RMC
Water and Environment

October 10, 2011

Novato Sanitary District
Beverly James, District Manager-Engineer
500 Davidson Street
Novato, CA 94945

Dear Ms. James:

The independent review of the odor control facilities at Novato Sanitary District's treatment plant has been completed by James Joyce of V&A Consulting Engineers. Mr. Joyce is an expert in odor control of wastewater facilities, has designed and reviewed numerous odor control facilities throughout the world, and is the author of the biofilter odor control chapter in the WEF Method of Practice 25 publication titled, "Control of Odors and Emissions from Wastewater Treatment Plants". This publication is a widely used in the wastewater industry as the reference for designing best practice odor control at wastewater facilities.

The complete review is attached to this letter. The key findings of the review are as follows:

1. Biofilters are appropriate for odor control at Novato SD's treatment plant. Use of other control technology, such as chemical or activated carbon would result in residual odor release from the plant.

2. The design air flow capacity of the odor control facilities is generally adequate.

3. The design air flow capacity is not being achieved because the interface liner in the odor beds (situated between the lower rock plenum and the upper sand media) is plugged. This is causing:

    a. Airflows that are approximately half the design airflow rates and inadequate air draw within the various treatment process structures.
    b. Foul air to be blown back through the odor bed drain system and emitted untreated to the atmosphere via various points in the plant drain system.

4. The foul air fans on three of the odor control beds are leaking foul air to the atmosphere.

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The following improvements to the odor scrubbing facilities, which should result in excellent odor control performance at the plant, are recommended by Mr. Joyce:

1. Replace the sand media in the odor beds with organic media, which would allow elimination of the interface liner that is plugged. Organic media does not need an interface liner between the lower rock plenum and the upper media. This will allow the design air flows to be achieved, and most importantly, will allow the air flow to pass through the odor treatment media as intended in the design.

2. Re build the P-trap drains on the odor beds so that they provide sufficient height of water seal to withstand the discharge pressure of the foul air fans. To be conservative, this height should be approximately 16 inches of water column.

3. Fix the air leaks on the three sets of fans that are currently leaking foul air.

4. Operate the aeration basins at the lowest MCRT tolerable to maintain adequate wastewater treatment. This will minimize the generation of aeration basin odors.

5. Provide landscaping to block the ground level air corridor directing air flow to the Lea Dr. area. Aeration basin odors have a high threshold of detection. Provision of landscaping that can direct airflow upwards, in conjunction with a modified aeration basin operation, may remedy detection of aeration type odors.

We are confident that the review conducted by Mr. Joyce has identified the causes of the odor releases to the Lea Dr. area, and that implementation of his recommendations will result in odor control facilities as successful as the wastewater treatment facilities.

RMC Water and Environment recognizes its responsibility to the District to deliver a successful project and looks forward to achieving that goal with the District. Please call if you have any questions, or need further information.

Very truly yours,

Stephen Clary

Stephen Clary, Project Manager

Enclosed: NTP Odor Control Evaluation – Summary Report

NTP Odor Control Evaluation – Summary Report

Prepared for: Steve Clary, P.E., RMC

Prepared by: James Joyce, P.E., V&A

Reviewed by: Chris Hunniford, P.E., V&A
Brian Huang, E.I.T., V&A

Date: October 4, 2011

BACKGROUND

Novato Sanitary District (NSD) completed the construction of new 7.0 mgd activated sludge (with nitrification), wastewater treatment plant in the fall of 2010. The new Novato Wastewater Treatment Plant (NTP) is the culmination of seven years of planning, design and construction, which consolidated NSD's two existing wastewater treatment facilities, the Novato Plant (3.6 mgd capacity) and the Ignacio Plant (1.6 mgd capacity) into a single new facility. As part of the facility design, detailed process and equipment options were analyzed based on effectiveness, energy use, greenhouse gas emissions, odor and cost, as well as other factors. The new plant was designed to accommodate a large flow span including peak wet weather flows up to 47 mgd (7:1 peaking factor).

During the start-up of the new wastewater process and subsequent to its completion, residents living near the NTP complained of odors originating from the plant. The NTP has four biofilters for odor control located at the following locations:

- Headworks/Primary Clarifier No. 2
- Primary Clarifier No. 1
- Influent Pump Station (IPS)/Aeration Basins
- Digesters/GBTs

INTRODUCTION

RMC Water and Environment (RMC) retained V&A Consulting Engineers Inc. (V&A) to perform an independent assessment of odor releases from the plant and to recommend improvements as necessary. A site visit to the plant was conducted on August 30 and 31 by James Joyce, P.E., Senior Technical Director for odor control at V&A Consulting Engineers. The following is the report on this site visit and recommendations.

METHODOLOGY

V&A reviewed design drawings, prior test reports, construction records and selected contractor submittals for the odor control systems prior to scheduling the field visit to help determine the most useful sampling, investigation and monitoring locations.

V&A performed field sampling and analysis during the site visit for the following air and water samples at various plant processes to determine the performance parameters of the odor control systems:

a. Dissolved sulfide (S^{2-})
b. Hydrogen sulfide gas (H_2S)
c. Ammonia (NH_3)
d. Mercaptans

V&A performed a visual and physical investigation of structures, junctions, process tanks, process equipment and other wastewater facilities. V&A investigated the following processes:

a. Headworks
b. Grit Tanks
c. Channels
d. Primary Clarifiers

Biofilters and ductwork were observed for proper operation, corrosion, maintenance, irrigation, media type, design criteria and construction.

V&A performed a service-level check of ventilation conditions and airflows including supply air/exhaust air and odor control volumes. Measurements using a calibrated hot-wire anemometer were performed where useful and accessible.

V&A performed two site odor surveys outside the facility property, one during daytime conditions and one at night/early morning to help identify both on-site and off-site odor impacts.

Following the site visit, V&A used the plant data and reviewed information to determine the effectiveness of the existing odor control systems and recommend activities as discussed below.

RESULTS AND DISCUSSION

The results of the field sampling effort are presented in Table 1 and Table 2, representing August 30 and 31 results, respectively.

Table 1.
Sampling and Analysis Results for 8/30/201

SAMPLING LOCATION	8/30/2011 1:10 PM	8/30/2011 2:40 PM	8/30/2011 4:00 PM	8/30/2011 6:00 PM	COMMENTS
PRIMARY NO. 1 BIOFILTER INLET	55 ppm H_2S *1.8 mg/l $S^=$	40 ppm H_2S 1.0 mg/l $S^=$	60 ppm H_2S 2.0 mg/l $S^=$	70 ppm H_2S 2.5 mg/l $S^=$	NO MERCAPTANS NO DISULFIDES NO AMMONIA
HEADWORKS/PRIMARY NO. 2** BIOFILTER INLET	2.0 H_2S Trace	2.0 H_2S 1.0 NH_3	2.0 H_2S 0.5 NH_3	2.0 H_2S 1.0 NH_3	NO MERCAPTANS NO DISULFIDES
IPS/AERATION BIOFILTER INLET	0.0 H_2S 2.0 NH_3	0.0 H_2S 1.0 NH_3	- 0.5 NH_3	- 0.5 NH_3	NO MERCAPTANS NO DISULFIDES
DIGESTERS/GBTS BIOFILTER INLET	0.0 H_2S 1.5 NH_3	0.0 H_2S 1.5 NH_3	0.0 H_2S 1.5 NH_3	0.0 H_2S 1.5 NH_3	NO MERCAPTANS NO DISULFIDES
HEADWORKS AIRFLOW ONLY***	0.5 H_2S 1.5 NH_3	1.0 H_2S 0.5 NH_3	1.5 H_2S 1.0 NH_3	1.0 H_2S 1.0 NH_3	NO MERCAPTANS NO DISULFIDES

*Dissolved sulfide concentration in the wastewater
**Primary No. 2 was not in service during the site visit
***Sample taken upstream of Headworks/Primary No. 2 Biofilter on Headworks Foul Air Duct

Table 2.
Sampling and Analysis Results for 8/31/2011

SAMPLING LOCATION	8/31/2011 8:30 AM	8/31/2011 9:00 AM	8/31/2011 10:10 AM	8/31/2011 11:00 AM	COMMENTS
PRIMARY NO. 1 BIOFILTER INLET	85 ppm H_2S *2.5 mg/l $S^=$	120 ppm H_2S 3.0 mg/l $S^=$	65 ppm H_2S 2.0 mg/l $S^=$	55 ppm H_2S 2.0 mg/l $S^=$	NO MERCAPTANS NO DISULFIDES NO AMMONIA
HEADWORKS/PRIMARY NO. 2** BIOFILTER INLET	2.0 H_2S 2.0 NH_3	2.0 H_2S 2.0 NH_3	2.0 H_2S 1.5 NH_3	1.0 H_2S 1.0 NH_3	NO MERCAPTANS NO DISULFIDES
IPS/AERATION BIOFILTER INLET	-	-	-	-	NOT SAMPLED DUE TO NO RESULTS
DIGESTER/GBTS BIOFILTER INLET	0.0 H_2S 2.0 NH_3	0.0 H_2S 2.0 NH_3	0.0 H_2S 1.5 NH_3	0.0 H_2S 1.0 NH_3	NO MERCAPTANS NO DISULFIDES
HEADWORKS AIRFLOW ONLY***	1.0 H_2S 1.0 NH_3	2.0 H_2S 1.0 NH_3	2.0 H_2S 1.5 NH_3	1.0 H_2S 1.0 NH_3	NO MERCAPTANS NO DISULFIDES

*Dissolved sulfide concentration in the wastewater
**Primary No. 2 was not in service during the site visit
***Sample taken upstream of Headworks/Primary No. 2 Biofilter on Headworks Foul Air Duct

The sampling results show that the primary clarifier airstream H_2S gas concentration spikes in the morning hours. This condition may exist only when one primary clarifier is out of service due to increased weir loadings and turbulence from the increased height of the drop over the weir during average flow conditions. The spike on 8/31 was observed to be as high as 120 ppm, which is very high for a biofilter to handle but not outside the high range. It is also suspected that the low airflow into the biofilter played a role in increasing the concentration since less dilution air is pulled into the covered space.

The concentrations of other odor constituents measured during the field testing were not noteworthy, except for the dissolved sulfide concentration. It is likely that hydrogen sulfide is being generated in the primary clarifier, since 3 mg/l were measured on 8/31. This is higher than the 1 mg/l measured at the headworks at the same time.

The high H_2S concentrations are also likely a result of low flows at night and increased flows during the morning hours. During the low flow evening hours the water spends more time in the clarifiers under anaerobic conditions, resulting in increased sulfide generation. The higher flows in the morning increase turbulence in the weir troughs and release the sulfide as H_2S gas.

BIOFILTER SYSTEMS

The design criteria for the four biofilters at the NTP are contained in Table 3.

Table 3.
Biofilter Design Criteria

BIOFILTER	TYPE	DESIGN AIRFLOW (CFM)	FAN TYPE	MAX FAN AIRFLOW (CFM)	MAX FAN PRESSURE (inH2O)	DEPTH OF SAND MEDIA (inches)	DEPTH OF ROCK MEDIA (inches)	TOTAL DEPTH OF BIOFILTER (inches)	IMPERVIOUS BIOFILTER LINER
HEADWORKS/ PRIMARY NO. 2	CUSTOM INORGANIC MEDIA	6,270	FRP B/C IMPELLER (2+0)	3135	11.9	36	48	84	YES
PRIMARY NO. 1	CUSTOM INORGANIC MEDIA	1,570	FRP IN-LINE (2+0)	785	8.55	24	24	48	NO
IPS/AERATION	CUSTOM INORGANIC MEDIA	2,800	FRP IN-LINE (2+0)	1400	9.3	24	30	54	NO
DIGESTERS / GBTS	CUSTOM INORGANIC MEDIA	200	FRP RADIAL BLOWER (1+1)	200	8.1	30	18	48	NO

The performance data for the biofilters at the time of investigation is presented in Table 4 below.

Table 4.
Biofilter Performance Data

BIOFILTER	DESIGN AIRFLOW (CFM)	FAN TYPE (DUTY + STANDBY)	MAX FAN AIRFLOW (CFM)	MEASURED AIRFLOW (CFM)	MEASURED PRESSURE (inH2O)
HEADWORKS / PRIMARY NO. 2	6270	FRP Backward Curved Pressure Fan (2+0)	3135	550	12
PRIMARY NO. 1	1570	FRP IN-LINE (2+0)	785	620	8.6
IPS/AERATION	2800	FRP IN-LINE (2+0)	1400	-	9.5
DIGESTERS / GBTS	200	FRP RADIAL BLOWER (1+1)	200	<100 (estimated)	8

The airflow from the surface of the biofilters was concentrated in a makeshift flux hood to attempt to measure airflow and odor concentration. The airflow from the surface was so low that an accurate flow or pressure measurement was not possible. Odor compounds in the outlet air from the surface were non-detectable

Biofilter Design Airflow and Loading Rate

Table 5 contains sizing, airflow and surface area loading rates for the four biofilters at the plant.

Table 5.
Biofilter Design Criteria and Inorganic Media Surface Loading Comparison

BIOFILTER	WIDTH (FT)	LENGTH (FT)	DESIGN AIRFLOW (CFM)	INORGANIC MEDIA AIRFLOW @ 2 CFM/FT^2	VARIATION FROM DESIGN (CFM)
HEADWORKS / PRIMARY NO. 2	25	130	6270	6500	230
PRIMARY NO. 1	15	45	1570	1350	-220
IPS/AERATION	20	65	2800	2600	-200
DIGESTERS / GBTS	8	16	200	256	56

The surface area airflow design criteria for the biofilters is generally in line with conventional custom, in-ground inorganic media biofilters (2 cfm/ft^2). Only the Aeration and Primary No. 1 biofilters are just slightly above this accepted surface area loading criterion.

Biofilter Media

The design criteria for biofilter media depths and duct diameters at the plant are presented in Table 6 below.

Table 6.
Biofilter and Duct Design Criteria

ODOR CONTROL SYSTEM	DUCT DIAMETER		MINERAL SOIL MEDIA DEPTH (IN.)	DRAIN ROCK DEPTH (IN.)
	HEADER DUCT (IN.)	PERF LATERALS (IN.) (HDPE DR-17)		
HEADWORKS / PRIMARY NO. 2	36	8	36	48
PRIMARY NO. 1	18	6	24	24
IPS/AERATION	26	8	24	30
DIGESTERS / GBTS	10	6	30	18

The depth of the sand media (Mineral Soil Media) is less than the common depth range for custom, in-ground inorganic media. Typically 8 feet[1] provides 190 to 240 seconds of media empty bed contact time (EBCT) at 2.0 to 2.5 cfm/ft^2. The sand media depth is more in line with organic media biofilters where a depth of 3 feet is common, providing 60 to 90 seconds of EBCT at 3.0 cfm/ft^2. Inorganic sand media biofilters are commonly constructed of a single layer of sand media on lined earth, with no plenum[2].

The inclusion of the plenum (drain rock) and its overall depth is more consistent with custom, in-ground organic media biofilters[3]. There is typically no need for the drain rock with an inorganic media biofilter, as the distribution ducting is simply buried in the media.

Biofilter Fans

The fan arrangement for the biofilters is not particularly unusual for plant operation where operators and backup equipment is readily available. Typically a 1 + 1 (1 duty and 1 standby) fan arrangement is desired to minimize downtime if one fan is disabled or requires extensive maintenance, but a 2 + 0 (2 duty and no standby) arrangement can be used at a plant where a spare fan can be easily stored for quick installation. At the NTP the 1 + 1 arrangement is not particularly critical.

It is not common to use in-line axial fans for biofilter applications. The in-line arrangement with an external drive requires an opening in the duct for the drive connection, typically belt operation. This opening in the duct can, under certain circumstances, release odor from the duct in an uncontrolled fashion. This odor

[1] Manual of Practice No. 25, page 398
[2] Manual of Practice No. 25, page 367 and Figure 12.12
[3] Manual of Practice No. 25, page 397

release can occur when airflow is restricted near the end of the useful life of the media and pressures at the fan rise. Odor release from the axial fans on the biofilters was observed during the field investigation.

Biofilter Drains

The 4-in diameter drains from the biofilter are equipped with a running trap consisting of four (4) 90-degree fittings as shown in Figure 1. The rock plenums of the biofilters are under pressure due to the headlosses presented by the sand media and geotextile. The pressure in the rock plenum can reach the same pressure rating of the fan blowing air into the biofilter under high headloss conditions.

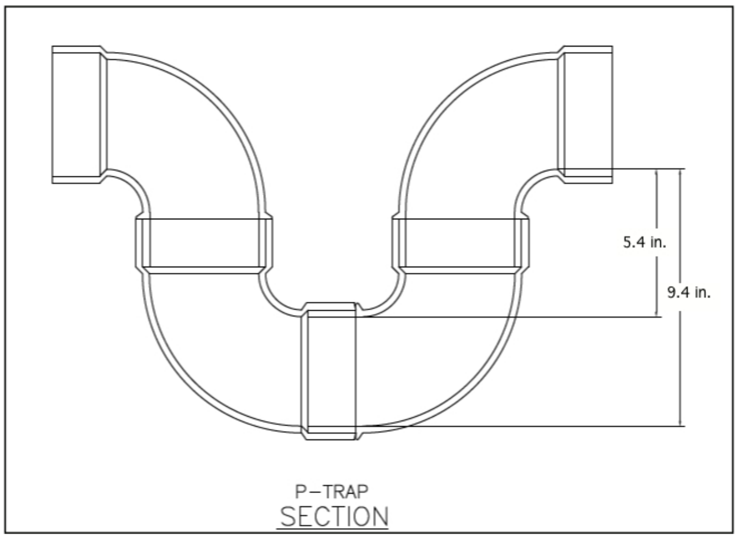

Figure 1. Running Trap Detail

The trap will resist up to 5.4 inches of water column before air pressure will push through the trap and enter the plant drain system. All of the fans on the biofilters have pressure ratings over 5.4 inches of water column. The discharge pressures were measured on the day of the visit to be 8 to 12 inches WC (See Table 4). If the foul air were released under pressure into the plant drain system, odors could be released from openings and vents around the plant, adding to the total odor release from the facility. Several locations on the plant drain system were located but it was not clear which portions of the system could be impacted since some drains may discharge below a standing waterline and thus block pressure release.

Subsequent to the site visit, drawings were reviewed and several locations were identified for further investigation. Figure 2 presents a representation of the plant drain system where further investigation may identify odor release points from the system. This figure can be found full size in Appendix A.

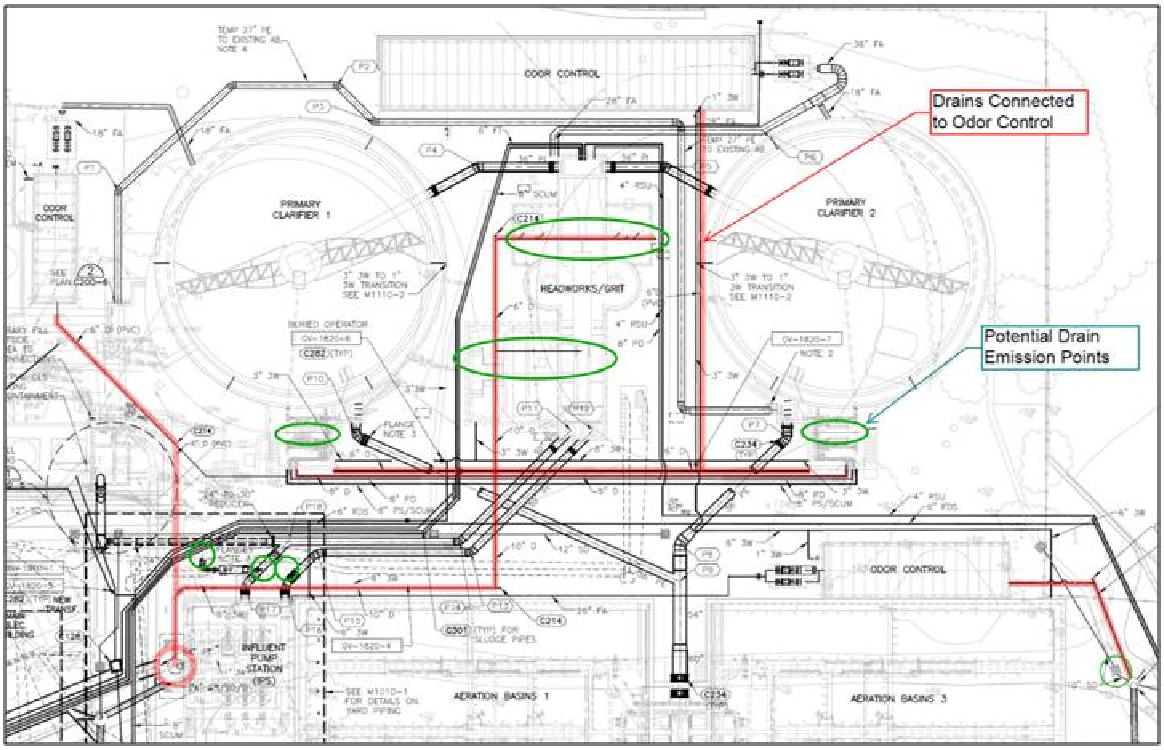

Figure 2. Plant Drain System and Potential Odor Release Locations

Geotextile Layer

The biofilters have a geotextile layer between the sand media and the rock media. A cut-sheet of the material is attached as Appendix B. The geotextile is Mirafi™ N-Series Non-woven Polypropylene Geotextile manufactured by TenCate©. Geotextile use in biofilters to separate different layers of media is extremely risky and numerous failures of geotextiles were identified in biofilters in the early 90s. Since then, most dual media biofilters (organic media type) are constructed without geotextiles. It was found that the geotextiles trapped fines and bacterial biomass and eventually plugged, short-circuited air or resisted the pressure of the fan to the point that no air was being treated.

The geotextile was exposed with a media 'dig-down' during the investigation of the biofilters. A 5-foot diameter hole was excavated in the sand media with the fan off to expose approximately two square feet of the geotextile. When the fans were turned on the geotextile inflated to form a fairly rigid hemisphere that looked like half of a black basketball. Air was moving through the geotextile as evidenced by air bubbles coming through the brownish-colored water that saturated the liner, but very little gross air movement was noted. A 6-inch long slit was made in the liner with a knife, whereupon a great volume of air was continuously discharged. It was clear that the liner was the greatest resistance to air moving through the biofilter.

Biofilter Excavation

Initially, none of the biofilters were constructed with a liner against the native soil. The headworks/primary No. 2 biofilter was later fitted with an impermeable liner against the soil. Custom, in-ground inorganic media biofilters are often designed with an impermeable liner against the soil, but not always. The determining factor for an impermeable liner in these cases is often the type and nature of the native soil. If the native soil permeability is higher than the media then there is a chance that the air will seek the path of least resistance and pass through the soil instead of the media, requiring a liner to keep the air in the biofilter. In addition, an impermeable liner is often provided to keep the products of biological degradation of odor compounds out of the local soil and groundwater.

Air was noted to pass through the asphalt pavement around all biofilters except the one that was fitted with a liner. When water was applied to the asphalt pavement around the biofilters air bubbled up through the pavement, looking much like a stone-type aeration diffuser. Subjective characterization of the rogue airflow did not detect offensive odor, however it is clear that the biofilters were short-circuiting some of the air through the native soil.

Ductwork

The ducts carrying air to the biofilter fans are buried in a “U” shape to pass under roads and trafficways. Buried ducts are sometimes fitted with drains to carry away excess condensation and prevent plugging of the duct with water. If the foul air is warm and humid, and the soil is cool, the air in the duct will reach the dew point on the inside walls and condense water. While the condensation of water in an odor control duct is dependent upon temperature and humidity conditions both inside and outside the duct, it may occur for only a few months of the year, or it may be a persistent problem. Buried ducts are routinely provided with self-draining traps that operate automatically if needed without releasing air or allowing air into the duct.

The buried ducts at the plant are not equipped with trap drains but the field investigation did not detect any restriction of airflow due to condensation water. Airflows on the upstream side were similar to the airflows on the downstream side, but the airflows were much lower than design values. It is believed that the reason for low airflows is high headlosses in the biofilter and not water in the buried ducts. The buried ducts were not visually inspected or probed to identify if any water was present.

Odor Surveys and Source Investigation

In-Plant Odor Survey

The site odor survey consisted of an in-plant survey and an off-site neighborhood survey. The in-plant survey was conducted along the downwind fenceline both on the evening of 8/30 and the morning of

8/31. The wind was blowing from the southwest at approximately 0-2 mph. On both occasions odors were detected subjectively but were not high enough to be measured with the field equipment.

A pattern of different odors was apparent along the northeast fenceline of the plant. Just downwind of the primary clarifier No. 1 biofilter, the general odor of hydrogen sulfide was detected. East of this location the odor shifted to more of a general sewer odor with some traces of grease-like odor. Still further east and rounding the corner to the south, the fenceline odor shifted to an aeration basin odor. Figure 3 illustrates the position and relative location of the odors detected during the in-plant odor fenceline survey.

Figure 3. In-Plant Odor Survey Results

From the in-plant survey, it was reasonably determined that the source of the H_2S odor was primary clarifier No. 1 and the belt-openings of the in-line fans on the associated biofilter. Similarly, the 'sewer' odor was coming from the headworks due to inadequate air capture, and the aeration basin odors were coming from the open aeration basins. It was also assumed that some of the aeration odor could be coming from the covered selector basins due to low airflow into the biofilter and low capture velocities on the covers.

Off-Site Odor Survey

Off-site odor surveys were also conducted on the evening of 8/30 and the morning of 8/31 in the neighborhood immediately north and east of the plant. The survey focused on Lea Court and Lea Drive.

Off-site odors were detected on the southernmost end of Lea Court and along the southern end of Lea Drive on both survey occasions. The wind was blowing from the southwest at 0-2 mph. Different odors were detected at different locations along the streets. At the southern end of Lea Court the odor was predominantly H_2S. Along the southernmost point of Lea Drive the odor shifted to a sewer-type character.

Finally, the odor shifted to aeration basin along the extreme southeast portion of Lea Drive. Figure 4 illustrates the locations where off-site odors were detected.

Figure 4. Off-Site Odor Survey Results

Odor Survey Conclusions

The odor survey revealed that odors from the plant are escaping the plant boundary and impacting public areas. The odors detected off-site match the odors detected during the in-plant fenceline survey both in intensity and location under the atmospheric and topographic conditions of the survey. Figure 5 illustrates how the odors from the plant were impacting the community at the time of the survey.

Figure 5. Plant and Off-Site Odor Survey Results

During the odor survey there was a construction crew building a new back road into the plant from the southern end of Lea Drive. The road construction and prior construction activities have cleared much of the original vegetation between the street and the plant. The lack of vegetation may be allowing air to migrate more directly between the plant and the community, not to mention more visual impact.

SUMMARY OF FINDINGS

Biofilters are appropriate for use at a wastewater treatment plant such as NTP and are recommended by the Bay Area Air Quality Management District for this purpose. Biofilters are a well-proven technology that provides cost-efficient, chemical-free, effective control for odors of the type and concentration found at NTP. The design airflow capacities for the biofilters at NTP are generally adequate for the processes they are intended to control.

The odor survey confirmed that odors are escaping the plant. Most of these odors are escaping the plant due to low odor control airflows associated with the existing biofilters that were far below design airflows. The low airflow draw by the biofilters pulls less air from the covered processes which means not all covered areas are under continuous negative pressure. Odors are then forced out through cracks in the covers or drawn out by wind eduction. Other insufficient odor capture occurs when operators must periodically open the covers to obtain samples or perform routine duties.

The primary cause for the low airflow to the biofilters is the geotextile liner between the rock plenum and the sand media. The geotextile material has trapped fine particles washing out of the sand media and also facilitated the growth of aerobic biological slimes in the matrix of the textile. The combination of organic and inorganic materials trapped in the geotextile matrix has plugged the textile matrix and created a significant headloss. Field estimates of the headloss created by the geotextile were in the range of 10 inches of water column (w/c) for the headworks/primary No. 2 biofilter. Direct measurements were not possible since once the liner was exposed under pressure there was no way to seal the liner around the manometer tubing securely to get an accurate reading.

The most significant secondary problem with the odor control systems may be insufficient depth of the traps on the biofilter drains. The drains from the rock plenum are under positive pressure equal to the maximum pressure of the fan. Water must be allowed out of the biofilter plenum without allowing the pressure out. The traps on the biofilter drains are not deep enough to resist the pressure of the fan, allowing untreated odorous air to be forced out of the drain piping and into the plant drain system.

Another significant odor source is the release of hydrogen sulfide from the axial fan drive openings on the Primary Clarifier No. 1 biofilter. This source is due to the high headlosses in the biofilter which prevent sufficient air draw through the drive opening to prevent odor release. If headlosses in the biofilter are corrected and design airflow is re-established this source of odor may go away.

Correction of the low biofilter airflow problems discussed above will restore the design flowrates and provide excellent odor removal for those NTP sources.

The aeration basin odor in the community will not be easy to solve. While the selector zones will be covered and the odor collected and treated by improved biofilter airflows, other odors are released from the uncovered aeration basin surface. Odors are escaping the plant aeration facilities and impacting the community. These odors are commonly described as “musty” and “earthy”, often with a slightly sweet “perfume-like” character.

RECOMMENDATIONS

The following recommendations are intended to improve odor control airflows and therefore improve air capture under the covers. The recommendations also address measures to reduce the impact of the effects of the uncovered aeration basins on the nearby community.

Biofilter Improvements

Due to the proximity of the neighboring community, only biological treatment is recommended as activated carbon and chemical scrubbers leave some odor in the airstream. There are two ways to restore airflow to the odor control system within the same footprint and obtain excellent odor removal. The biofilters can be modified to function as either organic or inorganic media biofilters. Table 7 below calculates the allowable airflow through inorganic and organic media biofilters using standard surface loading rates.

Table 7.
Inorganic and Organic Media Airflow Differences

BIOFILTER	DESIGN AIRFLOW (CFM)	INORGANIC MEDIA AIRFLOW @ 2 CFM/FT2	VARIATION FROM DESIGN (CFM)	ORGANIC MEDIA AIRFLOW @ 3 CFM/FT^2	VARIATION FROM DESIGN (CFM)
HEADWORKS / PRIMARY NO. 2	6270	6500	230	9750	3480
PRIMARY NO. 1	1570	1350	-220	2025	455
IPS/AERATION	2800	2600	-200	3900	1100
DIGESTERS / GBTS	200	256	56	384	184

It should be noted that conversion to organic media would actually increase the allowable airflow to the biofilters and still achieve excellent treatment. The HW/Primary No. 2 biofilter could handle an additional 3,480 cfm and Aeration an additional 1,100 cfm. The increased airflow would allow greater odor capture, resulting in lower fugitive emissions from the plant.

The existing biofilters contain a rock drain layer and an inorganic sand layer of the dimensions listed in Table 6. To convert the biofilters to full inorganic function, both media layers and perforated air laterals would be removed and additional depth added to the three biofilters that have insufficient depth (Aeration, Primary No. 1 and Digesters/GBTS). Following additional excavation a liner would be installed against the soil. It would then be filled with 100 percent sand along with the re-installed air distribution system. New fans to operate at the increased pressure would be required for all biofilters except possibly the Headworks/Primary #2 biofilter. Pressures in an inorganic media biofilter can reach as high as 20 inches of water column and fans should be designed to achieve design airflow at this pressure.

To convert the biofilters to organic media function, the sand media and geotextile would be removed and organic media placed on top of the rock to a depth of 3 to 3.5 feet. The concrete curb would be replaced with a taller curb to contain the media where necessary without disturbing the asphalt pavement as shown in Figure 7.

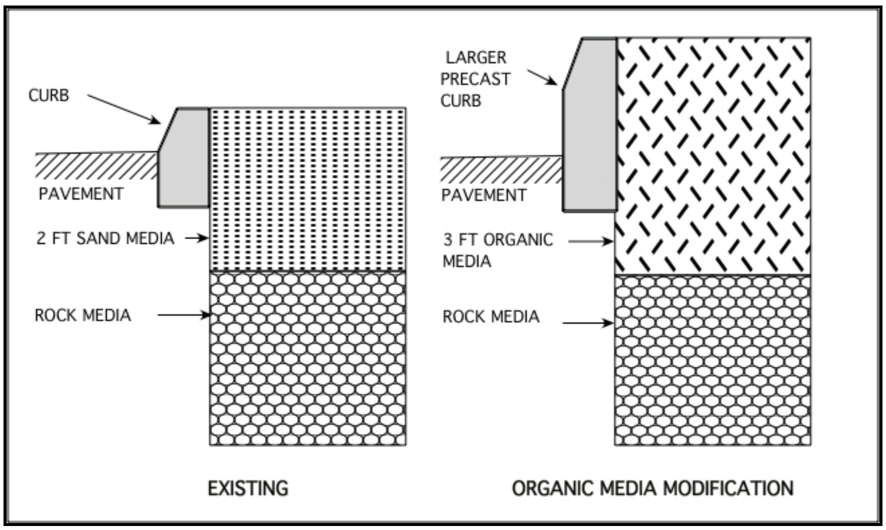

Figure 6. Biofilter Conversion to Organic Media

If it is desired to provide a liner in the organic media conversions to prevent drainage water from entering the soil, the rock media would also need to be removed. Applying a liner to the unlined biofilters results in higher cost due to the removal of the rock plenum. However, no additional excavation is required making conversion to organic media cheaper.

Organic media biofilters operate through a wider range of pressures depending upon the degree of compaction that occurs in the media. When the media is new there is very little headloss (1 to 2 inches of water column) and when the media is spent the pressure may reach as high as 10 inches of water column. This requires airflow control to the biofilter so the pressure and volume are always on the fan curve.

There are two primary methods used to control airflow during an organic media lifecycle: (1) put variable frequency drives (VFDs) on the fans, or (2) install dampers on the fan suction ducting. Depending upon the type of fan used, it is generally more useful and less wasteful of energy to starve the fans with a damper. This technique is particularly useful on backward inclined/curved impeller fans and other wheel-type pressure fans. Some centrifugal blower-type fans and positive displacement blowers cannot be controlled in this manner and would require a VFD. While the current odor control fans have suction side dampers, the decision to control airflow with VFDs or dampers should be made during fan selection for the rehabilitated biofilters.

Buried Ducting

The buried ducts at the plant should be tapped and probed to determine if water is accumulating and decreasing the available area of flow in the duct. If water accumulations are noted, self-draining traps should be installed.

Biofilter Drains

Further investigation of the airflow through the existing biofilter drain traps should be conducted to verify if odor is entering the plant drain system. If evidence is found that this is occurring or could potentially occur, the traps should be replaced with a standard drain trap as illustrated in Figure 8. In traffic areas the surface plug is located just below ground in a precast concrete meter vault box with cover.

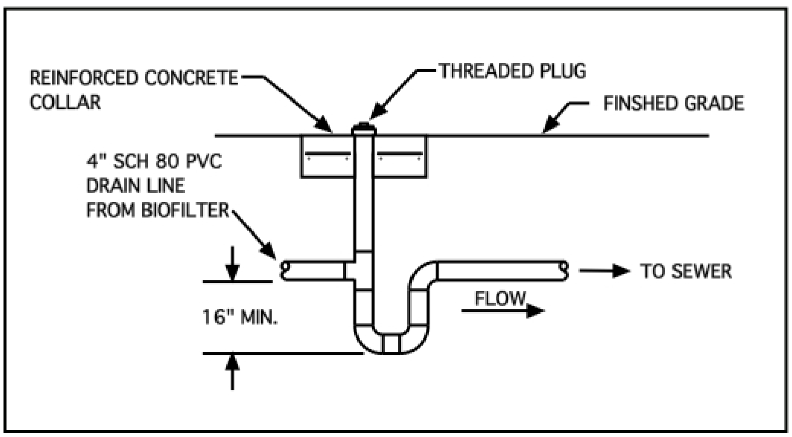

Figure 7. Typical Organic Media Biofilter Drain Trap

Odor Survey

The odor survey revealed that odors from the plant are escaping the plant boundary and impacting public areas. The odors detected off-site match the odors detected during the in-plant fenceline survey both in intensity and location under the atmospheric and topographic conditions of the survey. Figure 10 illustrates how the odors from the plant were impacting the community at the time of the survey.

Figure 8. Odor Survey Results

Interviews with residents support the identification of community odors illustrated in Figure 10. Trees and vegetation along the northeast perimeter of the plant has been removed for plant construction and recent road construction. The removal of the vegetation allows a direct route for air from the plant to enter the community.

Trees and vegetation help deflect and dilute odor in surface level breezes. The air is forced over some of the vegetation helping it rise to the atmospheric mixing zone (about 30 feet above ground) and be carried away. Leaves provide turbulence which helps disperse odor in air and prevent concentration gradients. Some vegetation can even adsorb odors and release a pleasant odor that helps mask and confuse low concentration odors.

It is recommended that re-vegetation of the denuded area on the northeast side of the plant be performed as soon as possible. Some near full-size trees and faster growing trees should be planted immediately to provide benefit while the master landscaping plan grows in.

Off-Site Odors

Restoring design airflows to the biofilters will eliminate the fugitive odors of hydrogen sulfide and sewer, since these odors arise from the primary clarifiers and the headworks buildings under the current low-capture airflows. Some improvement in the capture of the aeration selector odors is also anticipated.

However, the aerated sections of the aeration basins will still be uncovered, and the general musty odor from the aeration basins may persist off-site. Aeration basin odors typically disperse quickly in air below the human olfactory threshold for these compounds. The low-vegetation corridor to the community is largely responsible for this low intensity odor to persist off-site. Improvements in vegetation shielding that are currently underway will help mitigate this odor. The following step-wise approach to helping solve this odor is recommended.

1. Re-plant vegetation in the road area and along the fencelines and note any improvement (currently underway)
2. Operate the plant with the lowest mixed-liquor suspended solids (MLSS) concentration possible and the lowest practical solids retention time (SRT) and note any improvement. These activities have been shown in some cases to reduce the intensity of the aeration basin odors ($0)
3. Restore airflow to the biofilters and note any improvement ($150,000 but required for other reasons also)
4. Explore testing of odor dispersants, counteractants and masking chemicals and note any improvement ($30,000)
5. Evaluate walls and shields that would force the odorous air up higher in the air and into the mixing zone to keep it away from surface level ($50,000 if installed)
6. Explore partial covering and mechanical ventilation to get air up and into the atmospheric mixing zone ($200,000 if installed)

These solutions should be evaluated and pursued in a logical progression with the ultimate goal of eliminating the movement of aeration basin air into the community where it cannot cause additional odor complaints. Except for No. 4 above, the solutions are complimentary to each other and will not result in lost effort and costs. The solutions progress generally from least expensive to most expensive.