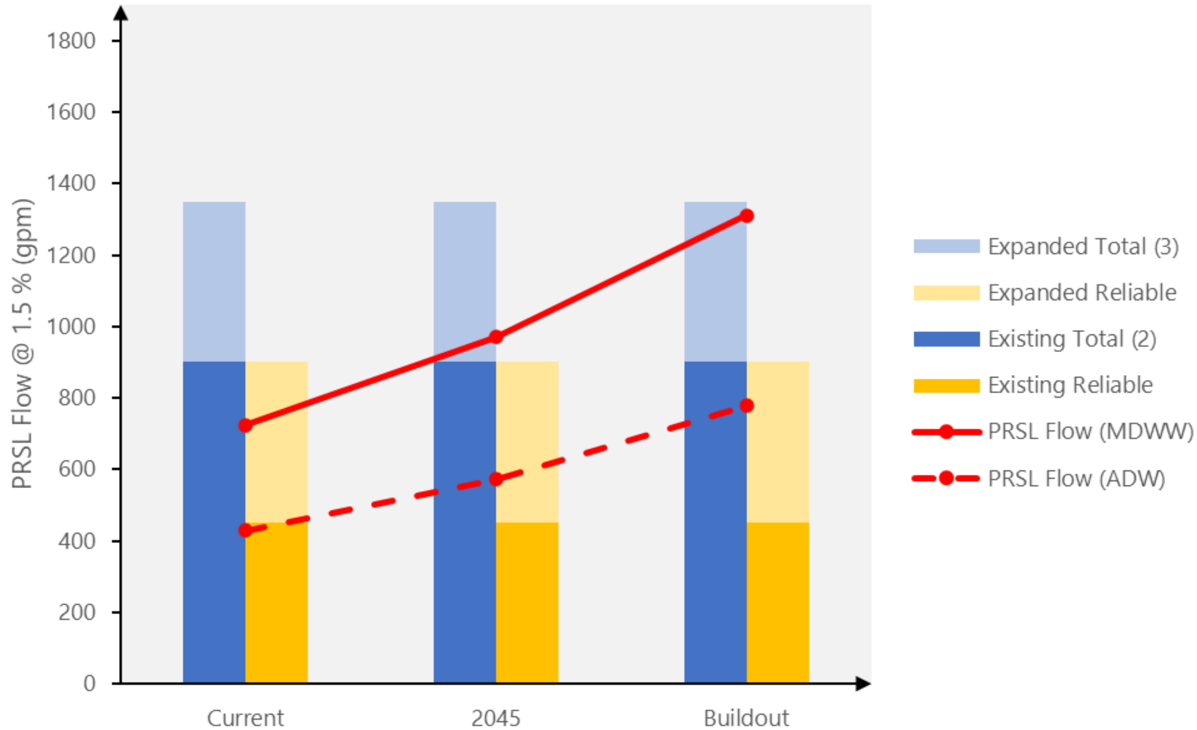

Figure 3.1 SlurryCup/Snail Existing and Expanded Capacity

3.2.5 Drivers for Modifying the Existing Degritting System

As described in the previous sections the existing degritting system is due for modifications to improve the system. There are four main drivers to modify the system: equipment age, temperamental operations, frequent maintenance, and insufficient capacity for the projected flows and loads.

- **Equipment Age:** The existing Slurry Cup/Snail system was installed in 2002 and is over 20 years old, which is the typical service life for this type of equipment. Despite a robust preventative maintenance program, the equipment is showing its age and key components are failing more frequently.
- **Temperamental Operation:** The Slurry Cup/Snail equipment is temperamental to operate and has a relatively narrow flow range where the system operates reliably. This limits operational flexibility of upstream and downstream processes.
- **Frequent Maintenance:** The Slurry Cup/Snail equipment requires frequent maintenance due to plugging of the bottom valve on the Slurry Cup. Modifications have been made to reduce plugging which has reduced the grit quality.
- **Insufficient Future Capacity:** The projected flows and loads are significantly greater than what the existing system can handle. If a unit were to go offline in the future scenarios, then the existing system would not be able to handle even an average day flow. The ability to reliably process future flows and loads is a major driver to modify the existing system.

3.3 Degritting System Improvement Alternatives

Based on the analysis and discussion with District staff three degritting improvement equipment alternatives were identified for Rock Creek's grit removal system. The first alternative is to replace the existing Slurry Cup/Snail grit washers in kind and install a third unit to increase firm capacity. The second alternative is to replace the existing system with two dual cyclone hydrogritters. The third alternative is to replace the existing system with three HUBER Coanda grit washers. For all alternatives, improvements will be needed to the primary sludge pumping system to increase the capacity and provide redundancy.

3.3.1 Improvements for Primary Sludge Pumping System

For all three alternatives described above, the primary sludge pumping system must be modified and expanded to accommodate the projected sludge flows for 2045. The projected maximum day flows will result in velocities greater than 11 feet per second (fps) for the existing header as shown in Table 3.1. These velocities will significantly increase wear on the pump and piping as well as significantly increase the total dynamic head that the pump has to operate against. The preferred velocity range for sludge piping is 5 to 7 fps in order to keep grit suspended and not create excessive headloss.

A redundant header is recommended to address velocity and redundancy concerns for MDDW and MDWW flows. The second header would require that tees or wyes be installed into the 4-inch lines coming off of all five primary sludge pumps. The new pipes from the five primary sludge pumps would then combine into a 6-inch pipe to create the second header. The new header would follow the alignment of the original header within the headworks building and into the grit removal units. Schematics of the proposed modifications are included for each alternative presented in the following sections.

3.3.2 Alternative 1 - Slurry Cup/Snail

The Slurry Cup is a free vortex grit removal unit that captures, classifies, and removes fine grit, sugar sand, and high-density fixed solids from grit slurries. The grit Snail uses a slow-moving belt to remove the grit from the clirifier pool and allows enough time for fine particles to settle. This produces dry grit with relatively low organic content to be disposed of in a landfill.

For Alternative 1, Rock Creek's existing SlurryCup/Snail grit washers would be replaced in kind and a third unit would be added for reliable capacity at projected MDWW. Each Slurry Cup/Snail unit would be configured for an optimum flow of 520 gpm to provide firm capacity for the 2045 MDWW flow projection. For this alternative, the basis of design equipment would be the Hydro International Slurry Cup grit washer and Grit Snail dewatering unit. Each unit would consist of a 42-inch Slurry Cup made of 316 stainless steel, with a hydraulic valve and a 316 stainless steel grit Snail. The grit Snail would have a 36-inch wide belt and a 96-inch wide clarifier. This unit is the same size unit that Rock Creek currently has installed. The design criteria for this alternative is summarized in Table 3.3 below.

With the addition of a third unit the layout within the headworks facility would need to be reconfigured. A schematic of the proposed configuration is shown in Figure 3.2.

Table 3.3 Alternative 1 - Slurry Cup/Snail Design Criteria

Criteria	Value/Summary
Proposed equipment model number	Slurry Cup/Snail GS3696
Number of units	2 duty + 1 standby
Slurry Cup/Snail size	42-inch diameter/36-inch belt width
Snail (conveyor) solids throughput capacity	6.0 cy/hr
Slurry Cup/Snail hydraulic capacity	520 gpm
Firm capacity	1,040 gpm
Overall unit capacity	1,560 gpm
Projected 2045 MDWW flow	1,020 gpm
Maximum influent solids concentration	1.5%
Snail belt width	36-inch
Clarifier width	96-inch

As shown in Figure 3.3, two of the new units would be installed in the same footprint as the existing equipment. The third unit would be installed either to the north of the existing equipment, where the screenings washer/compactors currently reside, or the the south of the exising equipment where the sludge screens currently reside. Since the sludge screens are fed by pumps rather than gravity it is assumed this process would be easier to relocate within the headworks building. However, that location has not yet been identified.

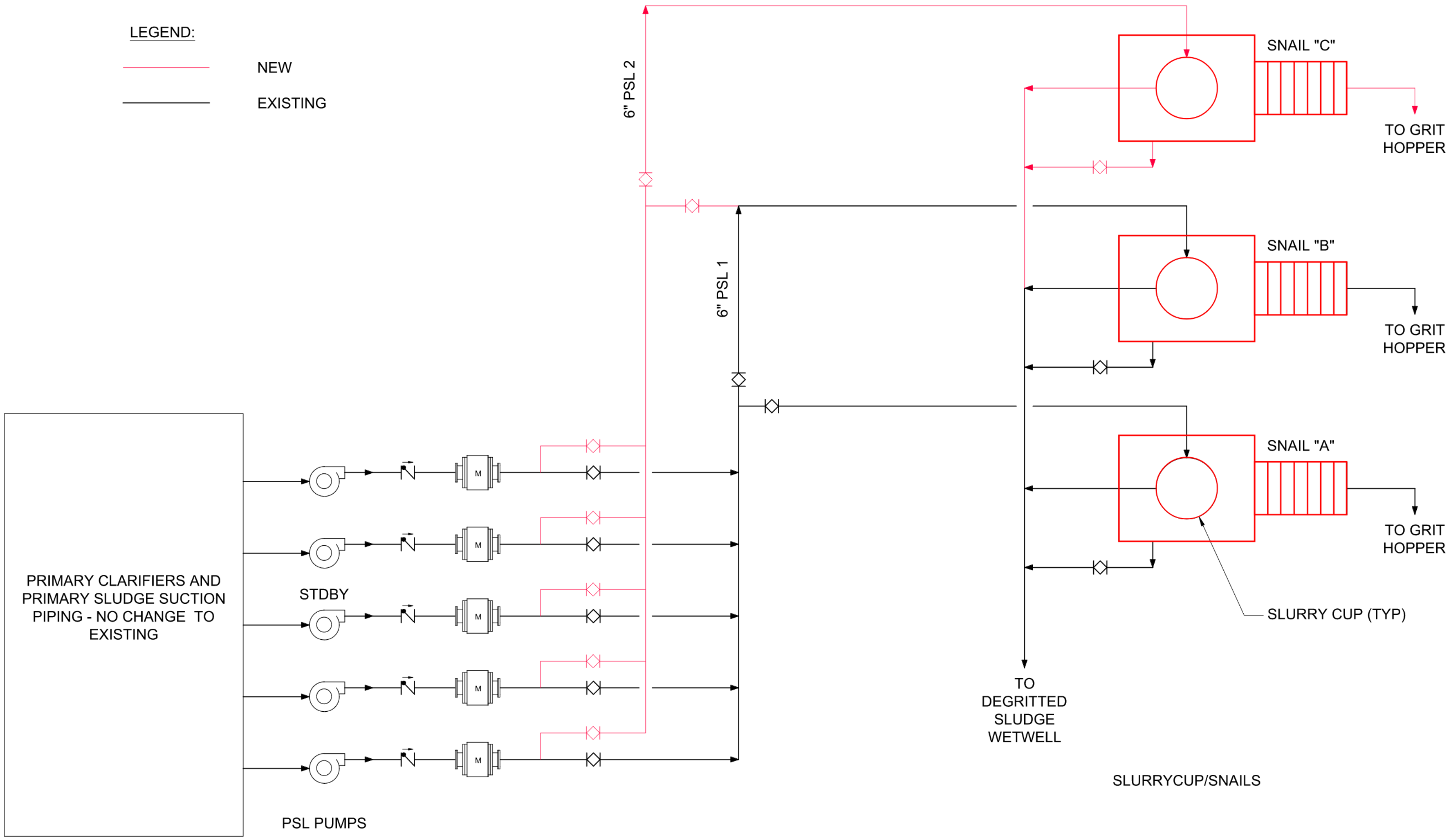

Figure 3.2 Alternative 1 - Slurry Cup/Snails Schematic

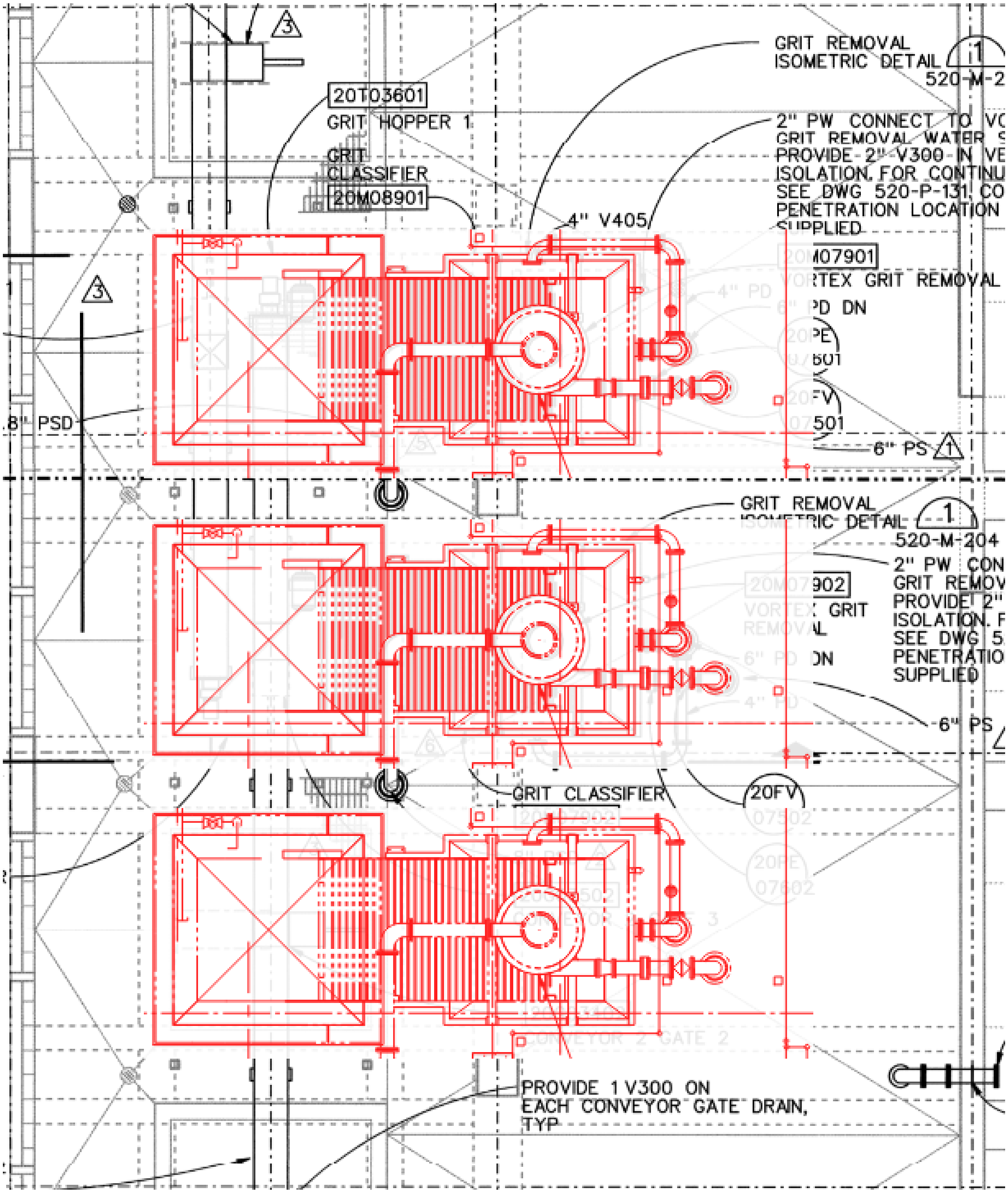

Figure 3.3 Alternative 1 - Slurry Cup/Snail Layout

3.3.3 Alternative 2 - Cyclones/Classifiers

For this alternative, the basis of design equipment is the WEMCO Hydrogritter. This unit mounts cyclones on top of the classifier. For Rock Creek, two hydrogritters with two cyclones each are recommended to provide redundant capacity for future MDWW flows. This dual cyclone configuration increases the flow capacity per unit since cyclone capacity is typically the limiting factor for degritting technologies. The dual cyclone hydrogritter is slightly longer than the current Slurry Cup/Snail configuration, but its flow capacity is nearly doubled because of the additional cyclone capacity.

A grit cyclone is used for grit separation and concentration. In the cyclone the grit is captured and pushed downwards towards the apex. The grit is concentrated in the cyclone underflow and then gets discharged through the apex into a classifier tank. Within the classifier the grit is allowed to settle. A screw conveyor conveys the grit up the classifier where it is dewatered and disposed of into the grit hopper.

Using this technology, two cyclone/classifier units would be needed as shown schematically in Figure 3.4. The unit capacity is large enough such that a total of two units would meet the projected flows and loads. The District staff visited the Willow Lake Water Pollution Contol Facility in Salem, OR which uses cyclone/classifiers for their grit removal. District staff was able to inspect the quality of grit, operations and maintenance (O&M) requirements, and determine the equipments compatability with the Rock Creek system. After this visit the District staff had a favorable opinion about this technology from O&M standpoints as well as the grit quality produced.

Table 3.4 Alternative 2 - Cyclones/Classifiers Design Criteria

Criteria	Value/Summary
Proposed equipment model number	WEMCO Hydrogritter 1500C/24F
Number of classifier units (2 cyclones per classifier)	1 duty + 1 standby
Cyclone/classifier size	15-inch diameter/ flared tank with 24-inch diameter auger
Auger (conveyor) solids throughput capacity	4 tons/hr
Cyclone hydraulic capacity, each	520 gpm
Firm capacity	1,040 gpm
Overall unit capacity	2,080 gpm
Projected 2045 MDWW flow	1,020 gpm
Maximum influent solids concentration	1.5%

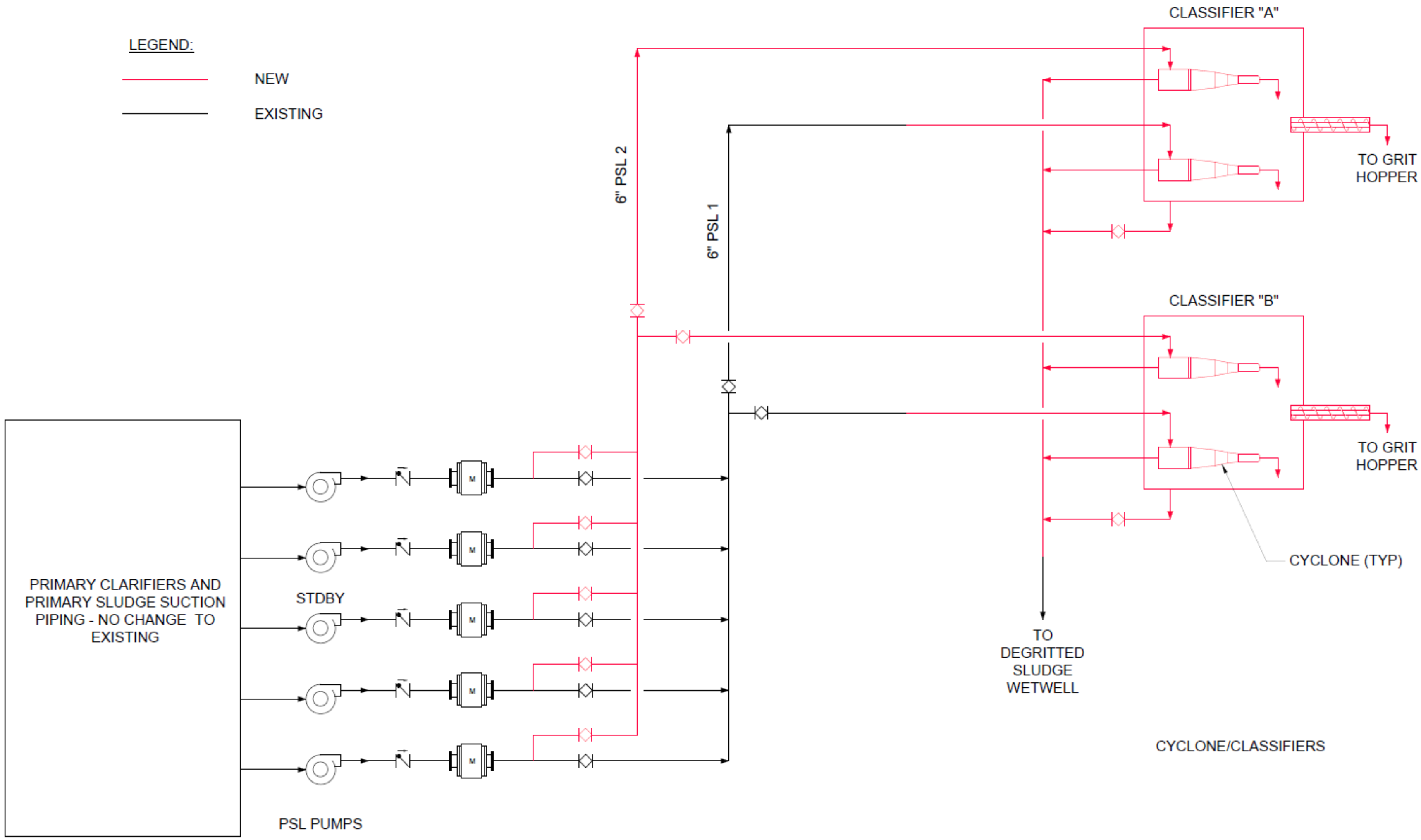

Figure 3.4 Alternative 2 - Hydrogritter Schematic

The equipment would include a 24-inch full flare hydrogritter with a double cyclone configuration. The size of the cyclone/classifier is slightly longer, but even with this extra length the unit will fit within the footprint of the existing systems as shown in Figure 3.5. Although the Hydrogritter units would fit into the same footprint, a secondary primary sludge header would be needed in order to keep the flow velocities within the primary sludge piping within an acceptable range.

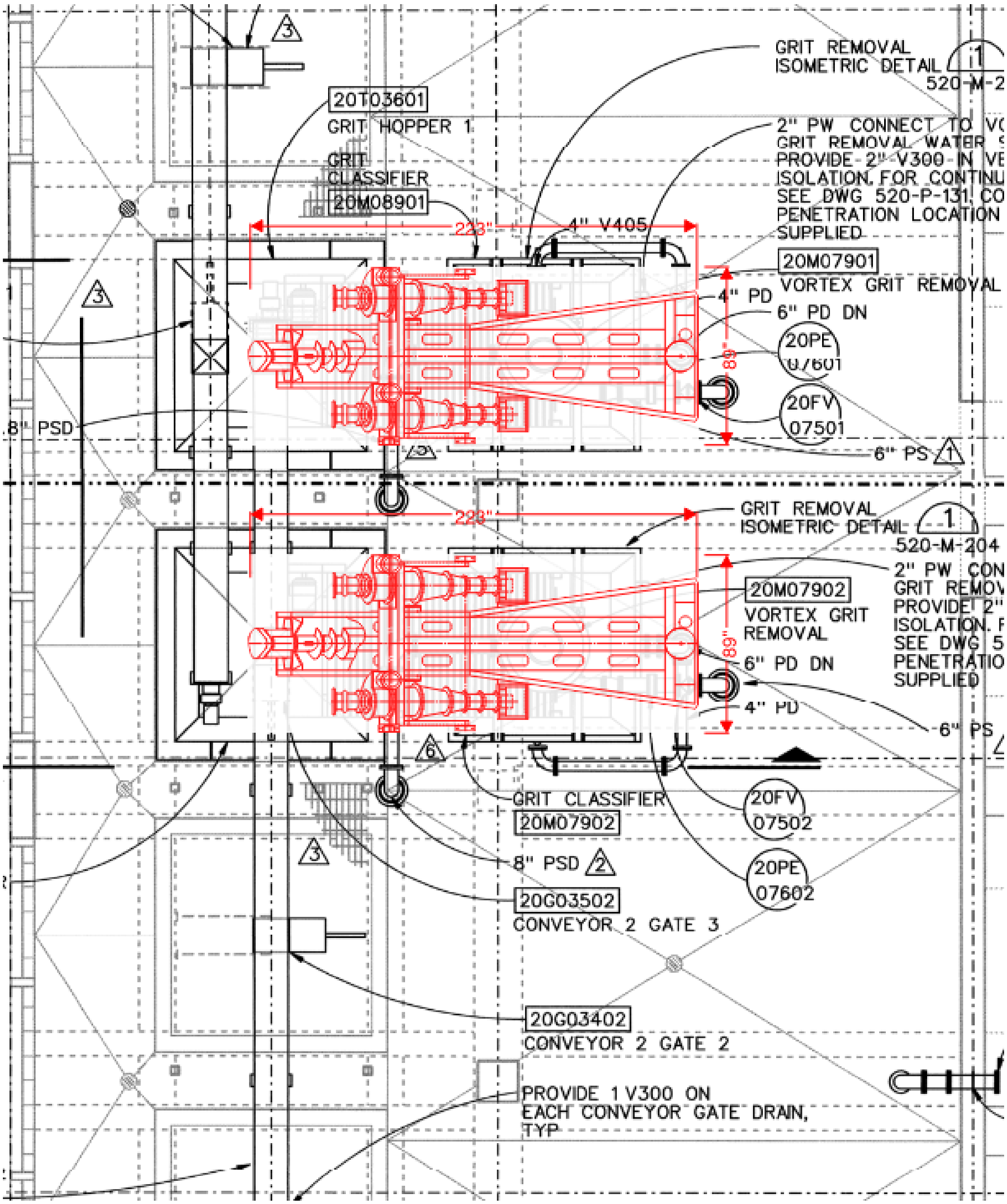

Figure 3.5 Alternative 2 - Hydrogritter Layout

3.3.4 Alternative 3 - Cyclones/Coanda

The basis of design equipment for this alternative is the HUBER RoSF4 Coanda grit washers with grit cyclones to separate grit from primary sludge and wash the grit. This technology has very little experience in primary sludge application with only two reported installations in the United States, but may produce cleaner grit than conventional technologies such as the SlurryCup/Snail or Hydrogritter. The two installations are in Torrington, Conneticut and Gallup, New Mexico. Cleaner grit, meaning less attached organic matter, may be advantageous in the future if the District were to move to a contract hauling operation or if tipping fees were to increase since the tonnage of hauled grit would be lower for the same primary sludge loading. A cyclone is used to concentrate grit and separate it from the primary sludge similar to the Hydrogritter technology. However, the concentrated grit is discharged into a washer tank where the combination of a stirrer arm and wash water injected through the bottom of the tank are used to create “rubbing action” between grit particles, thereby “peeling off” atttached organics.

This technology requires three units to be installed to provide firm capacity for 2045 MDWW flows. Design criteria for this alternative are summarized in Table 3.5. Each unit is rated for 1.5 tons per hour of solids capacity compared with the 4 ton per hour rating of the recommended size 24F Hydrogritter. One cyclone per Coanda grit washer is recommended since a second cyclone would exceed the solids handling capacity of the conveyor section of the unit. The unit setup would be the same as the Slurry Cup/Snail setup. Refer to the process flow diagram for the Slurry Cup/Snail alternative (Figure 3.2) as the flow paths are the same. The three cyclone/Coanda units will have the same piping size and arrangment as the Slurry Cup/Snail.

Table 3.5 Alternative 3 - Cyclones/Coanda Design Criteria(1)

Criteria	Value/Summary
Proposed equipment model number	HUBER RoSF4 with KREBS 15lb-S1384-SDM
Number of classifier units (1 cyclone per classifier)	2 duty + 1 standby
Cyclone/washer size	15-inch diameter cyclone/6-foot diameter tank
Auger (conveyor) solids throughput capacity	1.5 tons/hr
Cyclone hydraulic capacity	520 gpm
Firm capacity	1,040 gpm
Overall unit capacity	1,560 gpm
Projected 2045 MDWW flow	1,020 gpm
Maximum influent solids concentration	1.5%

Notes:
(1) Performance proven on liquid stream degritting applications only; performance on sludge degritting applications is unproven.

The Coanda grit washer equipment size is similar in length and width to the existing Slurry Cup/Snail (Figure 3.6), however the height of the unit is significantly more than the existing units (Figure 3.7). Due to the height of the unit some adjustments to the headworks platforms are needed and pipes may need to be rearranged to provide enough space for the equipment. This alternative requires three units to be installed. Two of the units would be installed in the same footprint as the existing Slurry Cup/Snail units. The third unit would be installed either to the north of the existing equipment, where the screenings washer/compactor currently resides, or the the south of the exising equipment where the sludge screens currently reside. Since the sludge screens are fed by pumps rather than gravity it is assumed this process would be easier to relocate within the headworks building. However, that location has not yet been identified.

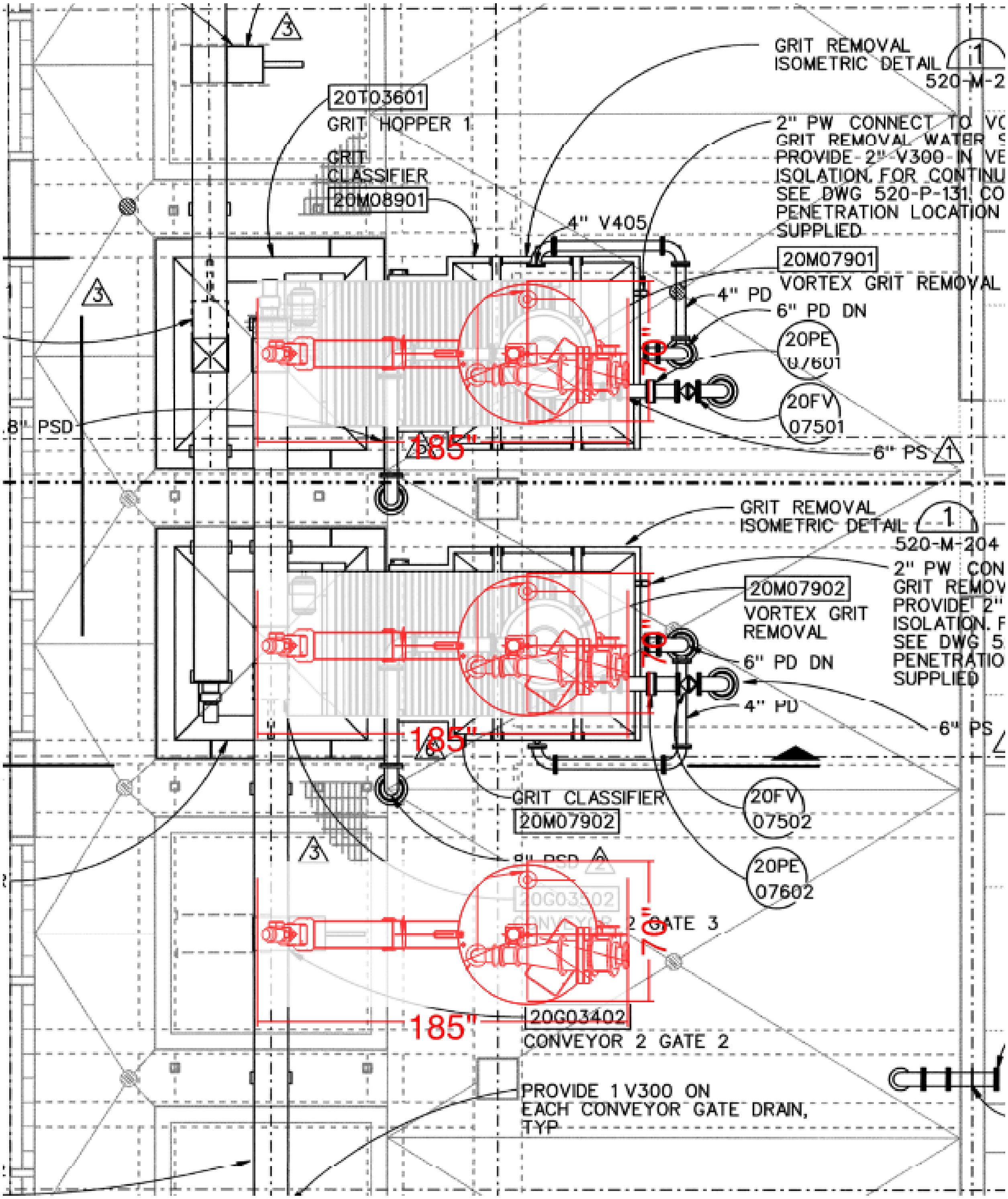

Figure 3.6 Alternative 3 - Coanda Layout

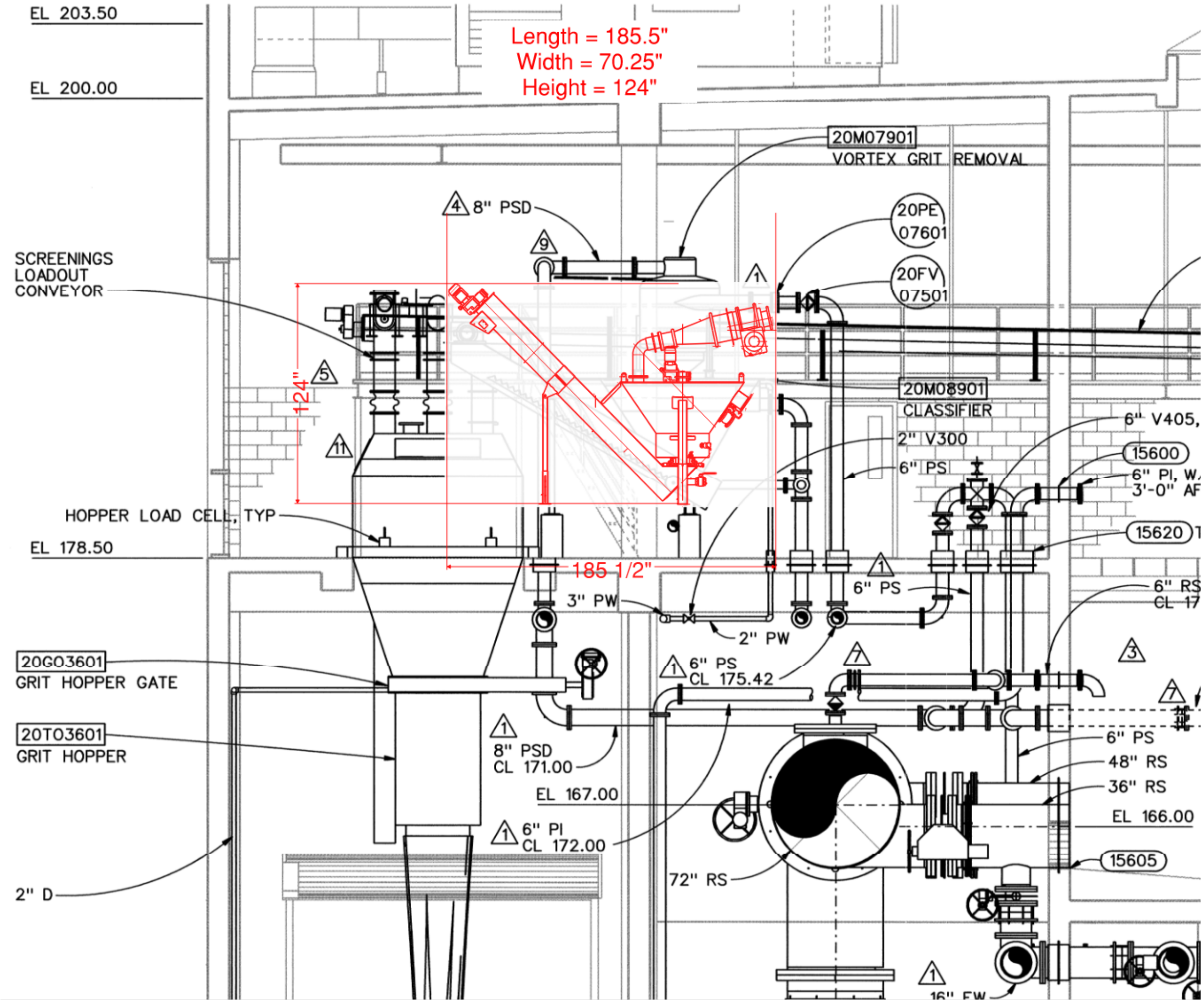

Figure 3.7 Alternative 3 - Cyclone/Coanda Section View

3.4 Comparison of Alternatives

3.4.1 Economic Comparison

The conceptual design of each alternative described in Section 3.3 was used to develop Association for the Advancement of Cost Engineering Class 4, planning level cost estimatse presented in Table 3.6. These preliminary estimates include direct and indirect costs. Direct costs include materials, labor, construction equipment required for installation, and subcontractor costs and are estimated based on quotes from equipment vendors, experience on similar projects, and estimated quantities and unit prices. Indirect costs include an estimating contingency, sales tax, and contractor general conditions and overhead and profit and risk consistent with assumptions outlined in the CAMP® documentation.

Table 3.6 Preliminary Opinion of Probable Project Costs for Grit Removal Equipment Alternatives

Item	Alternative 1 - Slurry Cup/Snail	Alternative 2 - Hydrogritter	Alternative 3 - Huber Coanda
Remove and replace transparent wall panels, demolish existing equipment. Also, for Alternatives 1 and 3, relocate sludge screens.	$1,576,000	$422,000	$1,576,000
Procure and install new degritting equipment.	$3,709,000	$1,710,000	$2,114,000
Piping, valves, and supports.	$576,000	$384,000	$576,000
Electrical, instrumentation, and controls	$1,153,000	$769,000	$1,153,000
General mobilization and demobilization	$352,000	$166,000	$271,000
Total Project Cost(1)(2)	**$7,367,000**	**$3,451,000**	**$5,690,000**

Notes:
(1) Construction costs include a 30 percent estimating contingency, 10 percent markup for contractor general conditions, and 12 percent markup for contractor overhead and profit.
(2) Project costs include a 20 percent markup of total construction cost for engineering, legal, and administrative fees.

Detailed estimates for each alternative are provided in in Appendix 2A. It should be noted that the actual construction costs will depend on labor and material costs, site conditions, productivity, market conditions, and other variable factors at the time of bidding. For these reasons, the final construction costs may vary from the preliminary estimates presented. Typically, Class 4 estimates have an expected accuracy range of between minus 30 percent and plus 50 percent.

Table 3.7 shows the estimated average annual O&M costs for the degritting alternatives in 2024 dollars between 2025 and 2045. The O&M costs include estimated annual costs for grit hauling, tipping fees, and maintenance labor. The assumptions used to estimate each of these categories are summarized below:

- Annual Sludge and Grit Loading: The projected primary sludge loading presented in Table 3.1 was used as a basis for evaluating annual maintenance costs. The annual sludge loads used for this evaluation assumed linear growth between 2023 loads and 2045. The annual weight of hauled grit was developed from the sludge projections and an assumed grit to primary sludge ratio of 0.14, based on 2023 data.
  - Alternative 3: Assumed to produce 40 percent cleaner grit than the other alternatives based on limited performance data for liquid stream operation, which was derated for primary sludge service.
- Hauling Cost: A cost of $135 per trip was provided by the District based on average costs of the 281 recorded trips in 2023.
  - Alternative 3: Assumed the same number of annual trips as other alternatives to maintain operating schedule despite a lower hauled weight per trip.
- Tipping Fee: A cost of $125 per wet ton was provided by the District based on average costs recorded in 2023 for a total hauled grit weight of 2,033 wet tons. Approximately seven tons of grit were hauled per trip in 2023.
- O&M Labor: Based on a rate of $69.61 per hour as defined in the East Basin Master Plan, Table 1.1, page 1-3.
  - Alternative 1: Assumed to be four hours per day per unit in service.
  - Alternative 2: Assumed to be two hours per day per unit in service.
  - Alternative 3: Assumed to be three hours per day per unit in service.

The annual operating cost for Alternative 1 is approximately $546,000 while the estimated annual operating costs for Alternatives 2 and 3 are approximately $399,000 and $349,000 respectively. Operating costs for Alternative 1 are significantly higher due to a higher O&M labor requirement to keep the equipment operating well and a need to have two units in service for future loads. Alternatives 2 and 3 have similar average annual operating costs. The savings in tipping fees from cleaner grit in Alternative 3 are offset by higher O&M labor requirements and a need to have two units in service for future loads. A more detailed breakdown of annual operating cost estimates is included in Appendix 3A.

Table 3.7 Average Annual Operating Costs (2025-2045) for Grit Removal Equipment Alternatives

Item	Alternative 1 - Slurry Cup/Snail	Alternative 2 – Hydrogritter	Alternative 3 – Huber Coanda
Hauling Cost	$45,000	$45,000	$45,000
Tipping Fee	$303,000	$303,000	$182,000
O&M Labor	$198,000	$51,000	$122,000
Average Annual Operating Cost	**$546,000**	**$399,000**	**$349,000**

A comparison of present worth costs for the three degritting equipment alternatives in 2024 dollars is presented in Table 3.8. As shown, Alternative 2 has the lowest present worth cost and is closely followed by Alternative 3. The difference between the two alternatives is driven by assumptions on construction complexity and assumptions on grit quality.

Table 3.8 Present Worth Cost Comparison for Grit Removal Equipment Alternatives

Item	Alternative 1 – Slurry Cup/Snail	Alternative 2 - Hydrogritter	Alternative 3 – Coanda
Total Project Cost(1)(2)	$7,367,000	$3,451,000	$5,690,000
20-Year Operating Cost	$10,920,000	$7,970,000	$6,970,000
Present Worth Total Costs	**$18,287,000**	**$11,421,000**	**$12,660,000**

Notes:
(1) Construction costs include a 30 percent estimating contingency, 10 percent markup for contractor general conditions, and 12 percent markup for contractor overhead and profit.
(2) Project costs include a 20 percent markup of the Construction cost for engineering, legal, and administrative fees.

3.4.2 Non-Economic Comparison

The three degritting improvement alternatives were compared with the non-economic criteria defined in Table 3.9. These criteria focus on installation difficulty, grit quality, equipment maintenance requirements, and risk of uncertainty. The planning team scored each alternative based on our engineering judgement and experience, understanding of the physical limitations of the existing building, and feedback provided by the District. Alternative 2 scored the highest for this non-economic comparison since this alternative is expected to have the lowest installation difficulty, has acceptable grit quality, requires an average amount of maintenance, and has proven performance for primary sludge degritting. Non-economic scoring for all alternatives is summarized in Table 3.9.

Table 3.9 Non-Economic Comparison Criteria

Criterion	Worst = 1	Intermediate = 2	Best = 3
Installation Risk	Alternative requires relocation of existing sludge screening process equipment and there may be insufficient space for the required number of units.	Alternative may require relocation of the existing sludge screening process equipment, but all required equipment will fit in the allocated space.	Alternative has the lowest difficulty of installation and does not require relocation of any equipment process equipment.
Grit Quality	Grit quality is lower than what is produced by existing equipment.	Grit quality is the same as what is produced by existing equipment.	Grit quality is better than what is produced by existing equipment.
Maintenance Requirements	Equipment requires frequent maintenance and/or observation to meet performance expectations.	Equipment maintenance and observation requirements are average.	Equipment requires little maintenance or observation to meet performance expectations
Performance Risk	Equipment performance is unproven.	Intermediate	Equipment performance is proven for primary sludge degritting.

Table 3.10 Non-Economic Comparison Scoring Summary

Criterion	Alternative 1 - Slurry Cup/Snail	Alternative 2 - Hydrogritter	Alternative 3 - Huber Coanda
Installation Risk	2	3	2
Grit Quality	2	2	3(1)
Maintenance Requirements	1	2	2
Performance Risk	3	3	1(1)
Total	**8**	**10**	**8**

Notes:
(1) Performance proved on liquid stream Degritting applications only. Performance on primary sludge degritting applications is unproven.

3.5 Conclusions and Recommendation

Near term improvements are recommended to increase the reliable capacity of the primary sludge degritting system. For all the alternatives in this analysis it was determined that the existing equipment should be replaced due to its age and condition. It was also determined that to accommodate the projected capacities a second primary sludge header is needed. Equipment layouts and piping/valving configuration should be confirmed for the recommended alternative during predesign.

This analysis considered cost and non-cost factors to determine the best alternative for the Rock Creek grit removal system. The planning team recommends that Alternative 2 be implemented at Rock Creek as it provides the best combination of capacity, cost, performance, and reliability. Alternative 1 is feasible and can be implemented if the District is comfortable with the existing system's performance and maintenance. Alternative 3 is not recommended without site visits and additional testing to confirm process applicability and performance. The Coanda equipment has very few installations in existence that treat primary sludge. For this reason, this alternative cannot be recommended without further investigation into the technology and its performance. A pilot study and further evaluation is recommended before the District pursues Alternative 3.

APPENDIX 3A PRELIMINARY COST INFORMATION

PRELIMINARY COST INFORMATION

PROJECT : West Basin Master Plan - Rock Creek Facility
CLIENT: Clean Water Services
JOB # : 200908
PROJECT : Grit Removal System Alternative 1

ESTIMATE CLASS: 5
PREPARED BY: JRM
DATE PREPARED: 02-Feb-24
REVIEWED BY:

ITEM	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
SUMMARY OF CONSTRUCTION COSTS					
Demolition and Rehab					
	Remove and Replace Transparent Wall Panels	1	LS	$ 200,000	$ 200,000
	Demolish Existing Equipment	2	LS	$ 10,000	$ 20,000
	Relocate Sludge Screens	1	LS	$ 600,000	$ 600,000
Equipment					
	Slurry Cup/Snail	3	EA	$ 541,000	$1,623,000
	Equipment Installation Adder	3	EA	$ 100,000	$ 300,000
Mechanical					
	Piping, valves, supports, etc. (includes new primary sludge header	1	LS	$ 300,000	$ 300,000
Electrical and Instrumentation					
	EI&C Allowance	3	EA	$ 200,000	$ 600,000
General					
	Mobilization/Demobilization	5	%		$ 180,000
	SUBTOTAL EQUIPMENT AND ITEMIZED DIRECT COSTS				**$3,823,000**
	Estimating Contingency	30	%		$1,147,000
	SUBTOTAL				**$4,970,000**
	Contractor General Conditions	10	%		$497,000
	SUBTOTAL				**$5,467,000**
	Contractor Overhead and Profit	12	%		$656,000
	SUBTOTAL				**$6,123,000**
	TOTAL CONSTRUCTION COST				**$6,100,000**
	Engineering, Legal, and Administration	20	%		$1,220,000
	SUBTOTAL				**$7,320,000**
	TOTAL PROJECT COST				**$7,300,000**

PROJECT : West Basin Master Plan - Rock Creek Facility
CLIENT: Clean Water Services
JOB # : 200908
PROJECT : Grit Removal System Alternative 2

ESTIMATE CLASS: 5
PREPARED BY: JRM
DATE PREPARED: 02-Feb-24
REVIEWED BY:

ITEM	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
SUMMARY OF CONSTRUCTION COSTS					
Demolition and Rehab					
	Remove and Replace Transparent Wall Panels	1	LS	$ 200,000	$ 200,000
	Demolish Existing Equipment	2	LS	$ 10,000	$ 20,000
	Relocate Sludge Screens or Washer/Compactor	0	LS	$ 500,000	$ -
Equipment					
	Hydrogritter	2	EA	$ 345,000	$ 690,000
	Equipment Installation Adder (30% of equipment cost)	2	EA	$ 100,000	$ 200,000
Mechanical					
	Piping, valves, supports, etc. (includes new primary sludge header	1	LS	$ 200,000	$ 200,000
Electrical and Instrumentation					
	EI&C Allowance	2	EA	$ 200,000	$ 400,000
General					
	Mobilization/Demobilization	5	%		$ 90,000
	SUBTOTAL EQUIPMENT AND ITEMIZED DIRECT COSTS				**$1,800,000**
	Estimating Contingency	30	%		$540,000
	SUBTOTAL				**$2,340,000**
	Contractor General Conditions	10	%		$234,000
	SUBTOTAL				**$2,574,000**
	Contractor Overhead and Profit	12	%		$309,000
	SUBTOTAL				**$2,883,000**
	TOTAL CONSTRUCTION COST				**$2,900,000**
	Engineering, Legal, and Administration	20	%		$580,000
	SUBTOTAL				**$3,480,000**
	TOTAL PROJECT COST				**$3,500,000**

PROJECT : West Basin Master Plan - Rock Creek Facility
CLIENT: Clean Water Services
JOB # : 200908
PROJECT : Grit Removal System Alternative 3

ESTIMATE CLASS: 5
PREPARED BY: JRM
DATE PREPARED: 02-Feb-24
REVIEWED BY:

ITEM	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
SUMMARY OF CONSTRUCTION COSTS					
Demolition and Rehab					
	Remove and Replace Transparent Wall Panels	1	LS	$ 200,000	$ 200,000
	Demolish Existing Equipment	2	LS	$ 10,000	$ 20,000
	Relocate Sludge Screens or Washer/Compactor	1	LS	$ 600,000	$ 600,000
Equipment					
	Huber Coanda	3	EA	$ 266,000	$ 798,000
	Equipment Installation Adder	3	EA	$ 100,000	$ 300,000
Mechanical					
	Piping, valves, supports, etc. (includes new primary sludge pump header)	1	LS	$ 300,000	$ 300,000
Electrical and Instrumentation					
	EI&C Allowance	3	EA	$ 200,000	$ 600,000
General					
	Mobilization/Demobilization	5	%		$ 140,000
	SUBTOTAL EQUIPMENT AND ITEMIZED DIRECT COSTS				**$2,958,000**
	Estimating Contingency	30	%		$887,000
	SUBTOTAL				**$3,845,000**
	Contractor General Conditions	10	%		$385,000
	SUBTOTAL				**$4,230,000**
	Contractor Overhead and Profit	12	%		$508,000
	SUBTOTAL				**$4,738,000**
	TOTAL CONSTRUCTION COST				**$4,700,000**
	Engineering, Legal, and Administration	20	%		$940,000
	SUBTOTAL				**$5,640,000**
	TOTAL PROJECT COST				**$5,600,000**