

◆ TC CONSULTING SERVICES ◆



◆ SYSTEM OPERATION AND MAINTENANCE ◆

Cherry Creek Basin Water Quality Authority
% Chuck Reid
R.S. Wells LLC
8390 E. Crescent Parkway, Suite 500
Greenwood Village, Colorado 80111

January 8, 2011

Dear Messrs:

The Cherry Creek Basin Water Quality Authority (Authority) owns and operates destratification facilities located at the Cherry Creek Reservoir. These facilities serve to enhance the quality of the water contained in the reservoir.

The Authority retained TC Consulting Services to operate and maintain the facility and equipment during the calendar year 2010.

Please, find attached for your review the Cherry Creek Basin Water Quality Authority, Reservoir Destratification Facilities, Operation and Maintenance, Annual Report 2010.

Sincerely,

Terry Cunningham



Cherry Creek Basin Water Quality Authority



RESERVOIR DESTRATIFICATION FACILITIES

**OPERATION AND MAINTENANCE
ANNUAL REPORT
2010**

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**CHERRY CREEK BASIN WATER QUALITY AUTHORITY
 RESERVOIR DESTRATIFICATION FACILITIES
 OPERATION AND MAINTENANCE
 ANNUAL REPORT
 2010**

December 30, 2010

INTRODUCTION:

TC Consulting Services was retained in 2010 to operate and maintain the Cherry Creek Reservoir Destratification Facilities. This was the third consecutive year that the facilities were operated continuously during the spring, summer and fall seasons.

OPERATION PERIOD:

The compressor was turned ON Sunday, March 14, 2010 at 1:17 PM. The equipment performed properly with no noted unusual or unordinary sounds or noticeable vibrations. The equipment was turned OFF for the season on Wednesday, November 24, 2010 at 4:30 PM

INSPECTIONS:

The facilities were inspected routinely throughout the operating season. Refer to **TABLE NO. 1 – 2010 AERATION EQUIPMENT LOG** below.

2010 AERATION EQUIPMENT LOG											
DATE	DAY OF WEEK	TIME OF DAY	UNIT HOURS	ELAPSED HOURS	UNIT STARTS	TEMPERATURE: DEGREES FAHRENHIE (° F)					OUTLET PRESSURE (PSI)
						OUTSIDE	AMBIENT	OUTLET	ELEMENT	OIL	
03/14/10	SUN	1:17 PM	11,860		217	49	59	95	468	133	52.7
03/15/10	MON	12:39 PM	11,884	24	218	41	50	105	478	125	52.7
03/16/10	TUE	12:24 PM	11,907	23	219	55	63	122	457	140	48.0
03/22/10	MON	12:22 PM	12,051	144	223	60	68	95	485	134	52.7
03/29/10	MON	12:15 PM	12,219	168	223	65	75	101	493	140	82.7
03/30/10	TUE	12:21 PM	12,244	25	223	75	81	108	510	149	50.7
04/01/10	THU	7:45 AM	12,244	0	224	38	42	81	430	80	52.7
04/01/10	THU	2:32 PM	12,251	7	225	59	65	93	413	136	49.2
04/01/10	THU	4:10 PM	12,251	0	225	59	61	84	485	123	52.7
04/12/10	MON	12:25 PM	12,511	260	225	71	73	101	460	143	52.8
04/15/10	THU	6:55 PM	12,590	79	225	60	68	110	450	147	52.5
04/16/10	FRI	3:30 PM	12,590	0	226	58	59	62	425	94	52.0
04/19/10	MON	10:02 AM	12,657	67	226	61	66	86	434	104	52.7

04/21/10	WED	5:15 PM	12,712	55	226	58	63	87	439	105	52.8
04/22/10	THU	6:55 AM	12,712	0	227	49	52	57	438	87	52.0
04/28/10	WED	3:31 PM	12,865	153	227	80	85	103	476	124	52.2
04/28/10	WED	6:30 PM	12,865	0	228	75	80	100	468	118	52.0
05/10/10	MON	12:00 PM	13,146	281	228	60	69	88	450	108	52.0
05/29/10	SAT	1:19 PM	13,609	463	228	84	88	110	485	127	52.1
06/14/10	MON	11:52 AM	13,986	377	228	59	62	84	445	105	52.1
07/01/10	THU	3:19 PM	14,397	411	228	91	97	117	498	140	52.2
07/12/10	MON	9:30 AM	14,656	259	228	77	80	101	473	124	52.4
07/21/10	WED	11:48 AM	14,874	218	228	83	86	109	482	132	52.2
07/27/10	TUE	1:08 PM	15,020	146	228	98	103	123	510	150	49.9
07/27/10	TUE	5:45 PM	15,020	0	229	85	86	95	484	120	51.3
07/28/10	WED	1:08 AM	15,027	7	229						
07/28/10	WED	7:00 AM	15,027	0	230	64	88	80	452	107	51.3
08/10/10	TUE	12:00 PM	15,344	317	230	85	85	107	471	133	51.3
08/23/10	MON	9:15 AM	15,653	309	230	73	80	102	458	132	51.2
09/07/10	TUE	11:48 AM	16,016	363	230	73	80	101	463	129	51.3
09/21/10	TUE	1:05 PM	16,353	337	230	69	76	96	454	125	51.2
09/26/10	SUN	5:49 PM	16,469	116	231	85	85	91	476	110	51.3
10/21/10	THU	1:35 PM	17,065	596	231	74	76	95	457	126	51.2
10/29/10	FRI	9:35 AM	17,253	188	231	52	56	73	445	109	51.2
11/17/10	WED	11:00 AM	17,710	457	231	33	44	61	425	101	51.2
11/24/10	WED	4:30 PM	17,885	175	231	25	44	64	434	102	51.2

The equipment operated with few interruptions and no internal part failures during 2010. A summary of the annual statistics are listed in **TABLE NO. 2 – 2010 ANNUAL OPERATION SUMMARY** below.

2010 ANNUAL OPERATION SUMMARY											
	KWHR	RUN (HOURS)	LOAD (HOURS)	LOAD RELAY COUNT	UNIT STARTS	TEMPERATURE: DEGREES FAHRENHIE (° F)					OUTLET PRESSURE (PSI)
						OUTSIDE	AMBIENT	OUTLET	ELEMENT	OIL	
TOTAL	8,257	6,025	2,485	658,000	14						
MINIMUM						25	42	57	412	80	48.0
MAXIMUM						91	103	123	510	150	52.8
AVERAGE						65	72	94	462	122	51.7

COMPARATIVE OPERATION SUMMARY:

An annual comparative summary is listed in **TABLE NO. 3 – 2010 ANNUAL OPERATION COMPARATIVE SUMMARY** below.

2010 ANNUAL OPERATION COMPARITIVE SUMMARY											
YEAR	KWHR	RUN (HOURS)	LOAD (HOURS)	LOAD RELAY COUNT	UNIT STARTS	AVERAGE TEMPERATURE: DEGREES FAHRENHET (° F)					OUTLET PRESSURE (PSI)
						OUTSIDE	AMBIENT	OUTLET	ELEMENT	OIL	
2008		5,119			77	50	78	102	421	109	53.2
2009	7,823	6,384	3,147	571,525	90	65	73	97	445	124	52.6
2010	8,257	6,025	2,485	658,000	14	65	72	94	462	122	51.7

EQUIPMENT SHUTDOWNS:

The compressor operated uninterrupted except for (8) eight shut downs. The equipment was intentionally turned OFF on (3) three separate occasions to perform work or accommodate requests. The unit shut down (5) five times due to uncontrolled circumstances. The shutdowns include times when the equipment was turned off for service or operating parameter changes. The length and duration of time that the unit was OFF each time is noted. The longest period of time that the equipment was OFF during the 2010 operating season was 43.0 hours due to "High Element Temperature". The alarm dialer did not call and provide notification. The shutdowns are listed in **TABLE NO. 4 – 2010 EQUIPMENT SHUTDOWNS** below.

2010 EQUIPMENT SHUT DOWNS				
DATE	DAY OF WEEK	TIME OF DAY	SHUTDOWN DESCRIPTION	DURATION OFF (HOURS)
03/30/10	TUE	12:21 PM	"High Element Temperature", 510° F, Dialer Did Not Call	43.0
04/01/10	THU	2:32 PM	"Starter Feedback Contact Open	1.5
04/15/10	THU	6:55 PM	Unit Turned OFF to Clean the Exchanger Cooling Fins	20.5
04/21/10	WED	5:15 PM	Unit Turned OFF at the Request of the Marina	13.5
04/28/10	WED	3:31 PM	Unit Turned OFF to Install New Silencers	3.0
07/27/10	TUE	1:08 PM	"High Element Temperature", 510° F, Reduced Unload Pressure From 52.5 PSI to 51.0 PSI	4.8
07/28/10	WED	1:28 PM	"Power Failure", Reason Unknown, Voltages – O.K., Tightened Electrical Connections	
09/26/10	SUN	8:59 AM	"Conditions All OK", Reason for Shut Down Unknown	9.0
11/24/10	WED	4:30 PM	Unit Turned OFF for the Season	

EQUIPMENT MODIFICATION:

The compressor unit was modified in 2010. The modification was implemented to subside, subdue and ebb the noise emitted by the compressor:

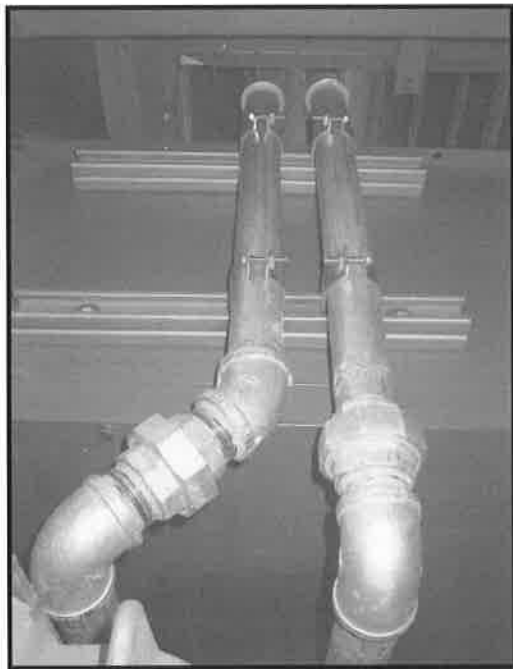
BLOW-OFF SILENCERS

The air discharged by the unloader valve is wasted to the atmosphere. The discharged air passes through "silencers" before exiting the building. The waste air has been muffled somewhat by (2) two existing

“silencers”. The existing silencers ultimately produced a rather shrill high frequency pitch that was noticeable external and outside of the facilities.

A total of (4) four new silencers were installed. The addition of (2) two more silencers increased the overall total surface area. The greater surface area has changed the pitch of the waste air exiting the building. The new silencers have reduced and diminished the decibel level of the wasted air. The noise emanated by the wasted air is however somewhat pronounced above the existing native, environmental and vehicle noise.

The internal compressor components in motion and functions represents a certain mechanical noise that reverberates and is channeled and conduited by the same system used to expel the unloader valve waste air. This particular noise continues to emanate from the unit and is unlikely to be easily resolved.



NEW BLOW-OFF SILENCER'S
PIPING



NEW BLOW-OFF SILENCER
TYPICAL OF (4) FOUR

EQUIPMENT PERFORMANCE:

HIGH TEMPERATURE SHUT DOWNS

“SETPOINTS”

The pressure control setpoints were changed in 2010 to preclude the unit from shutting down due to frequent “High Element Temperature”. The higher the discharge pressure the higher the element temperature. It has been observed that the element temperature increases approximately 9° F for every 1.0 PSI. Lowering the High or Unload setpoint slightly allowed the unit to operate more continuously.

High element temperatures have been the cause and reason for numerous shut downs in the past. It can be observed from **TABLE NO. 3 – 2010 ANNUAL OPERATION COMPARATIVE SUMMARY** that the total number of starts in 2010 was only (14) fourteen as compared to (90) ninety in 2009. The average system pressure in 2010 coincidentally was 51.7 PSI.
“HEAT EXCHANGERS”

Frequent shutdowns occurred near the end of the 2009 operating season. The recurring fault was “High Element Temperature”. These shutdowns persisted during September through November. Cleaning of the heat exchanges (air and oil) had been recommended in a September 14, 2009 memorandum after a survey and inspection of the equipment had been performed. The report identified that the heat exchanger cooling fins had fouled and partially obstructed due to the accumulation of debris. It was recommended that the cooling fins of the (2) two heat exchangers be cleaned by pressure washing with water. The oil (element) heat exchanger was especially in need of cleaning.

The cleaning was scheduled and performed satisfactorily on April 15, 2010. The unit was shut down and allowed to cool before cleaning. The surface temperature of the heat exchangers and most equipment surfaces are in excess of 250° F. After cleaning the equipment was allowed to air dry before starting the unit and resuming normal operation.

The high pressure washer for this procedure was provided by the Owner’s Representative, Mr. Bill Ruzzo. The pressure washer performed satisfactorily. Cleaning of the heat exchangers reduced the operating temperatures to acceptable and satisfactory operating parameters. It can be observed from **TABLE NO. 4 – 2010 EQUIPMENT SHUTDOWNS** that only (2) two shutdowns occurred due to High Element Temperature. One in March occurred prior to cleaning and one in July that occurred due to the typically high outside ambient temperatures that are customary during that time of season.

The Board approved the acquisition of a high pressure washer and a water storage tank for cleanings required in the future. A photograph of the purchased equipment is provided below.



HIGH PRESSURE SPRAYER AND
30 GALLON WATER STORAGE TANK

SHORT CYCLING

The loading and unloading frequency was measured and monitored during the past several years. The changes made to the pressure control setpoints directly affect the loading and unloading durations and frequency. The length of time for each load and unload period was timed using a stopwatch. The amount of time "ON" = Loaded and "OFF" = Unloaded was recorded. The percentage of time loaded and unloaded was then calculated. Additionally, the number of ON/OFF cycles per minute was computed. It can be observed that the number of cycles per minute increased during the calendar year 2010 in relation to the pressure control setpoints changes.

Subsequent to extending the discharge piping and relocating the unloader silencers the internal component parts are no longer subjected to the high temperature waste air discharged by the unloader valve. Although, cycling increased, the damage from heat upon the unit was dissipated. This heat dissipation has increased the life of the unloader valve diaphragm.

These measurements, calculations and comparative results are contained in **TABLE NO. 5 – 2010 LOADING AND UNLOADING FREQUENCY SUMMARY** below.

2010 LOADING AND UNLOADING FREQUENCY SUMMARY						
YEAR	UNIT OPERATION AVERAGE DURATION (SECONDS)		TIME		CYCLES PER MINUTE	AVERAGE DISCHARGE PRESSURE (PSI)
	LOADED	UNLOADED	% ON	% OFF		
2009	21	27	44	56	1.3	52.6
2010	22	20	48	52	1.8	51.7

EQUIPMENT PARAMETER CHECKS

The voltage and amperage draw of the motor was measured and recorded. These monitoring checks were performed once each month when the equipment was operating. These measurements are listed in **TABLE NO. 6 – 2010 ELECTRICAL MONITORING** below.

2010 ELECTRICAL MONITORING												
DATE	DAY OF WEEK	TIME OF DAY	MOTOR VOLTAGE		MOTOR AMPERAGE			UNIT OPERATION DURATION (SEC)		TIME		CYCLES PER MINUTE
			PHASE	VAC	PHASE	LOADED	UNLOADED	LOAD	UNLOAD	ON	OFF	
03/15/10	MON	12:45 PM	L ₁ - L ₂	485	L ₁	115.4	61.7	45.0 PSI	52.5 PSI	83 %	17 %	0.6
			L ₁ - L ₃	485	L ₂	123.2	70.5					
			L ₂ - L ₃	487	L ₃	116.9	64.3					
04/12/10	MON	12:26 PM	L ₁ - L ₂	487	L ₁	115.5	60.0	49.0 PSI	52.5 PSI	48 %	52 %	2.6
			L ₁ - L ₃	487	L ₂	123.0	68.7					
			L ₂ - L ₃	490	L ₃	115.7	63.6					
05/10/10	MON	12:30 PM	L ₁ - L ₂	486	L ₁	117.1	61.7	47.0 PSI	52.0 PSI	43 %	57 %	1.7
			L ₁ - L ₃	486	L ₂	123.2	68.7					
			L ₂ - L ₃	490	L ₃	116.4	63.2					

06/14/10	MON	12:10 PM	L ₁ - L ₂	485	L ₁	117.0	62.2	15	21	42 %	58 %	1.7
			L ₁ - L ₃	485	L ₂	124.9	71.9					
			L ₂ - L ₃	487	L ₃	114.9	64.7					
07/21/10	WED	12:00 PM	L ₁ - L ₂	480	L ₁	116.7	61.9	15	22	41 %	59 %	1.6
			L ₁ - L ₃	479	L ₂	122.9	69.3					
			L ₂ - L ₃	482	L ₃	114.6	64.3					
08/10/10	TUE	12:00 PM	L ₁ - L ₂	485	L ₁	114.6	61.7	47.0 PSI	52.0 PSI	43 %	57 %	2.1
			L ₁ - L ₃	487	L ₂	12.3	69.1	12	16			
			L ₂ - L ₃	484	L ₃	115.3	64.3					
09/21/10	TUE	1:30 PM	L ₁ - L ₂	477	L ₁	114.5	60.4	11	8	58 %	42 %	3.2
			L ₁ - L ₃	477	L ₂	121.4	68.2					
			L ₂ - L ₃	479	L ₃	115.4	64.9					
10/21/10	THU	1:35 PM	L ₁ - L ₂	480	L ₁	114.3	61.2	47.0 PSI	52.0 PSI	39 %	61 %	1.2
			L ₁ - L ₃	480	L ₂	121.7	68.9	19	30			
			L ₂ - L ₃	480	L ₃	115.9	64.7					
11/17/10	WED	10:00 AM	L ₁ - L ₂	484	L ₁	117.6	61.7	45.0 PSI	52.5 PSI	37 %	63 %	1.2
			L ₁ - L ₃	486	L ₂	115.5	66.2	18	31			
			L ₂ - L ₃	488	L ₃	124.5	72.0					

RECOMMENDATIONS:

The following recommendations are provided for consideration to improve system notification and operation:

- Install a meter to measure and monitor the total volume and rate of air flow.
- Install a pressure switch on the discharge pipeline. The switch initiates an alarm when the discharge pressure decreases to a minimum setpoint.
- Construct a platform to elevate the (30) thirty gallon water storage tank utilized by the recently acquired pressure washer.

Sincerely,



Terry Cunningham

