

August 24, 2006

TO: Bill Hartman, GW Partners

CC: JP Causey, WTM1
Skip Missimer, Glatfelter
Pat Zaepfel, Meyer, Unkovic & Scott
Nancy Peterson, Q&B
Tony Vogel, Q&B

Jeanne Tarvin, STS
Mike Jury, CH2MHill
Matt Binsfeld, J.F. Brennan
Steve Laszewski, Foth & Van Dyke

FR: Amie Obermeier, GW Partners
John Fassbender, Foth & Van Dyke
Denis Roznowski, Foth & Van Dyke

RE: OU1 Evaluation of Bag Filter Performance

Introduction

During 2005 and 2006, the OU1 water treatment plant has consistently met the agencies' performance expectations for total suspended solids (TSS) discharge, but has typically not met the performance expectation for mercury discharge of 0.2 to 0.5 ng/L (parts per trillion). In 2006, the agencies required the installation of bag filters as part of Best Demonstrated Treatment Technology Reasonably Achievable (BDTTRA) to remove trace amounts of mercury from the water released during on-site sediment dewatering operations. The intended purpose of the bag filters was to remove fine particulate matter from this water, and in so doing also reduce mercury concentrations prior to discharge of the treated water to Little Lake Butte des Morts. During June 2006, GW Partners installed a bank of 30 bag filters at the OU1 water treatment plant. GW Partners collected operational and analytical data during the operation of these filters from June 21, 2006 through August 9, 2006. This memorandum evaluates the performance of these bag filters during this period.

Operation Description and Results

The full-scale bag filter system consists of 5 filter units and each unit consists of 6 individual bag filter housings for a total of 30 bag filters. The filters were installed downstream of the Krofta system and prior to the granular activated carbon (GAC) system. The following filter bag types for the full-scale filtration system were installed and tested:

- ◆ PONG1, 1 micron polypropylene nominal (35 micron removal at 98% efficiency)
- ◆ PENG5, 5 micron polyester felt nominal (50 micron removal at 98 % efficiency)

This full scale system testing was run intermittently from June 21 to July 28, 2006 and samples were taken at the following points:

- ◆ Krofta influent (influent to water treatment plant)
- ◆ Pre-bag filters (effluent from the Krofta unit)
- ◆ Post-bag filters (pre-GAC)
- ◆ Final Effluent (post-GAC)

These samples were analyzed for TSS and total mercury with the complete analytical results summarized in Attachment A. The laboratory reports are available upon request. The full scale data across the bag filters are summarized in the following table.

Table 1
Full Scale Bag Filter Analytical Results

Bag Type	Date	Pre-Bag Filters (BI)		Post-Bag Filters (BE)		Percent Removal	
		Hg (ng/L)	TSS (mg/L)	Hg (ng/L)	TSS (mg/L)	% Hg Removed	% TSS Removed
1 Micron	6/30/2006	3.22	5.00	2.75	4.00	14.6	20.0
1 Micron	7/12/2006	1.02	1.90	1.08	1.30	-5.9	31.6
1-Micron	7/13/2006	1.20	2.00	1.33	1.80	-10.8	10.0
1-Micron	7/14/2006	1.44	2.00	1.53	1.50	-6.3	25.0
1-Micron	Average	1.72	2.73	1.67	2.15	-2.1	21.6
5-Micron	7/12/2006	1.69	1.90	1.76	1.40	-4.1	26.3
5-Micron	7/13/2006	1.65	1.80	1.25	1.60	24.2	11.1
5-Micron	7/14/2006	1.77	2.00	1.58	1.40	10.7	30.0
5-Micron	7/20/2006	2.53	6.60	1.84	2.00	27.3	69.7
5-Micron	Average	1.91	3.08	1.61	1.60	14.5	34.3

Prepared by: JJF1
Checked by: DMR
Date: 8/22/06

The full scale system ran for an estimated average of 4 hours (ranged from 1 to 8 hours) until the pressure drop across the filters required change-out of the bags. (The pressure drop is a result of the filter cloth becoming plugged with fine material that passes through the Krofta unit.)

However, the run times were found to decrease substantially – to the point where the bag filters had to be removed to maintain operation – when a relatively large amount of clay was present in the Krofta effluent. The time required to change out all 30 bags was approximately 45 minutes. Based on this 4 hour filter run time, the daily (24 hour/day) operation cost for the filter bags is estimated at \$626/day for the PENG5 bags and \$734/day for the PONG1 bags. (This cost does not include labor and is based on a PENG5 bag cost of \$3.48 each and a PONG1 bag cost of \$4.08 each.)

Because of the low percentage of TSS removal (average 21.6% and 34.3% for the 1 and 5 micron bags, respectively) and mercury removal (average -2.1% (0%) and 14.5% for the 1 and 5 micron bags, respectively), additional testing was completed using specialty type filter bags. These specialty filter bags have higher filtering capabilities, as shown by the removal efficiency particle size specifications below. The following filter bag types were installed and tested:

- ◆ PENG1, 1 micron polyester felt nominal (25 microns at 98% removal efficiency)
- ◆ POMF2, 2 micron polypropylene microfiber (10 microns at 98% removal efficiency)
- ◆ BOS10, 10 micron polypropylene microfiber (10 microns at 98% efficiency)
- ◆ BOS3, 3 micron poly microfiber with cartridge insert (3 microns at 98% efficiency)
- ◆ BOSG5, 5 micron graded density poly microfiber (5 microns at 98% efficiency)

These filter bags were run using a single bag filter unit with a bypass around the filter unit (slip stream). A flow meter was used to split the flow through the single unit (approximately 70 gpm flow rate) and the pressure drop across the filter was monitored. Each filter was installed and tested both before and after the GAC filters. The analytical results for TSS and mercury for these filter bags are summarized in Attachment A. The TSS removal across the filters ranged from 0% to 69% and the mercury removal across the filters ranged from 0% to 32%. (Negative removal percentages were interpreted as 0%.) The filter run times in the pre-GAC location were monitored once and are as follows:

- ◆ PENG1 – 34 minutes
- ◆ POMF2 – 27 minutes
- ◆ BOS10 – 25 minutes
- ◆ BOS3 – 13 minutes
- ◆ BOSG5 – 34 minutes

We anticipate that the run times on the bags would have been considerably longer in the post-GAC location, and possibly even in the pre-GAC location had they been run again. However, the main focus of this slip stream analysis was to determine if the specialty bags could reduce mercury levels to the project's performance expectations. As the data shows, the specialty bags were unable to meet the performance expectations.

Summary of Results

- ◆ The average full scale test using the nominal 1 and 5 micron bag filters removed, 21.6% and 34.3% of the TSS, respectively.
- ◆ The average full scale test using the nominal 1 and 5 micron bag filters removed 0% and 14.5% of the total mercury, respectively. (Negative removal percentages are interpreted as 0%.)
- ◆ The full scale pre-GAC bag filter system run time until filter bag change out is estimated at an average of 4 hours, with a range of 1 to 8 hours.
- ◆ The daily cost for the filter bags is estimated at \$626/day for the nominal 5 micron bags and \$734/day for the nominal 1 micron bags. (These costs do not include labor.) Costs for the specialty bags are much higher.

Conclusion

The treatment plant consistently meets its TSS discharge performance expectation (and all of the other Department water treatment performance expectations except for mercury) utilizing the current treatment system (i.e. without bag filters). It should be noted that, in 2005, even without bag filters, the treatment system effectively removed over 96% of the background mercury from the LFR. During this period, the treatment process removed about .094 pounds of mercury and returned about .003 pounds of mercury to the river at a concentration more than an order of magnitude below background.

The results of the bag filter testing, including the ineffective removal of both TSS and mercury by all the bags used, short run times, and high operational costs, show that mercury in the effluent cannot be reduced to the agencies' performance expectation of 0.2 to 0.5 ng/l using bag filter technology. As such, we believe that bag filters should not be required to meet Best Demonstrated Treatment Technology Reasonably Achievable and that the performance expectation for mercury discharge should be revised accordingly.

Attachment A

GW Partners, OU-1

2006 Water Treatment Plant Bag Filter Analytical Results Summary Table

Sample Date	Bag Type	Filter Location	Krofta Influent (KI)		Pre-Bag Filters (BI)		Percent Removal (KI - BI)		Post-Bag Filters (BE)		Percent Removal (BI-BE)		Final Effluent (FE)		FE Field Blank	Net FE Mercury	Percent Removal (BE-FE)		Percent Removal (KI-FE)	
			Hg (ng/L)	TSS (mg/L)	Hg (ng/L)	TSS (mg/L)	% Hg Removed	% TSS Removed	Hg (ng/L)	TSS (mg/L)	% Hg Removed	% TSS Removed	Hg (ng/L)	TSS (mg/L)	Hg (ng/L)	Hg (ng/L)	% Hg Removed	% TSS Removed	% Hg Removed	% TSS Removed
6/21/2006	No Filters	Pre-GAC	2.45	3.70	1.78	0.75	27.35	79.73	1.98	0.70	-11.24	6.67	1.47	0.55	0.389	1.081	25.76	21.43	40.00	85.14
6/22/2006	No Filters	Pre-GAC	3.14	3.00	1.82	0.95	42.04	68.33	1.83	0.95	-0.55	0.00	1.37	0.65	<0.169	1.370	25.14	31.58	56.37	78.33
6/23/2006	No Filters	Pre-GAC	4.12	3.20	2.14	0.75	48.06	76.56	2.41	0.70	-12.62	6.67	1.38	0.60	<0.169	1.380	42.74	14.29	66.50	81.25
6/27/2006	No Filters	Pre-GAC	4.21	10.00	1.99	4.30	52.73	57.00	2.09	3.50	-5.03	18.60	1.18	1.40	0.286	0.894	43.54	60.00	71.97	86.00
6/30/2006	No Filters	Pre-GAC	2.30	10.00	1.60	6.20	30.43	38.00	1.51	5.00	5.63	19.35	1.56	3.70	0.334	1.226	-3.31	26.00	32.17	63.00
6/30/2006	1 Micron	Pre-GAC	6.56	11.00	3.22	5.00	50.91	54.55	2.75	4.00	14.60	20.00	2.03	2.80	0.296	1.734	26.18	30.00	69.05	74.55
7/12/2006	No Filters	Pre-GAC	3.08	6.70	2.54	2.20	17.53	67.16	-	-	-	-	0.418	0.5	0.223	0.195	-	-	86.43	92.54
7/12/2006	1 Micron	Pre-GAC	2.25	5.80	1.02	1.90	54.67	67.24	1.08	1.30	-5.88	31.58	0.465	0.50	0.295	0.170	56.94	61.54	79.33	91.38
7/12/2006	5-Micron	Pre-GAC	3.28	4.90	1.69	1.90	48.48	61.22	1.76	1.40	-4.14	26.32	0.466	0.55	0.255	0.211	73.52	60.71	85.79	88.78
7/13/2006	5-Micron	Pre-GAC	2.02	5.50	1.65	1.80	18.32	67.27	1.25	1.60	24.24	11.11	0.659	0.75	0.301	0.358	47.28	53.13	67.38	86.36
7/13/2006	1-Micron	Pre-GAC	1.60	4.90	1.20	2.00	25.00	59.18	1.33	1.80	-10.83	10.00	0.702	0.90	0.435	0.267	47.22	50.00	56.13	81.63
7/14/2006	1-Micron	Pre-GAC	2.33	5.50	1.44	2.00	38.20	63.64	1.53	1.50	-6.25	25.00	0.793	0.70	0.416	0.377	48.17	53.33	65.97	87.27
7/14/2006	5-Micron	Pre-GAC	3.45	2.40	1.77	2.00	48.70	16.67	1.58	1.40	10.73	30.00	0.741	0.85	0.257	0.484	53.10	39.29	78.52	64.58
7/20/2006	No Filters	Pre-GAC	2.62	1.70	1.88	2.40	28.24	-41.18	-	-	-	-	1.070	1.20	0.192	0.878	-	-	59.16	29.41
7/20/2006	5-Micron	Pre-GAC	3.60	5.10	2.53	6.60	29.72	-29.41	1.84	2.00	27.27	69.70	1.360	1.40	<0.169	1.40	26.09	30.00	62.22	72.55
7/21/2006	5-Micron	Pre-GAC	-	-	-	-	-	-	-	-	-	-	1.180	1.30	<0.169	1.3	-	-	-	-
7/21/2006	1-Micron	Pre-GAC	-	-	-	-	-	-	-	-	-	-	1.060	1.20	<0.169	1.06	-	-	-	-
7/21/2006	No Filters	Pre-GAC	-	-	-	-	-	-	-	-	-	-	1.350	1.60	0.175	1.43	-	-	-	-
7/24/2006	5-micron	Pre-GAC	-	-	-	-	-	-	-	-	-	-	1.710	1.80	<0.169	1.80	-	-	-	-
7/25/2006	5-micron	Pre-GAC	-	-	-	-	-	-	-	-	-	-	1.210	0.80	0.226	0.98	-	-	-	-
7/26/2006	5-micron	Pre-GAC	-	-	-	-	-	-	-	-	-	-	1.860	1.50	<0.169	1.86	-	-	-	-
7/27/2006	5-micron	Pre-GAC	-	-	-	-	-	-	-	-	-	-	0.648	0.65	0.262	0.39	-	-	-	-
8/1/2006	PENG1	Pre-GAC	-	-	3.22	3.30	-	-	2.80	3.50	13.04	-6.06	-	-	-	-	-	-	-	-
8/1/2006	POMF2	Pre-GAC	-	-	3.25	3.20	-	-	2.33	2.40	28.31	25.00	-	-	-	-	-	-	-	-
8/1/2006	BOS10	Pre-GAC	-	-	3.235	3.25	-	-	2.41	1.70	25.50	47.69	-	-	-	-	-	-	-	-
8/1/2006	BOS3	Pre-GAC	-	-	3.235	3.25	-	-	2.40	1.00	25.81	69.23	-	-	-	-	-	-	-	-
8/1/2006	BOSG5	Pre-GAC	-	-	3.235	3.25	-	-	2.46	1.30	23.96	60.00	-	-	-	-	-	-	-	-
8/1/2006	No Filters	Pre-GAC	-	-	3.235	3.25	-	-	3.32	3.40	-2.63	-4.62	-	-	-	-	-	-	-	-
8/4/2006	PENG1	Post-GAC	-	-	1.03	1.60	-	-	1.06	1.80	-2.91	-12.50	-	-	-	-	-	-	-	-
8/4/2006	POMF2	Post-GAC	-	-	0.89	1.27	-	-	0.85	1.60	4.49	-25.98	-	-	-	-	-	-	-	-
8/4/2006	BOS10	Post-GAC	-	-	0.842	1.00	-	-	1.01	1.10	-19.95	-10.00	-	-	-	-	-	-	-	-
8/4/2006	BOS3	Post-GAC	-	-	0.89	1.27	-	-	0.77	0.90	13.60	29.13	-	-	-	-	-	-	-	-
8/4/2006	BOSG5	Post-GAC	-	-	0.809	1.20	-	-	0.95	1.00	-17.92	16.67	-	-	-	-	-	-	-	-
8/4/2006	No Filters	Post-GAC	-	-	0.89	1.27	-	-	1.04	1.60	-16.85	-25.98	-	-	-	-	-	-	-	-
8/4/2006	PENG1	Pre-GAC	-	-	2.95	3.20	-	-	2.73	2.50	7.46	21.88	-	-	-	-	-	-	-	-
8/9/2006	No Filters	Pre-GAC	-	-	8.19	3.65	-	-	5.91	2.80	27.84	23.29	-	-	-	-	-	-	-	-
8/9/2006	BOS3	Pre-GAC	-	-	7.83	3.50	-	-	5.29	1.70	32.44	51.43	-	-	-	-	-	-	-	-
8/9/2006	BOSG5	Pre-GAC	-	-	8.54	3.80	-	-	6.91	2.20	19.09	42.11	-	-	-	-	-	-	-	-
8/9/2006	No Filters	Post-GAC	-	-	4.11	2.45	-	-	3.13	2.30	23.84	6.12	-	-	-	-	-	-	-	-
8/9/2006	BOS3	Post-GAC	-	-	4.00	2.20	-	-	2.78	1.00	30.50	54.55	-	-	-	-	-	-	-	-
8/9/2006	BOSG5	Post-GAC	-	-	4.22	2.70	-	-	3.58	1.80	15.17	33.33	-	-	-	-	-	-	-	-

Notes * No sample on 6/26/06 due to WTP down until 4:00 pm.
 * No samples on 6/28, and 6/29 due to issues with clay.
 * No samples on 7/10 and 7/11
 * No samples 7/17 -7/19

*Blue indicates averaged result

By: Amie Obermeier, GW Partners
 JJF1, Foth & Van Dyke
 Date: 8/22/2006