APPENDIX E.

Earth Volumetric Studio Animations

As part of the development of this Parrot Performance Monitoring Program (PMP) Conceptual Site Model (CSM), video animations using the Earth Volumetric Studio (EVS) software program were generated. The visualizations provide a three-dimensional illustration of subsurface lithology, water levels, and analytical chemistry. Multiple video animations have been created and are available using the links provided below.

Bedrock Topography
Animation includes the interpreted weathered bedrock and bedrock surface based on existing PMP well logs. Wells and screened intervals are shown, along with weathered bedrock and bedrock.
Bedrock Topography Animation

Time Series Upper Alluvial Unit (UAU) Groundwater Elevations
Animation shows time series groundwater elevations from wells in the Upper Alluvial Unit. The time period is November 2017 to January 2019.
UAU Water Levels

Time Series Middle Alluvial Unit (MAU) Groundwater Elevations
Animation shows time series groundwater elevations from wells in the Middle Alluvial Unit. The time period is November 2017 to January 2019.
MAU Water Levels

Time Series Lower Alluvial Unit (UAU) Groundwater Elevations
Animation shows time series groundwater elevations from wells in the Lower Alluvial Unit. The time period is November 2017 to January 2019.
LAU Water Levels

Groundwater Copper Concentration with Lithology
Animation shows October 2018 copper concentrations starting from the high concentration to low concentration, down to 0.0036mg/l. Wells and screened intervals are shown, along with site geology.
Groundwater Copper Concentration with Lithology

Groundwater Zinc Concentration with Lithology
Animation shows October 2018 zinc concentrations starting from the high concentration to low concentration, down to 0.0036mg/l. Wells and screened intervals are shown, along with site geology.
Groundwater Zinc Concentration with Lithology

Time Series Groundwater Copper Concentration

Animation shows time series copper concentrations for data from all wells (PMP and BPSOU/BMFOU) within the upper BAO corridor. Wells and screened intervals are shown. The time period is April 2010 to January 2019.

Time Series Groundwater Copper Concentration

Time Series Groundwater Zinc Concentration

Animation shows time series zinc concentrations for data from all wells (PMP and BPSOU/BMFOU) within the upper BAO corridor. Wells and screened intervals are shown. The time period is April 2010 to January 2019.

Time Series Groundwater Zinc Concentration

APPENDIX F.

MEMORANDUM

To: Elizabeth Erickson

From: Michael Nicklin

Date: 1/22/20

Re: Mass Balance Summary – Parrot Tailings – Cross-section B-B'

A quantitative assessment of metal transport through cross-section B-B' was performed per your request. This technical memorandum summarizes the information used and the method employed in completing the quantitative assessment.

The primary sources of information used include the following:

- Montana Bureau of Mines and Geology Report (2010): Aquifer Test Evaluation Conducted on the Middle Gravel Unit of the Alluvial Aquifer in Upper Metro Storm Drain Area, Butte, MT (Open File Report Number 592) [MBMG-2010];
- Potentiometric surface contours developed by WET;
- Metal concentration contours of July 2019 developed by WET; and
- The chemistry and water level data files contained in the project Access database.

In order to quantify the mass of analytes flowing through cross-section B-B' it is necessary to know the rate of groundwater flow and the concentration of that groundwater flow. Darcy's Law was employed in order to quantify that flow. The form of that law was established as follows:

Q = **T** x **W** x **dh/dl**.

Q is the aquifer discharge through a given aquifer's width (**W**). Transmissivity (**T**) was defined using the pumping test summary set forth in Table 3 from the MBMG-2010 report. Table 1 provides a condensed summary of the MBMG table. Table 1 shows that the overall average **T** is 9,128 ft2/d which was selected for the mass balance evaluation conducted for the middle aquifer units. The upper unit was assumed to possess a **T** value of 440 ft^2/d which is the product of 55 ft^2/d assuming an average thickness of 8 feet based upon information provided in the "AR Report".

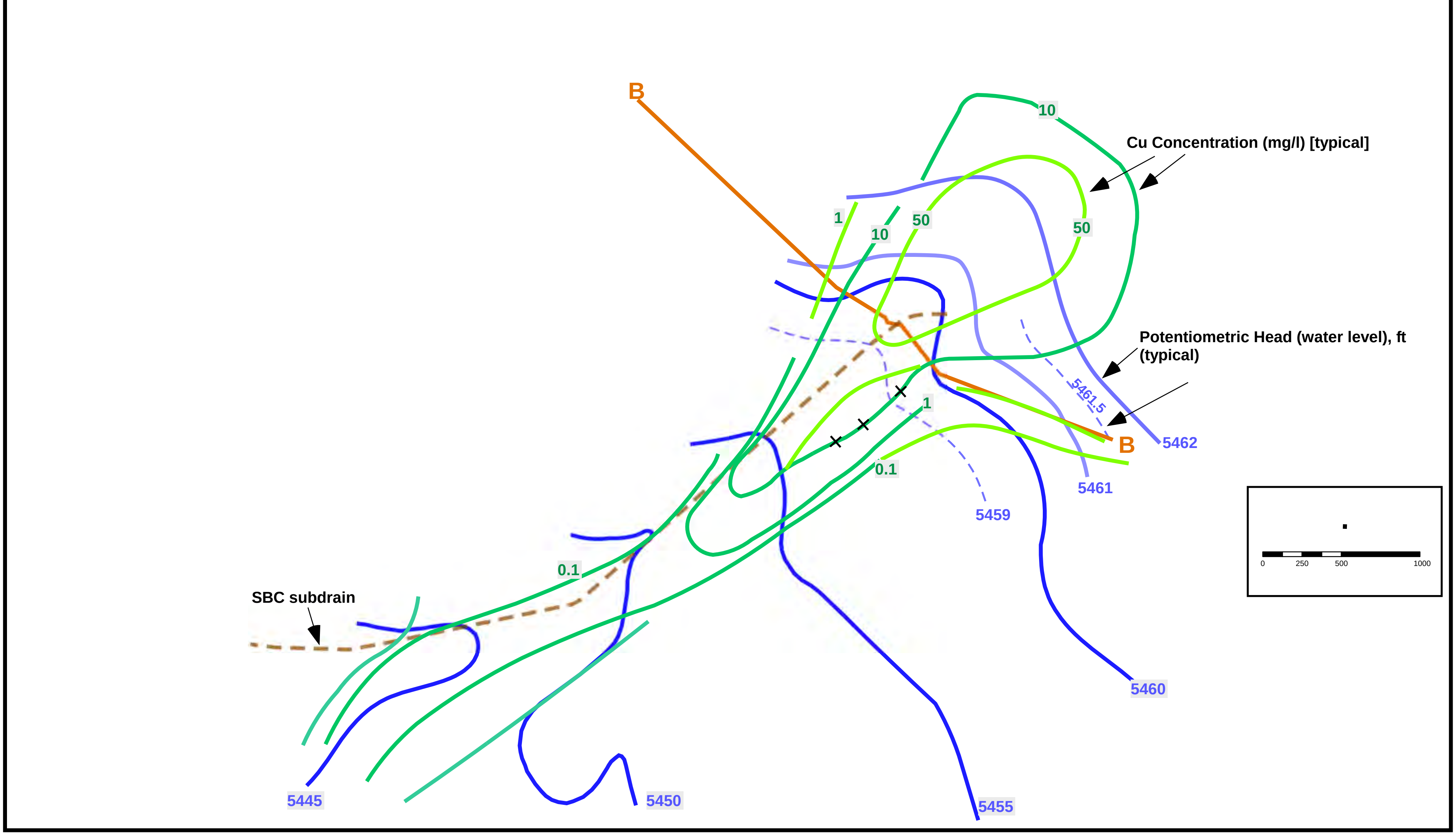
The **dh/dl** was defined using localized gradients near cross-section B-B'. Given that the flow direction and hydraulic gradient were variable over the length of cross-section B-B', the potentiometric surface was subdivided into discrete segments (stream tubes) that conveniently matched concentration contours. In effect, a series of Darcy equations were developed to summarize the flow over the portion of Section B-B' exhibiting contaminant plume contours. Each stream tube had its own unique hydraulic gradient and width.

The specific data utilized to assign the stream tubes were the water levels (and potentiometric maps) and chemistry data for Copper (Cu) and Zinc (Zn) (and concentration contour maps) from July 2018. In some instances, additional potentiometric and concentration contours were added in the immediate vicinity of Section B-B' to provide greater resolution for quantification purposes. See Figure 1 for an example showing copper concentrations and water levels which provide a starting point for the mass balance analysis.

Attachment A provides a detailed example of the procedure applied to Cu for the middle aquifer. Figures A-1 and A-2 provide a summary of the sequence employed to quantify the Cu mass transport through cross-section B-B'. The same procedure was repeated to quantify Cu and Zn for the middle and upper aquifers at this section.

Table 2 provides a summary of the mass balance results for Cu and Zn, middle and upper aquifers.

Lighter colored contours present refinements that were made for analysis purposes.



WET Water & Environmental TECHNOLOGIES

PARROT TAILINGS REMOVAL

Copper Concentration and Water Level Contours July 2018

Job#: NRDPM07

Date: 8/29/2019

FIGURE 1

Table 1
Summary of Transmissivity/Hydraulic Conductivity *
Middle Aquifer Unit

Well	Average Tranmissivity, feet2/day	Average K, feet/day
GS-41D	9,560	637
GS-42D	7,250	483
AMW-1D	1,790	120
MSD-1B	7,170	478
MSD-2B	15,500	1,000
MSD-3	13,500	902
Overall Average	9,128	603

* Information adapted from Table 3 of MBMG-2010.

Table 2
Summary of Mass Balance Analysis
Middle and Upper Aquifer Units

Aquifer	Flow, gpm *	Analyte	Mass, lbs/day	Mass, tons/year
Middle	272	Copper	59.1	10.8
Upper	14	Copper	7.2	1.3
		Total	***66.3***	***12.1***
Middle	268	Zinc	196.0	35.8
Upper	27	Zinc	11.4	2.1
		Total	***207.4***	***37.9***

* Different flow rates are observed for each analysis as flow computations were limited to plume width boundaries that were assessed for mass balance.

Attachment A (see Figures A-1 and A-2)
Worksheet - Parrot Mass Transport Cross-Section B-B'- Copper Middle Unit

Rate of flow by stream tube (uses Darcy's Law or Q= ***T*** *x* ***W*** *x(* ***drop/length*** *) or TxWxdh/dl*
Mass transport for stream tube is flow multiplied by analyte concentration

	L, ft	W, ft	T, ft2/d	Gradient	Q, ft3/d	Q, gpm	See below	
Flow A	470.5	181	9128	**0.0043**	7.02E+03	36.48		
	Rate gpm	Conversion gpm to l/d	Flow l/d	Avg C, mg/L	mg/d	kg/d	lbs/d	lbs/year
Transport A	36.48	5450.99	198863.4	5.5	1.09E+06	1.09	2.41	878.88
	Tube A Length, ft	Average Drop	Gradient ft/ft	Average Concentr.				
Left Arc	475	2		1				
Right Arc	466	2		10				
Width Entry *	110					* at x-section		
	470.5	2	0.004251	5.5				
	L, ft	W, ft	T, ft2/d	Gradient	Q, ft3/d	Q, gpm		
Flow B	333	172	9128	**0.0030**	4.71E+03	24.49		
	Rate gpm	Conversion gpm to l/d	Flow l/d	Avg C, mg/L	mg/d	kg/d	lbs/d	lbs/year
Transport B	24.49	5450.99	133502.7	30	4.01E+06	4.01	8.81	3218.28
	Tube B Length, ft	Average Drop	Gradient ft/ft	Average Concentr.				
Left Arc	276	1		10				
Right Arc	390	1		50				
Width Entry	172							
	333	1	0.003003	30				

Attachment A (see Figures A-1 and A-2)
Worksheet - Parrot Mass Transport Cross-Section B-B'- Copper Middle Unit

	L, ft	W, ft	T, ft2/d	Gradient	Q, ft3/d	Q, gpm		
Flow C	379.5	277	9128	**0.0026**	6.66E+03	34.610		
	Rate gpm	Conversion gpm to l/d	Flow l/d	Avg C, mg/L	mg/d	kg/d	lbs/d	lbs/year
Transport C	34.61	5450.99	188657.5	89.6	1.69E+07	16.90	37.19	13582.97

	Tube C Length, ft	Average Drop	Gradient ft/ft	Average Concentr.	
Left Arc	390	1		81.1	Local sample data used as opposed to contours.
Right Arc	369	1		98.1	
Width Entry	277				
	379.5	1	0.002635	89.6	

	L, ft	W, ft	T, ft2/d	Gradient	Q, ft3/d	Q, gpm		
Flow D	338.5	178	9128	**0.0030**	4.80E+03	24.93		
	Rate gpm	Conversion gpm to l/d	Flow l/d	Avg C, mg/L	mg/d	kg/d	lbs/d	lbs/year
Transport D	24.93	5450.99	135915	30	4.08E+06	4.08	8.97	3276.43

	Tube D Length, ft	Average Drop	Gradient ft/ft	Average Concentr.
Left Arc	369	1		50
Right Arc	308	1		10
Width Entry	178			
	338.5	1	0.002954	30

Attachment A (see Figures A-1 and A-2)
Worksheet - Parrot Mass Transport Cross-Section B-B'- Copper Middle Unit

	L, ft	W, ft	T, ft2/d	Gradient	Q, ft3/d	Q, gpm		
Flow E	293.5	209	9128	**0.0030**	5.64E+03	29.28		
	Rate gpm	Conversion gpm to l/d	Flow l/d	Avg C, mg/L	mg/d	kg/d	lbs/d	lbs/year
Transport E	29.28	5450.99	159585.6	0.6065	9.68E+04	0.10	0.21	77.77

	Tube F Length, ft	Average Drop	Gradient ft/ft	Average Concentr.	
Left Arc	310	1		0.093	Local sample data used as opposed to contours.
Right Arc	277	1		1.12	
Width Entry	209				
	293.5	1	0.002954	0.6065	

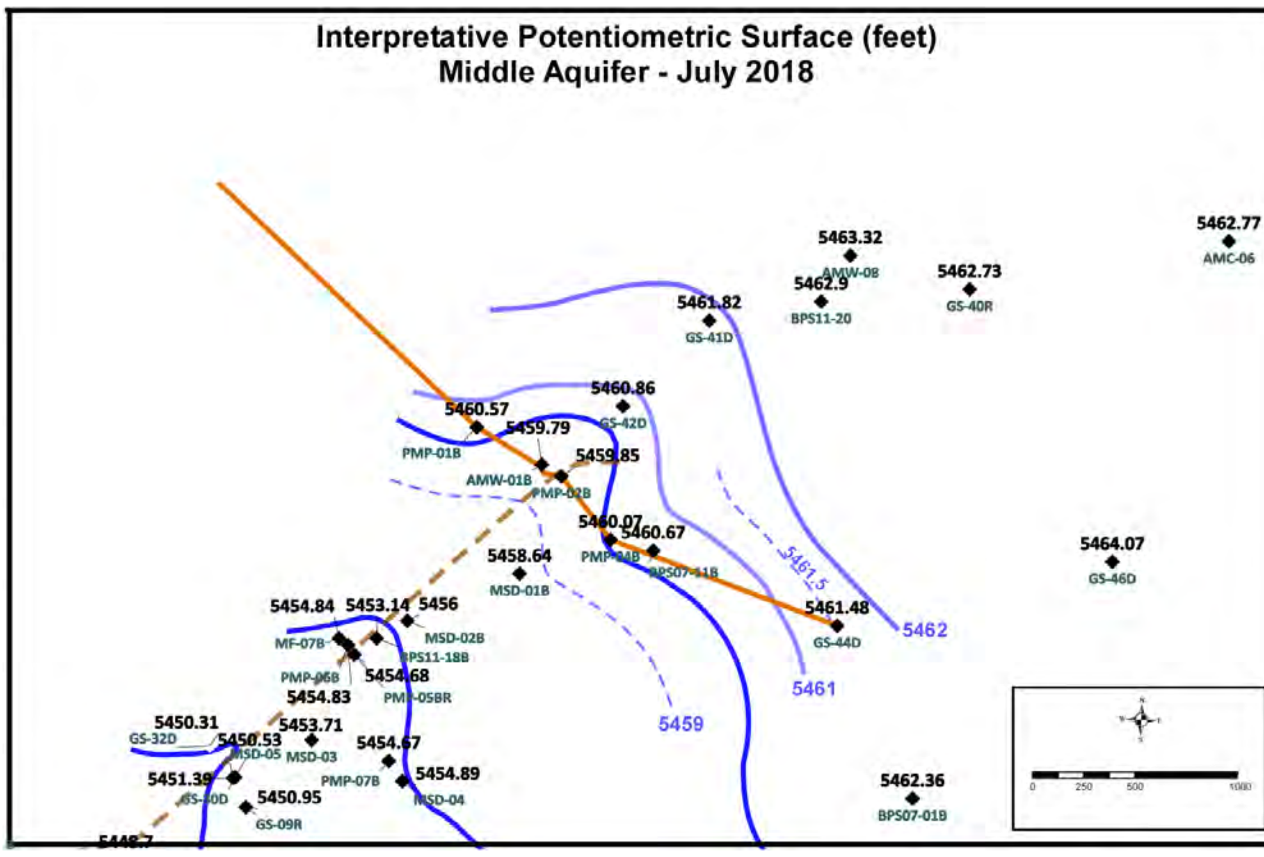
	L, ft	W, ft	T, ft2/d	Gradient	Q, ft3/d	Q, gpm		
Flow F	559.5	875	9128	**0.0030**	2.36E+04	122.57		
	Rate gpm	Conversion gpm to l/d	Flow l/d	Avg C, mg/L	mg/d	kg/d	lbs/d	lbs/year
Transport E	122.57	5450.99	668121.4	1	6.68E+05	0.67	1.47	536.87

	Tube F Length, ft	Average Drop	Gradient ft/ft	Average Concentr.
Left Arc	609	1.5		1
Right Arc	510	1.5		1
Width Entry	875			
	559.5	1.5	0.002954	1

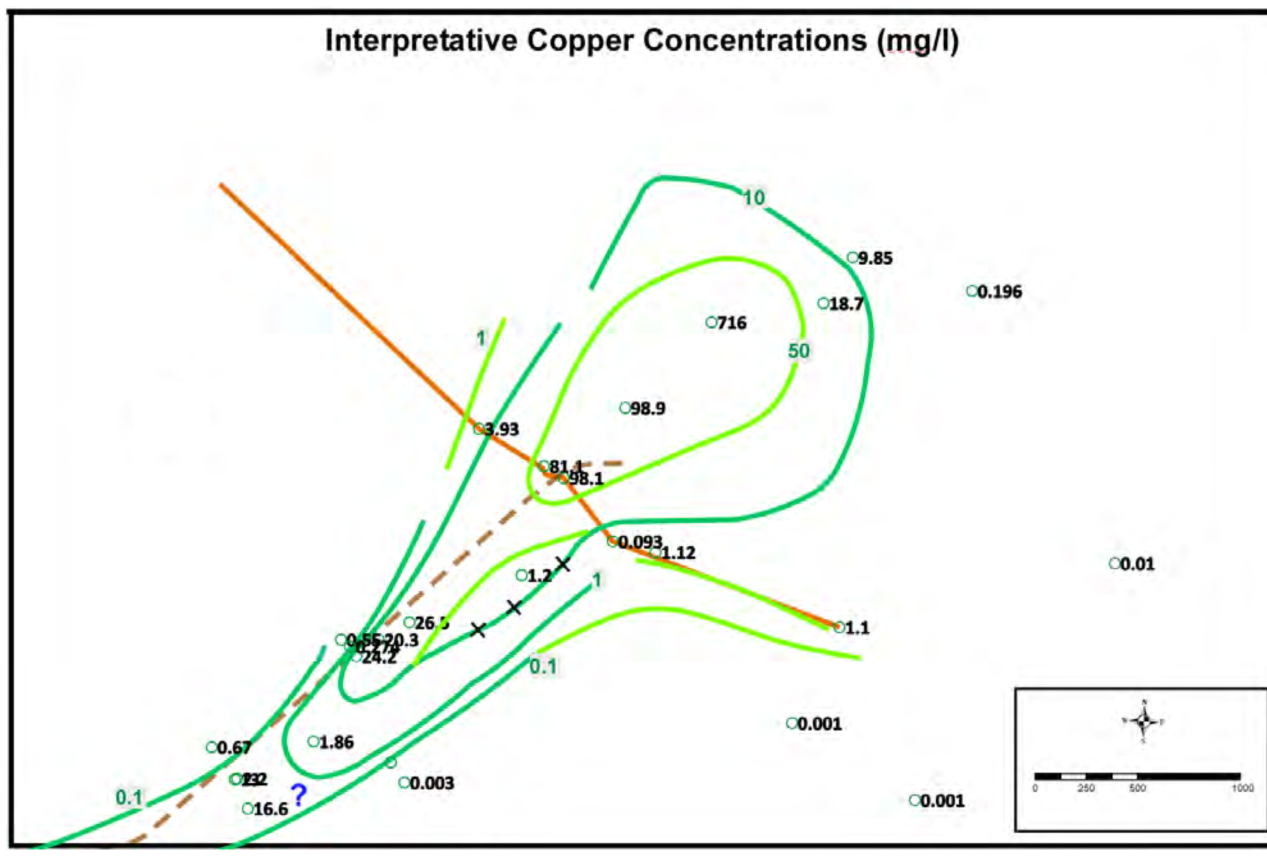
Attachment A (see Figures A-1 and A-2)
Worksheet - Parrot Mass Transport Cross-Section B-B'- Copper Middle Unit

Total Flow	***272***	***gpm***
Total Cu	***59.1***	***lbs/day***
Total Cu	***21,571***	***lbs/yr***
Total Cu	***10.8***	***tons/yr***

Step 1 was to provide additional resolution of the hydraulic gradient in the vicinity of the cross-section B-B'.



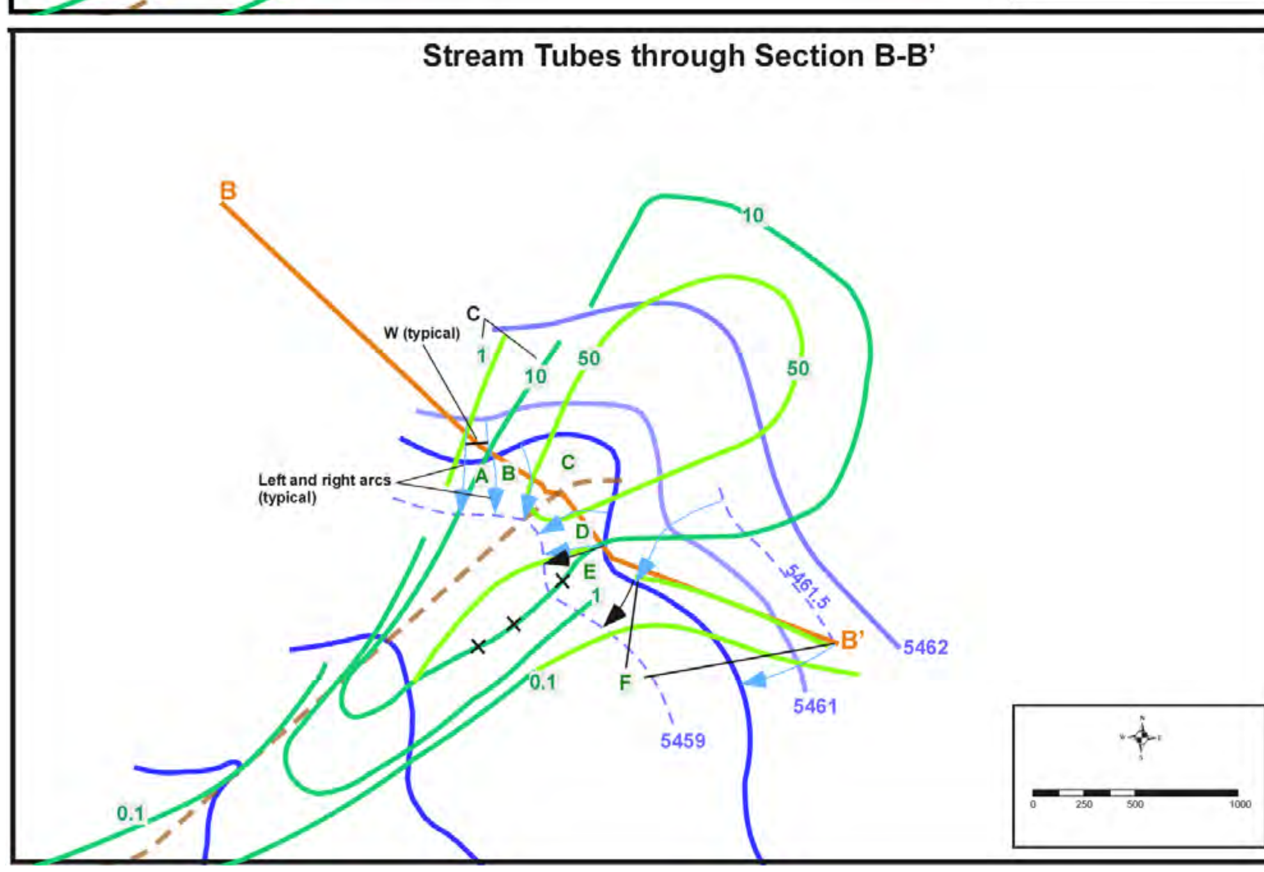
Step 2 was to provide additional resolution of the copper concentrations in the vicinity of the cross-section B-B'.



Step 3 was to combine the water level contours with the copper concentrations to create stream lines/tubes. Stream tubes were defined so that each boundary coincided with the intersection of the plume contour and Section B-B'. Note that flow and associated transport were assumed to be parallel the stream tube. The hydraulic gradients of each tube were assumed to be the average of the gradient of the right and left arc (streamline). The stream tube width for quantifying the mass transport was defined at the cross-section as shown below. The average concentration was assumed to be the average of the two bounding plume contours. Note that if sufficient local chemical data were present near the cross-section and between plume contours (two or more data points) that information superseded the average of the two plume contours.

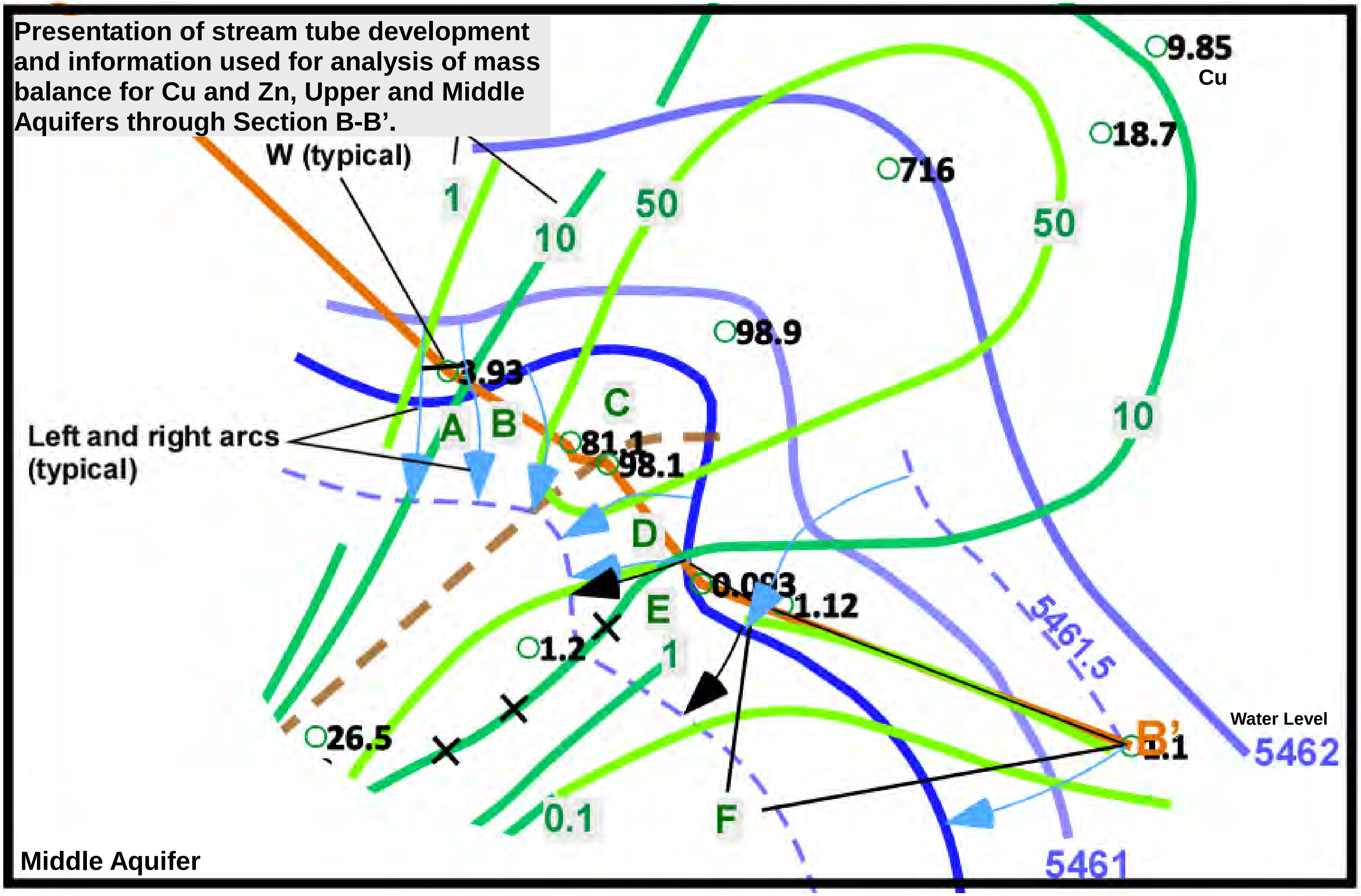
Step 3 was repeated for each stream tube present.

See Figure A-2 for additional procedure information.



PARROT TAILINGS REMOVAL	
Copper Concentration/Water Level Contours July 2019 *Stream Tube Development - Middle Aquifer*	
Job#: NRDPM07 Date: 8/29/2019	**FIGURE A-1**

Water & Environmental TECHNOLOGIES



PARROT TAILINGS REMOVAL

Copper Concentration/Water Level Contours July 2019
Stream Tube Mass Balance - Middle Aquifer

Water & Environmental TECHNOLOGIES

Job#: NRDPM07

Date: 8/29/2019

FIGURE A-2