DEQ
Montana Department of Environmental Quality

Memo

TO: Autumn Coleman

FROM: Eric Regensburger

DATE: 2/3/2016

SUBJECT: Nondegradation review of New World Mine repository drainfield mixing zones

I reviewed the available information supplied by you and Shane Matolyak (Tetra Tech) and conducted a nondegradation analysis for the proposed repository drainfield discharge water. Based on the available data, I conducted mixing zone analyses in both ground water and surface water for 12 parameters: sulfate, aluminum, arsenic, cadmium, copper, iron, lead, manganese, mercury, selenium, silver and zinc. For the ground water mixing zone, dissolved portions of all metals were used pursuant to DEQ-7 water quality standards. For the surface water mixing zone, total recoverable portions of all metals (except for aluminum, which has a water quality standard based on the dissolved fraction) were used pursuant to DEQ-7 water quality standards. Nitrogen is not included in the analysis because there is no data for nitrogen concentrations in the repository discharge water.

GROUND WATER MIXING ZONE

The local geology consists of roughly 20 to 30 feet of till overlying bedrock as described in the lithology of multiple wells constructed near the repository. The Maxim (1999) report indicated that the till was a confining unit over the bedrock, that conclusion was primarily due to upward gradients measured in the fall of 1999. However, the dye tracer test conducted in 1999-2000 (Cambrian Ground Water Co., 2000) showed both downward movement of dyes from the till into the bedrock and upward movement of dyes from the bedrock into the till. In addition, a pumping test conducted on bedrock well SB-101 showed immediate and significant response in a nearby well completed in the till. The till and bedrock appear to hydraulically connected and behave as a single aquifer with different hydraulic conductivities. Based on the ground water measurements and the dye tests, there is likely a seasonal shift in local groundwater gradients with increased downward flow during spring runoff and more upward flow in the fall and winter seasons. For the nondegradation analysis I assumed the standard mixing zone dimensions of 500 feet long and 15 feet deep (ARM 17.30.517(1)(d)) would be entirely in the till unit; the width of the mixing zone was set at the width of the proposed drainfield, 250 feet, plus the 5 degree widening downstream in a standard mixing zone. These are the same mixing zone dimensions used by Tetra Tech (2014).

The hydraulic gradient was measured using multiple wells in the vicinity of the chosen repository (referred to as site SB-4B) and in the vicinity of a second potential repository site SB-4I approximately 1,200 feet to the southeast of SB-4B (Maxim, 1999). The nondegradation analysis submitted by Tetra Tech (2014) indicated that the 1999 potentiometric map was used to estimate a groundwater gradient of 13.8% (0.138 ft/ft). Based on the data and maps (Figure 4 of the Maxim 1999 report) of the measured groundwater levels in October 1999, the gradient of 0.138 ft/ft appears to be taken from the unused repository location, SB-4I. There is less data available in the area of SB-4B than near SB-4I, but the data is sufficient to estimate a gradient of 0.073 ft/ft using wells SB-108 and SB-107 located near the proposed drainfield location and mixing zone. Therefore, the shallower 0.073 ft/ft hydraulic gradient was used in the mixing zone analyses instead of the 0.138 ft/ft gradient used by Tetra Tech (2014).

The hydraulic conductivity was estimated at 0.088 ft/day from the average of six slug tests conducted in till wells in the vicinity of the repository (Maxim, 1999), this value was used in the mixing zone analysis. A pumping test was also conducted on bedrock well SB-101 with monitoring in adjacent till wells. The slug test results were used over the pumping test results because the pumping test results are based on a combination of both the bedrock and till hydraulic conductivity. Since the mixing zone is assumed to be completely in the till, the slug tests are likely more representative of the mixing zone properties. This is the same hydraulic conductivity used by Tetra Tech (2014).

The water quality of the receiving water in the mixing zone was based on the available water quality data from nearby wells completed in till. The data was collected between 1999 and 2015. These wells include SB-23-TD, SBGW-101-TD, SBGW-101-TDD, SBGW-101-TS, SBGW-103-TD, SBGW-105T, SBGW-107T, and SBGW-108T. The ground water concentration used in the mixing zone analyses was based on the 75th percentile of the available data, which is consistent with methods used in the DEQ discharge permit section. All measurements that were less than laboratory quantification limits were assigned a value equal to one-half the quantification limit for purposes of determining the 75th percentile value. For mercury, selenium and silver there was only a single measurement available from a nearby bedrock well (SB-22), for lack of any other data those single values were used as the ground water concentration. The arsenic concentration (0.0005 mg/L) was based on three samples from three of the till wells, all three samples were below the laboratory quantification limit (0.001 mg/L). All the other parameter concentrations were based on 58 samples from the above listed wells (52 of those samples were from the same wells used by Tetra Tech (2014) to estimate existing ground water concentrations, SBGW-105T, SBGW-107T, and SBGW-108T). Tetra Tech (2014) used the laboratory quantification limit for their calculations instead of one-half that limit, which doubled the existing groundwater concentration for many of the parameters over what is used in the attached calculations.

The water quality of the sump water was based on samples collected from the repository sump between 2001 and 2015. For the parameters included in the mixing zone analyses there were between 2 and 27 samples available. A representative concentration of each parameter from the repository was based on the reasonable potential analyses that is used for DEQ water quality discharge permits and described in USEPA (1991). The reasonable potential analysis uses the coefficient of variation and the number of samples to estimate a maximum likely discharge concentration from an effluent source. To be consistent with methods used in the water quality discharge section, measurements that were below the laboratory quantification limit were set at that quantification value in the reasonable potential analysis. A 95% confidence interval was used for the reasonable potential analysis. Tetra Tech (2014) used an average of the available repository data, which provided lower concentrations than those derived using the reasonable potential analysis. As discussed later, any parameter that did not meet the nondegradation criteria was also assessed using the average repository effluent concentration for comparison.

The effluent flow rate from the repository (Tetra Tech, 2014) was based on the maximum monthly discharge rate measured in 2013, 0.04 gpm (7.7 ft3/day), the same value used by Tetra Tech (2014).

Of the 12 parameters analyzed, only two do not meet the nondegradation limits at the end of the ground water mixing zone, arsenic and mercury (see ground water mixing zone spreadsheet for the calculations).

Arsenic is a carcinogen that has a strict nondegradation limit which doesn't allow any discharge with concentrations above the receiving water quality. The total recoverable arsenic data from the repository discharge was used instead of the dissolved data because after the reasonable potential analysis was applied to the data the total recoverable value was lower. The reasonable potential concentration of arsenic discharged from the repository (0.0065 mg/L) is greater than the existing dissolved ground water concentration (0.0005 mg/L) and therefore does not meet the nondegradation criteria. If a less conservative approach is taken and the average measured total recoverable arsenic concentration from the repository (0.00277 mg/L) is used in the analysis (instead of the reasonable potential value), it is still greater than the ground water concentration, 0.0005 mg/L, and does not meet the nondegradation criteria. As noted in the spreadsheet arsenic does meet the water quality standard at the end of the mixing zone using the reasonable potential effluent concentration.

Mercury is a toxic with a bioconcentrating factor (BCF) greater than 300, which gives it a more stringent nondegradation standard than other toxic pollutants (ARM 17.30.715(1)(b)). However, in groundwater the BCF factor is moot since there are no aquatic organisms to be affected by the BCF characteristics of mercury. Therefore, in groundwater, the nondegradation standard for mercury is treated the same as toxics with a BCF less than 300 (15% of the ground water quality standard). The dissolved mercury concentration at the end of the mixing zone is 0.00031 mg/L, which is just above the nondegradation limit for toxics, 0.0003 mg/L. Because mercury is close to meeting the nondegradation limit, a small increase of the width of the drainfield perpendicular to ground water flow from the proposed 250 feet to 275 feet would increase the dilution sufficiently to allow mercury to pass the nondegradation limit.

Alternatively, if a less conservative approach is taken and the average measured dissolved mercury concentration (0.00033 mg/L) from the repository is used in the analysis (instead of the reasonable potential value, 0.0021 mg/L), mercury will comply with the nondegradation standard. As noted in the spreadsheet mercury does meet the water quality standard at the end of the mixing zone using the reasonable potential effluent concentration.

SURFACE WATER MIXING ZONE

Based on the hydraulic gradient measured in 1999, the approximate ground water flow direction in the repository area is S35^{0}E (Maxim, 1999). That approximate direction is supported by the dye test results. The dye test results also showed some ground water movement towards the east-northeast along the strike plane of the bedrock. More importantly the dye test showed dye that was injected into the unused repository area was detected in the unnamed tributary to Soda Butte Creek that runs in a north to south direction downgradient of the proposed drainfield, which demonstrates a connection between the till and the unnamed tributary. The dye injected into the existing repository area wasn't detected in the unnamed tributary but there were no sampling points downstream of where that dye would likely enter the unnamed tributary based on the hydraulic gradient. Based on the information available, a surface water mixing zone analysis was also conducted. Using the likely primary direction of flow (S35^{0}E), the effluent discharged from the repository would intersect the unnamed tributary to Soda Butte Creek approximately 1,400 feet downgradient from the drainfield. That location is approximately 1,000 feet upstream of the confluence with Soda Butte Creek. I used that location to estimate the amount of surface water available to mix with the repository discharge. The tributary flow rate used by Tetra Tech (2014) to mix with the repository effluent was based on the average measured flow rate at SBT-3, which was 900 gpm (173,250 ft^3/day). However, the streamflow value used for a standard mixing zone is the 7-day 10-year (7Q10) low flow statistical value (ARM 17.30.516(3)). Because there is insufficient streamflow data from SBT-3 to calculate a 7Q10 for the unnamed tributary, the 7Q10 was estimated using data from the downstream USGS stream gage on Soda Butte Creek (USGS gage 06187950) in Yellowstone National Park. The USGS program Stream Stats 3.0 was used to extrapolate the unnamed tributary 7Q10 from the Soda Butte gage using drainage basin area as the primary function. Based on that analysis the 7Q10 value for the unnamed tributary is 63 gpm (or 12,095 ft^3/day), which is the water available for dilution in the surface water mixing zone.

The effluent concentration from the repository was based on the same method as described for the ground water mixing zone but was based on total recoverable values for metals (except for aluminum which has a surface water standard based on the dissolved fraction). The repository discharge rate was the same as used for the ground water mixing zone, 0.04 gpm or 7.7 ft^3/day (Tetra Tech, 2014). The concentration and volume of pollutants entering the unnamed tributary were based on the concentrations after the repository discharge has mixed with groundwater in the 1,400 feet between the drainfield and the estimated location of the discharge to surface waters.

The water quality of the unnamed tributary was based on the available water quality data from three sampling sites, SB4-4, SBT-3 and SBT-6 collected between 1992 and 2011. The concentration used in the mixing zone analyses was based on the 75th percentile of the available data, which is consistent with DEQ water quality discharge permit practices. All measurements that were less than laboratory quantification limits were assigned a value equal to one-half the quantification limit for purposes of determining the 75th percentile value. The silver concentrations were based on only two measurements. There were 25 measurements for arsenic, mercury, and selenium. The remainder of the parameters had 87 measurements. Tetra Tech (2014) used data from SBT-3 only and used the laboratory quantification limit for their calculations instead of one-half that limit, which doubled the existing surface water concentration for many of the parameters over what is used in the attached calculations.

Of the 12 parameters analyzed two did not meet the nondegradation limits at the end of the surface water mixing zone, mercury and iron (see surface water mixing zone spreadsheet for the calculations).

Mercury is a toxic with a BCF greater than 300, it has the same nondegradation standard as carcinogens (ARM 17.30.715(1)), no discharge with concentrations above the receiving water quality. The mercury concentration that is discharged to the unnamed tributary after migrating and mixing with ground water over the 1,400 foot distance from the drainfield is greater than the mercury concentration in the unnamed tributary (0.0001 mg/L), and therefore does not meet the nondegradation criteria. If a less conservative approach is taken and the average measured total recoverable mercury concentration (0.00235 mg/L) from the repository is used in the analysis (instead of the reasonable potential value, 0.111 mg/L), it is still greater than the surface water concentration and does not meet the nondegradation criteria. Tetra Tech (2014) noted that in the repository effluent data there is one high total recoverable mercury value (0.037 mg/L) that is anomalous from the other 16 samples that were all below the laboratory quantification limit of 0.0002 mg/L or 0.00001 mg/L. The 0.037 mg/L value has a quality control flag (J) that indicates a concentration should be considered estimated as it was measured at a value that was above the Method Detection Limit but below the Practical Quantitation Limit; the measured value of 0.037 mg/L was not discounted based solely on the J flag. However, if the 0.037 mg/L value is removed from the calculations of average total recoverable mercury concentrations, mercury still does not meet the nondegradation criteria. As noted in the spreadsheet mercury does meet the water quality standard at the end of the mixing zone using the reasonable potential effluent concentration.

The iron concentration at the end of the mixing zone exceeds the nondegradation limit; the iron standard in surface waters is 1 mg/L, therefore the nondegradation limit at the end of the mixing zone is 15% of that, or 0.15 mg/L. Because the instream iron concentration is already above 0.15 mg/L (0.325 mg/L) iron cannot meet the nondegradation criteria using either the reasonable potential effluent concentration or the average effluent concentration from the repository. As noted in the spreadsheet iron does meet the water quality standard at the end of the mixing zone using the reasonable potential effluent concentration.

REFERENCES

Cambrian Ground Water Co, 2000(?), Ground-water Tracing Investigations, Proposed Waste Rock Repository Sites, Cooke City, Montana.

Maxim, 1999. Phase II Repository Site Investigation Report: New World Mining District – Response and Restoration Project. December 24, 1999

Tetra Tech, September 19, 2014. Memo report from Shane Matolyak (TT) to Mary Beth Marks (USFS).

USEPA, 1991. Technical Support Document for Water Quality-based Toxics Control. EPA/505/2-90-001.

USGS, 2004. Statistical Summaries of Streamflow in Montana and Adjacent Areas, Water Years 1900 through 2002. Scientific Investigations Report 2004-5266.

GROUND WATER MIXING ZONE VALUES		PARAMETERS													
		Sulfate	Aluminum	Arsenic [6]	Arsenic[6]	Cadmium	Copper	Iron	Lead	Manganese	Mercury	Mercury	Selenium	Silver	Zinc
			(dissolved)	(total recoverable)	(total recoverable)	(dissolved)	(dissolved)	(dissolved)	(dissolved)	(dissolved)	(dissolved)	(dissolved)	(dissolved)	(dissolved)	(dissolved)
	Units														
Pollutant Type (DEQ-7)		harmful	toxic	carcinogen	carcinogen	toxic	toxic	harmful	toxic	harmful	toxic	toxic	toxic	toxic	toxic
Reasonable Potential Effluent Concentration[1]	mg/l	2090.00	0.08500	0.00650		0.00028	0.01080	9.50000	0.00540	8.68000	0.00210		0.00186	0.00070	0.16800
Average Effluent Concentration					0.00277							0.00033			
Effluent Discharge rate (2013 maximum)	ft^3/day	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70
Existing Ground Water Concentration[2]	mg/L	29.75	0.02500	0.00050	0.00050	0.00005	0.00100	0.05000	0.00050	0.11500	0.00010	0.00010	0.00500	0.00060	0.01000
Ground Water Flow Rate at end of Mixing Zone[3]	ft^3/day	32.52	32.52	32.52	32.52	32.52	32.52	32.52	32.52	32.52	32.52	32.52	32.52	32.52	32.52
Concentration at end of Mixing Zone[3]	mg/L	424.16	0.03649	0.00165	0.00093	0.00009	0.00288	1.85911	0.00144	1.75468	0.00048	0.00014	0.00440	0.00062	0.04025
Increase Over Existing Water Quality	mg/L	394.41	0.01149	0.00115	0.00043	0.00004	0.00188	1.80911	0.00094	1.63968	0.00038	0.00004	-0.00060	0.00002	0.03025
Trigger Value (DEQ-7)	mg/L	N/A	0.03	N/A	N/A	0.0001	0.0005	N/A	0.0001	N/A	N/A	N/A	0.0006	0.0002	0.005
Nondegration Limit (ARM 17.30.715(1)) [4]	mg/L	N/A	no standard	see footnote 4	see footnote 4	0.000750	0.19500	N/A	0.00225	N/A	0.00030	0.00030	0.00750	0.01500	0.30000
Water Quality Standard (DEQ-7)	mg/L	250[5]	no standard	0.01	0.01	0.005	1.3	0.3[5]	0.015	0.05[5]	0.00200	0.00200	0.05	0.10000	2
Pass Trigger Value	Yes/No	N/A	Yes	N/A	N/A	Yes	No	N/A	No	N/A	N/A	N/A	Yes	Yes	No
Pass Nondegradation Limit	Yes/No	N/A		No	No		Yes	N/A	Yes	N/A	No	Yes			Yes
Pass Water Quality Standard	Yes/No	N/A		Yes	Yes			N/A		N/A	Yes				

NOTES

(1) Based on reasonable potential analysis at 95th percent confidence interval, per USEPA Technical Support Document for Water Quality-based Toxics Control

(2) Based on 75th percentile of ground water wells completed in till near repository (SB-23-TD, SBGW-101-TD, SBGW-101-TDD, SBGW-101-TS, SBGW-103-TD, SBGW-105T, SBGW-107T, SBGW-107TX SBGW-107X, SBGW-108T). For sites where all measurements were below laboratory quantification limits, the concentration is set at one-half that quantification limit. Mercury, Selenium and Silver concentrations based on only available data - a single measurement in bedrock well SB-22.

(3) Based on mixing in standard ground water mixing zone (see calculations below)

(4) For toxics the nondegradation limit is 15% of the water quality standard (ARM 17.30.715(1)(c)). For carcinogens the limit is at or below the receiving water concentration (ARM 17.30.715(1)(b))

(5) Secondary standards for aesthetic qualities (taste,odor, color) - not an enforceable nondegradation or water quality standard

(6) the effluent concentration for arsenic is based on total recoverable values because based on the reasonable potential analysis the total recoverable concentration is less than the dissolved arsenic concentration.

MIXING ZONE GROUND WATER FLOW RATE CALCULATIONS			
DESCRIPTION	**VARIABLES**	**VALUE**	**UNITS**
Hydraulic Conductivity (average of slug tests in till)	K	0.088	ft/day
Hydraulic Gradient (measured October 1999)	I	0.0730	ft/ft
Standard Mixing Zone Thickness [ARM 17.30.517(1)(d)(iii)(A)]	D	15.0	ft
Standard Mixing Zone Length [ARM 17.30.517(1)(d)(viii)(D)]	L	500	ft
Width of Drainfield Perpendicular to Ground Water Flow	Y	250	ft
Groundwater Background Concentration (75th percentile of data)	Ng	see above	mg/L
Parameter Concentration in Effluent (reasonable potential)	Ne	see above	mg/L
Effluent Discharge Rate (average of 2013 measurements)	Ql	3.85	ft3/day
	EQUATIONS		
Width at end of Mixing Zone = (0.175)(L)+(Y)	W	337.50	ft
Cross Sectional Area of Aquifer Mixing Zone = (D)(W)	Am	5062.50	ft2
Surface Area of Mixing Zone = (L)(W)	As	168750.00	ft2
Ground Water Flow Rate at End of 500' Mixing Zone = (K)(I)(Am)	Qg	32.52	ft3/day
Effluent Flow Rate = (Ql)	Qe	7.70	ft3/day
Concentration at end of 500' Mixing Zone			
Nt = ((Ng)(Qg)+(Ne)(Qe)) / ((Qg)+(Qe))		**see table**	**mg/L**

CALCULATIONS FOR DETERMINING CONCENTRATION AND FLOW TO USE IN SURFACE WATER MIXING ZONE

VALUES		PARAMETERS													
		Sulfate	Aluminum	Arsenic	Cadmium	Copper	Iron	Iron	Lead	Manganese	Mercury	Mercury	Selenium	Silver	Zinc
			(dissolved)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)
	Units														
Pollutant Type (DEQ-7)		harmful	toxic	carcinogen	toxic	toxic	harmful	harmful	toxic	harmful	toxic	toxic	toxic	toxic	toxic
Reasonable Potential Effluent Concentration[1]	mg/l	2090.00	0.08500	0.00650	0.00128	0.03840	11.85000		0.03400	6.39600	0.11100		0.00800	0.00060	0.19200
Average Effluent Concentration								2.32000				0.00235			
Effluent Discharge rate (2013 maximum)	ft^3/day	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70
Existing Ground Water Concentration[2]	mg/L	29.75	0.02500	0.00050	0.00005	0.00100	0.05000	0.05000	0.00050	0.11500	0.00010	0.00010	0.00500	0.00060	0.01000
Ground Water Flow entering Unnamed tributary[3]	ft^3/day	**47.70**	**47.70**	**47.70**	**47.70**	**47.70**	**47.70**	**47.70**	**47.70**	**47.70**	**47.70**	**47.70**	**47.70**	**47.70**	**47.70**
Concentration entering Unnamed tributary[3]	mg/L	**316.11**	**0.03334**	**0.00133**	**0.00022**	**0.00620**	**1.69013**	**0.36552**	**0.00516**	**0.98802**	**0.01551**	**0.00041**	**0.00542**	**0.00060**	**0.03530**

NOTES

(1) Based on reasonable potential analysis at 95th percent confidence interval, per USEPA Technical Support Document for Water Quality-based Toxics Control

(2) Based on 75th percentile of ground water wells completed in till near repository (SB-23-TD, SBGW-101-TD, SBGW-101-TDD, SBGW-101-TS, SBGW-103-TD, SBGW-105T, SBGW-107T, SBGW-107TX SBGW-107X, SBGW-108T). For sites where all measurements were below laboratory quantification limits, the concentration is set at one-half that quantification limit. Mercury, Selenium and Silver concentrations based on only available data - a single measurement in bedrock well SB-22.

(3) Based on mixing for 1,400 feet between the drainfield and the estimated discharge location on the unnamed tributary (see calculations below). These values used for surface water mixing zone calculations

MIXING ZONE GROUND WATER FLOW RATE CALCULATIONS

DESCRIPTION	VARIABLES	VALUE	UNITS
Hydraulic Conductivity (average of slug tests in till)	K	0.088	ft/day
Hydraulic Gradient (measured October 1999)	I	0.0730	ft/ft
Standard Mixing Zone Thickness [ARM 17.30.517(1)(d)(iii)(A)]	D	15.0	ft
Standard Mixing Zone Length [ARM 17.30.517(1)(d)(viii)(D)]	L	1400	ft
Width of Drainfield Perpendicular to Ground Water Flow	Y	250	ft
Groundwater Background Concentration (75th percentile of data)	Ng	see above	mg/L
Parameter Concentration in Effluent (reasonable potential)	Ne	see above	mg/L
Effluent Discharge Rate (average of 2013 measurements)	Ql	3.85	ft3/day
	EQUATIONS		
Width at end of Mixing Zone = (0.175)(L)+(Y)	W	495.00	ft
Cross Sectional Area of Aquifer Mixing Zone = (D)(W)	Am	7425.00	ft2
Surface Area of Mixing Zone = (L)(W)	As	693000.00	ft2
Ground Water Flow Rate at discharge to tributary = (K)(I)(Am)	Qg	47.70	ft3/day
Effluent Flow Rate = (Ql)	Qe	7.70	ft3/day
Concentration at end of 500' Mixing Zone			
Nt = ((Ng)(Qg)+(Ne)(Qe)) / ((Qg)+(Qe))		**see table**	**mg/L**

SURFACE WATER MIXING ZONE VALUES		PARAMETERS													
		Sulfate	**Aluminum**	**Arsenic**	**Cadmium**	**Copper**	**Iron**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Mercury**	**Selenium**	**Silver**	**Zinc**
			(dissolved)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)	(total recoverable)
	Units														
Pollutant Type (DEQ-7)		harmful	toxic	carcinogen	toxic	toxic	harmful	harmful	toxic	harmful	toxic (BCF>300)	toxic (BCF>300)	toxic	toxic	toxic
Concentration Entering Surface Water based on Reasonable Potential Effluent Concentration[1,2]	mg/l	316.11	0.03334	0.00133	0.00022	0.00620	1.69013		0.00516	0.98802	0.01551		0.00542	0.00060	0.03530
Concentration Entering Surface Water based on Average Effluent Concentration[2]	mg/L							0.36552				0.00041			
Ground Water Volume Entering Tributary	ft^3/day	47.70	47.70	47.70	47.70	47.70	47.70	47.70	47.70	47.70	47.70	47.70	47.70	47.70	47.70
Existing Surface Water Conc.[3]	mg/L	13.00	0.02500	0.00150	0.00010	0.00400	0.32500	0.32500	0.00150	0.01800	0.00010	0.00010	0.00050	0.00025	0.00500
Surface Water Flow rate (7Q10)	ft^3/day	12,095	12,095	12,095	12,095	12,095	12,095	12,095	12,095	12,095	12,095	12,095	12,095	12,095	12,095
Concentration at end of Mixing Zone[4]	mg/L	14.19	0.02503	0.00150	0.00010	0.00401	0.33036	0.32516	0.00151	0.02181	0.00016	0.00010	0.00052	0.00025	0.00512
Increase Over Existing Water Quality	mg/L	1.19	0.00003	0.00000	0.00000	0.00001	0.00536	0.00016	0.00001	0.00381	0.00006	0.00000	0.00002	0.00000	0.00012
Trigger Value (DEQ-7)	mg/L	N/A	0.03	N/A	0.0001	0.0005	N/A	N/A	0.0001	N/A	N/A	N/A	0.0006	0.0002	0.005
Nondegration Limit (ARM 17.30.715(1))[5]	mg/L	N/A	0.01305	see footnote 4	0.00005	0.00167	0.15000	0.15000	0.00062	N/A	see footnote 4	see footnote 4	0.00075	0.00087	0.02130
Water Quality Standard DEQ-7[6]	mg/L	250[7]	0.087	0.01	0.00032	0.0111	1	1	0.00414	0.05[7]	0.00091	0.00091	0.005	0.00579	0.142
Pass Trigger Value	Yes/No	N/A	Yes	N/A	Yes	Yes	N/A	N/A	Yes	N/A	N/A	N/A	Yes	Yes	Yes
Pass Nondegradation Limit	Yes/No	N/A		Yes			No	No		N/A	No	No			
Pass Water Quality Standard	Yes/No	N/A					Yes	Yes		N/A	Yes	Yes			

NOTES

(1) Based on reasonable potential analysis at 95th percent confidence interval, per USEPA Technical Support Document for Water Quality-based Toxics Control

(2) Concentrations calculated using ground water mixiing zone that extends 1,400 feet fromt the proposed drainfield location to where the effluent is estimated to enter unnamed tributary of Soda Butte Creek.

(3) Based on 75th percentile of data collected in tributary sites near the repository (SB4-4, SBT-3, SBT-6). For sites where all measurements were below laboratory quantification limits, the concentration is set at one-half that quantification limit.

(4) Based on mixing in Soda Butte tributary at the estimated 7Q10

(5) For toxics the nondegradation limit is 15% of the water quality standard (ARM 17.30.715(1)(c)). For carcinogens and toxics with BCF>300 the limit is at or below the receiving water concentration (ARM 17.30.715(1)(b))

(6) Water quality standards for cadmium, copper, lead, silver and zinc are dependant on hardness. Calculations were based on the median hardness (123 mg/L) of 138 samples from tributary sites SB4-4, SBT-3 and SBT-6.

(7) Secondary standards for aesthetic qualities (taste,odor, color) - not an enforceable nondegradation or water quality standard