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CITY OF SUNNYVALE

MASTER PLAN AND PRIMARY TREATMENT DESIGN

TECHNICAL MEMORANDUM

GRIT CHARACTERIZATION STUDY: MASTER PLAN

FINAL
December 2013

carollo in association with HDR

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1.0 OVERVIEW

The City of Sunnyvale is currently in the process of upgrading their existing Water Pollution Control Plant (WPCP) as part of a master planning/primary facilities project. This includes the evaluation of grit removal technologies as part of constructing a new headworks facility. Completion of a grit characterization study will assist with the selection of the preferred technology and help to optimize the design and operation of the selected grit removal process. The purpose of the study was to assess the amounts of grit in the influent to the WPCP, characterize it by size and weight distribution, and determine its settleability. Additionally, the study was to characterize the grit in the primary sludge and the grit currently being removed at the WPCP.

On July 16, 17, and 18, 2013 Black Dog Analytical (BDA) performed sampling and field testing of the influent, primary sludge, and captured grit at the WPCP. Samples were collected on the influent and captured grit from 8 a.m. until 2 p.m. on each of the three days. A composite sample of the primary sludge from all sedimentation tanks in service was collected at 10 a.m. on those days.

During the testing period, the process and grit slurry flow streams were as depicted in Figure 1. The figure also indicates the locations where sampling for grit was performed.

The report prepared by BDA provides an in-depth discussion of the sampling and testing protocol. It is included in the Appendix.

2.0 OBSERVATIONS AND CONCLUSIONS

A summary of the results contained in the report by BDA is presented in Table 1.

Table 1 Grit Quantities
Master Plan and Primary Treatment Design
City of Sunnyvale

Date	Plant Flow[(1)], MG	Influent Grit[(2)] Conc.[(4)], lb/MG	Load[(4)], lbs	Removed Grit[(2)] Volume, cf	Removed Grit[(2)] Weight[(4)], lbs	Primary Sludge Grit[(3)] Conc.[(4)], lb/MG of Sludge
16-Jul	2.304	181.0	417	3.53	26.1	1240
17-Jul	2.282	40.7	93	2.80	18.6	1115
18-Jul	2.301	25.1	58	2.48	13.5	1062

Notes:
(1) Volume of influent plant flow during the sampling period 8 AM – 2PM.
(2) Total during sampling period 8 AM - 2 PM.
(3) Grab samples at 10 AM.
(4) Fixed solids (ash).

Legend

Main Wastewater Flow	Pre-Aeration Tanks
Grit Slurry	Grit Classifier
Classifier Overflow	Primary Clarifiers

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Figure 1
GRIT SAMPLING LOCATION
GRIT CHARACTERIZATION STUDY
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CITY OF SUNNYVALE

A review of Table 1 yields the following observations:

- Collected Grit. Grit removed and captured during the six hours of sampling decreased each day of the program. The unit weight (lb/MG of influent flow) of the collected grit decreased over nearly 50 percent from July 16 to 18. It appears that there was some unusual activity that could account for the unusual grit concentrations observed on July 16 (see below).

- The amount of moisture and organics in the collected grit was fairly consistent ranging from 62 to 67 percent and 22 to 25 percent, respectively. The amount of organics was typical of older grit handling systems but the amount of moisture was significantly higher than most older systems. The quality of the collected grit in terms of amounts of both moisture and organics can be improved significantly with newer grit handling technologies.

- Primary Sludge Grit. Grit recovered from the primary sludge grab samples decreased each day of the program. The unit weight (lb/MG of influent flow) change from July 16 to July 18 of 17 percent was considerably less than the change in collected grit. The concentration of grit in the primary sludge is significantly less than typically found at wastewater treatment plants.

- Influent Wastewater Grit. Grit in the influent wastewater exhibited the largest decrease during the sampling program. The unit weight (lb/MG of influent flow) decreased 78 percent from July 16 to July 17 and 38 percent from July 17 to July 18.

To simplify the design criteria for grit removal and handling, it is common practice to group grit size distribution into the four gradations shown in Table 2.

Table 2 Grit Size Group
Master Plan and Primary Treatment Design
City of Sunnyvale

Wet Sieve Size, microns	Gradation
≤ 105	Extra Fine
> 105 ≤ 150	Fine
> 150 ≤ 210	Medium
> 210	Coarse

A review of grit size distribution and settling velocities obtained from the sampling and contained in the BDA report allows these additional observations:

- Grit Size Distribution. The grit size distribution was fairly consistent in the collected grit and primary sludge during the three days of sampling. The coarse (>210 μ) particles in the collected grit was in the 80 to 90 percent range and in the primary

sludge was in the 40 to 50 percent range. The grit size distribution in the influent wastewater varied greatly with the percent of coarse particles decreasing each day – approximate percentages were 95 percent on July 16, 80 percent on July 17, and 60 percent on July 18.

- Influent Wastewater Grit Settling. The settling characteristic of the influent wastewater particles was much slower than the size would indicate. On July 16, almost all particles settled slower than a 150 μ spherical sand particle. On July 17, over 90 percent of the particles settled slower than a 150 μ spherical sand particle and on July 18, the percentage was 80 percent.

A study and analysis of these observations yields the following conclusions:

- The influent grit data on July 16 is anomalous and should not be used for design purposes. Based on discussions with WPCP staff, it appears that one of the digesters was being drained on July 16.
- 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 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. A good grit handling system can improve these values considerably.

The percentage by weight (fixed solids) of each size group in the influent and collected grit is shown in Figure 2 (for July 17) and Figure 3 (for July 18).

The percentage by weight of each size group in the influent and primary sludge grit is shown in Figure 4 (for July 17) and Figure 5 (for July 18).

These figures indicate that the greatest percentage of grit by weight is contained in the coarse group. The figures also demonstrate a significant shift in the size distribution in the grit particles between the grit particles in the influent and those in the primary sludge. Biological breakdown of the organics attached to the influent grit particles is the cause of this phenomenon. A significant portion of the coarse grit found in the influent is converted to finer sizes during its detention in the primary sludge. A significant increase in the amount of grit removed can be attained by targeting the coarse group. The settling velocity distribution (expressed in terms of surface overflow rate) for the influent grit is shown on Figure 6. This data shows that for the City of Sunnyvale, the coarse-sized grit particles have a settling velocity more similar to a fine-sized grit particle.

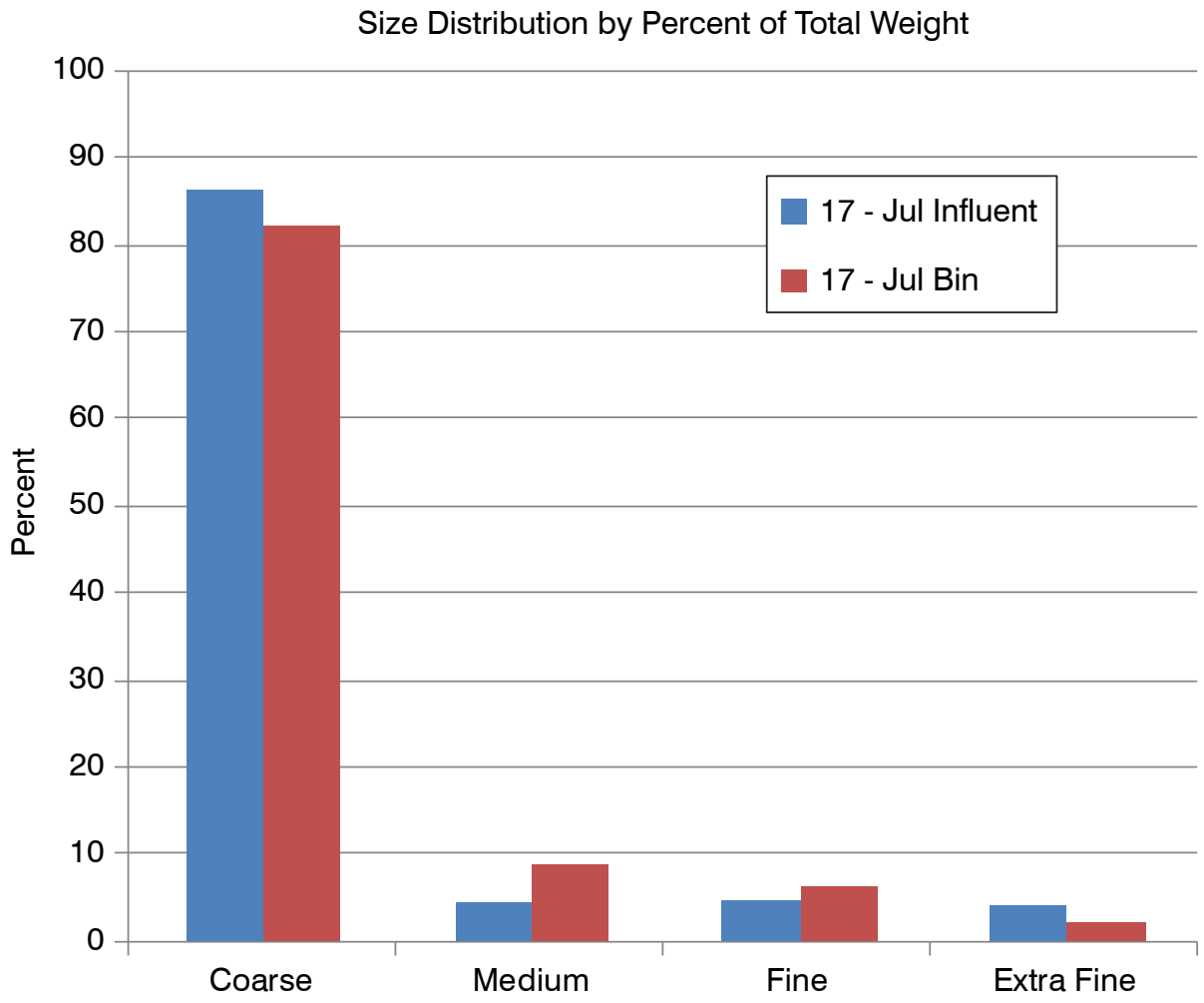

Figure 2
INFLUENT AND COLLECTED GRIT SIZE DISTRIBUTION ON JULY 17
GRIT CHARACTERIZATION STUDY
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CITY OF SUNNYVALE

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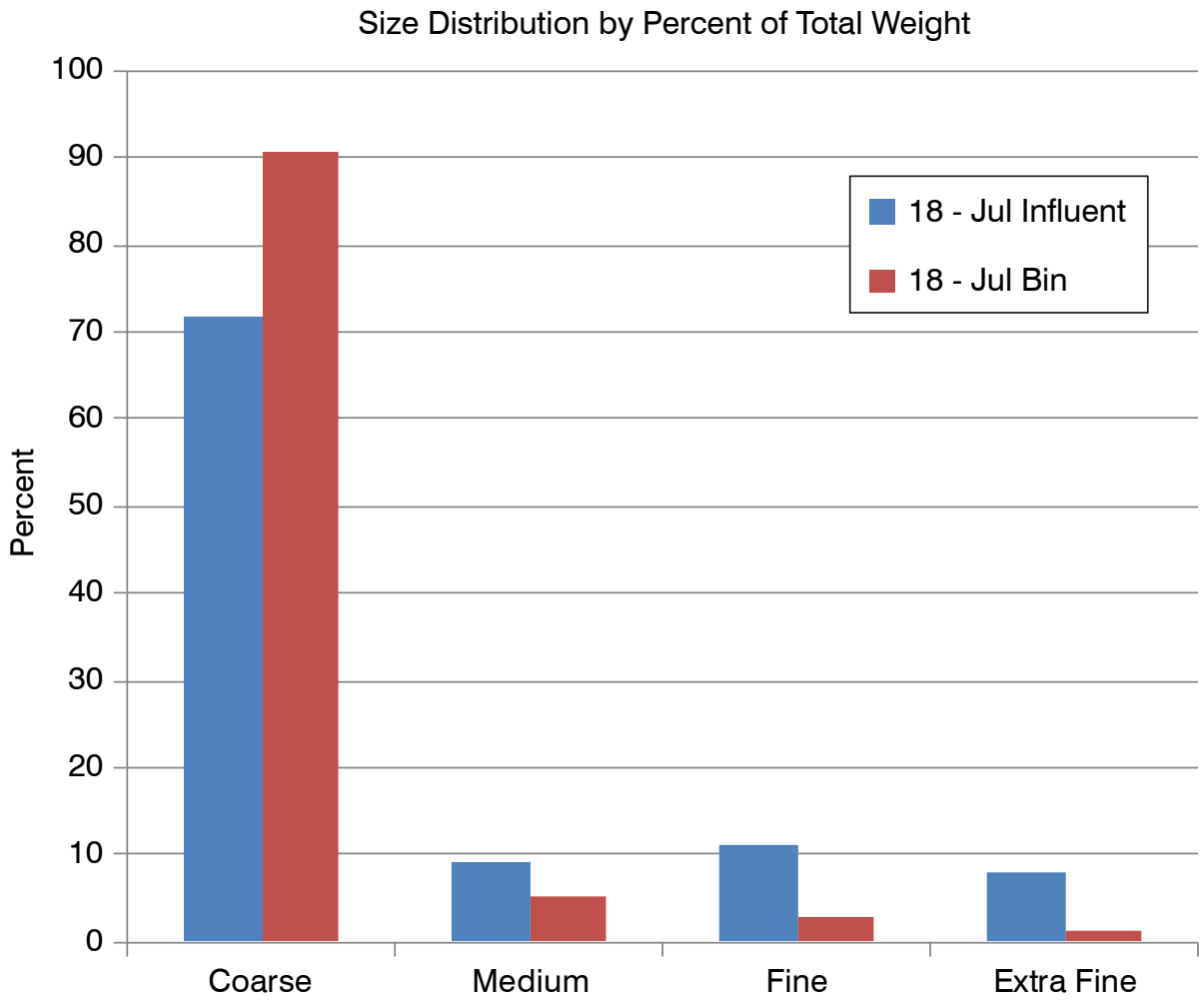

Figure 3
INFLUENT AND COLLECTED GRIT SIZE DISTRIBUTION ON JULY 18
GRIT CHARACTERIZATION STUDY
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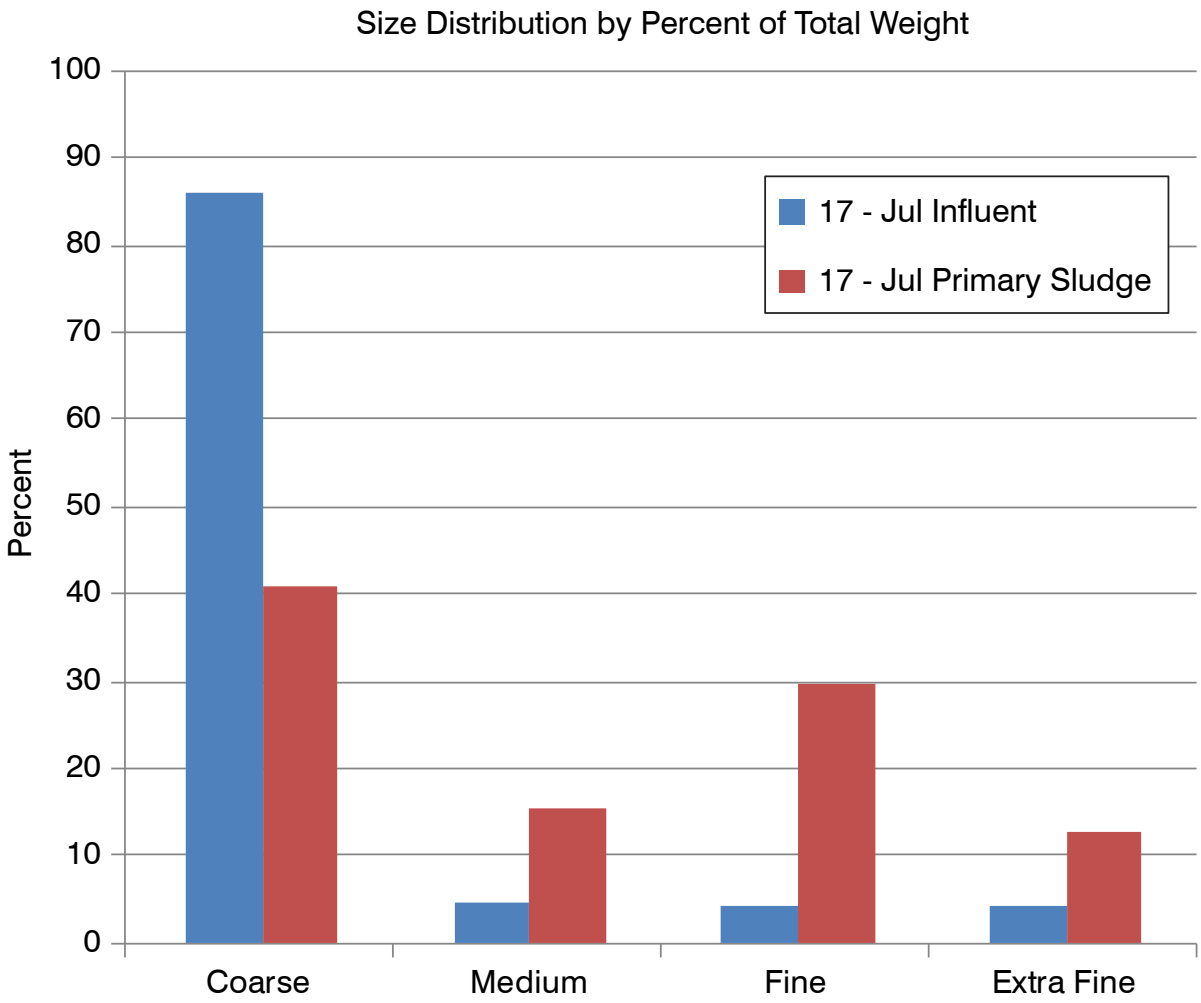

Figure 4
INFLUENT AND PRIMARY SLUDGE GRIT SIZE DISTRIBUTION ON JULY 17
GRIT CHARACTERIZATION STUDY
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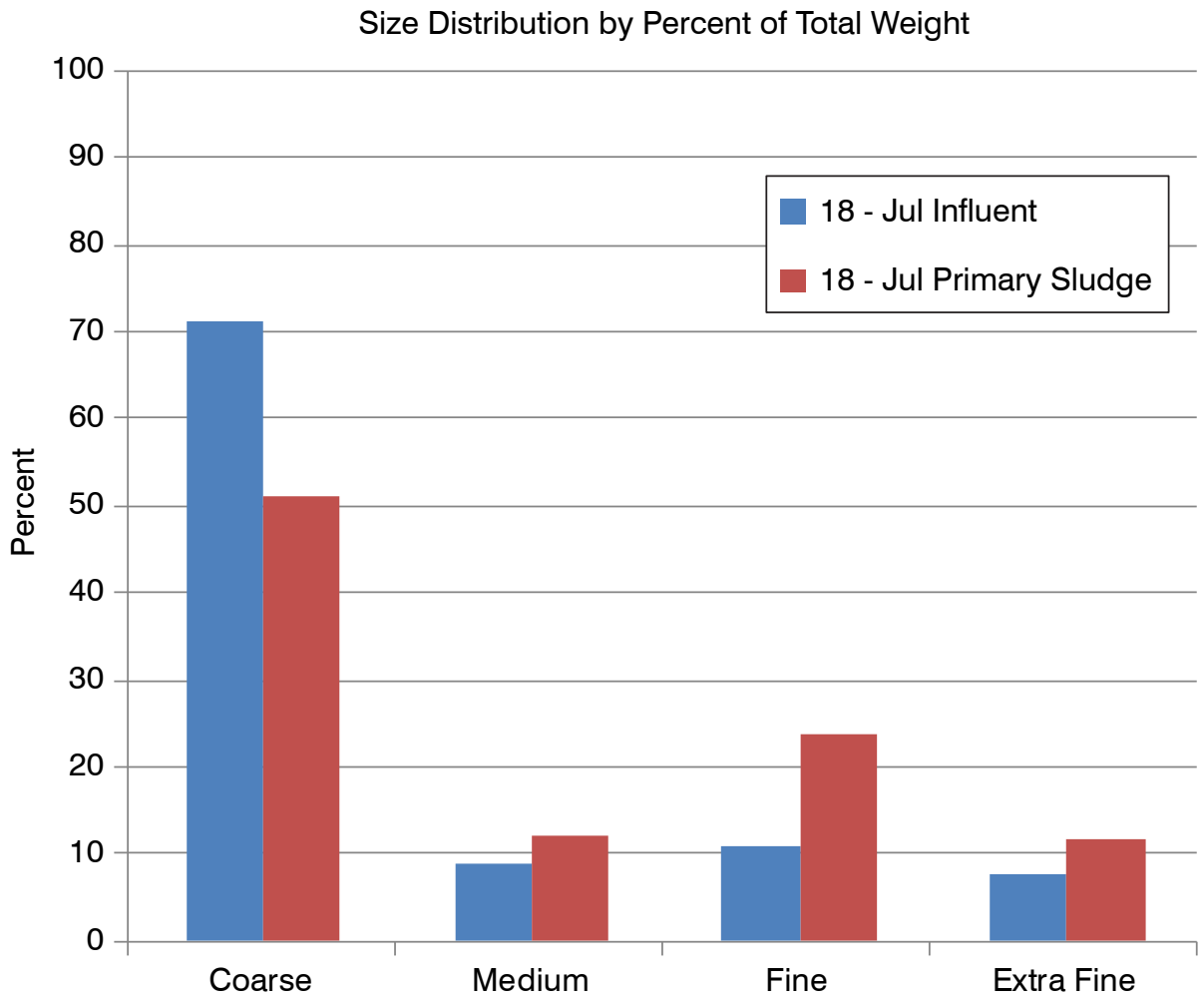

Figure 5
INFLUENT AND PRIMARY SLUDGE GRIT SIZE DISTRIBUTION ON JULY 18
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CITY OF SUNNYVALE

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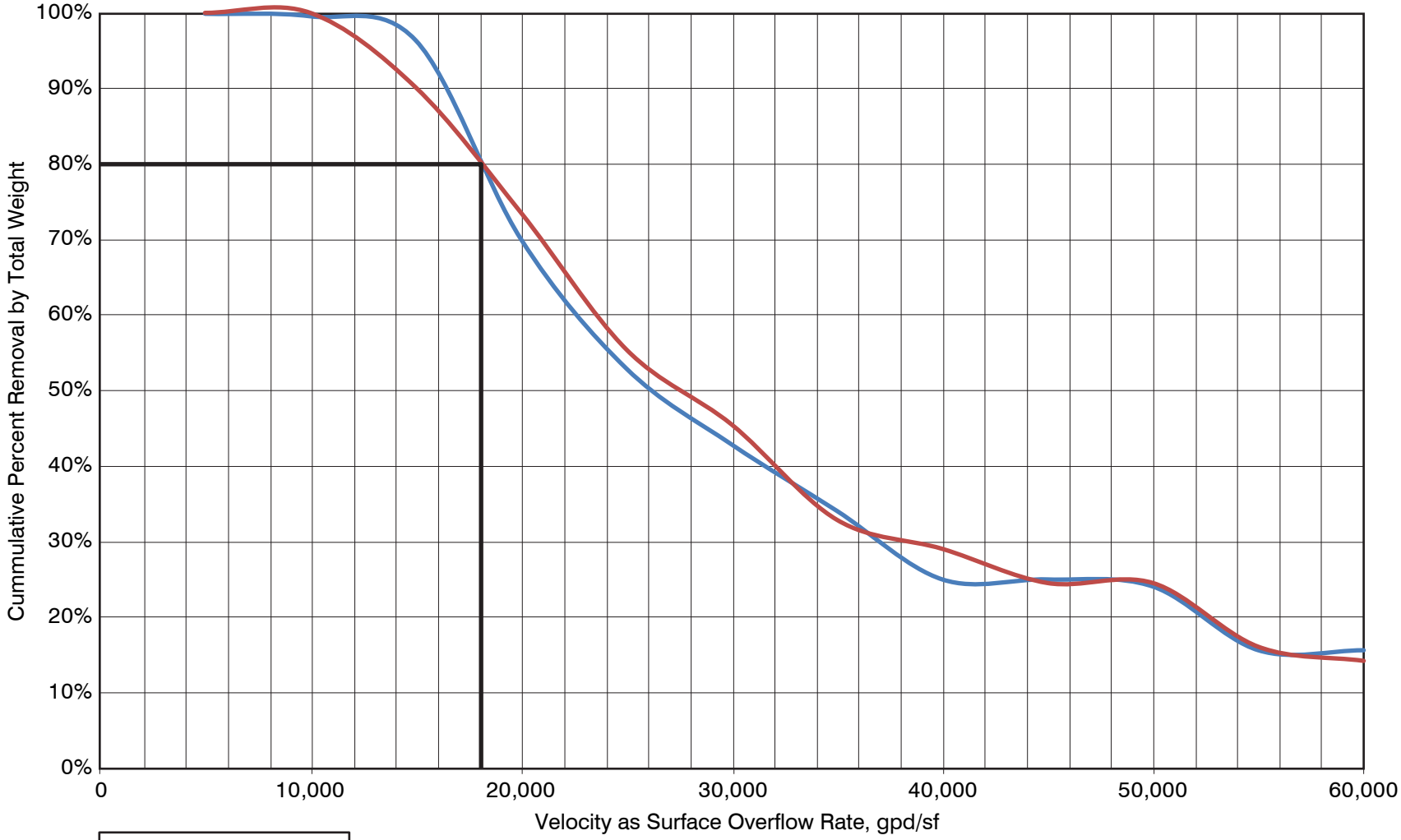

LEGEND
July 17th, 2013(1)
July 18th, 2013(1)

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

Figure 6
INFLUENT GRIT SETTLING VELOCITY DISTRIBUTION BY WEIGHT
GRIT CHARACTERIZATION STUDY
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

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Because the settling velocity of the coarse grit is significantly less than that of comparability-sized sand, a new grit removal system would have to target grit settling as slow as 0.85 cm/sec (equivalent to a surface overflow rate of 18,000 gpd/sf) in order to significantly increase the capture of the new system.

3.0 RECOMMENDATIONS

Good performance of the new grit removal systems can be achieved by application of newer technologies. Potential technologies include forced vortex grit, aerated grit basins or the proprietary HeadCell® units. It is Carollo's and HDR's experience that the forced vortex grit basin technology has not been effective in removing slow settling grit particles. Therefore, this technology would not be considered a viable alternative.

It is recommended that a surface overflow rate (SOR) of 18,000 gpd/sf be used as the design criteria for sizing of the aerated grit and HeadCell® process units. Based on the influent grit settling characteristics presented in Figure 6, this would result in a theoretical removal of 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. This SOR criteria is considered conservative and results in larger and more expensive units, therefore the City should be involved in the overall decision-making process for the proposed grit removal technology. For additional review and comparison of grit removal and grit handling technologies, and further development of design criteria recommendations, refer to the Preliminary Treatment Technical Memorandum.

APPENDIX – BLACK DOG ANALYTICAL REPORT

BLACK DOG ANALYTICAL, LLC

GRIT CHARACTERIZATION STUDY

SUNNYVALE WATER POLLUTION CONTROL PLANT

- SUNNYVALE, CA

STUDY PREPARED FOR CAROLLO ENGINEERS

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Definitions/Abbreviations

gpm - gallons per minute.

Grit – A settleable inorganic kernel with attached organics larger than 50 microns and characterized by physical size and settling velocity.

Grit Concentration – the amount of grit present in the wastestream based on the fixed solids measurements

Grit Fixed Solids (FS) – also expressed as "**fixed solids**" - the inorganic portion of sample remaining after organics are removed by ashing in a muffle furnace at 550^{o}C.

lbs./MG – Pounds per Million Gallons

MG - Million Gallons

MGD – Million Gallons per Day

NR1 – the Reynolds number for the trial SES

NR2 – the Revised Reynolds number

SAA – Surface Active Agents – material affixed to the grit particle, such as organics, fats, oils, and greases that may affect the settling velocity of municipal grit.

Sample – All material accumulated in the bottom of the grit settler which includes settleable organics.

Sand Equivalent Size (SES) - The sand particle size, measured in microns, having the same settling velocity as the selected grit particle.

Sed h, cm – The height of water in the Imhoff cone through which the sediment passed to reach the surface of accumulated material during SES determination

Sed Time, sec – The time required for sediment to reach the recorded volume during SES determination

Sed vel, cm/s – the settling velocity (v) of the sediment reaching a particular settled volume

Sed. Vol., cc – Sedimentation Volume (cc or ml) – The amount of material that settles in the Imhoff Cone during SES determinations

SES, d1, u – Trial Sand Equivalent Size, in microns

Definitions/Abbreviations Continued

SES, d2, u – Revised Reynolds Number based on NR2 and d1

VIS – Vertically Integrated Sampler

Vol Frac, % - the cumulative sedimentation percentage occurring during SES determination

WPCP – Water Pollution Control Plant

Introduction

The City of Sunnyvale, CA is assessing the amounts and characteristics of grit entering their Water Pollution Control Plant (WPCP) as well as primary sludge and dewatered grit. Data collected during this study will contribute to future headworks design considerations.

In conventional grit removal system design, grit has commonly been treated as clean sand with a specific gravity of 2.65. Metcalf and Eddy's Wastewater Engineering: Treatment and Reuse (standard textbook) says "Grit consists of sand, gravel, cinders, or other heavy materials that have specific gravities or settling velocities considerably greater than those of organic particles". These inorganic solids are often associated with Surface Active Agents (SAA) that include fats, oils, greases, and other organic materials can lower their effective specific gravity to 1.3 (Tchobanoglous, 2003). The shape and composition of grit and inert solids also greatly affects settling velocities. Material with similar specific gravities may have very different settling velocities due to the shape of the particle.

When determining quantities of grit during this study, grit will be defined as settleable inorganic material larger than 50 microns. Settling velocities, attached organics and SAA has been considered during the on-site laboratory analyses. The settling velocity is expressed as the Sand Equivalent Size (SES), which is the sand particle size having the same settling velocity as the more buoyant grit particle. Materials less than 50 microns in size have been considered silt or clay and thus excluded from the data.

Study Objectives

The purpose of this study was to determine the amounts and characteristics of influent, primary sludge and dewatered grit collected by the grit chambers at the Sunnyvale WPCP.

Methods/Materials

Obtaining Representative Grit Fixed Solids (FS) Sample

The volume and characteristics of grit received at wastewater treatment facilities can vary widely depending on the characteristics of the collection system, weather conditions, septic waste haulers, and industrial activities. The analytical procedures used in compiling these data take into account and compensate for the non-homogeneity of the grit.

The influent samples were collected from the influent channel after screening (Figure 1). A Vertically Integrated Sampler (VIS) was secured in the channel and positioned to face the flow. A VIS is constructed from a section of four-inch diameter PVC pipe with a sealed bottom and a slot cut along the length of the pipe. A suction hose plumbed to a trash pump was affixed to a two-inch pipe secured approximately two-inches from the bottom of the sampler. The VIS is designed to collect sample from the entire height of the water column. The slot width is determined by the velocity present in the channel during maximum flows. Since the pump rate and the channel depth are known, it is possible to calculate the width of slot required to match the velocity across the slot with the velocity in the wastestream. If a slot is too wide, the slow velocity may create a non-isokinetic condition that may cause a grit particle to go around the VIS and avoid being sampled. A slot that is too thin can always be widened or, if the pump is starving, reduce the speed of the pump. During the start of the sampling event, the trash pump will often remove wastewater at a rate higher than can flow through the slot; therefore the pump speed is lowered until the plant flow increases. Turbulence present in the channel helped insure a homogenous sample was collected.

Figure 1. Sunnyvale WPCP Influent VIS

A portion of the influent sample is diverted to a grit settler. A PVC wye is used to split the flow (Figure 2), and a valve following the wye is used to increase flow to the settler if necessary. A one-inch hose supplies the grit settler, while a two-inch hose returns the majority of flow to the wastestream.

Figure 2. PVC Splitter and Valve

Grit settlers (Figure 3) are constructed from 50-gallon plastic storage tanks with an influent port and a discharge weir. Flow enters the tank and is diverted to the side with a 90^{o} elbow to reduce the velocity and turbulence. Grit settles to the bottom of the tank, and wastewater exits through the discharge fitting at the top of the tank. In order to settle 50-micron grit with a specific gravity of 2.65, the overflow rate must be less than three-gallons per minute/ft^2 of surface area. The settler has a diameter of 24-inches, or a surface area of 3.14 ft^2. At ten-gpm, the overflow rate is 3.18 gallons per minute/ft^2. The settler feed rate is adjusted to less than eight-gpm to insure settling of fine grit and this is checked by timing the overflow rate of the settler. This is repeated every 30 minutes to insure stability. The excess flow provided by the pump is bypassed back into the wastestream.

Figure 3. Grit Settler

At the end of the sampling period, the settler contents are allowed to settle for 20 minutes. The supernatant is discarded and grit that has accumulated in the bottom of the settler is rinsed into buckets. The liquid portions of the grit samples are gradually poured off until the remaining grit/sludge samples are thick enough to obtain a homogenous mixture without grit settling out of the slurry. The entire volume of each sample is recorded before being split for analysis. Since bacteria will reduce the organics that are attached to the grit particles, it is important to perform the analyses on fresh grit immediately after collection. If immediate analysis is not possible, samples may be stored at 4^{O}C for no longer than 12 hrs.

Primary Sludge

Samples of primary sludge were collected from the common sampling port. Five gallons of sludge were collected from each of the five basins in service, totaling 25 gallons. Basins 2, 3, 6, 7, and 8 were in service during the study. Each five-gallon sample was split into several buckets and rinsed, the supernatant was discarded, and the remaining grit from each bucket combined into a composite sample. This process is detailed below.

Primary sludge processing procedure

1. Five gallons of primary sludge were collected from the sludge sampling port located on the primary sludge pump.

2. The sample is split evenly into six buckets

3. Each bucket is rinsed, directing water towards the side of the bucket to create a circular motion.

4. The washed grit is allowed to settle in the buckets. Settling is assumed to have occurred once the circular motion has ceased or significantly subsided.

5. Each bucket is decanted, leaving only the collected grit.

6. The buckets are combined into a composite bucket.

Dewatered Grit

At the beginning of the sampling segment, the grit dumpster contents were flattened and covered with a plastic sheet. The pile of grit accumulated during sampling was measured for height and width to determine a volume. A grab sample was collected for sieving, %TS and %TVS determination.

Figure 4: Dewatered Grit

Determination of Grit Particle Distribution

A 200-gram portion of the sample collected by the 50-micron Grit Settler is immediate sieved. Wet sieving for size fractions and the SES settling tests are conducted on fresh grit from the sewer waste stream samples as the Surface Active Agents (SAA) attached to the grit kernel may substantially reduce its effective specific gravity and consequently it's settling velocity. Sieve sizes are listed below in Table 1.

Table 1. Sieve Size Equivalents

		Opening	
U.S. Sieve Size	Tyler Equivalent	microns	inches
1/4	3.25 mesh	6300	0.2500
1/8	6.5 mesh	3180	0.1250
#12	10 mesh	1680	0.0661
#20	20 mesh	841	0.0331
#50	48 mesh	297	0.0117
#70	65 mesh	210	0.0083
#100	100 mesh	149	0.0059
#140	150 mesh	105	0.0041
#200	200 mesh	74	0.0029
#270	270 mesh	53	0.0021
Pan			

Determination of Sand Equivalent Size (SES) distribution

Settling tests were conducted immediately on solids passing the U.S. #20 sieve and sequentially retained on the #50, #70, #100, #150, #200, and #270 sieves. Large organics often interfere with the settling of grit on screens larger than #50. A portion of the retained material is placed into a modified Imhoff cone filled with water (See Figure 5). The column is inverted and as the grit settles in the cone corresponding time and volume measurements are recorded. The objective of these measurements is to determine the size of a sand sphere having the same settling velocity as the collected grit fraction.

Figure 5. Modified Imhoff Cone for SES Measurements

The weight measurements of the grit particles retained on each of the ten sieves were determined according to methods SM2540B and SM2540E as outlined in Standard Methods for the Examination of Water and Wastewater, 1998 APHA, AWWA, WEF, 20th edition. Fixed solids fractions were arranged into fractional and cumulative distributions. From this data a cumulative curve factoring physical size and weight of fixed solids is generated. All solids data are listed in Appendix B-1 "Fractional Solids Analysis"

Data from the settling tests are entered into a spreadsheet for each size fraction that converts the settling velocities and volumes into Sand Equivalent Size. The SES value generated is plotted against the corresponding volume fraction to generate a series of SES charts. Each chart is divided into 20-micron SES intervals and the percentages of grit falling within each interval are entered into a spreadsheet for analysis. From this data, a cumulative curve factoring SES and weight of fixed solids per size fraction is generated. By comparing the "SES" curve with the "Physical Size" curve, we can determine the amount of grit that can bypass a grit removal system designed around a known sand particle size.

The SES charts are also used to compare the average SES within a sieve fraction with the average physical size of clean, round silica sand for that same sieve fraction. To calculate the concentration of grit present in the sewer during normal flow conditions, the volume of wastewater sampled each day is compared to the measured volume of wastewater passing through the sewer during the sampling periods. The total amount of grit collected during each sampling period is applied to the total volume of wastewater to determine the lbs/MG of grit present in the sewer.

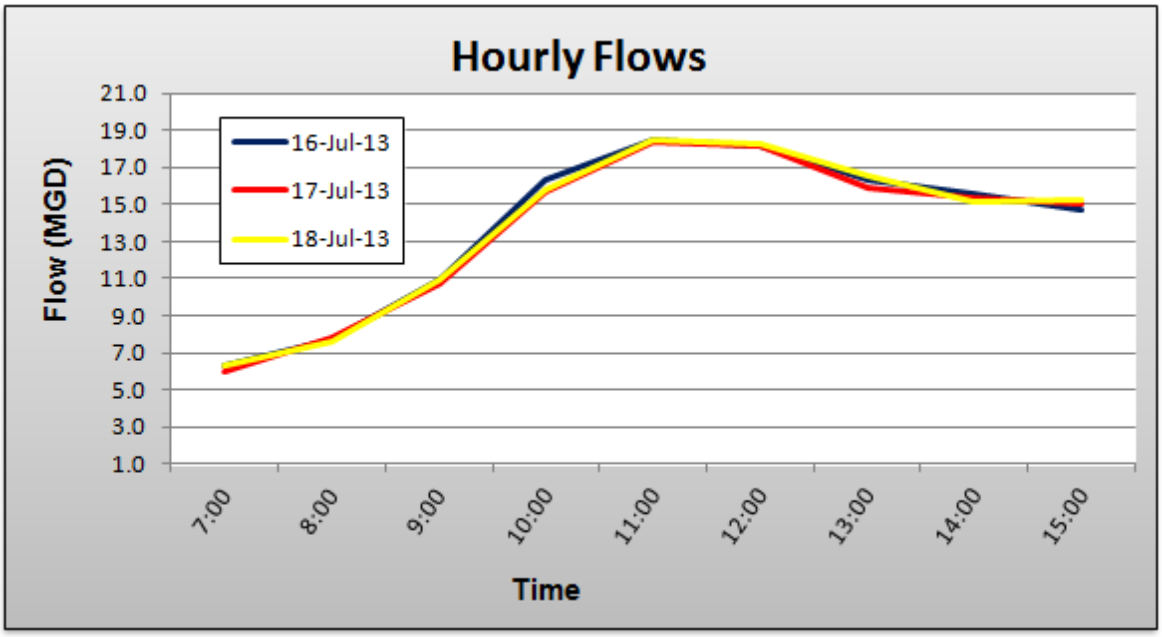
Discussion of Results

Sunnyvale WPCP Influent Grit Characterization

The trial was conducted on July 16, 17, and 18, 2013. Sampling conditions are presented below in Table 2, and flows present during the sampling days are charted in Figure 6.

Table 2. Sunnyvale WPCP Grit Evaluation Sampling Period					
Sampling Date	Average Influent Flow During Sampling Period (MGD)	Start Time	Finish Time	Hours	Settler Feed Rate (gpm)
July 16, 2013	13.826	8:00	14:00	6.0	7.80
July 17, 2013	13.692	8:00	14:00	6.0	7.98
July 18, 2013	13.806	8:00	14:00	6.0	8.13

Figure 6. Sunnyvale WPCP Flow Data



Grit Size Distributions

Figures 7 and 8 plot the distributions of grit collected at the treatment facility, and Figure 9 plots the fractional concentrations. From Figures 7 and 8, between 61.5 and 92.2% of influent grit was larger than 297-microns physical size, while between 7.8% and 38.5% of grit was smaller than 297-microns. The concentration of influent grit varied despite a consistent flow, totaling 181 lbs/MG on July 16, 40.7 lbs/MG on July 17, and 25.1 lbs/MG on July 18.

Figure 7. Fractional Distribution of Grit Collected From the Influent Wastestream at the Sunnyvale WPCP

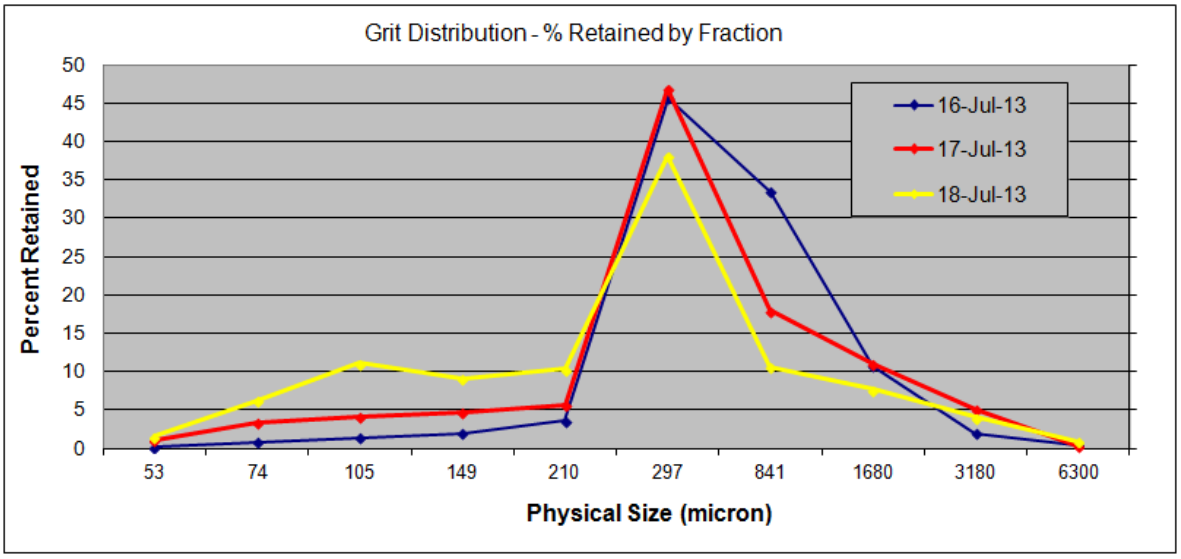


Figure 8. Cumulative Distribution of Grit Collected From the Influent Wastestream at the Sunnyvale WPCP

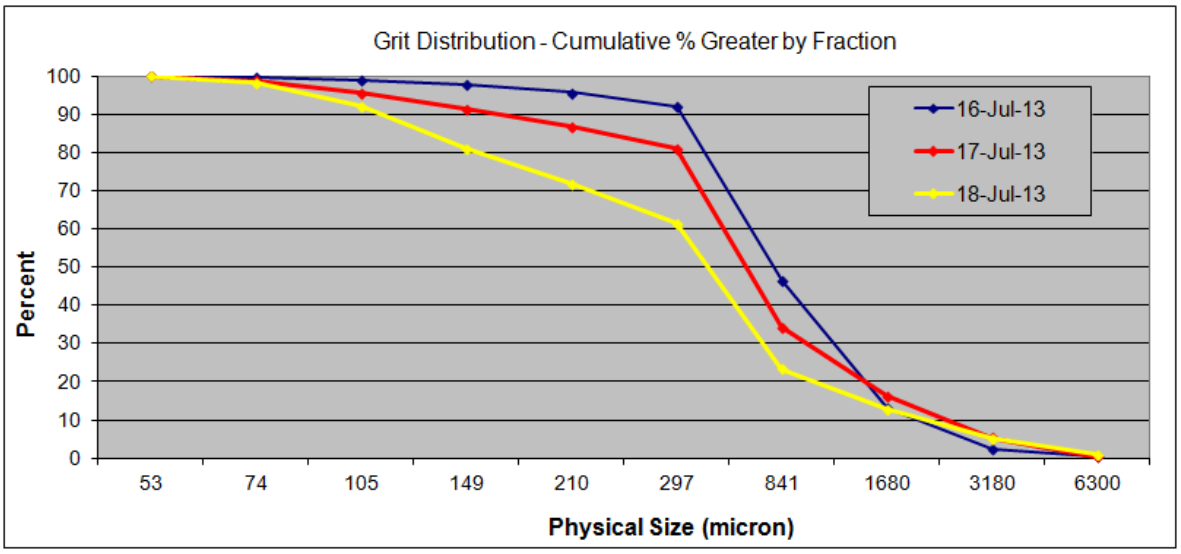
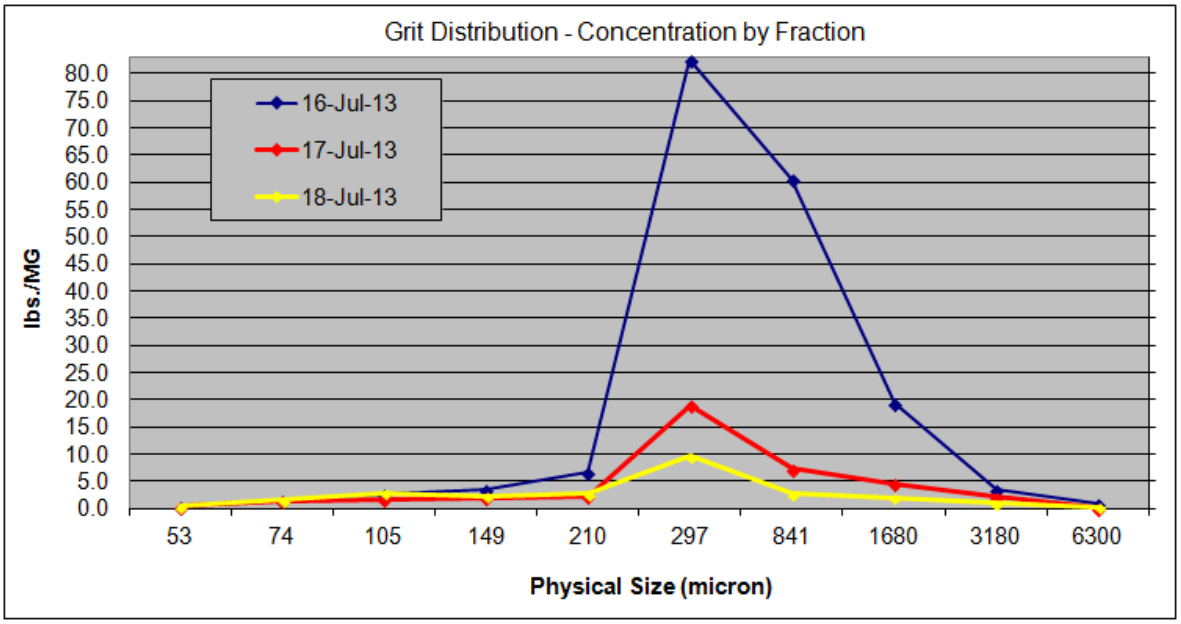


Figure 9. Concentrations of Grit Collected From the Influent Wastestream at the Sunnyvale WPCP



Settling Characteristics

Sand Equivalent Size (SES) vs. Physical Size plots can be used to determine grit removal system design parameters. The following table lists theoretical removal efficiencies for a system designed to remove grit based on the SES data collected from the influent sampling location.

Table 3. Predicted Removal Efficiencies (%) of a System Designed to Remove Grit of a Specific SES at the Sunnyvale WPCP

Sample Date	300-micron SES Design	150-micron SES Design	100-micron SES Design	75-micron SES Design
July 16, 2013	39.5	82.5	98.3	100
July 17, 2013	12.5	51.5	91.6	99.8
July 18, 2013	10.9	48.8	92.6	100

Efficiencies listed in Table 3 are found in Figures 10, 11 and 12, which compares the Sand Equivalent Size and physical size of influent grit. Figure 13 compares the physical and SES distributions of collected grit with a clean sand distribution. Values found in Figure 13 are determined from the median SES of material on each sieve, and fractional data is not applied as is the previous companion charts.

Figure 10. Comparison of the Sunnyvale WPCP Influent Grit Physical Size and Sand Equivalent Size on July 16, 2013

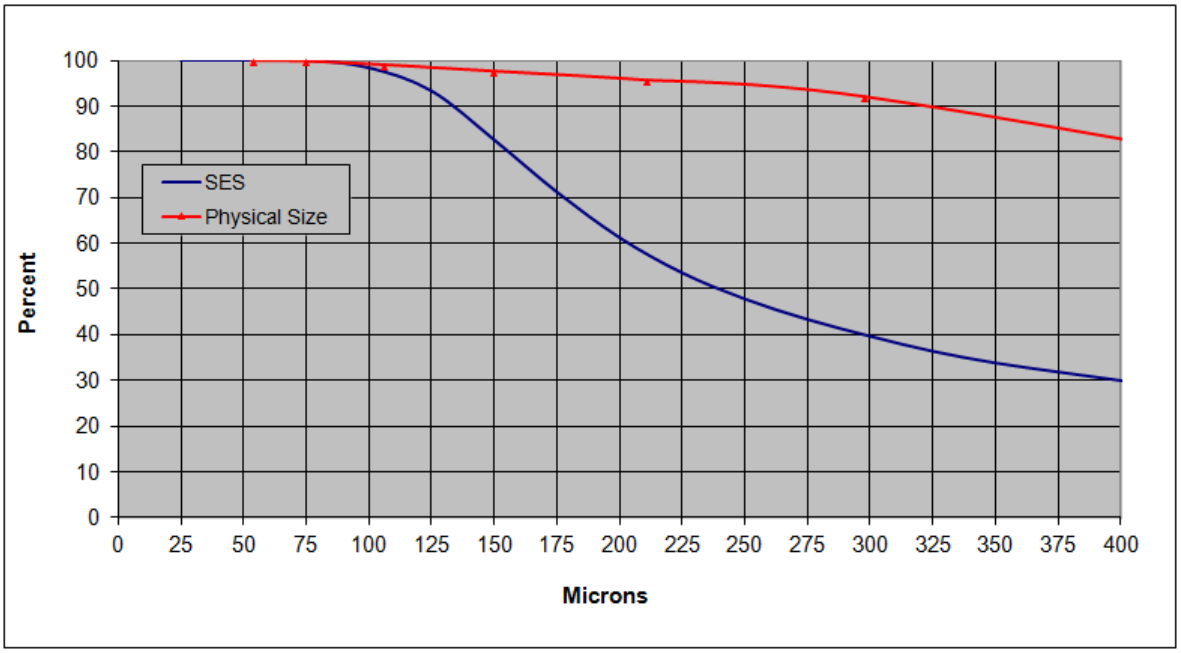


Figure 11. Comparison of the Sunnyvale WPCP Influent Grit Physical Size and Sand Equivalent Size on July 17, 2013

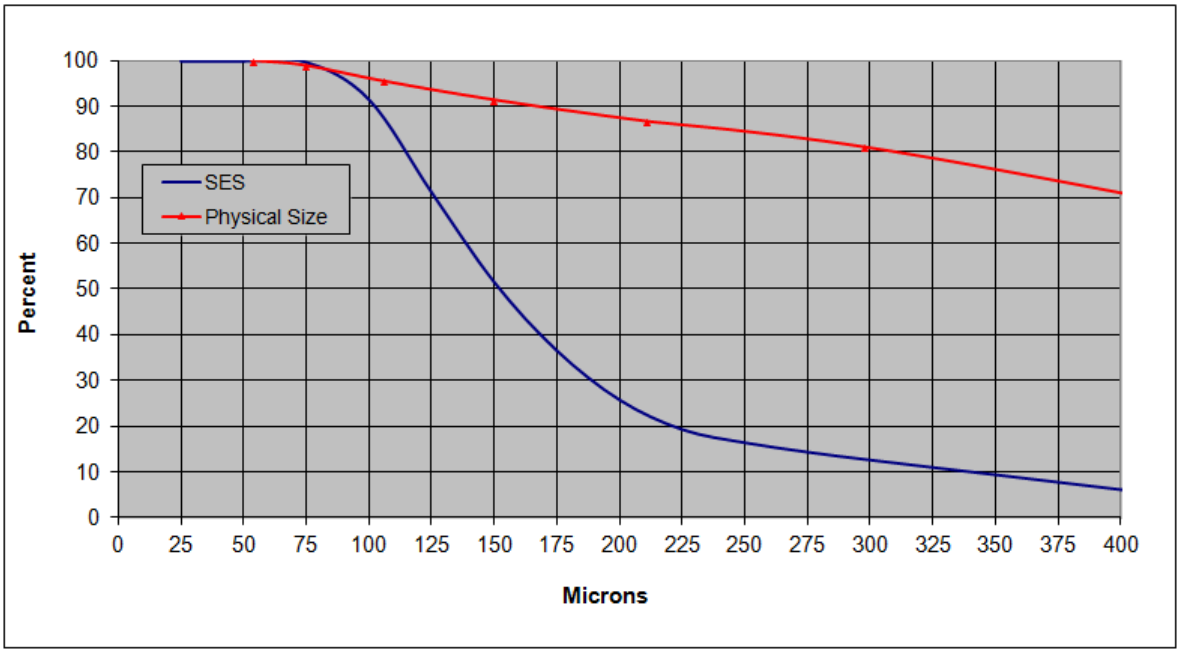


Figure 12. Comparison of the Sunnyvale WPCP Influent Grit Physical Size and Sand Equivalent Size on July 18, 2013

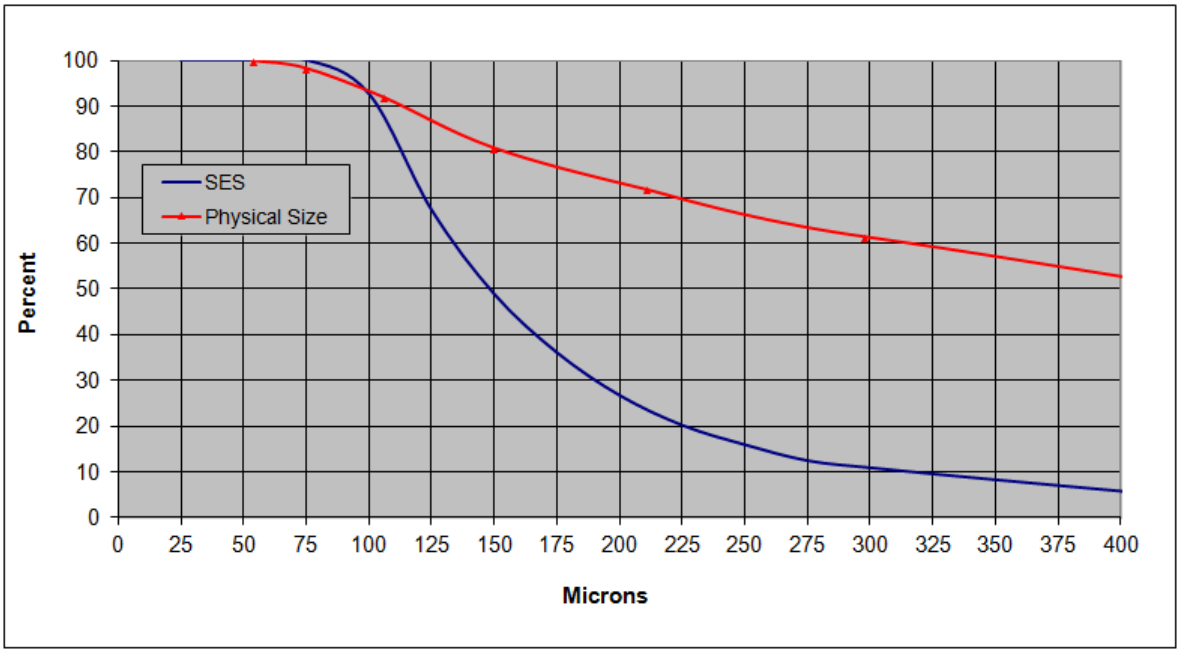
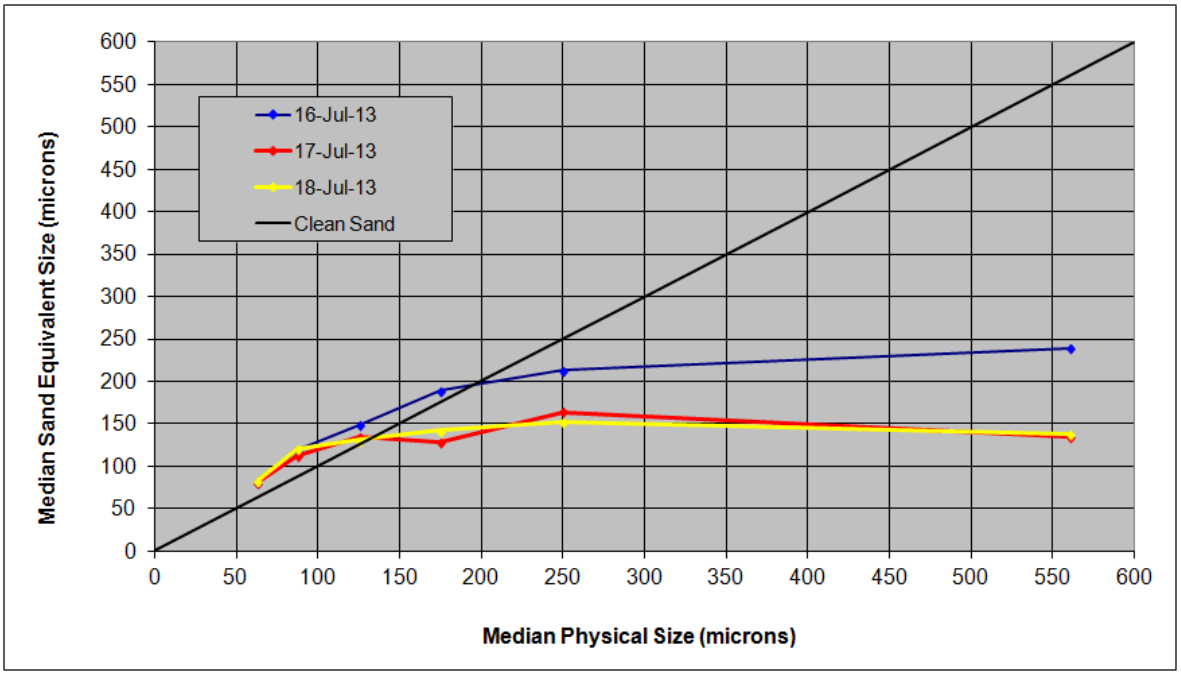


Figure 13. Median Size Distribution of Influent Grit at the Sunnyvale WPCP vs. a Clean Sand Distribution



Settling velocities of the influent grit were slower on July 17 and 18, with heavier grit present on July 16. This is typical for wastestreams with high grit concentrations.

Primary Sludge

Samples were collected at 10:00 am on July 16, 17, and 18 according to the method previously described.

Grit Size Distributions

Figures 14 and 15 plot the distributions of grit present in the primary sludge, and Figure 16 plots the fractional concentrations. From Figures 14 and 15, between 27.3 and 36.3% of grit was larger than 297-microns physical size, while between 63.7 and 72.7% of grit was smaller than 297-microns. A significant portion of the distribution occurs below 300-micron, identifying the type of material that is bypassing the grit chambers. The concentration of grit was similar for all three days, with 1,240 lbs/MG on July 16, 1,115 lbs/MG on July 17, and 1,062 lbs/MG on July 18.

Figure 14. Fractional Distribution of Grit Collected From the Primary Sludge at the Sunnyvale WPCP

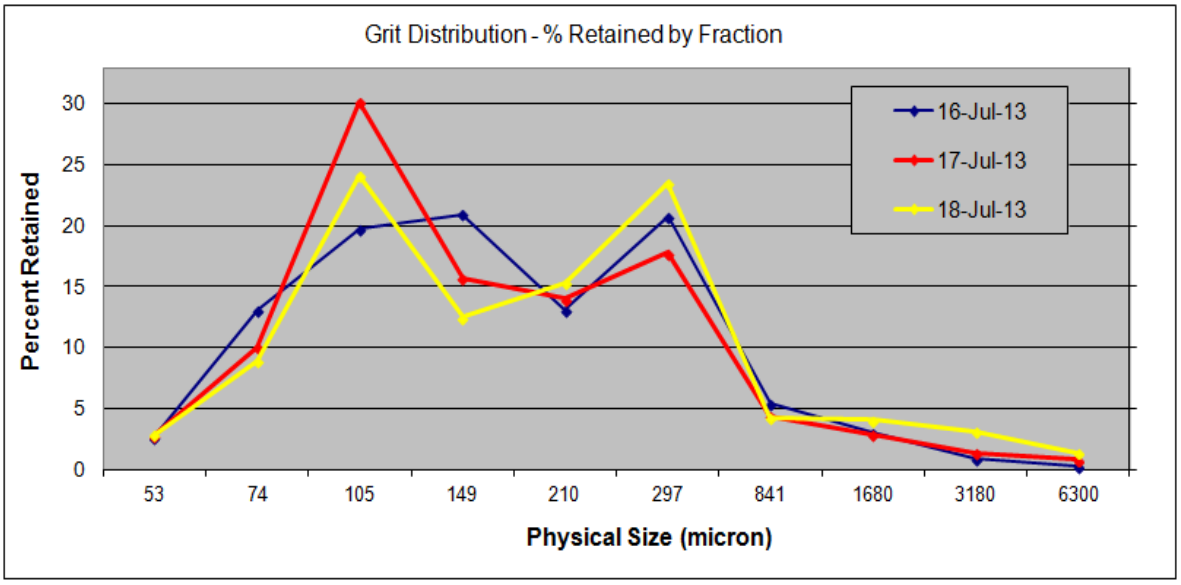


Figure 15. Cumulative Distribution of Grit Collected From the Primary Sludge at the Sunnyvale WPCP

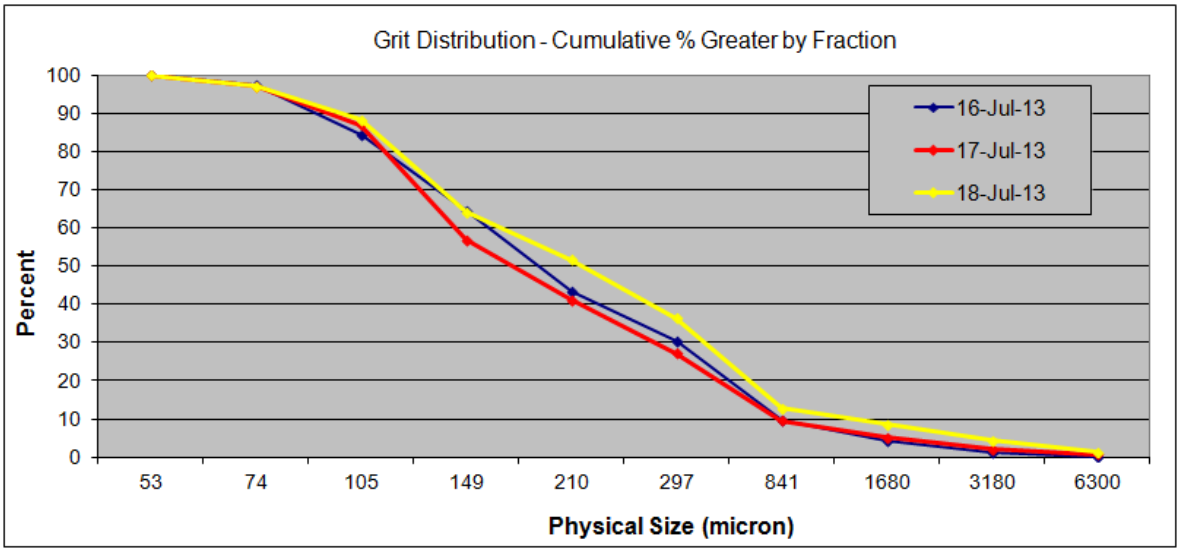
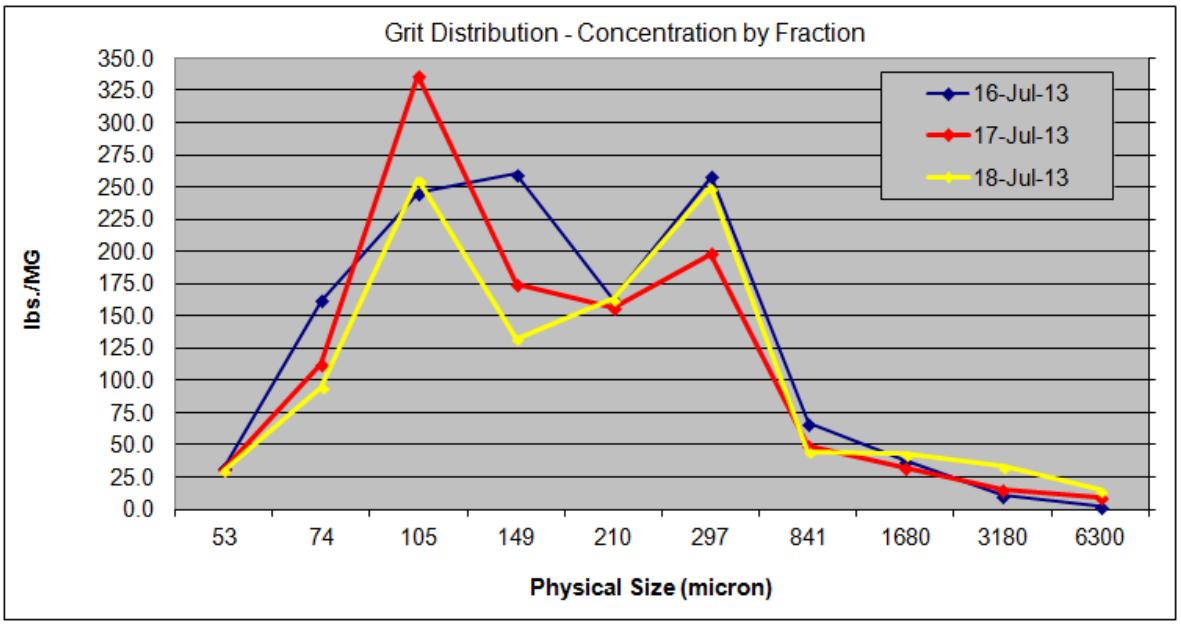


Figure 16. Concentrations of Grit Collected From the Primary Sludge at the Sunnyvale WPCP



Settling Characteristics

Sand Equivalent Size (SES) vs. Physical Size plots were determined for each primary sludge composite sample. The following table lists theoretical removal efficiencies for a system designed to remove grit based on the SES data collected from the sludge.

Table 4. Predicted Removal Efficiencies (%) of a System Designed to Remove Primary Sludge Grit of a Specific SES at the Sunnyvale WPCP

Sample Date	300-micron SES Design	150-micron SES Design	100-micron SES Design	75-micron SES Design
July 16, 2013	0.1	49.5	85.9	99.2
July 17, 2013	3.4	38.9	77.8	96.1
July 18, 2013	1.2	51.2	85.6	99.3

Efficiencies listed in Table 4 are found in Figures 17, 18 and 19, and Figure 20 compares the physical and SES distributions of collected grit with a clean sand distribution.

Figure 17. Comparison of the Sunnyvale WPCP Primary Sludge Grit Physical Size and Sand Equivalent Size on July 16, 2013

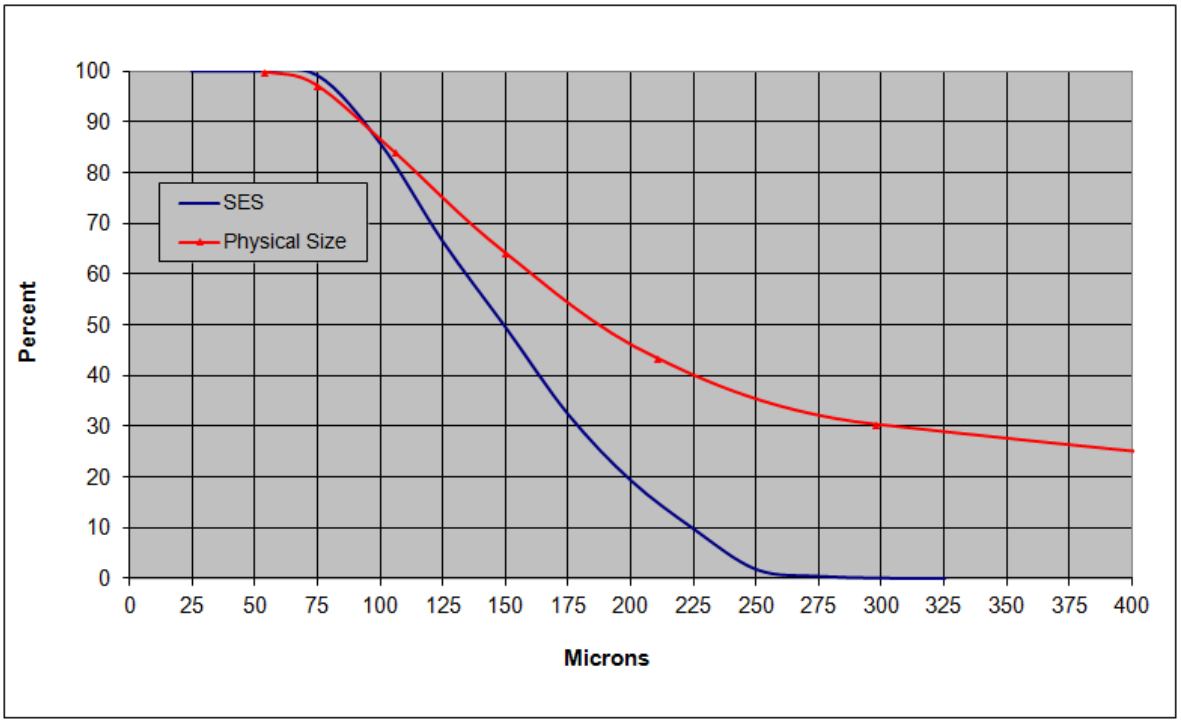


Figure 18. Comparison of the Sunnyvale WPCP Primary Sludge Grit Physical Size and Sand Equivalent Size on July 17, 2013

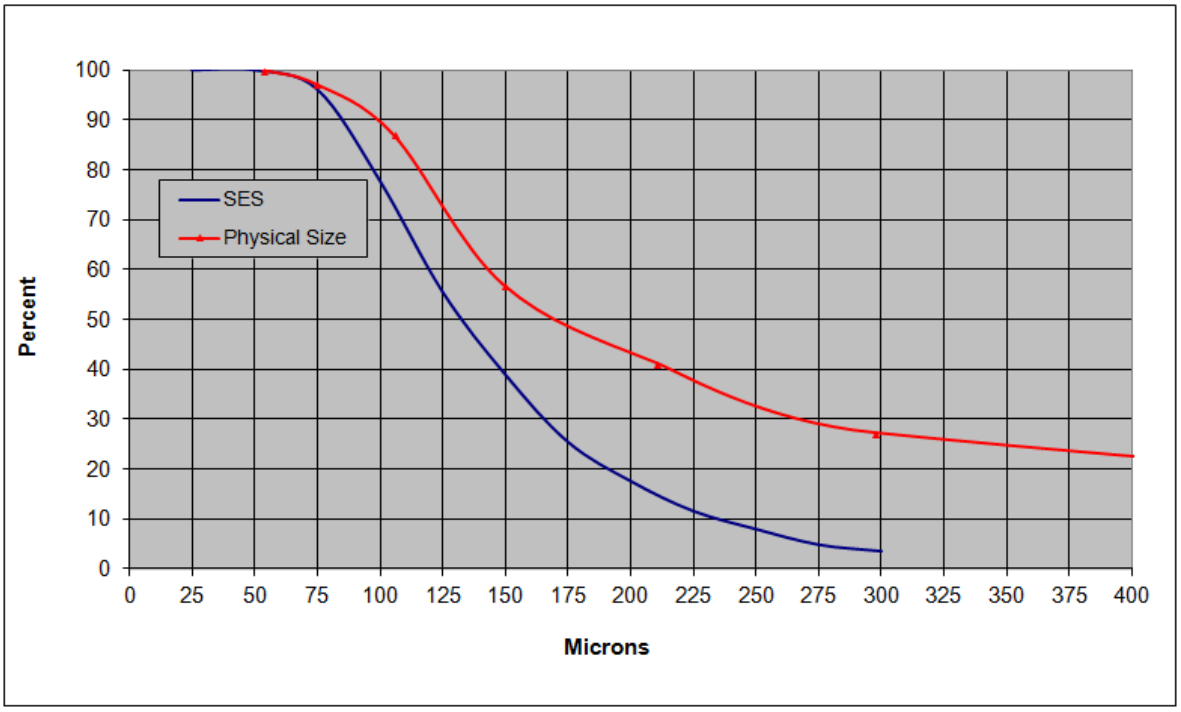


Figure 19. Comparison of the Sunnyvale WPCP Primary Sludge Grit Physical Size and Sand Equivalent Size on July 18, 2013

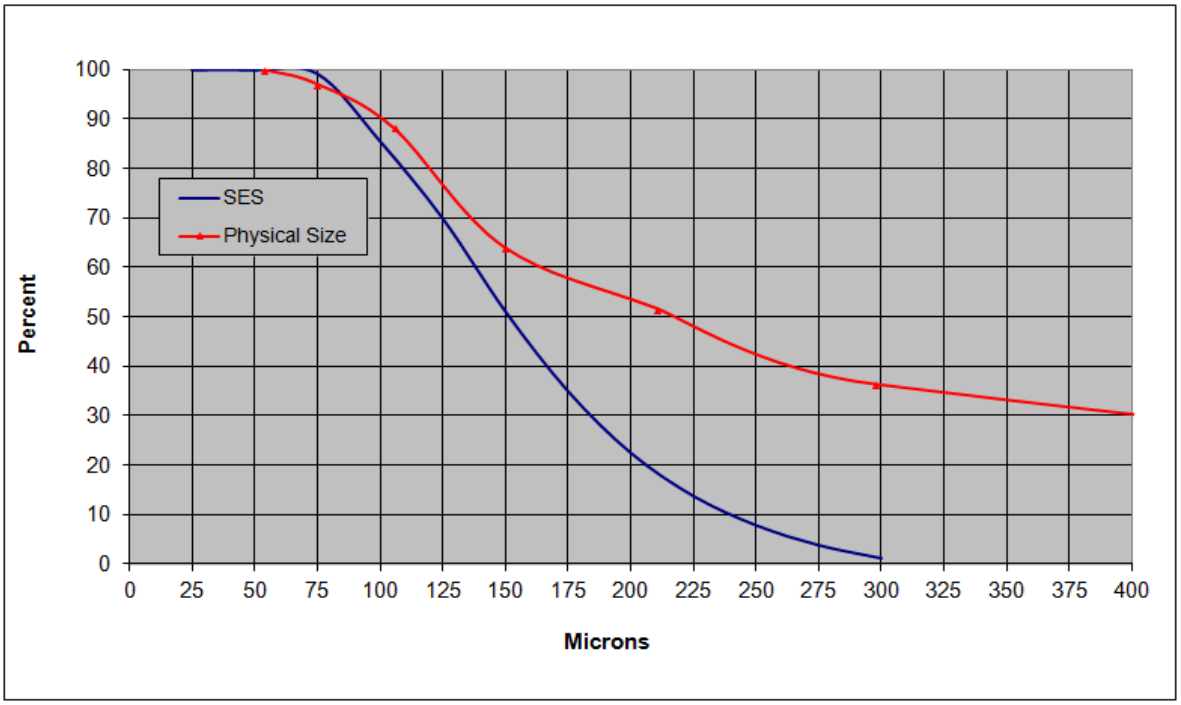
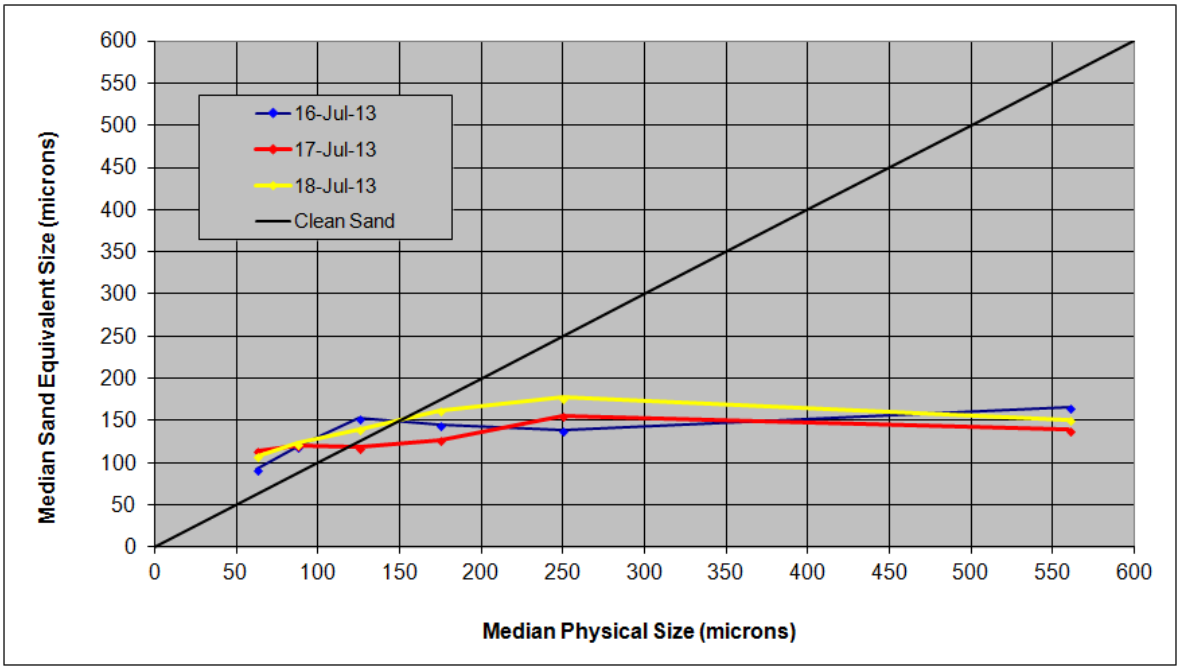


Figure 20. Median Size Distribution of Primary Sludge Grit at the Sunnyvale WPCP vs. a Clean Sand Distribution



Dewatered Grit

Sampling occurred on July 16, 17, and 18, 2013. Data collected for the dumpster contents are listed below in Table 5.

Table 5. Sunnyvale WPCP Dewatered Grit Characteristics					
Sampling Date	Volume (in^3)	%TS	%TVS	Total lbs. of Inert Material (Fixed Solids)	Density (lbs/ft^3)
July 16, 2013	6,107.26	32.61	21.69	26.14	29.0
July 17, 2013	4,846.69	38.45	22.38	18.60	22.0
July 18, 2013	4,289.32	34.37	25.08	13.45	21.0

Grit Size Distributions

Figures 21 and 22 plot the distributions of grit exiting the facility, and Figure 23 plots the fractional concentrations. From Figures 21 and 22, between 67.8 and 80.7% of grit was larger than 297-microns physical size, while between 19.3 and 32.2% of grit was smaller than 297-microns. The amounts of inert material accumulated in the dumpster during sampling (Table 5) follows the daily concentrations of influent grit reported above.

Figure 21. Fractional Distribution of Dewatered Grit at the Sunnyvale WPCP

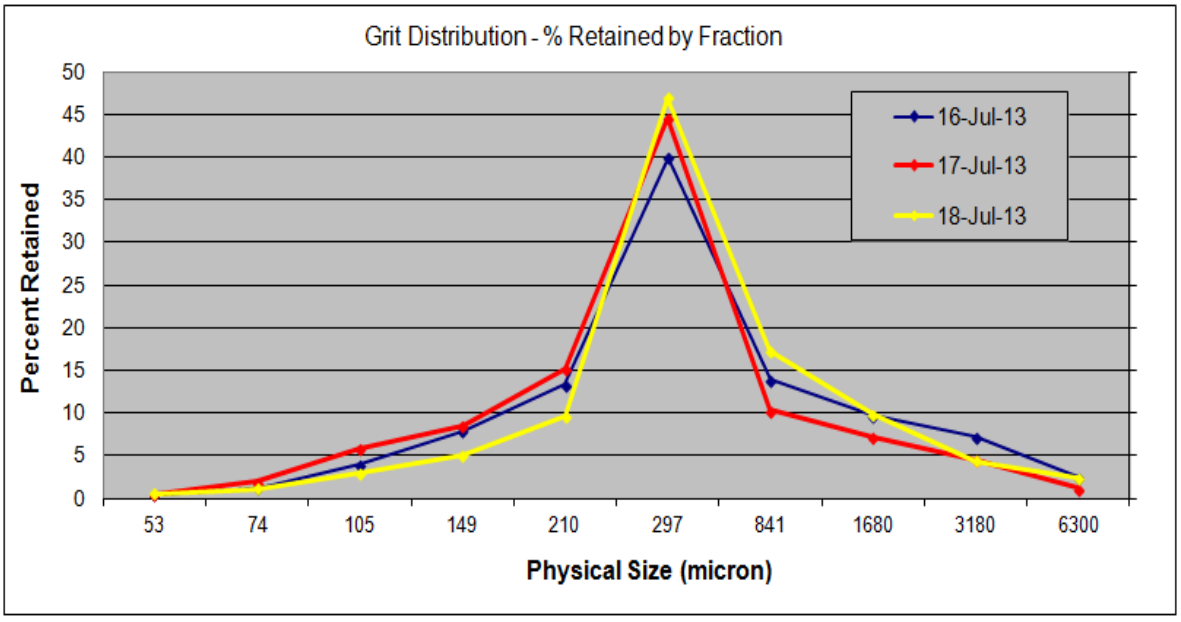


Figure 22. Cumulative Distribution of Dewatered Grit at the Sunnyvale WPCP

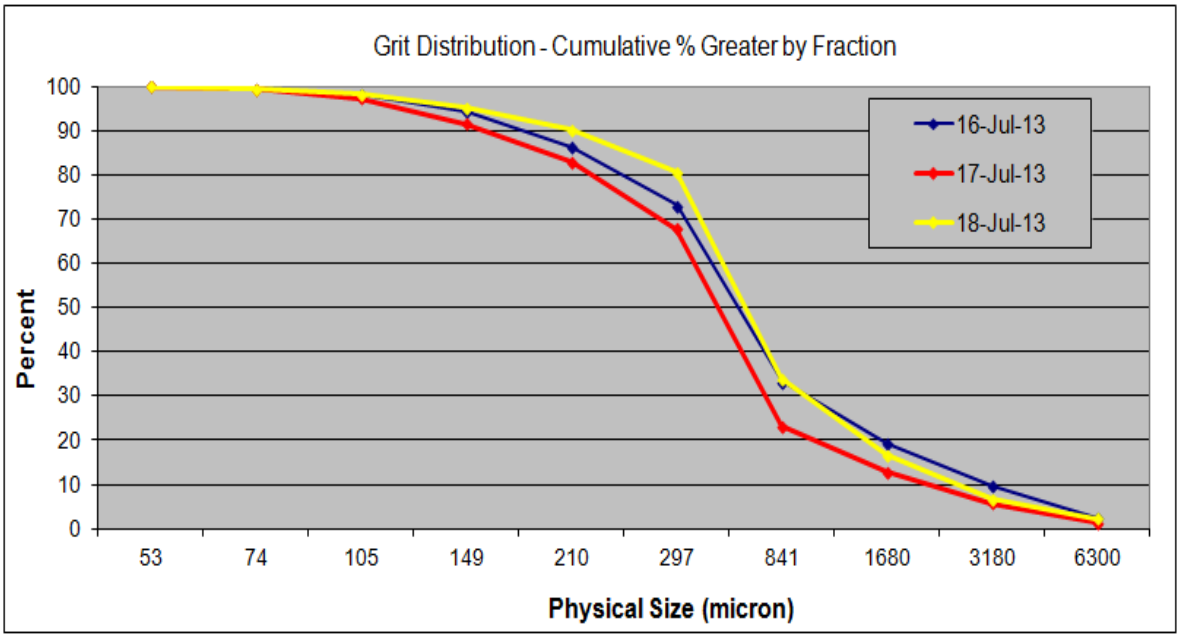
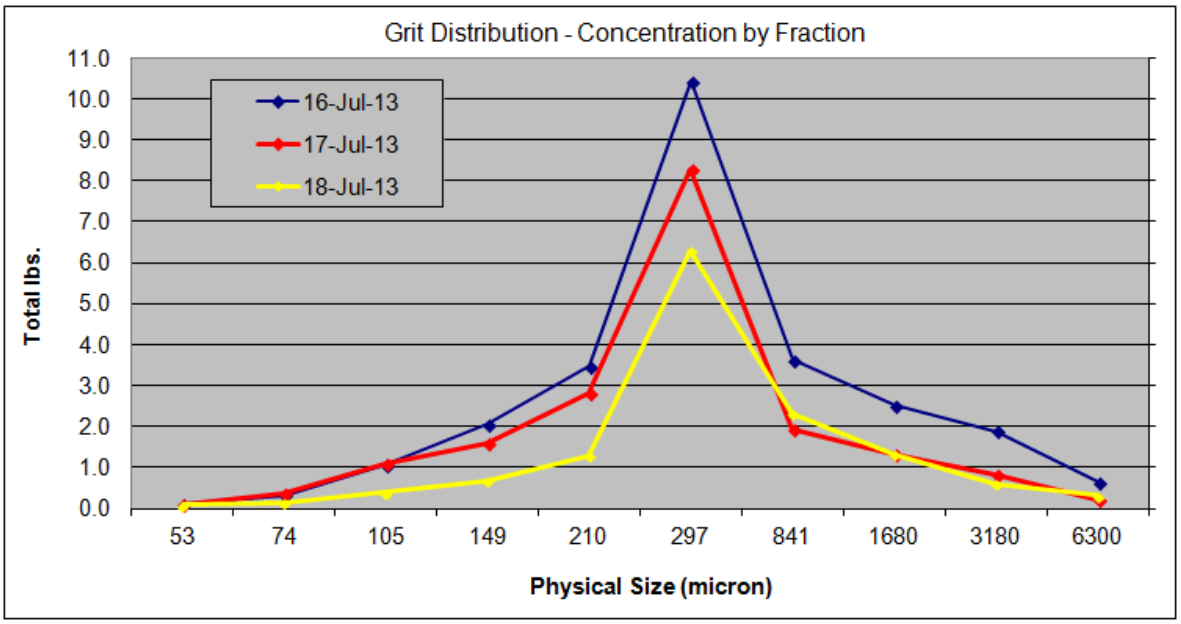


Figure 23. Concentrations of Dewatered Grit at the Sunnyvale WPCP



Settling Characteristics

Companion plots for the dewatered grit are found in Figures 24, 25 and 26, and Figure 27 compares the physical and SES distributions of dewatered grit with a clean sand distribution.

Figure 24. Comparison of the Sunnyvale WPCP Dewatered Grit Physical Size and Sand Equivalent Size on July 16, 2013

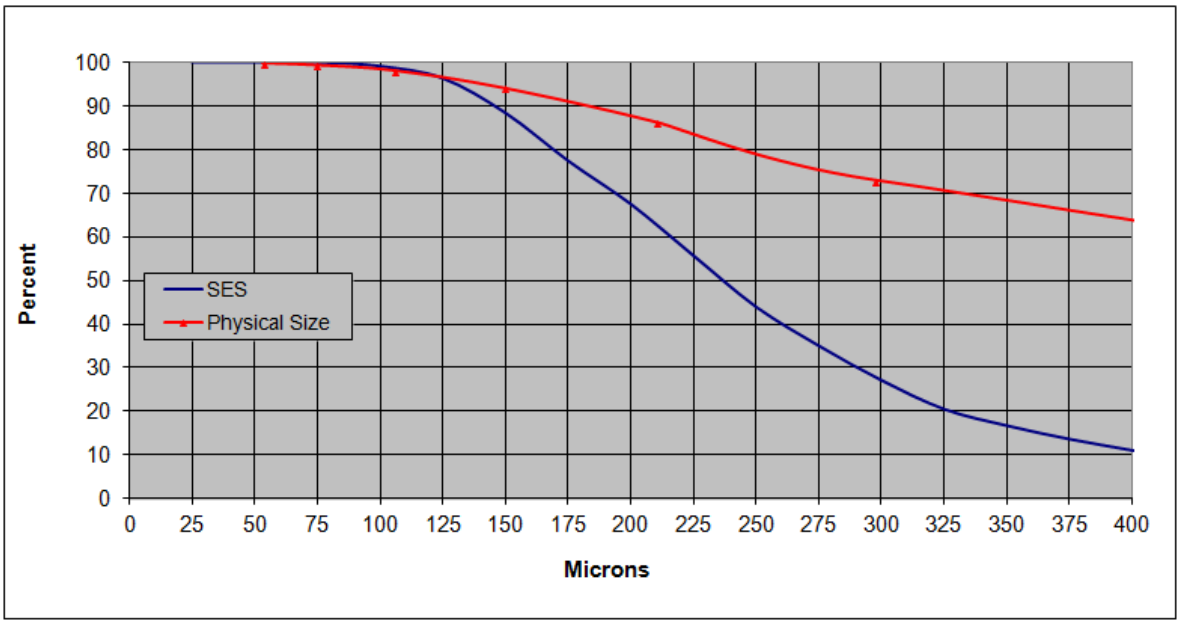


Figure 25. Comparison of the Sunnyvale WPCP Dewatered Grit Physical Size and Sand Equivalent Size on July 17, 2013

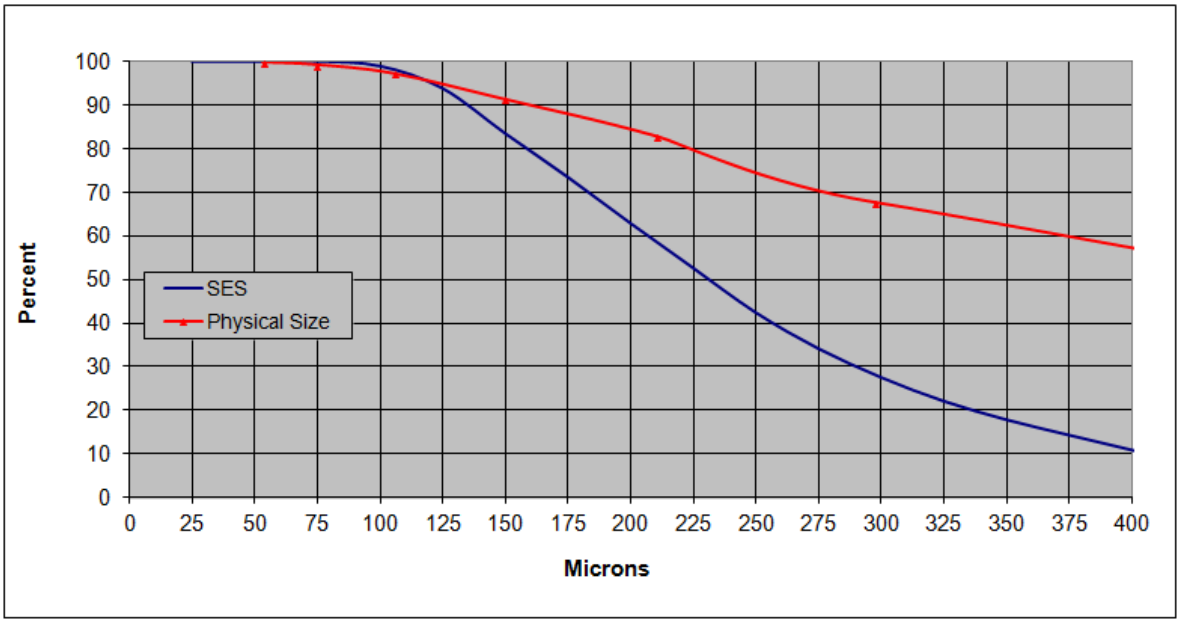


Figure 26. Comparison of the Sunnyvale WPCP Dewatered Grit Physical Size and Sand Equivalent Size on July 18, 2013

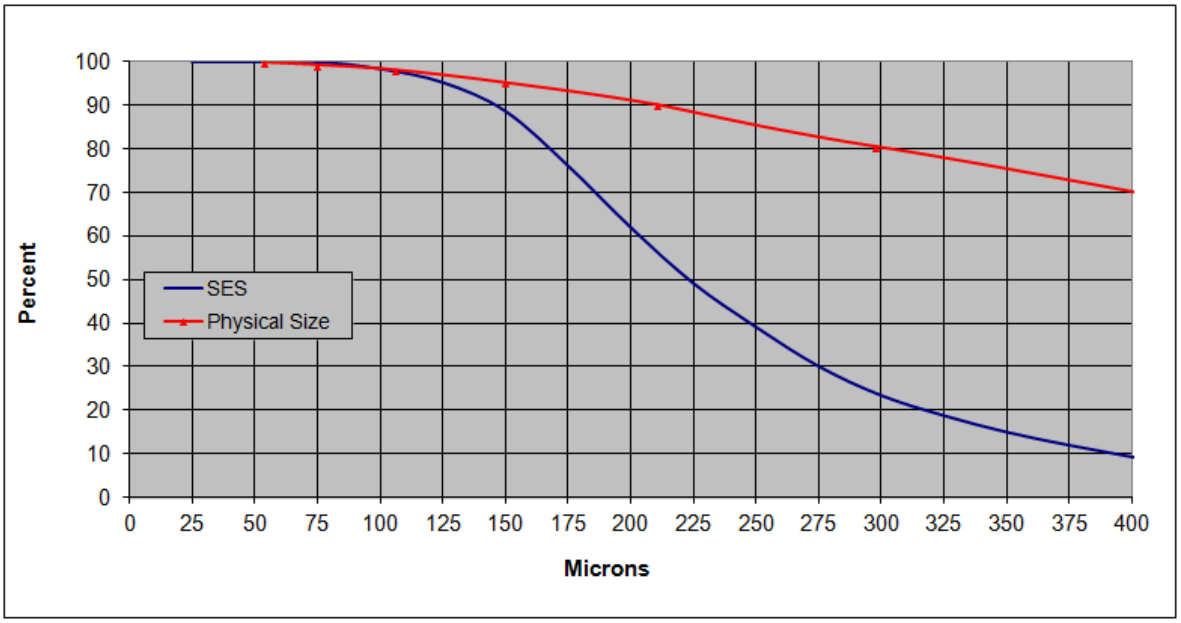
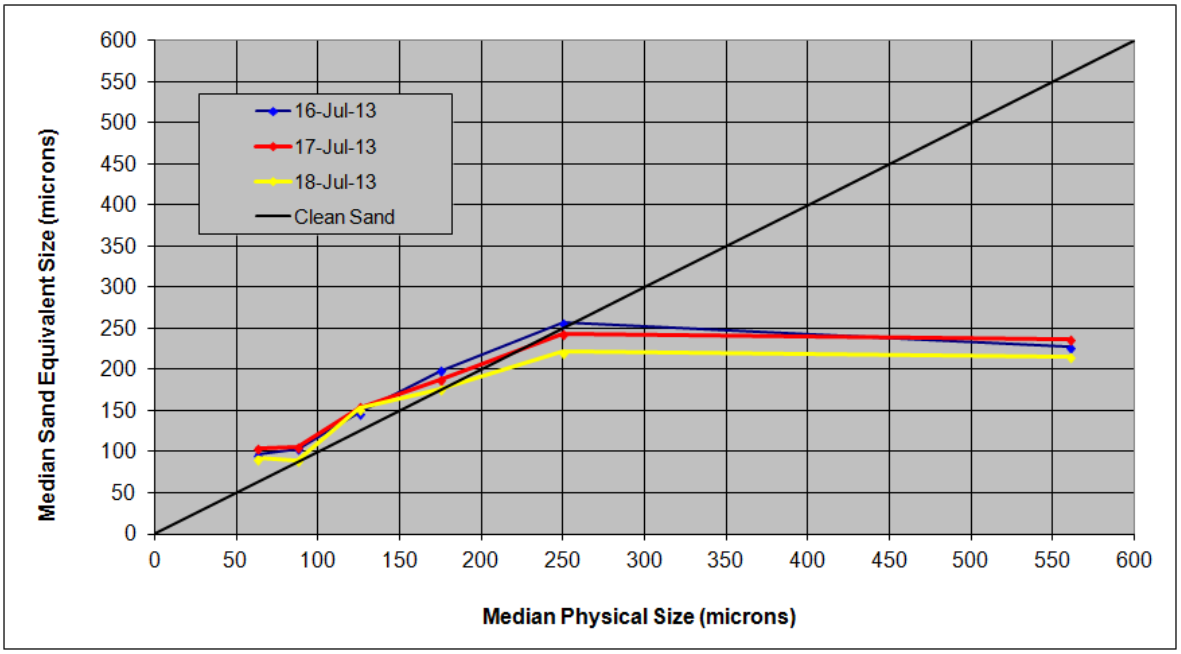


Figure 27. Median Size Distribution Dewatered Grit at the Sunnyvale WPCP vs. a Clean Sand Distribution



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Conclusions

Sunnyvale WPCP Influent

1. At the Sunnyvale WPCP, between 61.5 and 92.2% of influent grit was larger than 297-microns physical size, while between 7.8% and 38.5% of grit was smaller than 297-microns. (Figures 7 and 8)

2. Concentrations of grit entering the facility were 181 lbs/MG on July 16, 40.7 lbs/MG on July 17, and 25.1 lbs/MG on July 18. (Figure 9) The high concentration present on July 16 may be the result of a previous high flow event.

3. A grit removal system design based on 150-micron Sand Equivalent Size would collect between 48.8 and 82.5% of influent grit while a 100-micron SES system would improve to between 91.6 and 98.3% efficiency. (See Table 3)

Primary Sludge

1. For Primary Sludge, between 27.3 and 36.3% of grit was larger than 297-microns physical size, while between 63.7 and 72.7% of grit was smaller than 297-microns. (Figures 14 and 15)

2. The concentration of grit totaled 1,240 lbs/MG on July 16, 1,115 lbs/MG on July 17, and 1,062 lbs/MG on July 18. (Figure 16)

3. Based on settling velocity data collected, a grit removal system design based on 150-micron Sand Equivalent Size would collect between 38.9 and 51.2% of primary sludge grit while a 100-micron SES system would improve to between 77.8 and 85.9% efficiency. (See Table 4)

Dewatered Grit

1. From the grit dumpster, between 67.8 and 80.7% of grit was larger than 297-microns physical size, while between 19.3 and 32.2% of grit was smaller than 297-microns. (Figures 21 and 22)

2. The total amount of inert material collected in the dumpster during sampling was 26.14 pounds on July 16, 18.60 on July 17, and 13.45 on July 18. (Table 5)

3. From Figure 27, the collected grit followed the clean sand line to between 222 and 257 microns.

Bibliography

Clesceri, L., Greenberg, A. and Eaton, A., “Standard Methods for the Examination of Water and Wastewater”, 20th Edition, 1998, American Public Health Association, Washington, DC

Tchobanoglous, G., Burton, F.L. and Stensel, H.D., “Wastewater Engineering: Treatment and Reuse”, 4th Edition, 2003. TATA McGraw-Hill

Appendix A – Raw Data

A-1 Concentration Calculation Spreadsheet

Concentration Calculation Spreadsheet - Sunnyvale Water Pollution Control Pant - July 16, 2013

Sample Site	Start Time	End Time	Sampling Time (hrs.)	Settler Feed Rate (gpm)	Plant Flow (MGD)	Amount of Flow During Sampling Period (MG)	Gallons Sampled	Total Grit FS Collected (grams)
Influent	8:00	14:00	6.00	7.80	13.826	3.457	2,808	230.56
Primary Sludge				#DIV/0!	1.000	0.000	25	14.06
Dewatered Grit				#DIV/0!	1.000	0.000	#DIV/0!	11856.48
				#DIV/0!	1.000	0.000	#DIV/0!	23.09

Sample Site	Sample Dilution/mls of sample	Total Sample Volume (gal)	Sample Dilution/volume analyzed (mls)	Weight of Sample Put in Wet Sieve (gm)	Total FS Weight (gm)	Total Grit FS Collected (pounds)	Total Grit FS Entering Channel During Sampling (pounds)	Concentration (lbs/MG)
Influent	675	0.1783	120	1	40.99	0.51	625.7	181.0
Primary Sludge	1	0.0003	1	1	14.06	0.03	0.0	1240.4
Dewatered Grit	100080	26.4411	120	1	14.22	26.14	#DIV/0!	#DIV/0!
	1	0.0003	1	1	23.09	0.05	#DIV/0!	#DIV/0!

Concentration Calculation Spreadsheet - Sunnyvale Water Pollution Control Pant - July 17, 2013

Sample Site	Start Time	End Time	Sampling Time (hrs.)	Settler Feed Rate (gpm)	Plant Flow (MGD)	Amount of Flow During Sampling Period (MG)	Gallons Sampled	Total Grit FS Collected (grams)
Influent	8:00	14:00	6.00	7.98	13.692	3.423	2,871	52.93
Primary Sludge				#DIV/0!	1.000	0.000	25	12.64
Dewatered Grit				#DIV/0!	1.000	0.000	#DIV/0!	8434.26
				#DIV/0!	1.000	0.000	#DIV/0!	11.85

Sample Site	Sample Dilution/mls of sample	Total Sample Volume (gal)	Sample Dilution/volume analyzed (mls)	Weight of Sample Put in Wet Sieve (gm)	Total FS Weight (gm)	Total Grit FS Collected (pounds)	Total Grit FS Entering Channel During Sampling (pounds)	Concentration (lbs/MG)
Influent	625	0.1651	120	1	10.16	0.12	139.2	40.7
Primary Sludge	1	0.0003	1	1	12.64	0.03	0.0	1115.1
Dewatered Grit	79423	20.9836	120	1	12.74	18.60	#DIV/0!	#DIV/0!
	1	0.0003	1	1	11.85	0.03	#DIV/0!	#DIV/0!

Concentration Calculation Spreadsheet - Sunnyvale Water Pollution Control Pant - July 18, 2013

Sample Site	Start Time	End Time	Sampling Time (hrs.)	Settler Feed Rate (gpm)	Plant Flow (MGD)	Amount of Flow During Sampling Period (MG)	Gallons Sampled	Total Grit FS Collected (grams)
Influent	8:00	14:00	6.00	8.13	13.806	3.452	2,928	33.36
Primary Sludge				#DIV/0!	1.000	0.000	25	12.04
Dewatered Grit				#DIV/0!	1.000	0.000	#DIV/0!	6098.92
				#DIV/0!	1.000	0.000	#DIV/0!	9.71

Sample Site	Sample Dilution/mls of sample	Total Sample Volume (gal)	Sample Dilution/volume analyzed (mls)	Weight of Sample Put in Wet Sieve (gm)	Total FS Weight (gm)	Total Grit FS Collected (pounds)	Total Grit FS Entering Channel During Sampling (pounds)	Concentration (lbs/MG)
Influent	600	0.1585	120	1	6.67	0.07	86.7	25.1
Primary Sludge	1	0.0003	1	1	12.04	0.03	0.0	1061.8
Dewatered Grit	70289	18.5704	120	1	10.41	13.45	#DIV/0!	#DIV/0!
	1	0.0003	1	1	9.71	0.02	#DIV/0!	#DIV/0!

A-2 Solids Analysis Bench Sheets

Fixed Solids -Sunnyvale WPCP

Fixed Solids Sample Weight (grams)

Sample Date 16-Jul-13

Micron	US Sieve	Influent	Primary Sludge	Dewatered Gri	avg.
6300	1/4	0.187	0.029	0.351	0.189
3180	1/8	0.807	0.127	1.021	0.652
1680	#12	4.388	0.428	1.370	2.062
841	#20	13.686	0.754	1.964	5.468
297	#50	18.664	2.920	5.651	9.078
210	#70	1.472	1.837	1.883	1.731
149	#100	0.795	2.938	1.113	1.615
105	#140	0.571	2.775	0.570	1.306
74	#200	0.318	1.833	0.175	0.775
53	#270	0.052	0.365	0.062	0.160
<53	pan	0.049	0.058	0.057	0.054
Total FS Weight		40.99	14.06	14.22	23.09

Fixed Solids Sample Percent Retained

Sample Date 16-Jul-13

Micron	US Sieve	Influent	Primary Sludge	Dewatered Grit	avg.
6300	1/4	0.46	0.20	2.48	0.82
3180	1/8	1.97	0.91	7.21	2.83
1680	#12	10.72	3.06	9.68	8.95
841	#20	33.43	5.39	13.87	23.74
297	#50	45.59	20.85	39.91	39.41
210	#70	3.60	13.12	13.30	7.51
149	#100	1.94	20.98	7.86	7.01
105	#140	1.39	19.82	4.03	5.67
74	#200	0.78	13.08	1.23	3.36
53	#270	0.13	2.60	0.44	0.69
<53	pan	0.12	0.41	0.40	0.24
Total (%) minus pan		100.00	100.00	100.00	####

Fixed Solids Sample Cumulative %>

Sample Date 16-Jul-13

Micron	US Sieve	Influent	Primary Sludge	Dewatered Grit	avg.
53	#270	100	100	100	100
74	#200	99.87	97.40	99.56	99.31
105	#140	99.10	84.31	98.33	95.94
149	#100	97.70	64.49	94.30	90.28
210	#70	95.76	43.52	86.44	83.26
297	#50	92.17	30.40	73.14	75.75
841	#20	46.58	9.55	33.23	36.34
1680	#12	13.15	4.17	19.36	12.60
3180	1/8	2.43	1.11	9.68	3.65
6300	1/4	0.46	0.20	2.48	0.82

A-2 Solids Analysis Bench Sheets

Fixed Solids - Sunnyvale WPCP

Fixed Solids Sample Weight (grams)

Sample Date 17-Jul-13

Micron	US Sieve	Influent	Primary Sludge	Dewatered Grit	avg.
6300	1/4	0.029	0.101	0.154	0.094
3180	1/8	0.510	0.173	0.572	0.418
1680	#12	1.117	0.365	0.910	0.797
841	#20	1.817	0.553	1.313	1.228
297	#50	4.733	2.233	5.650	4.205
210	#70	0.571	1.756	1.926	1.418
149	#100	0.478	1.969	1.086	1.177
105	#140	0.416	3.787	0.745	1.649
74	#200	0.343	1.265	0.255	0.621
53	#270	0.103	0.353	0.070	0.175
<53	pan	0.048	0.089	0.066	0.067
Total FS Weight		10.16	12.64	12.74	11.85

Fixed Solids Sample Percent Retained

Sample Site 17-Jul-13

Micron	US Sieve	Influent	Primary Sludge	Dewatered Grit	avg.
6300	1/4	0.28	0.80	1.21	0.80
3180	1/8	5.04	1.38	4.51	3.55
1680	#12	11.04	2.91	7.18	6.77
841	#20	17.96	4.41	10.35	10.42
297	#50	46.79	17.79	44.56	35.69
210	#70	5.64	13.99	15.19	12.03
149	#100	4.72	15.68	8.56	9.99
105	#140	4.11	30.16	5.87	14.00
74	#200	3.39	10.08	2.01	5.27
53	#270	1.01	2.81	0.55	1.48
<53	pan	0.47	0.71	0.52	0.57
Total (%) minus pan		100.00	100.00	100.00	100.00

Fixed Solids Sample Cumulative %>

Sample Site 17-Jul-13

Micron	US Sieve	Influent	Primary Sludge	Dewatered Grit	avg.
53	#270	100	100	100	100
74	#200	98.99	97.19	99.45	98.52
105	#140	95.59	87.11	97.44	93.25
149	#100	91.48	56.95	91.57	79.25
210	#70	86.76	41.27	83.00	69.26
297	#50	81.12	27.28	67.81	57.22
841	#20	34.33	9.49	23.25	21.53
1680	#12	16.37	5.09	12.90	11.12
3180	1/8	5.33	2.18	5.72	4.35
6300	1/4	0.28	0.80	1.21	0.80

A-2 Solids Analysis Bench Sheets

Fixed Solids - Sunnyvale WPCP

Fixed Solids Sample Weight (grams)

Sample Date 18-Jul-13

Micron	US Sieve	Influent	Primary Sludge	Dewatered Grit	avg.
6300	1/4	0.064	0.165	0.243	0.157
3180	1/8	0.272	0.372	0.454	0.366
1680	#12	0.508	0.486	1.022	0.672
841	#20	0.707	0.506	1.789	1.001
297	#50	2.520	2.817	4.862	3.400
210	#70	0.686	1.837	0.994	1.172
149	#100	0.607	1.493	0.528	0.876
105	#140	0.734	2.880	0.300	1.305
74	#200	0.417	1.064	0.118	0.533
53	#270	0.104	0.338	0.060	0.168
<53	pan	0.054	0.081	0.043	0.059
Total FS Weight		6.67	12.04	10.41	9.71

Fixed Solids Sample Percent Retained

Sample Site 18-Jul-13

Micron	US Sieve	Influent	Primary Sludge	Dewatered Grit	avg.
6300	1/4	0.97	1.38	2.35	1.63
3180	1/8	4.10	3.11	4.38	3.79
1680	#12	7.68	4.06	9.85	6.96
841	#20	10.68	4.23	17.25	10.37
297	#50	38.08	23.56	46.89	35.23
210	#70	10.37	15.36	9.59	12.15
149	#100	9.16	12.48	5.09	9.07
105	#140	11.09	24.09	2.90	13.52
74	#200	6.30	8.90	1.13	5.52
53	#270	1.58	2.83	0.58	1.74
<53	pan	0.81	0.68	0.41	0.61
Total (%) minus pan		100.00	100.00	100.00	100.00

Fixed Solids Sample Cumulative %>

Sample Site 18-Jul-13

Micron	US Sieve	Influent	Primary Sludge	)ewatered Gr	avg.
53	#270	100	100	100	100
74	#200	98.42	97.17	99.42	98.26
105	#140	92.13	88.27	98.28	92.74
149	#100	81.04	64.19	95.39	79.22
210	#70	71.87	51.70	90.30	70.14
297	#50	61.51	36.34	80.72	57.99
841	#20	23.43	12.78	33.83	22.76
1680	#12	12.76	8.55	16.58	12.39
3180	1/8	5.07	4.49	6.72	5.42
6300	1/4	0.97	1.38	2.35	1.63

A-3 Fractional Grit Concentration Calculation Bench Sheet

Influent							
		16-Jul-13		17-Jul-13		18-Jul-13	
Micron	US Sieve	%	lbs/MG	%	lbs/MG	%	lbs/MG
6300	0.25	0.457	0.827	0.282	0.115	0.972	0.244
3180	0.125	1.972	3.569	5.044	2.053	4.103	1.030
1680	#12	10.718	19.403	11.042	4.494	7.682	1.928
841	#20	33.430	60.517	17.963	7.311	10.677	2.680
297	#50	45.589	82.528	46.789	19.043	38.076	9.557
210	#70	3.595	6.508	5.642	2.296	10.366	2.602
149	#100	1.942	3.516	4.721	1.921	9.165	2.300
105	#140	1.394	2.524	4.110	1.673	11.087	2.783
74	#200	0.776	1.404	3.394	1.381	6.297	1.580
53	#270	0.127	0.230	1.013	0.412	1.578	0.396
<53	pan	0.120	0.217	0.472	0.192	0.808	0.203
	Total (lbs)	181.027	181.027	40.700	40.700	25.100	25.100

Primary Sludge							
		16-Jul-13		17-Jul-13		18-Jul-13	
Micron	US Sieve	%	lbs/MG	%	lbs/MG	%	lbs/MG
6300	0.25	0.203	2.524	0.802	8.944	1.378	14.634
3180	0.125	0.907	11.248	1.380	15.384	3.112	33.041
1680	#12	3.055	37.897	2.906	32.402	4.061	43.120
841	#20	5.386	66.805	4.406	49.128	4.232	44.940
297	#50	20.849	258.610	17.787	198.340	23.557	250.130
210	#70	13.118	162.721	13.990	156.007	15.362	163.110
149	#100	20.976	260.187	15.682	174.873	12.483	132.546
105	#140	19.817	245.804	30.162	336.334	24.087	255.751
74	#200	13.084	162.296	10.077	112.369	8.901	94.506
53	#270	2.605	32.309	2.809	31.319	2.827	30.022
<53	pan	0.411	5.092	0.708	7.896	0.677	7.193
	Total (lbs)	1240.400	1240.400	1115.100	1115.100	1061.800	1061.800

Dewatered Grit							
		16-Jul-13		17-Jul-13		18-Jul-13	
Micron	US Sieve	%	pounds	%	pounds	%	pounds
6300	0.25	2.475	0.647	1.211	0.225	2.346	0.316
3180	0.125	7.208	1.884	4.508	0.838	4.378	0.589
1680	#12	9.677	2.530	7.177	1.335	9.851	1.325
841	#20	13.873	3.626	10.354	1.926	17.253	2.321
297	#50	39.910	10.433	44.562	8.289	46.886	6.306
210	#70	13.295	3.475	15.193	2.826	9.585	1.289
149	#100	7.862	2.055	8.564	1.593	5.087	0.684
105	#140	4.028	1.053	5.874	1.093	2.896	0.390
74	#200	1.234	0.323	2.008	0.374	1.134	0.153
53	#270	0.437	0.114	0.549	0.102	0.582	0.078
<53	pan	0.400	0.104	0.517	0.096	0.415	0.056
	Total (lbs)	26.140	26.140	18.600	18.600	13.450	13.450

A-4 SES Data Analysis

Sunnyvale WPCP - Influent - July 16, 2013

sed vol, cc	fractional volume, %	sed time, sec	sed h, cm	sed vel, cm/s	SES, d1 µ	NR1	NR2	SES, d2 µ		SES, µ	vol frac, %≥
20M - 50M, 300µ - 820µ											
0.5	11	4.84	52.4	1.08E+01	592.0	64.1	64.1	592.0		592.0	11
1.0	21	5.54	51.4	9.28E+00	511.5	47.5	47.5	511.5		511.5	21
1.5	32	6.51	50.7	7.79E+00	438.1	34.1	34.1	438.1		438.1	32
2.0	43	10.20	50.2	4.92E+00	304.6	15.0	15.0	304.6		304.6	43
2.5	53	16.26	49.7	3.06E+00	219.7	6.7	6.7	219.7		219.7	53
3.0	64	21.47	49.3	2.30E+00	183.3	4.2	4.2	183.3		183.3	64
3.5	74	28.17	48.9	1.74E+00	155.0	2.7	2.7	155.0		155.0	74
4.0	85	33.89	48.6	1.43E+00	138.6	2.0	2.0	138.6		138.6	85
4.5	96	47.29	48.3	1.02E+00	114.4	1.2	1.2	114.4		114.4	96
4.7	100	63.23	48.2	7.62E-01	97.3	0.7	0.7	97.3		97.3	100
50M - 70M, 200µ - 300µ											
0.50	22	11.35	52.4	4.62E+00	291.0	13.4	13.4	291.0		291.0	22
1.0	44	15.10	51.4	3.41E+00	235.8	8.0	8.0	235.8		235.8	44
1.5	67	32.66	50.7	1.55E+00	145.2	2.3	2.3	145.2		145.2	67
2.0	89	68.80	50.2	7.29E-01	95.1	0.7	0.7	95.1		95.1	89
2.3	100	93.85	49.9	5.32E-01	80.2	0.4	0.4	80.2		80.2	100
70M - 100M, 150µ - 200µ											
0.20	22	16.78	53.4	3.18E+00	225.6	7.2	7.2	225.6		225.6	22
0.5	56	22.76	52.4	2.30E+00	183.7	4.2	4.2	183.7		183.7	56
0.7	78	32.42	52.0	1.60E+00	147.8	2.4	2.4	147.8		147.8	78
0.9	100	55.35	51.6	9.32E-01	108.7	1.0	1.0	108.7		108.7	100
100M - 140M, 100µ - 150µ											
0.20	33	28.97	53.4	1.84E+00	160.6	3.0	3.0	160.6		160.6	33
0.4	67	37.04	52.7	1.42E+00	138.0	2.0	2.0	138.0		138.0	67
0.6	100	61.20	52.2	8.53E-01	103.5	0.9	0.9	103.5		103.5	100
140M - 200M, 75µ - 100µ											
0.10	25	39.61	54.0	1.36E+00	134.6	1.8	1.8	134.6		134.6	25
0.2	50	48.22	53.4	1.11E+00	119.7	1.3	1.3	119.7		119.7	50
0.3	75	67.14	53.0	7.90E-01	99.3	0.8	0.8	99.3		99.3	75
0.4	100	95.97	52.7	5.49E-01	81.6	0.4	0.4	81.6		81.6	100
200M - 270M, 50µ - 75µ											
0.01	10	52.56	55.2	1.05E+00	116.2	1.2	1.2	116.2		116.2	10
0.05	50	101.49	54.5	5.37E-01	80.6	0.4	0.4	80.6		80.6	50
0.1	100	119.34	54.0	4.53E-01	73.6	0.3	0.3	73.6		73.6	100

A-4 SES Data Analysis

Sunnyvale WPCP - Primary Sludge - July 16, 2013

sed vol, cc	fractional volume, %	sed time, sec	sed h, cm	sed vel, cm/s	SES, d1 µ	NR1	NR2	SES, d2 µ		SES, µ	vol frac, %≥
20M - 50M, 300µ - 820µ											
0.5	9	16.77	52.4	3.13E+00	222.9	7.0	7.0	222.9		222.9	9
1.0	18	19.64	51.4	2.62E+00	199.0	5.2	5.2	199.0		199.0	18
1.5	27	21.91	50.7	2.32E+00	184.3	4.3	4.3	184.3		184.3	27
2.0	36	24.30	50.2	2.07E+00	171.8	3.5	3.5	171.8		171.8	36
2.5	45	26.75	49.7	1.86E+00	161.3	3.0	3.0	161.3		161.3	45
3.0	55	29.53	49.3	1.67E+00	151.4	2.5	2.5	151.4		151.4	55
3.5	64	32.36	48.9	1.51E+00	142.9	2.2	2.2	142.9		142.9	64
4.0	73	37.14	48.6	1.31E+00	131.5	1.7	1.7	131.5		131.5	73
4.5	82	44.81	48.3	1.08E+00	117.9	1.3	1.3	117.9		117.9	82
5.0	91	51.63	48.0	9.30E-01	108.6	1.0	1.0	108.6		108.6	91
5.5	100	68.29	47.8	6.99E-01	92.9	0.6	0.6	92.9		92.9	100
50M - 70M, 200µ - 300µ											
0.50	11	13.77	52.4	3.81E+00	254.2	9.7	9.7	254.2		254.2	11
1.00	22	18.68	51.4	2.75E+00	205.4	5.7	5.7	205.4		205.4	22
1.50	33	23.58	50.7	2.15E+00	176.2	3.8	3.8	176.2		176.2	33
2.00	44	29.52	50.2	1.70E+00	153.0	2.6	2.6	153.0		153.0	44
2.50	56	39.91	49.7	1.25E+00	127.9	1.6	1.6	127.9		127.9	56
3.00	67	48.45	49.3	1.02E+00	114.1	1.2	1.2	114.1		114.1	67
3.50	78	61.16	48.9	8.00E-01	100.0	0.8	0.8	100.0		100.0	78
4.00	89	75.51	48.6	6.44E-01	88.8	0.6	0.6	88.8		88.8	89
4.50	100	92.89	48.3	5.20E-01	79.2	0.4	0.4	79.2		79.2	100
70M - 100M, 150µ - 200µ											
0.50	11	16.22	52.4	3.23E+00	227.8	7.4	7.4	227.8		227.8	11
1.00	21	19.12	51.4	2.69E+00	202.4	5.4	5.4	202.4		202.4	21
1.50	32	22.80	50.7	2.23E+00	179.8	4.0	4.0	179.8		179.8	32
2.00	43	27.40	50.2	1.83E+00	159.9	2.9	2.9	159.9		159.9	43
2.50	53	33.99	49.7	1.46E+00	140.2	2.1	2.1	140.2		140.2	53
3.00	64	43.35	49.3	1.14E+00	121.5	1.4	1.4	121.5		121.5	64
3.50	74	54.43	48.9	8.99E-01	106.6	1.0	1.0	106.6		106.6	74
4.00	85	69.31	48.6	7.01E-01	93.0	0.7	0.7	93.0		93.0	85
4.50	96	89.89	48.3	5.37E-01	80.6	0.4	0.4	80.6		80.6	96
4.70	100	107.97	48.2	4.46E-01	73.1	0.3	0.3	73.1		73.1	100
100M - 140M, 100µ - 150µ											
0.50	17	18.63	52.4	2.81E+00	208.2	5.9	5.9	208.2		208.2	17
1.00	33	24.32	51.4	2.11E+00	174.3	3.7	3.7	174.3		174.3	33
1.50	50	29.94	50.7	1.69E+00	152.7	2.6	2.6	152.7		152.7	50
2.00	67	37.80	50.2	1.33E+00	132.6	1.8	1.8	132.6		132.6	67
2.50	83	48.40	49.7	1.03E+00	114.7	1.2	1.2	114.7		114.7	83
3.00	100	76.40	49.3	6.45E-01	89.0	0.6	0.6	89.0		89.0	100
140M - 200M, 75µ - 100µ											
0.20	10	26.07	53.4	2.05E+00	171.1	3.5	3.5	171.1		171.1	10
0.50	25	32.02	52.4	1.64E+00	149.7	2.5	2.5	149.7		149.7	25
0.70	35	38.86	52.0	1.34E+00	133.2	1.8	1.8	133.2		133.2	35
1.00	50	46.32	51.4	1.11E+00	119.8	1.3	1.3	119.8		119.8	50
1.50	75	63.38	50.7	8.01E-01	100.0	0.8	0.8	100.0		100.0	75
2.00	100	105.22	50.2	4.77E-01	75.7	0.4	0.4	75.7		75.7	100
200M - 270M, 50µ - 75µ											
0.100	25	53.53	54.0	1.01E+00	113.6	1.1	1.1	113.6		113.6	25
0.20	50	77.83	53.4	6.87E-01	92.0	0.6	0.6	92.0		92.0	50
0.30	75	110.47	53.0	4.80E-01	75.9	0.4	0.4	75.9		75.9	75
0.40	100	141.69	52.7	3.72E-01	66.4	0.2	0.2	66.4		66.4	100

A-4 SES Data Analysis

Sunnyvale WPCP - Dewatered Grit - July 16, 2013

sed vol, cc	fractional volume, %	sed time, sec	sed h, cm	sed vel, cm/s	SES, d1 µ	NR1	NR2	SES, d2 µ		SES, µ	vol frac, %≥
20M - 50M, 300µ - 820µ											
0.50	13	7.49	52.4	7.00E+00	400.3	28.0	28.0	400.3		400.3	13
1.00	26	10.50	51.4	4.90E+00	303.7	14.9	14.9	303.7		303.7	26
1.50	38	13.35	50.7	3.80E+00	253.9	9.6	9.6	253.9		253.9	38
2.00	51	15.70	50.2	3.20E+00	226.1	7.2	7.2	226.1		226.1	51
2.50	64	18.69	49.7	2.66E+00	200.9	5.3	5.3	200.9		200.9	64
3.00	77	24.61	49.3	2.00E+00	168.7	3.4	3.4	168.7		168.7	77
3.50	90	32.26	48.9	1.52E+00	143.2	2.2	2.2	143.2		143.2	90
3.90	100	42.62	48.7	1.14E+00	121.7	1.4	1.4	121.7		121.7	100
50M - 70M, 200µ - 300µ											
0.50	25	11.23	52.4	4.67E+00	293.3	13.7	13.7	293.3		293.3	25
1.0	50	13.32	51.4	3.86E+00	256.6	9.9	9.9	256.6		256.6	50
1.5	75	19.54	50.7	2.60E+00	197.9	5.1	5.1	197.9		197.9	75
1.8	88	29.29	50.4	1.72E+00	154.2	2.7	2.7	154.2		154.2	88
2.0	100	50.53	50.2	9.93E-01	112.6	1.1	1.1	112.6		112.6	100
70M - 100M, 150µ - 200µ											
0.20	18	16.52	53.4	3.23E+00	227.9	7.4	7.4	227.9		227.9	18
0.50	45	19.47	52.4	2.69E+00	202.5	5.5	5.5	202.5		202.5	45
0.70	64	22.65	52.0	2.29E+00	183.2	4.2	4.2	183.2		183.2	64
0.90	82	26.48	51.6	1.95E+00	165.9	3.2	3.2	165.9		165.9	82
1.00	91	32.22	51.4	1.60E+00	147.5	2.4	2.4	147.5		147.5	91
1.10	100	51.55	51.3	9.95E-01	112.7	1.1	1.1	112.7		112.7	100
100M - 140M, 100µ - 150µ											
0.20	40	31.77	53.4	1.68E+00	152.1	2.6	2.6	152.1		152.1	40
0.40	80	41.29	52.7	1.28E+00	129.7	1.7	1.7	129.7		129.7	80
0.50	100	51.86	52.4	1.01E+00	113.7	1.1	1.1	113.7		113.7	100
140M - 200M, 75µ - 100µ											
0.05	25	52.02	54.5	1.05E+00	116.0	1.2	1.2	116.0		116.0	25
0.10	50	63.62	54.0	8.49E-01	103.3	0.9	0.9	103.3		103.3	50
0.15	75	94.29	53.7	5.69E-01	83.2	0.5	0.5	83.2		83.2	75
0.20	100	120.22	53.4	4.44E-01	72.9	0.3	0.3	72.9		72.9	100
200M - 270M, 50µ - 75µ											
0.01	20	67.16	55.2	8.22E-01	101.5	0.8	0.8	101.5		101.5	20
0.05	100	102.26	54.5	5.33E-01	80.3	0.4	0.4	80.3		80.3	100

A-4 SES Data Analysis

Sunnyvale WPCP - Influent - July 17, 2013

sed vol, cc	fractional volume, %	sed time, sec	sed h, cm	sed vel, cm/s	SES, d1 µ	NR1	NR2	SES, d2 µ	SES, µ	vol frac, %≥
20M - 50M, 300µ - 820µ										
0.5	9	8.50	52.4	6.17E+00	361.6	22.3	22.3	361.6	361.6	9
1.0	18	13.61	51.4	3.78E+00	252.9	9.6	9.6	252.9	252.9	18
1.5	27	21.52	50.7	2.36E+00	186.3	4.4	4.4	186.3	186.3	27
2.0	36	27.40	50.2	1.83E+00	159.9	2.9	2.9	159.9	159.9	36
2.5	45	34.02	49.7	1.46E+00	140.1	2.0	2.0	140.1	140.1	45
3.0	55	38.16	49.3	1.29E+00	130.6	1.7	1.7	130.6	130.6	55
3.5	64	42.24	48.9	1.16E+00	122.7	1.4	1.4	122.7	122.7	64
4.0	73	47.43	48.6	1.02E+00	114.6	1.2	1.2	114.6	114.6	73
4.5	82	52.67	48.3	9.17E-01	107.7	1.0	1.0	107.7	107.7	82
5.0	91	58.20	48.0	8.25E-01	101.7	0.8	0.8	101.7	101.7	91
5.5	100	67.10	47.8	7.12E-01	93.8	0.7	0.7	93.8	93.8	100
50M - 70M, 200µ - 300µ										
0.20	20	16.93	53.4	3.16E+00	224.3	7.1	7.1	224.3	224.3	20
0.4	40	20.68	52.7	2.55E+00	195.6	5.0	5.0	195.6	195.6	40
0.6	60	37.46	52.2	1.39E+00	136.3	1.9	1.9	136.3	136.3	60
0.8	80	56.89	51.8	9.10E-01	107.3	1.0	1.0	107.3	107.3	80
1.0	100	65.68	51.4	7.83E-01	98.8	0.8	0.8	98.8	98.8	100
70M - 100M, 150µ - 200µ										
0.20	20	24.20	53.4	2.21E+00	179.0	4.0	4.0	179.0	179.0	20
0.4	40	31.96	52.7	1.65E+00	150.3	2.5	2.5	150.3	150.3	40
0.6	60	54.36	52.2	9.60E-01	110.5	1.1	1.1	110.5	110.5	60
0.8	80	83.56	51.8	6.20E-01	87.0	0.5	0.5	87.0	87.0	80
1.0	100	102.42	51.4	5.02E-01	77.8	0.4	0.4	77.8	77.8	100
100M - 140M, 100µ - 150µ										
0.10	20	29.07	54.0	1.86E+00	161.3	3.0	3.0	161.3	161.3	20
0.2	40	36.56	53.4	1.46E+00	140.1	2.0	2.0	140.1	140.1	40
0.3	60	41.64	53.0	1.27E+00	129.5	1.6	1.6	129.5	129.5	60
0.4	80	50.43	52.7	1.05E+00	115.8	1.2	1.2	115.8	115.8	80
0.5	100	69.87	52.4	7.50E-01	96.5	0.7	0.7	96.5	96.5	100
140M - 200M, 75µ - 100µ										
0.10	20	35.90	54.0	1.50E+00	142.5	2.1	2.1	142.5	142.5	20
0.2	40	46.62	53.4	1.15E+00	122.0	1.4	1.4	122.0	122.0	40
0.3	60	56.85	53.0	9.33E-01	108.8	1.0	1.0	108.8	108.8	60
0.4	80	67.95	52.7	7.76E-01	98.3	0.8	0.8	98.3	98.3	80
0.5	100	94.82	52.4	5.53E-01	81.9	0.5	0.5	81.9	81.9	100
200M - 270M, 50µ - 75µ										
0.01	7	50.56	55.2	1.09E+00	118.7	1.3	1.3	118.7	118.7	7
0.05	33	91.12	54.5	5.98E-01	85.4	0.5	0.5	85.4	85.4	33
0.10	67	105.10	54.0	5.14E-01	78.8	0.4	0.4	78.8	78.8	67
0.15	100	141.81	53.7	3.79E-01	67.0	0.3	0.3	67.0	67.0	100

A-4 SES Data Analysis

Sunnyvale WPCP - Primary Sludge - July 17, 2013

sed vol, cc	fractional volume, %	sed time, sec	sed h, cm	sed vel, cm/s	SES, d1 µ	NR1	NR2	SES, d2 µ		SES, µ	vol frac, %≥
20M - 50M, 300µ - 820µ											
0.2	4	13.99	53.4	3.82E+00	254.7	9.7	9.7	254.7		254.7	4
0.5	10	18.92	52.4	2.77E+00	206.2	5.7	5.7	206.2		206.2	10
1.0	20	21.39	51.4	2.40E+00	188.6	4.5	4.5	188.6		188.6	20
1.5	30	24.76	50.7	2.05E+00	171.0	3.5	3.5	171.0		171.0	30
2.0	40	29.90	50.2	1.68E+00	151.9	2.5	2.5	151.9		151.9	40
2.5	50	34.30	49.7	1.45E+00	139.4	2.0	2.0	139.4		139.4	50
3.0	60	40.87	49.3	1.21E+00	125.6	1.5	1.5	125.6		125.6	60
3.5	70	48.86	48.9	1.00E+00	113.1	1.1	1.1	113.1		113.1	70
4.0	80	60.72	48.6	8.01E-01	100.0	0.8	0.8	100.0		100.0	80
4.5	90	74.72	48.3	6.46E-01	89.0	0.6	0.6	89.0		89.0	90
5.0	100	94.05	48.0	5.11E-01	78.5	0.4	0.4	78.5		78.5	100
50M - 70M, 200µ - 300µ											
0.20	8	13.47	53.4	3.97E+00	261.4	10.4	10.4	261.4		261.4	8
0.50	19	15.63	52.4	3.35E+00	233.4	7.8	7.8	233.4		233.4	19
1.00	38	21.80	51.4	2.36E+00	186.4	4.4	4.4	186.4		186.4	38
1.50	58	35.43	50.7	1.43E+00	138.5	2.0	2.0	138.5		138.5	58
2.00	77	55.51	50.2	9.04E-01	106.9	1.0	1.0	106.9		106.9	77
2.50	96	77.50	49.7	6.41E-01	88.7	0.6	0.6	88.7		88.7	96
2.60	100	108.51	49.6	4.57E-01	74.0	0.3	0.3	74.0		74.0	100
70M - 100M, 150µ - 200µ											
0.20	5	13.94	53.4	3.83E+00	255.4	9.8	9.8	255.4		255.4	5
0.50	12	16.33	52.4	3.21E+00	226.8	7.3	7.3	226.8		226.8	12
1.00	24	20.76	51.4	2.48E+00	192.2	4.8	4.8	192.2		192.2	24
1.50	36	27.08	50.7	1.87E+00	162.1	3.0	3.0	162.1		162.1	36
2.00	48	38.28	50.2	1.31E+00	131.6	1.7	1.7	131.6		131.6	48
2.50	60	50.00	49.7	9.94E-01	112.7	1.1	1.1	112.7		112.7	60
3.00	71	68.46	49.3	7.20E-01	94.4	0.7	0.7	94.4		94.4	71
3.50	83	83.44	48.9	5.87E-01	84.5	0.5	0.5	84.5		84.5	83
4.00	95	112.49	48.6	4.32E-01	71.8	0.3	0.3	71.8		71.8	95
4.20	100	133.41	48.5	3.63E-01	65.6	0.2	0.2	65.6		65.6	100
100M - 140M, 100µ - 150µ											
0.50	9	22.36	52.4	2.34E+00	185.7	4.4	4.4	185.7		185.7	9
1.00	18	26.50	51.4	1.94E+00	165.5	3.2	3.2	165.5		165.5	18
1.50	27	31.24	50.7	1.62E+00	149.0	2.4	2.4	149.0		149.0	27
2.00	36	35.62	50.2	1.41E+00	137.2	1.9	1.9	137.2		137.2	36
2.50	45	42.67	49.7	1.17E+00	123.1	1.4	1.4	123.1		123.1	45
3.00	55	48.37	49.3	1.02E+00	114.2	1.2	1.2	114.2		114.2	55
3.50	64	53.12	48.9	9.21E-01	108.0	1.0	1.0	108.0		108.0	64
4.00	73	60.31	48.6	8.06E-01	100.4	0.8	0.8	100.4		100.4	73
4.50	82	71.61	48.3	6.74E-01	91.1	0.6	0.6	91.1		91.1	82
5.00	91	93.48	48.0	5.14E-01	78.7	0.4	0.4	78.7		78.7	91
5.50	100	129.42	47.8	3.69E-01	66.1	0.2	0.2	66.1		66.1	100
140M - 200M, 75µ - 100µ											
0.20	11	27.81	53.4	1.92E+00	164.5	3.2	3.2	164.5		164.5	11
0.50	26	34.28	52.4	1.53E+00	143.8	2.2	2.2	143.8		143.8	26
1.00	53	46.89	51.4	1.10E+00	119.0	1.3	1.3	119.0		119.0	53
1.50	79	65.40	50.7	7.76E-01	98.3	0.8	0.8	98.3		98.3	79
1.75	92	96.64	50.4	5.22E-01	79.4	0.4	0.4	79.4		79.4	92
1.90	100	126.42	50.3	3.98E-01	68.8	0.3	0.3	68.8		68.8	100
200M - 270M, 50µ - 75µ											
0.100	14	32.96	54.0	1.64E+00	149.8	2.5	2.5	149.8		149.8	14
0.30	43	46.21	53.0	1.15E+00	122.1	1.4	1.4	122.1		122.1	43
0.50	71	71.31	52.4	7.35E-01	95.5	0.7	0.7	95.5		95.5	71
0.70	100	112.38	52.0	4.62E-01	74.5	0.3	0.3	74.5		74.5	100

A-4 SES Data Analysis

Sunnyvale WPCP - Dewatered Grit - July 17, 2013										
sed vol, cc	fractional volume, %	sed time, sec	sed h, cm	sed vel, cm/s	SES, d1 µ	NR1	NR2	SES, d2 µ	SES, µ	vol frac, %≥
20M - 50M, 300µ - 820µ										
0.50	16	8.02	52.4	6.54E+00	378.7	24.8	24.8	378.7	378.7	16
1.00	31	10.75	51.4	4.78E+00	298.5	14.3	14.3	298.5	298.5	31
1.50	47	13.98	50.7	3.63E+00	246.1	8.9	8.9	246.1	246.1	47
2.00	63	18.53	50.2	2.71E+00	203.2	5.5	5.5	203.2	203.2	63
2.50	78	28.22	49.7	1.76E+00	156.3	2.8	2.8	156.3	156.3	78
3.00	94	38.57	49.3	1.28E+00	129.8	1.7	1.7	129.8	129.8	94
3.20	100	61.66	49.2	7.97E-01	99.8	0.8	0.8	99.8	99.8	100
50M - 70M, 200µ - 300µ										
0.20	10	10.73	53.4	4.98E+00	307.4	15.3	15.3	307.4	307.4	10
0.5	25	12.41	52.4	4.22E+00	273.1	11.5	11.5	273.1	273.1	25
1.0	50	14.35	51.4	3.58E+00	244.0	8.7	8.7	244.0	244.0	50
1.5	75	17.74	50.7	2.86E+00	210.4	6.0	6.0	210.4	210.4	75
1.8	88	26.12	50.4	1.93E+00	165.0	3.2	3.2	165.0	165.0	88
2.0	100	49.62	50.2	1.01E+00	113.7	1.2	1.2	113.7	113.7	100
70M - 100M, 150µ - 200µ										
0.20	18	17.09	53.4	3.13E+00	222.9	7.0	7.0	222.9	222.9	18
0.50	45	20.87	52.4	2.51E+00	193.8	4.9	4.9	193.8	193.8	45
0.70	64	23.84	52.0	2.18E+00	177.6	3.9	3.9	177.6	177.6	64
0.90	82	28.23	51.6	1.83E+00	159.7	2.9	2.9	159.7	159.7	82
1.00	91	39.99	51.4	1.29E+00	130.2	1.7	1.7	130.2	130.2	91
1.10	100	53.56	51.3	9.57E-01	110.3	1.1	1.1	110.3	110.3	100
100M - 140M, 100µ - 150µ										
0.30	38	27.03	53.0	1.96E+00	166.6	3.3	3.3	166.6	166.6	38
0.50	63	34.49	52.4	1.52E+00	143.3	2.2	2.2	143.3	143.3	63
0.70	88	50.56	52.0	1.03E+00	114.8	1.2	1.2	114.8	114.8	88
0.80	100	63.32	51.8	8.18E-01	101.2	0.8	0.8	101.2	101.2	100
140M - 200M, 75µ - 100µ										
0.10	25	43.59	54.0	1.24E+00	127.5	1.6	1.6	127.5	127.5	25
0.20	50	60.23	53.4	8.87E-01	105.8	0.9	0.9	105.8	105.8	50
0.30	75	83.38	53.0	6.36E-01	88.3	0.6	0.6	88.3	88.3	75
0.40	100	106.55	52.7	4.95E-01	77.2	0.4	0.4	77.2	77.2	100
200M - 270M, 50µ - 75µ										
0.05	25	36.35	54.5	1.50E+00	142.2	2.1	2.1	142.2	142.2	25
0.10	50	63.36	54.0	8.53E-01	103.5	0.9	0.9	103.5	103.5	50
0.20	100	84.50	53.4	6.32E-01	88.0	0.6	0.6	88.0	88.0	100

A-4 SES Data Analysis

Sunnyvale WPCP - Influent - July 18, 2013

sed vol, cc	fractional volume, %	sed time, sec	sed h, cm	sed vel, cm/s	SES, d1 µ	NR1	NR2	SES, d2 µ	SES, µ	vol frac, %≥
20M - 50M, 300µ - 820µ										
0.5	10	7.91	52.4	6.63E+00	382.9	25.4	25.4	382.9	382.9	10
1.0	20	12.99	51.4	3.96E+00	261.1	10.3	10.3	261.1	261.1	20
1.5	30	21.01	50.7	2.41E+00	189.1	4.6	4.6	189.1	189.1	30
2.0	40	26.11	50.2	1.92E+00	164.6	3.2	3.2	164.6	164.6	40
2.5	50	35.16	49.7	1.41E+00	137.5	1.9	1.9	137.5	137.5	50
3.0	60	40.92	49.3	1.20E+00	125.5	1.5	1.5	125.5	125.5	60
3.5	70	45.35	48.9	1.08E+00	117.9	1.3	1.3	117.9	117.9	70
4.0	80	50.87	48.6	9.56E-01	110.2	1.1	1.1	110.2	110.2	80
4.5	90	58.58	48.3	8.25E-01	101.6	0.8	0.8	101.6	101.6	90
5.0	100	71.52	48.0	6.71E-01	90.9	0.6	0.6	90.9	90.9	100
50M - 70M, 200µ - 300µ										
0.20	18	15.11	53.4	3.54E+00	241.8	8.6	8.6	241.8	241.8	18
0.4	36	19.47	52.7	2.71E+00	203.1	5.5	5.5	203.1	203.1	36
0.6	55	36.02	52.2	1.45E+00	139.4	2.0	2.0	139.4	139.4	55
0.8	73	49.80	51.8	1.04E+00	115.5	1.2	1.2	115.5	115.5	73
1.0	91	58.33	51.4	8.82E-01	105.4	0.9	0.9	105.4	105.4	91
1.1	100	72.56	51.3	7.07E-01	93.4	0.7	0.7	93.4	93.4	100
70M - 100M, 150µ - 200µ										
0.20	25	22.51	53.4	2.37E+00	187.1	4.4	4.4	187.1	187.1	25
0.4	50	35.01	52.7	1.51E+00	142.5	2.1	2.1	142.5	142.5	50
0.6	75	61.22	52.2	8.52E-01	103.5	0.9	0.9	103.5	103.5	75
0.8	100	91.22	51.8	5.68E-01	83.0	0.5	0.5	83.0	83.0	100
100M - 140M, 100µ - 150µ										
0.10	20	28.00	54.0	1.93E+00	164.9	3.2	3.2	164.9	164.9	20
0.2	40	37.41	53.4	1.43E+00	138.3	2.0	2.0	138.3	138.3	40
0.3	60	42.65	53.0	1.24E+00	127.7	1.6	1.6	127.7	127.7	60
0.4	80	52.80	52.7	9.98E-01	112.9	1.1	1.1	112.9	112.9	80
0.5	100	65.33	52.4	8.03E-01	100.1	0.8	0.8	100.1	100.1	100
140M - 200M, 75µ - 100µ										
0.10	25	38.67	54.0	1.40E+00	136.5	1.9	1.9	136.5	136.5	25
0.2	50	47.55	53.4	1.12E+00	120.6	1.4	1.4	120.6	120.6	50
0.3	75	61.31	53.0	8.65E-01	104.3	0.9	0.9	104.3	104.3	75
0.4	100	71.56	52.7	7.36E-01	95.6	0.7	0.7	95.6	95.6	100
200M - 270M, 50µ - 75µ										
0.01	10	50.81	55.2	1.09E+00	118.4	1.3	1.3	118.4	118.4	10
0.05	50	95.65	54.5	5.70E-01	83.2	0.5	0.5	83.2	83.2	50
0.10	100	110.26	54.0	4.90E-01	76.8	0.4	0.4	76.8	76.8	100

A-4 SES Data Analysis

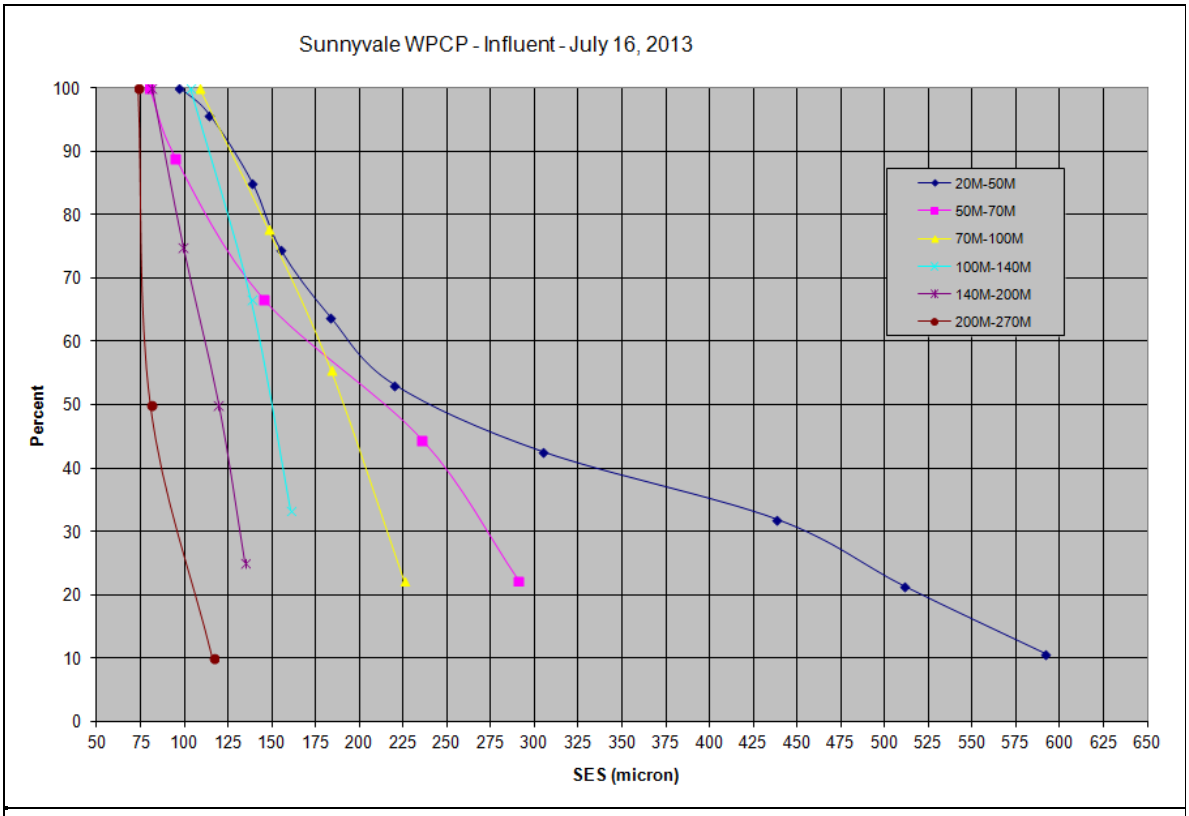
Sunnyvale WPCP - Primary Sludge - July 18, 2013

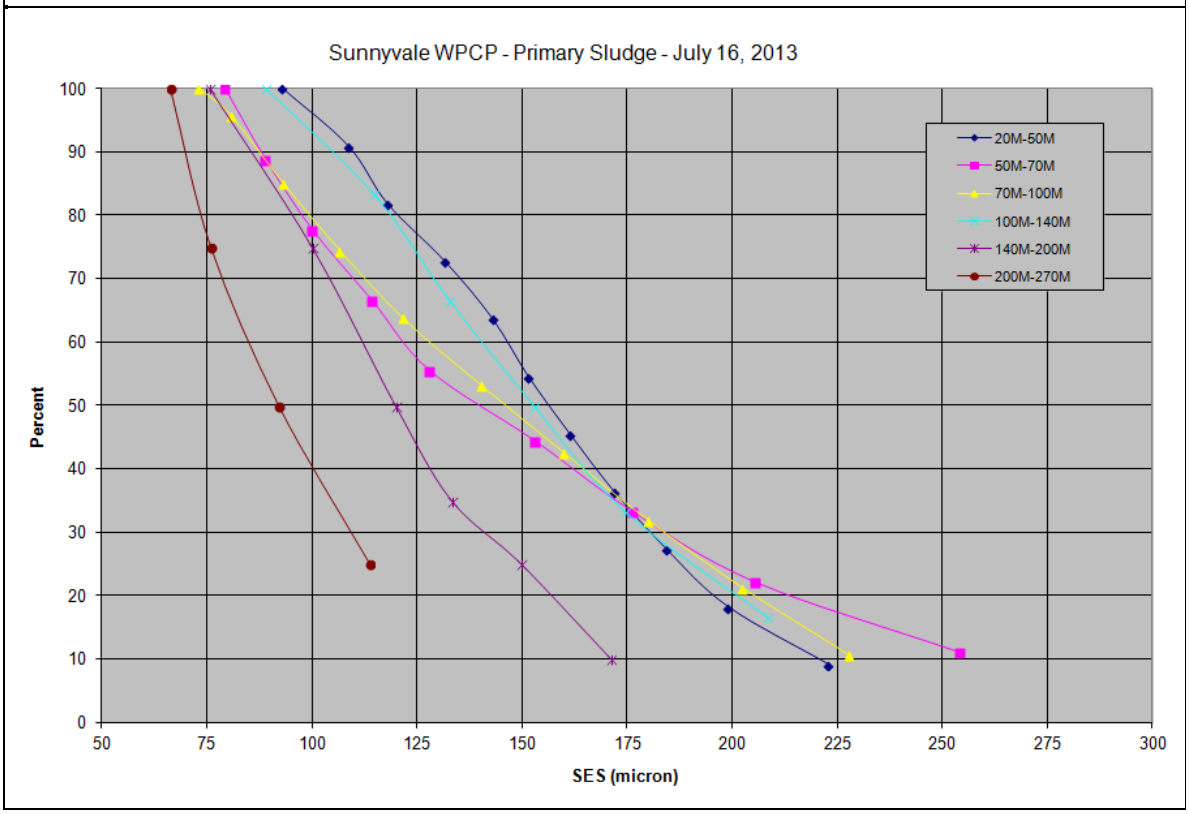
sed vol, cc	fractional volume, %	sed time, sec	sed h, cm	sed vel, cm/s	SES, d1 µ	NR1	NR2	SES, d2 µ		SES, µ	vol frac, %≥
20M - 50M, 300µ - 820µ											
0.2	4	12.78	53.4	4.18E+00	271.2	11.3	11.3	271.2		271.2	4
0.5	11	15.61	52.4	3.36E+00	233.6	7.8	7.8	233.6		233.6	11
1.0	21	19.71	51.4	2.61E+00	198.5	5.2	5.2	198.5		198.5	21
1.5	32	22.34	50.7	2.27E+00	182.1	4.1	4.1	182.1		182.1	32
2.0	43	27.46	50.2	1.83E+00	159.7	2.9	2.9	159.7		159.7	43
2.5	53	31.36	49.7	1.59E+00	146.9	2.3	2.3	146.9		146.9	53
3.0	64	36.63	49.3	1.35E+00	133.6	1.8	1.8	133.6		133.6	64
3.5	74	42.31	48.9	1.16E+00	122.6	1.4	1.4	122.6		122.6	74
4.0	85	56.06	48.6	8.67E-01	104.5	0.9	0.9	104.5		104.5	85
4.5	96	72.78	48.3	6.64E-01	90.3	0.6	0.6	90.3		90.3	96
4.7	100	106.88	48.2	4.51E-01	73.5	0.3	0.3	73.5		73.5	100
50M - 70M, 200µ - 300µ											
0.50	29	16.89	52.4	3.10E+00	221.8	6.9	6.9	221.8		221.8	29
1.00	59	29.30	51.4	1.76E+00	155.9	2.7	2.7	155.9		155.9	59
1.25	74	53.88	51.1	9.48E-01	109.7	1.0	1.0	109.7		109.7	74
1.50	88	74.01	50.7	6.86E-01	91.9	0.6	0.6	91.9		91.9	88
1.70	100	102.13	50.5	4.95E-01	77.2	0.4	0.4	77.2		77.2	100
70M - 100M, 150µ - 200µ											
0.20	10	17.11	53.4	3.12E+00	222.7	7.0	7.0	222.7		222.7	10
0.50	25	21.02	52.4	2.49E+00	193.0	4.8	4.8	193.0		193.0	25
1.00	50	27.47	51.4	1.87E+00	162.0	3.0	3.0	162.0		162.0	50
1.25	63	33.85	51.1	1.51E+00	142.7	2.2	2.2	142.7		142.7	63
1.50	75	47.67	50.7	1.06E+00	117.0	1.2	1.2	117.0		117.0	75
1.75	88	77.80	50.4	6.48E-01	89.2	0.6	0.6	89.2		89.2	88
2.00	100	100.02	50.2	5.02E-01	77.8	0.4	0.4	77.8		77.8	100
100M - 140M, 100µ - 150µ											
0.20	6	18.66	53.4	2.86E+00	210.6	6.0	6.0	210.6		210.6	6
0.50	14	22.59	52.4	2.32E+00	184.5	4.3	4.3	184.5		184.5	14
1.00	29	27.98	51.4	1.84E+00	160.3	2.9	2.9	160.3		160.3	29
1.50	43	32.33	50.7	1.57E+00	146.0	2.3	2.3	146.0		146.0	43
2.00	57	37.02	50.2	1.36E+00	134.2	1.8	1.8	134.2		134.2	57
2.50	71	44.80	49.7	1.11E+00	119.8	1.3	1.3	119.8		119.8	71
3.00	86	60.28	49.3	8.18E-01	101.2	0.8	0.8	101.2		101.2	86
3.50	100	96.88	48.9	5.05E-01	78.0	0.4	0.4	78.0		78.0	100
140M - 200M, 75µ - 100µ											
0.20	14	28.96	53.4	1.85E+00	160.6	3.0	3.0	160.6		160.6	14
0.40	29	35.53	52.7	1.48E+00	141.3	2.1	2.1	141.3		141.3	29
0.60	43	41.71	52.2	1.25E+00	128.2	1.6	1.6	128.2		128.2	43
0.80	57	46.39	51.8	1.12E+00	120.2	1.3	1.3	120.2		120.2	57
1.00	71	53.90	51.4	9.54E-01	110.1	1.1	1.1	110.1		110.1	71
1.25	89	84.65	51.1	6.03E-01	85.8	0.5	0.5	85.8		85.8	89
1.40	100	112.60	50.9	4.52E-01	73.5	0.3	0.3	73.5		73.5	100
200M - 270M, 50µ - 75µ											
0.200	29	39.63	53.4	1.35E+00	133.8	1.8	1.8	133.8		133.8	29
0.40	57	64.85	52.7	8.13E-01	100.8	0.8	0.8	100.8		100.8	57
0.60	86	121.11	52.2	4.31E-01	71.7	0.3	0.3	71.7		71.7	86
0.70	100	144.40	52.0	3.60E-01	65.3	0.2	0.2	65.3		65.3	100

A-4 SES Data Analysis

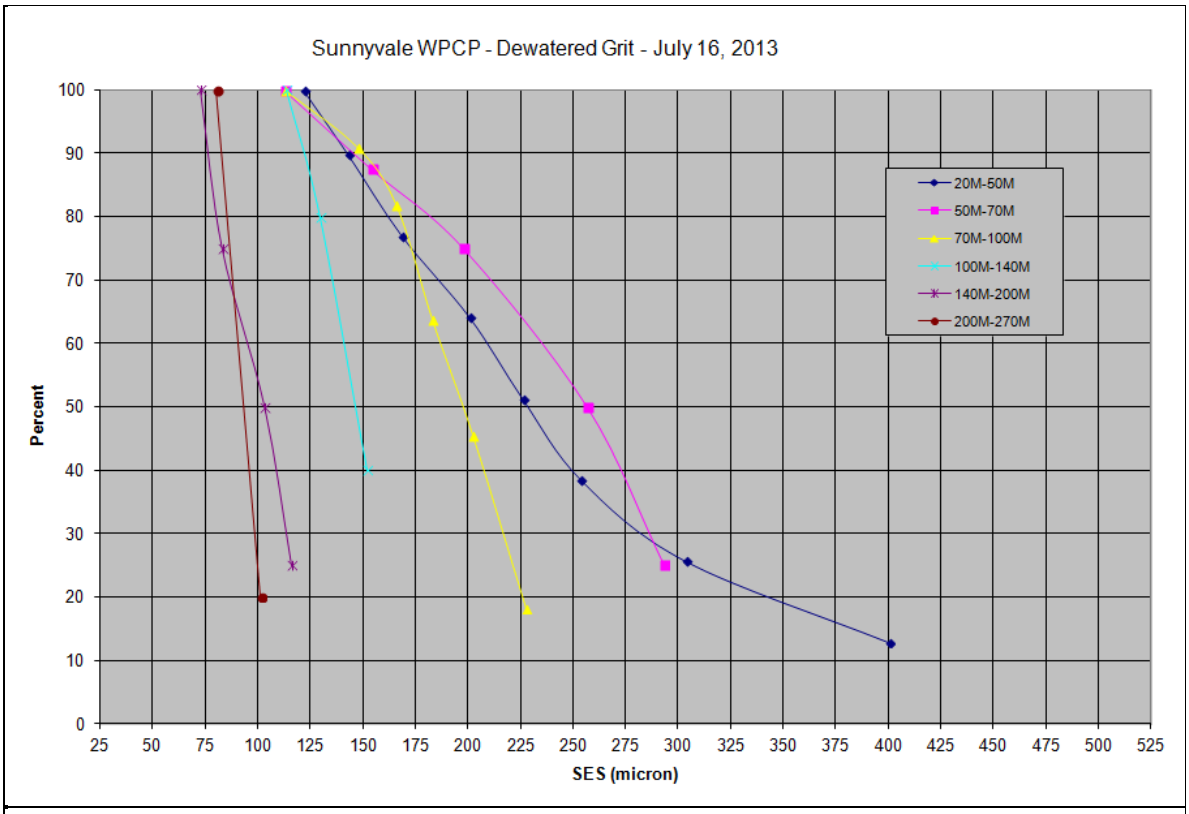
Sunnyvale WPCP - Dewatered Grit - July 18, 2013										
sed vol, cc	fractional volume, %	sed time, sec	sed h, cm	sed vel, cm/s	SES, d1 µ	NR1	NR2	SES, d2 µ	SES, µ	vol frac, %≥
20M - 50M, 300µ - 820µ										
0.20	9	7.54	53.4	7.09E+00	404.4	28.7	28.7	404.4	404.4	9
0.50	22	10.41	52.4	5.04E+00	309.9	15.6	15.6	309.9	309.9	22
1.00	44	16.24	51.4	3.17E+00	224.8	7.1	7.1	224.8	224.8	44
1.50	67	22.41	50.7	2.26E+00	181.7	4.1	4.1	181.7	181.7	67
2.00	89	30.22	50.2	1.66E+00	150.9	2.5	2.5	150.9	150.9	89
2.25	100	50.01	49.9	9.99E-01	112.9	1.1	1.1	112.9	112.9	100
50M - 70M, 200µ - 300µ										
0.50	45	16.16	52.4	3.24E+00	228.3	7.4	7.4	228.3	228.3	45
0.7	64	19.01	52.0	2.73E+00	204.4	5.6	5.6	204.4	204.4	64
0.9	82	21.66	51.6	2.38E+00	187.5	4.5	4.5	187.5	187.5	82
1.0	91	32.32	51.4	1.59E+00	147.2	2.3	2.3	147.2	147.2	91
1.1	100	75.31	51.3	6.81E-01	91.6	0.6	0.6	91.6	91.6	100
70M - 100M, 150µ - 200µ										
0.30	50	24.49	53.0	2.17E+00	176.8	3.8	3.8	176.8	176.8	50
0.40	67	33.72	52.7	1.56E+00	145.7	2.3	2.3	145.7	145.7	67
0.50	83	48.19	52.4	1.09E+00	118.5	1.3	1.3	118.5	118.5	83
0.60	100	81.58	52.2	6.40E-01	88.5	0.6	0.6	88.5	88.5	100
100M - 140M, 100µ - 150µ										
0.20	67	36.57	53.4	1.46E+00	140.1	2.0	2.0	140.1	140.1	67
0.30	100	50.68	53.0	1.05E+00	115.9	1.2	1.2	115.9	115.9	100
140M - 200M, 75µ - 100µ										
0.05	25	35.15	54.5	1.55E+00	145.0	2.2	2.2	145.0	145.0	25
0.10	50	81.44	54.0	6.63E-01	90.3	0.6	0.6	90.3	90.3	50
0.20	100	111.15	53.4	4.81E-01	76.0	0.4	0.4	76.0	76.0	100
200M - 270M, 50µ - 75µ										
0.01	20	65.53	55.2	8.43E-01	102.8	0.9	0.9	102.8	102.8	20
0.05	100	115.01	54.5	4.74E-01	75.4	0.4	0.4	75.4	75.4	100

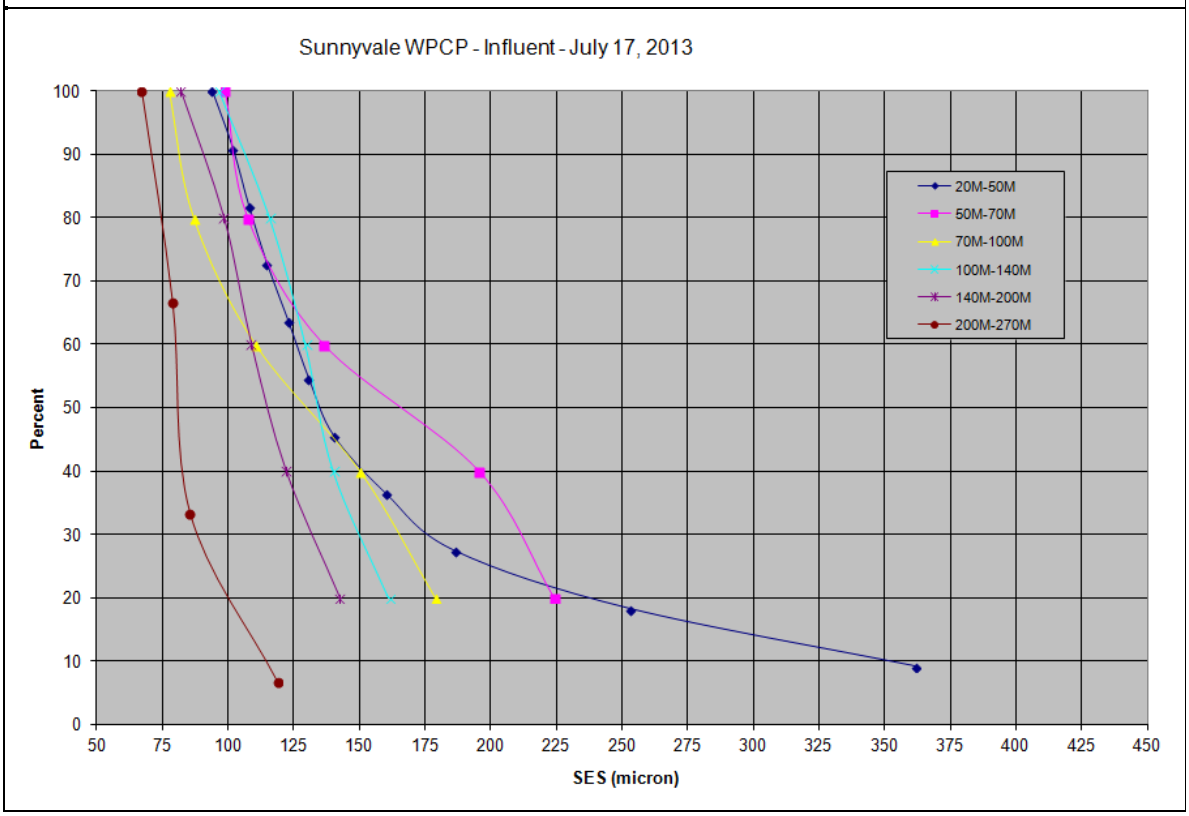
A-5 SES Charts



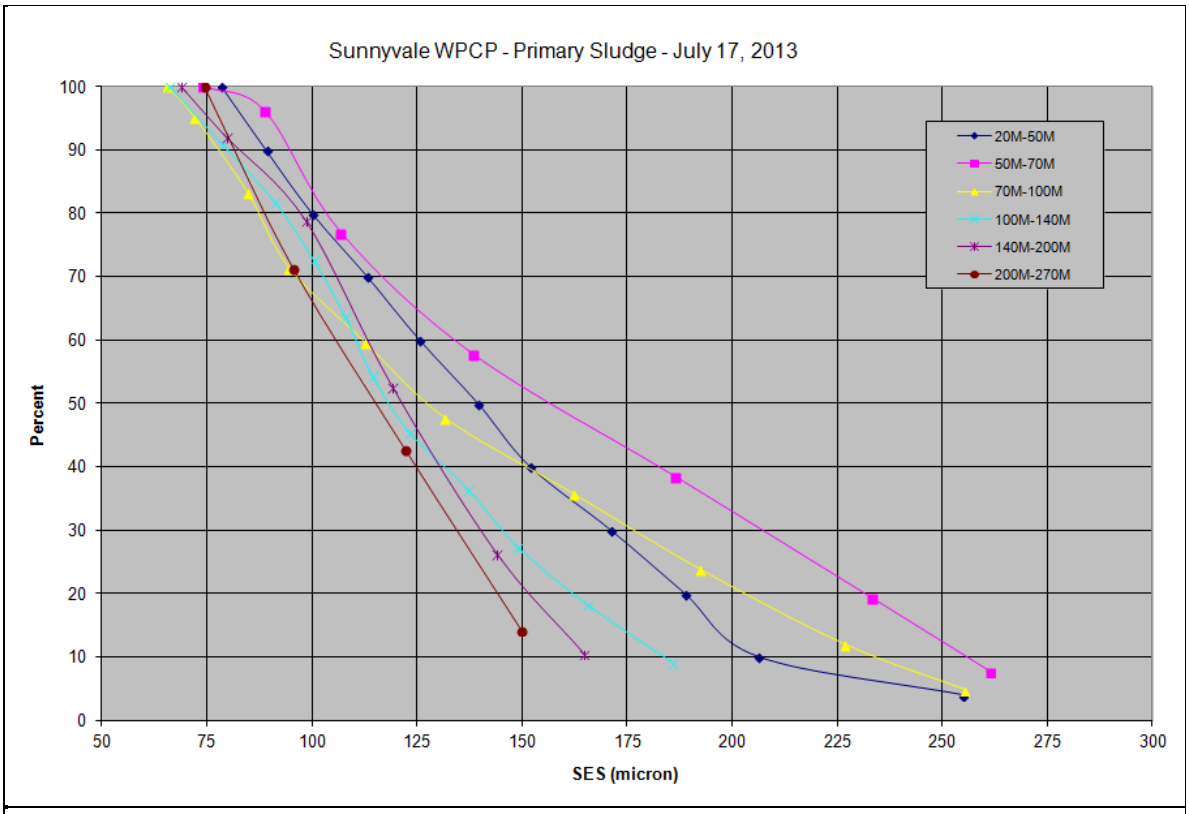


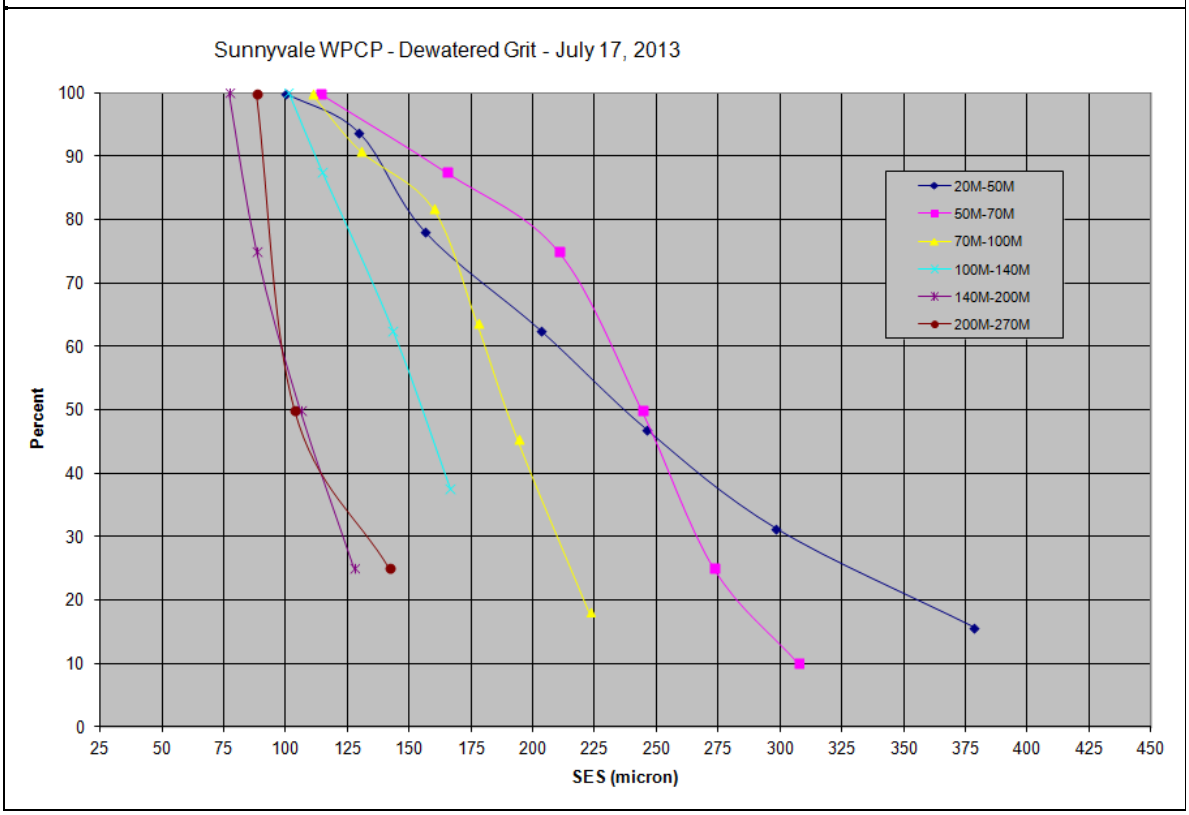
A-5 SES Charts



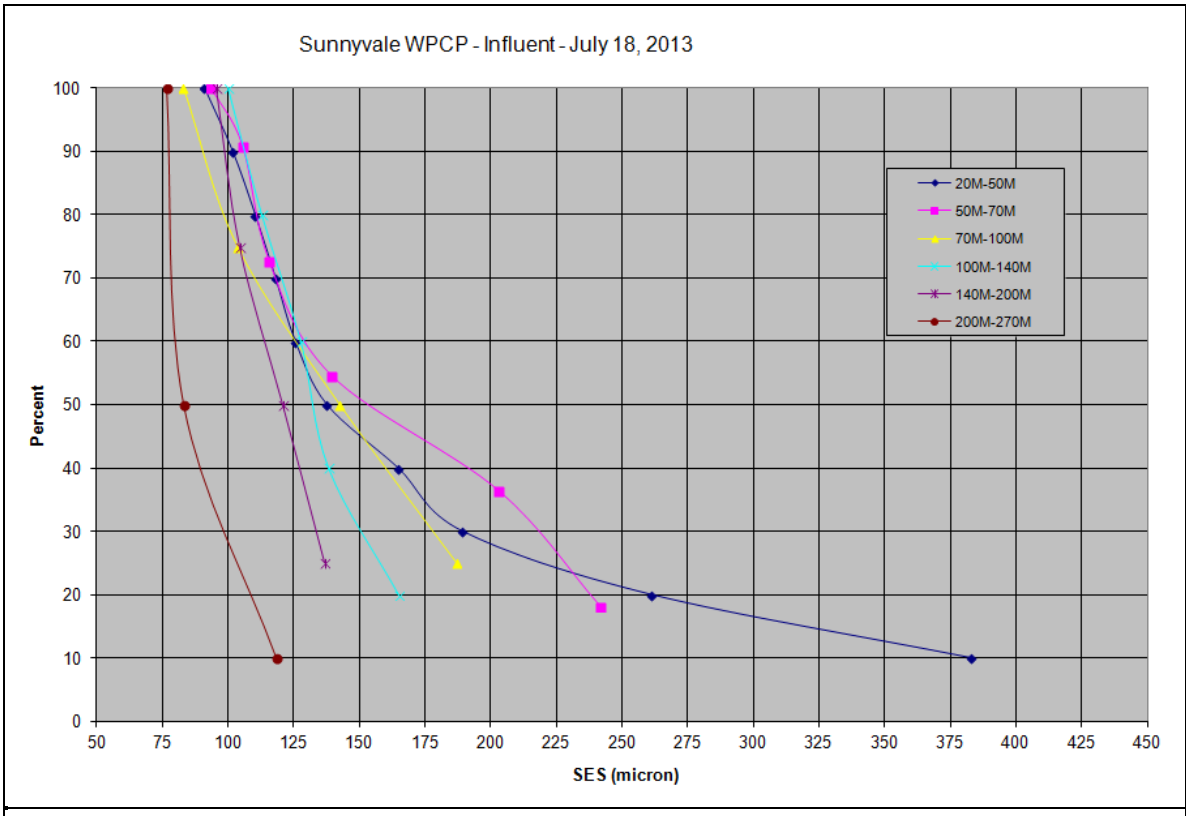


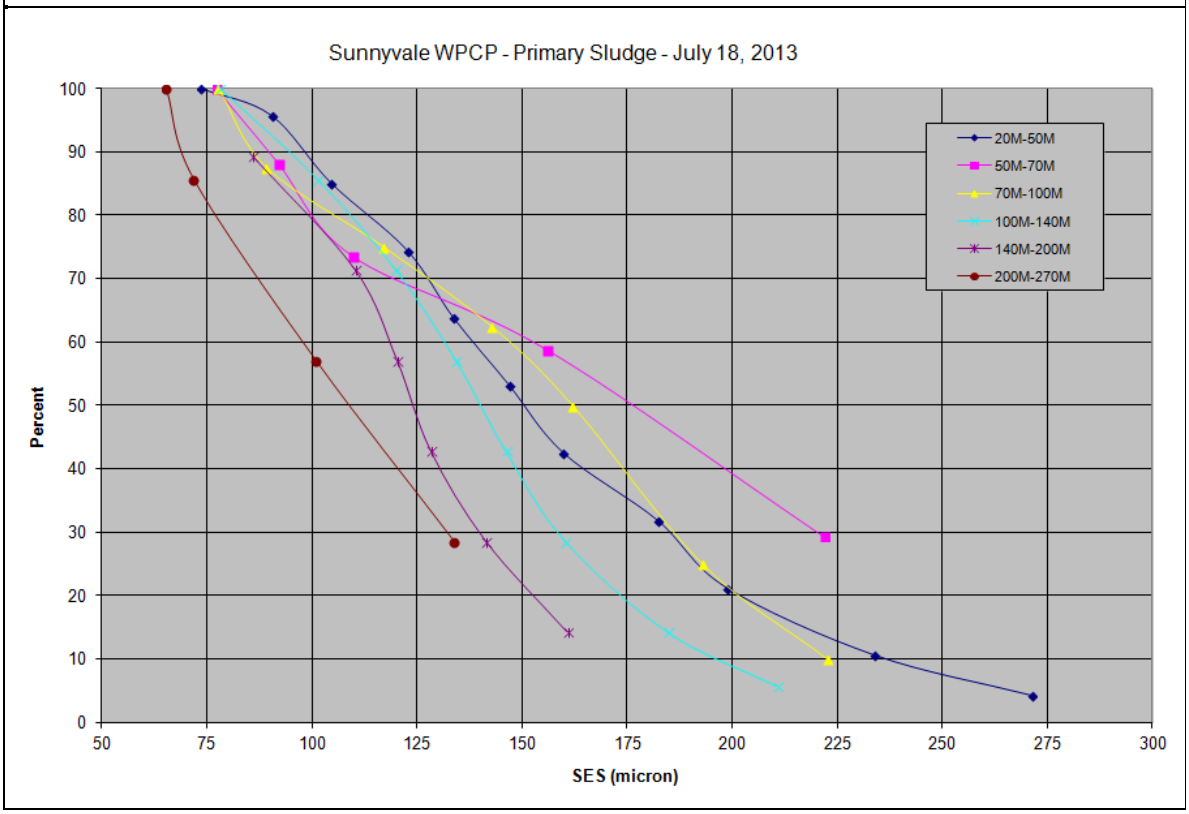
A-5 SES Charts



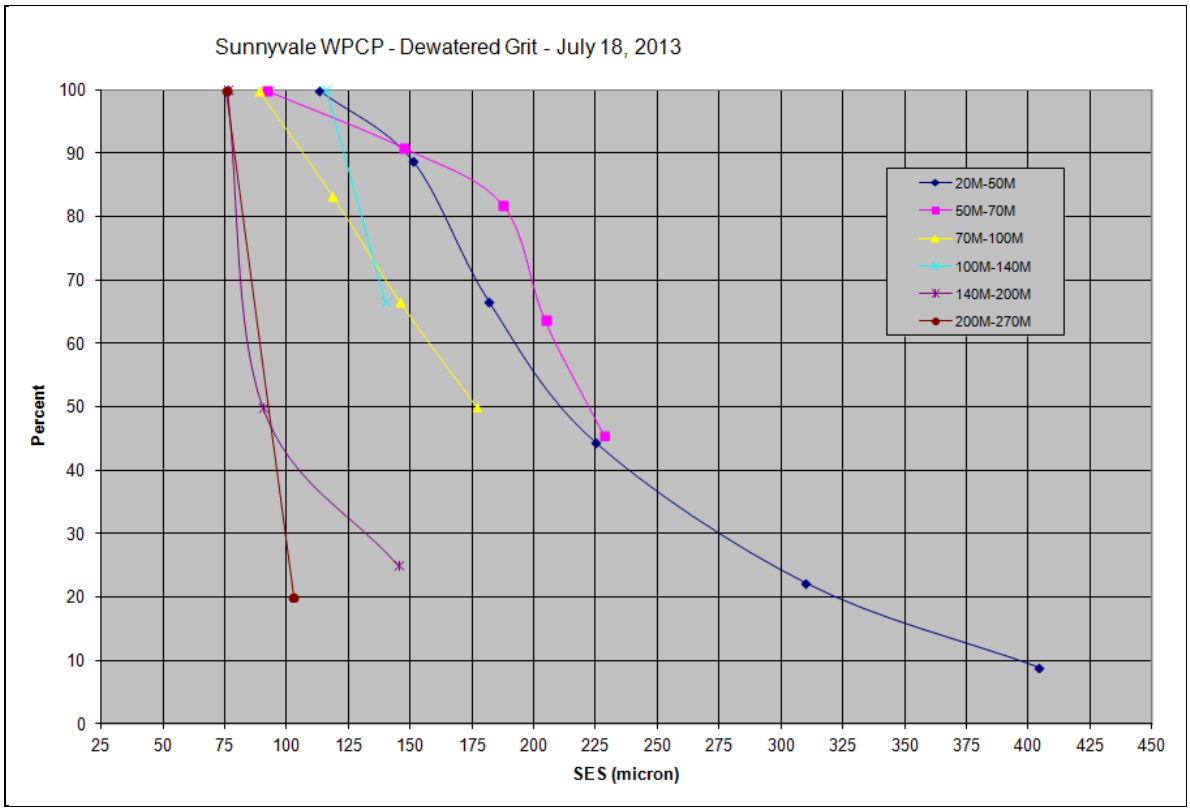


A-5 SES Charts





A-5 SES Charts



A-6 SES Chart Analysis

Sunnyvale WPCP - Influent - July 16, 2013

Sieve Size >	1/4	1/8	#12	#20	#50	#70	#100	#140	#200	#270	% Total in SES Range			
fxd solids fraction	0.46	1.97	10.72	33.43	45.59	3.60	1.94	1.39	0.78	0.13				
											SES (micron)	% Percent Retained	Cumulative % Retained	% >
SES Interval											25			100
25-50											50	0.00	0.00	100.00
50-75											75	0.00	0.00	100.00
75-100					2.0	13.0			25.0	73.0	100	1.67	1.67	98.33
100-125				2.0	7.0	13.0	9.0	20.0	33.0	24.0	125	5.07	6.73	93.27
125-150			2.0	7.0	15.0	9.0	14.0	30.0	41.0	3.0	150	10.73	17.46	82.54
150-175		2.0	7.0	15.0	10.0	7.0	15.0	37.0	1.0		175	11.43	28.89	71.11
175-200	2.0	7.0	15.0	10.0	9.0	6.0	19.0	13.0			200	9.97	38.86	61.14
200-225	7.0	15.0	10.0	9.0	6.0	5.0	21.0				225	7.73	46.59	53.41
225-250	15.0	10.0	9.0	6.0	4.0	8.0	20.0				250	5.74	52.33	47.67
250-275	10.0	9.0	6.0	4.0	4.0	11.0	2.0				275	4.46	56.79	43.21
275-300	9.0	6.0	4.0	4.0	3.0	11.0					300	3.69	60.47	39.53
300-325	6.0	4.0	4.0	3.0	3.0	11.0					325	3.30	63.78	36.22
325-350	4.0	4.0	3.0	3.0	2.0	6.0					350	2.55	66.32	33.68
350-375	4.0	3.0	3.0	2.0	2.0						375	1.98	68.30	31.70
375-400	3.0	3.0	2.0	2.0	2.0						400	1.87	70.17	29.83
400-425	3.0	2.0	2.0	2.0	2.0						425	1.85	72.02	27.98
425-450	2.0	2.0	2.0	2.0	2.0						450	1.84	73.86	26.14
450-475	2.0	2.0	2.0	2.0	3.0						475	2.30	76.16	23.84
475-500	2.0	2.0	2.0	3.0	4.0						500	3.09	79.25	20.75
500-525	2.0	2.0	3.0	4.0	3.0						525	3.07	82.33	17.67
525-550	2.0	3.0	4.0	3.0	3.0						550	2.87	85.19	14.81
550-575	3.0	4.0	3.0	3.0	3.0						575	2.78	87.98	12.02
575-600	4.0	3.0	3.0	3.0	3.0						600	2.77	90.75	9.25
600-625	3.0	3.0	3.0	3.0	3.0						625	2.76	93.51	6.49
625-650	3.0	3.0	3.0	3.0	3.0						650	2.76	96.28	3.72
650-675	3.0	3.0	3.0	3.0	2.0						675	2.31	98.59	1.41
>675	11.0	8.0	5.0	2.0							>675	1.41	100.00	0.00
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.00		

Sunnyvale WPCP - Primary Sludge - July 16, 2013

Sieve Size >	1/4	1/8	#12	#20	#50	#70	#100	#140	#200	#270	% Total in SES Range			
fxd solids fraction	0.20	0.91	3.06	5.39	20.85	13.12	20.98	19.82	13.08	2.60				
											SES (micron)	% Percent Retained	Cumulative % Retained	% >
SES Interval											25			100
25-50											50	0.00	0.00	100.00
50-75							1.0			23.0	75	0.81	0.81	99.19
75-100					4.0	22.0	19.0	7.0	25.0	37.0	100	13.33	14.14	85.86
100-125				4.0	19.0	21.0	18.0	19.0	32.0	28.0	125	19.39	33.52	66.48
125-150			4.0	19.0	21.0	12.0	14.0	22.0	17.0	12.0	150	16.93	50.46	49.54
150-175		4.0	19.0	21.0	23.0	12.0	14.0	19.0	18.0		175	17.17	67.63	32.37
175-200	4.0	19.0	21.0	23.0	15.0	13.0	12.0	13.0	8.0		200	13.03	80.66	19.34
200-225	19.0	21.0	23.0	15.0	10.0	11.0	10.0	11.0			225	9.54	90.21	9.79
225-250	21.0	23.0	15.0	10.0	8.0	9.0	10.0	9.0			250	7.98	98.19	1.81
250-275	23.0	15.0	10.0	8.0			2.0				275	1.34	99.53	0.47
275-300	15.0	10.0	8.0								300	0.37	99.89	0.11
300-325	10.0	8.0									325	0.09	99.98	0.02
>325	8.0										>325	0.02	100.00	0.00
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.00		

A-6 SES Chart Analysis

Sunnyvale WPCP - Dewatered Grit - July 16, 2013

Sieve Size >	1/4	1/8	#12	#20	#50	#70	#100	#140	#200	#270	% Total in SES Range			
fxd solids fraction	2.48	7.21	9.68	13.87	39.91	13.30	7.86	4.03	1.23	0.44				
											SES (micron)	% Percent Retained	Cumulative % Retained	% >
SES Interval											25			100
25-50											50	0.00	0.00	100.00
50-75									5.0		75	0.06	0.06	99.94
75-100									46.0	75.0	100	0.90	0.96	99.04
100-125					2.0	4.0	3.0	13.0	46.0	25.0	125	2.77	3.72	96.28
125-150				2.0	11.0	7.0	7.0	43.0	3.0		150	7.92	11.64	88.36
150-175			2.0	11.0	13.0	7.0	18.0	43.0			175	10.99	22.63	77.37
175-200		2.0	11.0	13.0	10.0	8.0	23.0	1.0			200	9.92	32.54	67.46
200-225	2.0	11.0	13.0	10.0	12.0	10.0	28.0				225	11.81	44.35	55.65
225-250	11.0	13.0	10.0	12.0	12.0	11.0	21.0				250	11.74	56.09	43.91
250-275	13.0	10.0	12.0	12.0	8.0	14.0					275	8.92	65.02	34.98
275-300	10.0	12.0	12.0	8.0	5.0	19.0					300	7.91	72.92	27.08
300-325	12.0	12.0	8.0	5.0	4.0	18.0					325	6.62	79.54	20.46
325-350	12.0	8.0	5.0	4.0	4.0	2.0					350	3.77	83.32	16.68
350-375	8.0	5.0	4.0	4.0	4.0						375	3.10	86.41	13.59
375-400	5.0	4.0	4.0	4.0	3.0						400	2.55	88.96	11.04
400-425	4.0	4.0	4.0	3.0	3.0						425	2.39	91.35	8.65
425-450	4.0	4.0	3.0	3.0	3.0						450	2.29	93.64	6.36
450-475	4.0	3.0	3.0	3.0	3.0						475	2.22	95.86	4.14
475-500	3.0	3.0	3.0	3.0	3.0						500	2.19	98.06	1.94
>500	12.0	9.0	6.0	3.0							>500	1.94	100.00	0.00
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.00		

Sunnyvale WPCP - Influent - July 17, 2013

Sieve Size >	1/4	1/8	#12	#20	#50	#70	#100	#140	#200	#270	% Total in SES Range			
fxd solids fraction	0.28	5.04	11.04	17.96	46.79	5.64	4.72	4.11	3.39	1.01				
											SES (micron)	% Percent Retained	Cumulative % Retained	% >
SES Interval											25			100
25-50											50	0.00	0.00	100.00
50-75										22.0	75	0.22	0.22	99.78
75-100					7.0	34.0	32.0	3.0	22.0	58.0	100	8.16	8.38	91.62
100-125				7.0	32.0	11.0	16.0	29.0	41.0	18.0	125	20.37	28.76	71.24
125-150			7.0	32.0	21.0	8.0	12.0	37.0	24.0	2.0	150	19.72	48.48	51.52
150-175		7.0	32.0	21.0	10.0	9.0	17.0	23.0	13.0		175	15.03	63.51	36.49
175-200	7.0	32.0	21.0	10.0	6.0	18.0	19.0	8.0			200	10.80	74.31	25.69
200-225	32.0	21.0	10.0	6.0	4.0	20.0	4.0				225	6.52	80.83	19.17
225-250	21.0	10.0	6.0	4.0	2.0						250	2.88	83.71	16.29
250-275	10.0	6.0	4.0	2.0	2.0						275	2.07	85.78	14.22
275-300	6.0	4.0	2.0	2.0	2.0						300	1.73	87.51	12.49
300-325	4.0	2.0	2.0	2.0	2.0						325	1.63	89.14	10.86
325-350	2.0	2.0	2.0	2.0	2.0						350	1.62	90.76	9.24
350-375	2.0	2.0	2.0	2.0	2.0						375	1.62	92.38	7.62
375-400	2.0	2.0	2.0	2.0	2.0						400	1.62	94.01	5.99
400-425	2.0	2.0	2.0	2.0	2.0						425	1.62	95.63	4.37
425-450	2.0	2.0	2.0	2.0	2.0						450	1.62	97.25	2.75
450-475	2.0	2.0	2.0	2.0	2.0						475	1.62	98.87	1.13
>475	8.0	6.0	4.0	2.0							>475	1.13	100.00	0.00
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.00		

A-6 SES Chart Analysis

Sunnyvale WPCP - Primary Sludge - July 17, 2013

Sieve Size >	1/4	1/8	#12	#20	#50	#70	#100	#140	#200	#270	% Total in SES Range			
fxd solids fraction	0.80	1.38	2.91	4.41	17.79	13.99	15.68	30.16	10.08	2.81				
											SES (micron)	% Percent Retained	Cumulative % Retained	% >
SES Interval											25			100
25-50											50	0.00	0.00	100.00
50-75							8.0	7.0	5.0		75	3.87	3.87	96.13
75-100					20.0	17.0	24.0	20.0	17.0	33.0	100	18.37	22.24	77.76
100-125				20.0	19.0	19.0	17.0	29.0	32.0	27.0	125	22.31	44.56	55.44
125-150			20.0	19.0	19.0	12.0	11.0	17.0	25.0	26.0	150	16.58	61.13	38.87
150-175		20.0	19.0	19.0	14.0	10.0	10.0	14.0	18.0	14.0	175	13.55	74.69	25.31
175-200	20.0	19.0	19.0	14.0	16.0	10.0	9.0	1.0	3.0		200	7.85	82.54	17.46
200-225	19.0	19.0	14.0	16.0	6.0	10.0	9.0	2.0			225	6.01	88.55	11.45
225-250	19.0	14.0	16.0	6.0	2.0	10.0	5.0				250	3.61	92.16	7.84
250-275	14.0	16.0	6.0	2.0	2.0	10.0	5.0				275	3.13	95.29	4.71
275-300	16.0	6.0	2.0	2.0	2.0	2.0	2.0				300	1.31	96.60	3.40
>300	12.0	6.0	4.0	2.0							>300	0.38	96.98	3.02
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	90.0	100.0	100.0		96.98		

Sunnyvale WPCP - Dewatered Grit - July 17, 2013

Sieve Size >	1/4	1/8	#12	#20	#50	#70	#100	#140	#200	#270	% Total in SES Range			
fxd solids fraction	1.21	4.51	7.18	10.35	44.56	15.19	8.56	5.87	2.01	0.55				
											SES (micron)	% Percent Retained	Cumulative % Retained	% >
SES Interval											25			100
25-50											50	0.00	0.00	100.00
50-75											75	0.00	0.00	100.00
75-100									42.0	44.0	100	1.09	1.09	98.91
100-125					5.0	2.0	7.0	21.0	30.0	22.0	125	5.09	6.17	93.83
125-150				5.0	14.0	6.0	8.0	23.0	28.0	13.0	150	10.34	16.51	83.49
150-175			5.0	14.0	9.0	6.0	19.0	27.0		14.0	175	10.02	26.53	73.47
175-200		5.0	14.0	9.0	8.0	6.0	26.0	28.0		7.0	200	10.55	37.08	62.92
200-225	5.0	14.0	9.0	8.0	9.0	13.0	24.0	1.0			225	10.27	47.35	52.65
225-250	14.0	9.0	8.0	9.0	8.0	21.0	16.0				250	10.21	57.55	42.45
250-275	9.0	8.0	9.0	8.0	7.0	21.0					275	8.25	65.81	34.19
275-300	8.0	9.0	8.0	7.0	7.0	11.0					300	6.59	72.40	27.60
300-325	9.0	8.0	7.0	7.0	5.0	10.0					325	5.44	77.84	22.16
325-350	8.0	7.0	7.0	5.0	5.0	4.0					350	4.27	82.11	17.89
350-375	7.0	7.0	5.0	5.0	5.0						375	3.50	85.62	14.38
375-400	7.0	5.0	5.0	5.0	5.0						400	3.41	89.03	10.97
400-425	5.0	5.0	5.0	5.0	5.0						425	3.39	92.42	7.58
425-450	5.0	5.0	5.0	5.0	5.0						450	3.39	95.81	4.19
450-475	5.0	5.0	5.0	5.0	3.0						475	2.50	98.31	1.69
>475	18.0	13.0	8.0	3.0							>475	1.69	100.00	0.00
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.00		

A-6 SES Chart Analysis

Sunnyvale WPCP - Influent - July 18, 2013

Sieve Size >	1/4	1/8	#12	#20	#50	#70	#100	#140	#200	#270	% Total in SES Range			
fxd solids fraction	0.97	4.10	7.68	10.68	38.08	10.37	9.16	11.09	6.30	1.58				
											SES (micron)	% Percent Retained	Cumulative % Retained	% >
SES Interval											25			100
25-50											50	0.00	0.00	100.00
50-75											75	0.00	0.00	100.00
75-100					8.0	4.0	22.0		12.0	72.0	100	7.37	7.37	92.63
100-125				8.0	32.0	34.0	18.0	36.0	45.0	24.0	125	25.42	32.78	67.22
125-150			8.0	32.0	15.0	11.0	14.0	34.0	38.0	4.0	150	18.39	51.17	48.83
150-175		8.0	32.0	15.0	11.0	7.0	14.0	17.0	5.0		175	12.78	63.96	36.04
175-200	8.0	32.0	15.0	11.0	6.0	6.0	14.0	13.0			200	9.35	73.31	26.69
200-225	32.0	15.0	11.0	6.0	4.0	11.0	16.0				225	6.54	79.85	20.15
225-250	15.0	11.0	6.0	4.0	3.0	14.0	2.0				250	4.26	84.11	15.89
250-275	11.0	6.0	4.0	3.0	3.0	13.0					275	3.47	87.58	12.42
275-300	6.0	4.0	3.0	3.0	2.0						300	1.53	89.12	10.88
300-325	4.0	3.0	3.0	2.0	2.0						325	1.37	90.48	9.52
325-350	3.0	3.0	2.0	2.0	2.0						350	1.28	91.76	8.24
350-375	3.0	2.0	2.0	2.0	2.0						375	1.24	93.00	7.00
375-400	2.0	2.0	2.0	2.0	2.0						400	1.23	94.23	5.77
400-425	2.0	2.0	2.0	2.0	2.0						425	1.23	95.46	4.54
425-450	2.0	2.0	2.0	2.0	2.0						450	1.23	96.69	3.31
450-475	2.0	2.0	2.0	2.0	2.0						475	1.23	97.93	2.07
475-500	2.0	2.0	2.0	2.0	2.0						500	1.23	99.16	0.84
>500	8.0	6.0	4.0	2.0							>500	0.84	100.00	0.00
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.00		

Sunnyvale WPCP - Primary Sludge - July 18, 2013

Sieve Size >	1/4	1/8	#12	#20	#50	#70	#100	#140	#200	#270	% Total in SES Range			
fxd solids fraction	1.38	3.11	4.06	4.23	23.56	15.36	12.48	24.09	8.90	2.83				
											SES (micron)	% Percent Retained	Cumulative % Retained	% >
SES Interval											25			100
25-50											50	0.00	0.00	100.00
50-75					1.0					18.0	75	0.74	0.74	99.26
75-100				1.0	10.0	20.0	18.0	14.0	21.0	24.0	100	13.64	14.38	85.62
100-125			1.0	10.0	17.0	12.0	11.0	19.0	31.0	22.0	125	15.64	30.02	69.98
125-150		1.0	10.0	17.0	22.0	7.0	14.0	28.0	26.0	21.0	150	18.81	48.84	51.16
150-175	1.0	10.0	17.0	22.0	15.0	10.0	18.0	20.0	19.0	15.0	175	16.20	65.03	34.97
175-200	10.0	17.0	22.0	15.0	14.0	11.0	19.0	11.0	3.0		200	12.47	77.51	22.49
200-225	17.0	22.0	15.0	14.0	8.0	11.0	11.0	7.0			225	8.75	86.26	13.74
225-250	22.0	15.0	14.0	8.0	5.0	11.0	9.0	1.0			250	5.91	92.17	7.83
250-275	15.0	14.0	8.0	5.0	5.0	11.0					275	4.05	96.22	3.78
275-300	14.0	8.0	5.0	5.0	3.0	7.0					300	2.64	98.85	1.15
>300	21.0	13.0	8.0	3.0							>300	1.15	100.00	0.00
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.00		

A-6 SES Chart Analysis

Sunnyvale WPCP - Dewatered Grit - July 18, 2013

Sieve Size >	1/4	1/8	#12	#20	#50	#70	#100	#140	#200	#270	% Total in SES Range			
fxd solids fraction	2.35	4.38	9.85	17.25	46.89	9.59	5.09	2.90	1.13	0.58				
											SES (micron)	% Percent Retained	Cumulative % Retained	% >
SES Interval											25			100
25-50											50	0.00	0.00	100.00
50-75											75	0.00	0.00	100.00
75-100							2.0	7.0		58.0	72.0	100	1.62	1.62	98.38
100-125						3.0	4.0	14.0	12.0	10.0	28.0	125	3.13	4.75	95.25
125-150					3.0	8.0	4.0	15.0	36.0	10.0		150	6.57	11.32	88.68
150-175				3.0	8.0	18.0	6.0	13.0	37.0	10.0		175	12.54	23.86	76.14
175-200			3.0	8.0	18.0	16.0	15.0	13.0	15.0	10.0		200	14.17	38.03	61.97
200-225		3.0	8.0	18.0	16.0	11.0	22.0	12.0		2.0		225	12.85	50.89	49.11
225-250		8.0	18.0	16.0	11.0	7.0	18.0	12.0				250	10.07	60.95	39.05
250-275		18.0	16.0	11.0	7.0	7.0	18.0	12.0				275	9.03	69.99	30.01
275-300		16.0	11.0	7.0	7.0	6.0	11.0	2.0				300	6.72	76.71	23.29
300-325		11.0	7.0	7.0	6.0	5.0						325	4.63	81.34	18.66
325-350		7.0	7.0	6.0	5.0	4.0						350	3.80	85.14	14.86
350-375		7.0	6.0	5.0	4.0	3.0						375	3.02	88.16	11.84
375-400		6.0	5.0	4.0	3.0	3.0						400	2.68	90.84	9.16
400-425		5.0	4.0	3.0	3.0	3.0						425	2.51	93.35	6.65
425-450		4.0	3.0	3.0	3.0	3.0						450	2.44	95.79	4.21
450-475		3.0	3.0	3.0	3.0	3.0						475	2.42	98.22	1.78
>475		12.0	9.0	6.0	3.0							>475	1.78	100.00	0.00
TOTAL		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.00		

A-7 Median SES Versus Median Physical Size Data

Influent

Median Size (microns)	Size Range (microns)		16-Jul-13	17-Jul-13	18-Jul-13
62.5	50	75	81	80	83
87.5	75	100	119	113	121
125	100	150	149	134	131
175	150	200	189	128	142
250	200	300	213	164	152
560	300	820	239	135	138

Primary Sludge

Median Size (microns)	Size Range (microns)		16-Jul-13	17-Jul-13	18-Jul-13
62.5	50	75	92	114	108
87.5	75	100	120	121	123
125	100	150	153	118	140
175	150	200	145	127	162
250	200	300	139	156	177
560	300	820	166	139	151

Dewatered Grit

Median Size (microns)	Size Range (microns)		16-Jul-13	17-Jul-13	18-Jul-13
62.5	50	75	96	104	92
87.5	75	100	103	106	90
125	100	150	147	154	153
175	150	200	198	188	177
250	200	300	257	244	222
560	300	820	227	237	216

Appendix B – Calculations

Drag Coefficient (C_d)

$24/N_R + 3/\text{sqrt } N_R + 0.34$

Reynolds number (N_R)

(settling velocity of particle)(diameter of particle)/kinematic viscosity

Stoke's Law

Settling velocity (m/s) = $g(sg_p - 1)d^2_p/18v$

Where g = acceleration due to gravity (9.81 m/s^2)
sg_p = specific gravity of particle
d_p = diameter of particle
v = kinematic viscosity (m^2/s)

% Total Solids

(grams dry weight/grams wet weight)*100

% Total Volatile Solids

[(grams dry weight - grams ash weight)/ grams dry weight]*100