Interlaboratory Comparison Report for the Community Environmental Monitoring Program of the Stibnite Gold Mine Project, 2021

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1. Introduction

In conjunction with the Stibnite Advisory Council, the Idaho Water Resources Research Institute (IWRRI) at the University of Idaho has signed a contract to bring transparency to the Perpetua Resources, Stibnite Gold Project and to independently verify ground and surface water quality conditions at the site. The goal of the collaboration is to develop an independent and appropriate sampling, analysis, and reporting plan for the Stibnite Gold Project.

This report summarizes the pre-mining surface and groundwater monitoring within the locality of the Stibnite Gold Project location on July 8th, 2021, and August 26th, 2021, respectively. The samples collected by IWRRI were analyzed by Anatek Laboratories in Moscow, Idaho. Perpetua Resources also collected samples from the same locations and sent them to SVL Analytic Laboratory in Kellog, Idaho for analysis.

2. Methods

2.1. Split sampling

Water samples were collected and analyzed by split sampling, that is, each large water sample was split into two aliquots, and each aliquot analyzed independently. Each aliquot was assumed to be a replicate of the original sample. Water was taken from a single source (e.g., a groundwater well or stream reach) then divided in two, with each sample analyzed by a different certified laboratory. Samples were collected from each location as per stipulated protocols given in the 2021-2022 Work Plan for the Community Environmental Monitoring Program of the Stibnite Gold Project. The objective of the split sampling was to verify the results obtained from both laboratories, to assure that the methods were appropriate, and to ensure that laboratory results accurately reflected environmental conditions. Samples were submitted to Anatek Laboratory and to the SVL Analytical laboratory, both EPA-certified laboratories, for the parameters listed in Table 1.

Table 1. The seventeen water quality parameters measured in this study. The table includes the method, practical quantitation limit (PQL), the minimum detection limit (MDL), and the concentration units.

Item	Method	PQL	MDL	units
Cyanide	EPA 335.4	0.01	0.0039	mg/L
Nitrate	EPA 300	0.1	0.045	mg/L
Sulfate	EPA 300	0.1	0.055	mg/L
Ammonia	SM 4500NH3-g	0.05	0.0088	mg/L
Chromium VI	SM3500-CR-B	5	1.9	mg/L
Low level Hg	EPG 1631	1	0.2	ng/L
Total Arsenic	EPA 200.8	1	0.082	mg/L
Dissolved Arsenic				
Total Antimony	EPA 200.8	1	0.3	mg/L
Dissolved Antimony				
Total Cadmium	EPA 200.8	1	0.039	mg/L
Dissolved Cadmium				
Total Chromium	EPA 200.8	1	0.04	mg/L
Dissolved Chromium				
Total Copper	EPA 200.8	1	0.065	mg/L
Dissolved Copper				
Total Lead	EPA 200.8	1	0.015	mg/L
Dissolved Lead				
Total Nickel	EPA 200.8	1	0.18	mg/L
Dissolved Nickel				
Total Selenium	EPA 200.8	1	0.29	mg/L
Dissolved Selenium				
Total Silver	EPA 200.8	1	0.66	mg/L
Dissolved Silver				
Total Zinc	EPA 200.8	1	0.2	mg/L
Dissolved Zinc				

2.2. Sampling Locations

2.2.1. Surface water

Surface water samples were collected on July 29th, 2021, at 11 sites (Appendix 1-2). The site nomenclature is listed in Table 2. The total number of analytes quantified was 25, and therefore the total number of samples taken from 11 sites sums up to 275. Among the 11 sites, two of the sites were not actual sites, instead they corresponded to a duplicate site and a blank site. The duplicate sample corresponds to a second set of samples collected from a selected site, which in this specific case was site YP-SR-2, the EFSFSR below Sugar Creek. The blanks sample corresponds to a distilled water sample, which in this specific case was collected at YP-T-1, Sugar Creek above EFSFSR. The site selection for both duplicate and blanks were random. This was done to validate the data reported by the two laboratories.

Table 2. The eleven surface water sites sampled on July 29, 2021.

Site names	Site description
YP-AS-7	Meadow Creek Mine adit seep
YP-S-8	North Keyway Dam seep
YP-SR-10	EFSFSR below Meadow Creek
YP-SR-11	EFSFSR above Meadow Creek
YP-SR-2	EFSFSR below Sugar Creek
YP-Duplicate	@ EFSFSR below Sugar Creek
YP-T-1	Sugar Creek above EFSFSR
YP-Blanks	@ Sugar Creek above EFSFSR
YP-T-29	Blowout Creek
YP-T-33	Meadow Creek above SODA
YP-T-43	Meadow Creek above Keyway Dam

2.2.2. Groundwater

Groundwater samples were collected on August 26th, 2021, at 11 sites (Appendix 3-4). The site nomenclature is listed in Table 3. The total number of analytes quantified was 25, and therefore the total number of samples taken from 11 sites sums up to 275. Similar to surface water sampling, one site was a duplicate and another a blank site. The duplicate sample corresponds to a second set of samples collected from a selected site, which in this specific case was site MWH-A08, Alluvial well east of EFSFSR and Meadow Creek confluence. The blanks sample corresponds to using distilled water in filling the bottles, which in this specific case was collected at MWH-A18, Alluvial well North of the EFSFSR, across the river from the Bradley dumps. The site selection for both duplicate and blanks were random to validate the data reported by two laboratories.

Table 3. Groundwater sampling site description.

Site names	Site description
MWH-A01	Alluvial well located in Upper Meadow Creek area
MWH-B01	Bedrock well located in Upper Meadow Creek area
MWH-A02	Alluvial well within the SODA spent ore and tailings
MWH-B02	Bedrock well adjacent to the SODA spent ore and tailings
MWH-A05	Alluvial well just east of HECLA heap leach pad and Hangar Flats deposit
MWH-B05	Bedrock well just east of HECLA heap leach pad and Hangar Flats deposit
MWH-A08	Alluvial well east of EFSFSR and Meadow Creek confluence
MWH-A19	Alluvial well at the toe edge of the Bradley Dumps
MWH-A18	Alluvial well North of the EFSFSR, across the river from the Bradley dumps.
MWH-Duplicate	Alluvial well east of EFSFSR and Meadow Creek confluence
MWH-Blanks	Alluvial well North of the EFSFSR, across the river from the Bradley dumps.

2.3. Quality assurance and quality control protocol

A standard protocol was developed for comparing the estimates of sample results from analytical tests conducted at Anatek Laboratories and the SVL Laboratories. The protocol is based on Quality Assurance Plan from Anatek Laboratories dated May 1st 2021 (Pearson et al., 2021), Quality Assurance Project Plan and Surface Water Quality Sampling Plan for the Stibnite Gold Project (QAPP-SWQSP) dated April 1st 2020 (Serrin, 2020), and Groundwater Quality Supplemental Baseline Study Work Plan for Stibnite Gold Project dated July 1st 2019 (Serrin, 2019). In this protocol, the relative percent difference (RPD) is used as a measure to compare the sample results between the two laboratories (e.g., Boyer et al. (1985)). RPD is defined as the ratio of the absolute difference between the sample results as a product of the mean result, Equation 1 below.

$$\text{Relative Percent Difference, } RPD = \frac{abs(Perpetua\ Result - Anatek\ Result)}{mean(Perpetua\ Result,\ Anatek\ Result)} \quad (1)$$

Along with the RPD, professional judgement, based on standard practices, was also used to classify the data as either “Acceptable”, “Caution”, and “Flagged”. The classification scheme was influenced by the relationship between the RPD and the analyte detection limit, in that the closer the values were to detection levels, the greater the RPD that was considered acceptable.

For example, when the sample results were greater than four times the detection limit (> 4*DL), acceptable RPDs were less than 20%, cautionary RPDs were between 20-30%, and flagged RPDs were greater than 30% (Table 4).

Table 4. The relationship between RPD and qualitative sample acceptability when the sample results were greater than four time the detection limit.

RPD	Remarks
<20% RPD	Acceptable data
20%-30% RPD	Caution
> 30% RPD	Flagged

Likewise, when the sample results were greater than three times the detection limit but less than four times the detection limit, acceptable RPDs up to 30% were considered acceptable, RPDs between 30% to 50% were considered cautionary, while those with RPDs exceeding 50% were flagged (Table 5).

Table 5. The relationship between RPD and qualitative sample acceptability when the sample results were greater than three times the detection limit, but less than four times the detection limit.

RPD	Remarks
<30% RPD	Acceptable data
30%-50% RPD	Caution
> 50% RPD	Flagged

Finally, when the sample results were less than three times the detection limit RPDs up to 50% were considered acceptable, while RPDs between 50% to 100% were considered cautionary, while those with RPDs exceeding 100% were flagged (Table 6).

Table 6. The relationship between RPD and qualitative sample acceptability when the sample results were less than three times the detection limit detection limit.

RPD	Remarks
<50% RPD	Acceptable data
50%-100% RPD	Caution
> 100% RPD	Flagged

3. Analytical Results

3.1. Surface water

Following the rubric for data acceptability (Tables 4-6), the results of analytes from the two analytic laboratories were compared and grouped into acceptable, caution, and flagged. Figure 1 shows the pie-chart of the distribution of the three categories based on the comparison of surface water results from both laboratories.

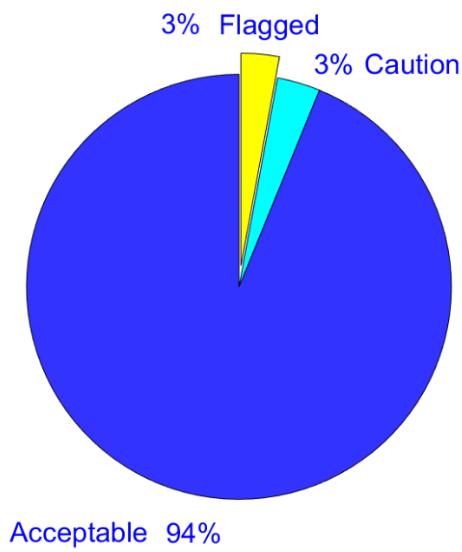


Figure 1. The proportion of the data (11 sites x 25 analytes measured) that fell within the acceptable, cautionary, and flagged categories from the surface water sampling conducted on July 29th, 2021**.**

The analytes and sites that correspond to the 3% flagged data are given in Table 7. Among the flagged data points (a total of eight water sample measurements), three water sample measurements were reported higher by Anatek in comparison to SVL, and five water sample measurements were reported higher by SVL in comparison to Anatek (Table 7, Figure 2).

Table 7. The flagged data identified by Anatek and SVL Laboratories based on the surface water sampling conducted on July 29th, 2021.

Site name	Anatek > SVL	SVL > Anatek
YP-T-43	Sulfate	
YP-T-29		Sulfate
YP-SR-11		Sulfate
YP-SR-10	Dissolved Selenium	
YP-SR-10		Mercury
YP-SR-10		Total Selenium
YP-S-8		Mercury
YP-Blanks	Mercury	

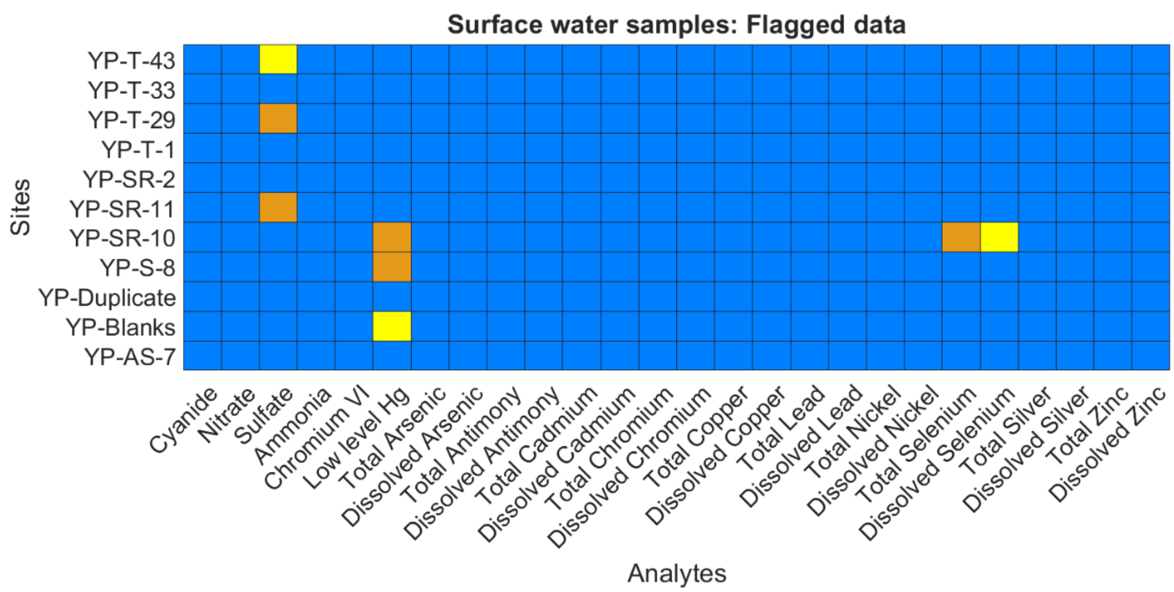


Figure 2. The flagged data points reported by Anatek Laboratory and SVL Analytical from and surface water sampling at Stibnite, Yellow Pine. The light-yellow cells represent cases where the estimate from Anatek exceeded that from SVL. The dark gold cells represent cases where the estimate from SVL exceeded that from Anatek.

3.2. Groundwater

Similarly, groundwater sampling results were analyzed from both laboratories, and it was identified that 96% of the results are in the acceptable range, 2% caution, and 2% flagged. Figure 3 shows the pie-chart of the distribution of the three categories based on the comparison of groundwater results from both laboratories.

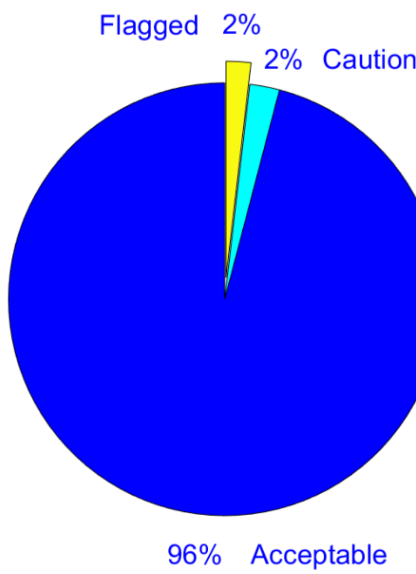


Figure 3. The proportion of the data (11 sites x 25 analytes measured) that fell within the acceptable, cautionary, and flagged categories from the surface water sampling conducted on July 29th, 2021.

Table 8 shows the analytes and sites corresponding to the 2% flagged data. Among the flagged data points (a total of five water sample measurements), two water sample measurements were reported higher by Anatek in comparison to SVL, and three water sample measurements were reported higher by SVL in comparison to Anatek (Table 8, Figure 4).

Table 8. The flagged data identified by Anatek and SVL Laboratories based on the groundwater sampling conducted on August 26th, 2021.

Site name	Anatek > SVL	SVL > Anatek
MWH_A02		Total Zinc
MWH_A02		Total Copper
MWH_A18	Total Arsenic	
MWH_A18	Total Nickel	
MWH_AD1		Dissolved Selenium

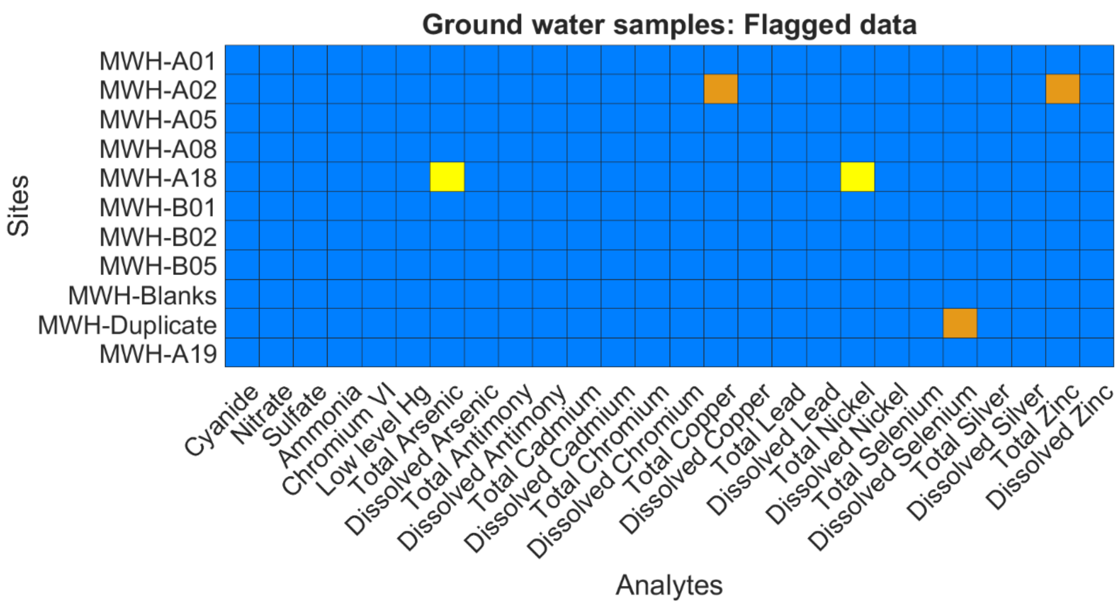


Figure 4. The flagged data points reported by Anatek Laboratory and SVL Analytical from and groundwater sampling at Stibnite, Yellow Pine. The light-yellow cells represent cases where the estimate from Anatek exceeded that from SVL. The dark gold cells represent cases where the estimate from SVL exceeded that from Anatek.

3.3. QA-QC Data Cleaning

In the groundwater sampling, two adjacent sites MWH A18 and MWH A19 showed distinct inconsistencies relative to 8 analytes. Historic data collected from these two sites confirms that they are quite different from each other. For instance, the total arsenic concentration at groundwater well MWH A18 collected from 2012 to 2020 (37 samples) ranged between 0.022 mg/l to 0.774 mg/l, whereas the total arsenic concentration at groundwater well MWH A19 was an order of magnitude higher, ranging between 3.15 to 7.52 mg/l. However, while analyzing these samples during the summer of 2021, the two sites were reversed, such that total arsenic concentration at MWH A18 was consistent with the long-term trend at MWH A19, and vice versa. Similar discrepancies between the two sites and between the current samples and past trends yielded the same result for 6 other analytes including nitrate, sulphate, mercury, antimony, and selenium. By consensus among the scientific experts on this project, it was considered that the most parsimonious explanation for these discrepancies was a mislabeling of sample bottles, such that water from MWH A18 was inappropriately compared to water collected from MWH A19, and vice versa. When the water samples were matched to the presumptive sites of origin, the error in these sites disappeared. Results presented in this study have been corrected for this discrepancy.

4. Discussion

4.1. Surface water

The results of surface water sampling conducted on 11 sites by two laboratories show that 97% of the samples were acceptable while only 3% were flagged. Although 3% of the data was considered in the cautionary category, they are still within acceptable limits, and as such are not flagged as samples of concern. The flagged data (3% or 9 total samples) were split among the analytic laboratories, the field sites and the analytes. For the two laboratories, Anatek laboratory yielded higher values than SVL in 3 of the 275 (1%) of the flagged cases, while SVL was higher in 2% of the flagged cases. In addition, there was not consistent bias among laboratories relative to any specific analyte or any specific site location.

4.2. Groundwater

The results of groundwater sampling conducted in 11 sites by two laboratories show that 98% of the samples were acceptable, while only 2% were flagged. Although 2% of the data was considered in the cautionary category, they are still within acceptable limits, and as such are not flagged as samples of concern. The flagged data (2% or 5 samples) were split among the analytic laboratories and the analytes. For the two laboratories, Anatek laboratory yielded higher values than SVL in 2 of the 275 (1%) of the flagged cases, while SVL was higher in 3 of the flagged cases.

4.3. Comparison between groundwater and surface water

While analyzing surface and groundwater sampling results, the interlaboratory comparison produced acceptable values over 97% of the time, suggesting that the results from the two laboratories were, for the most part, consistent and reliable. Although the surface water samples had a slightly higher percentage of flagged data points (3%) relative to groundwater samples (2%), the flagged analytes were completely different. There was no consistent relationship between a specific analyte being flagged by two laboratories. The only analyte which was flagged during both surface and groundwater sampling was dissolved selenium, but only at one site in surface water sampling (YP-SR-10) and one site in groundwater sampling (MWH_AD1).

Since the flagged samples were very low (3% and 2%) in both surface and groundwater sampling conducted at 11 sites, the differences in the methodology of the laboratories were not analyzed. This will occur, however in the event that the proportion of flagged values increases or is located at one or more specific site locations. A quality assurance-quality control data cleaning procedure was also performed in this study before we analyze the results from both laboratories.

In addition to the water quality parameter evaluation by an EPA-certified laboratory, other on-site water quality parameters including water temperature, pH, conductivity, and salinity were measured using a calibrated YSI Pro 1030 meter. While these values were collected at each surface water and groundwater location, these analytes are not included in the split sampling protocol as only one measurement was made per site.

5. References

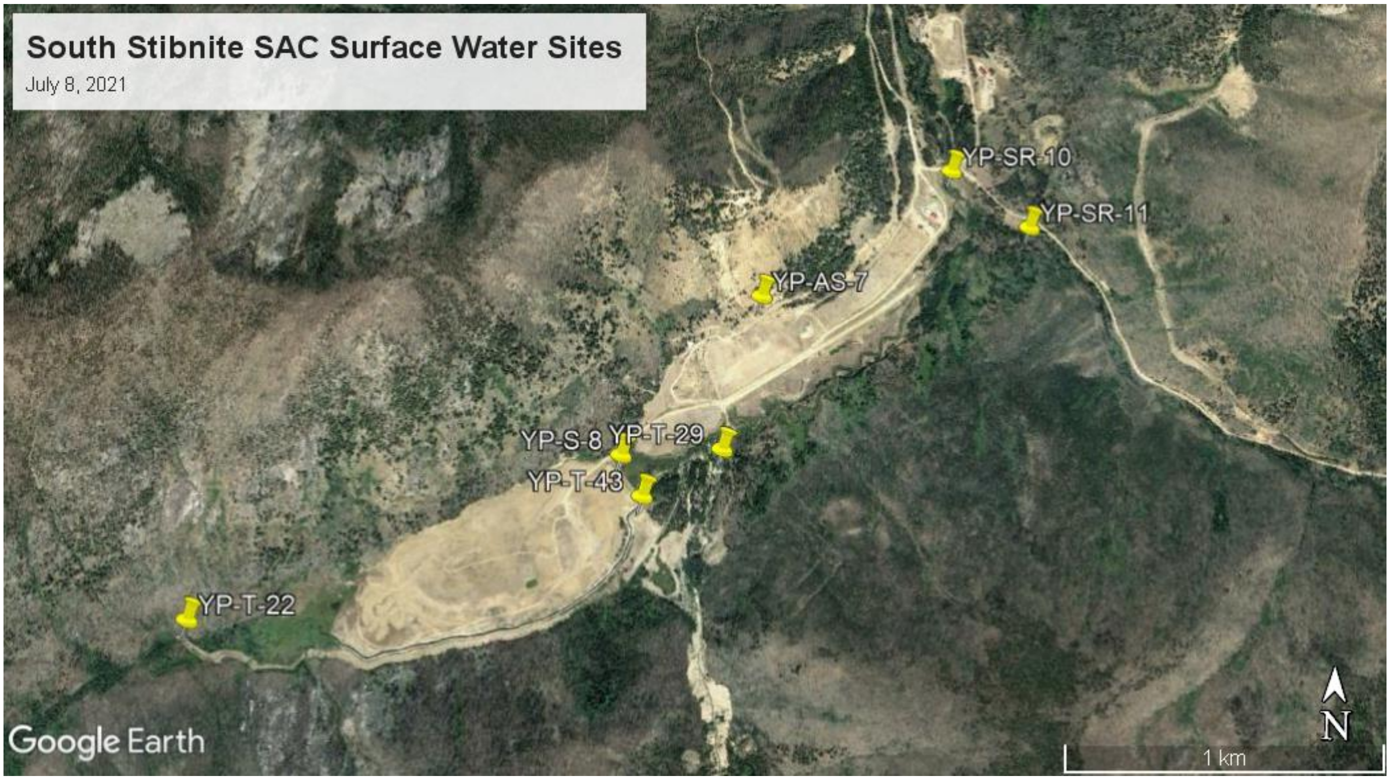
Boyer, K. W., Horwitz, W., & Albert, R. (1985). Interlaboratory variability in trace element analysis. *Analytical Chemistry, 57*(2), 454-459.

Pearson, M., Sattler, K., Taruscio, T., Solomon, G., Linskey, E., & Clappes, L. (2021). *Quality Assurance Plan, Anatek Labs*. Retrieved from 1282 Alturas Drive, Moscow, Idaho:

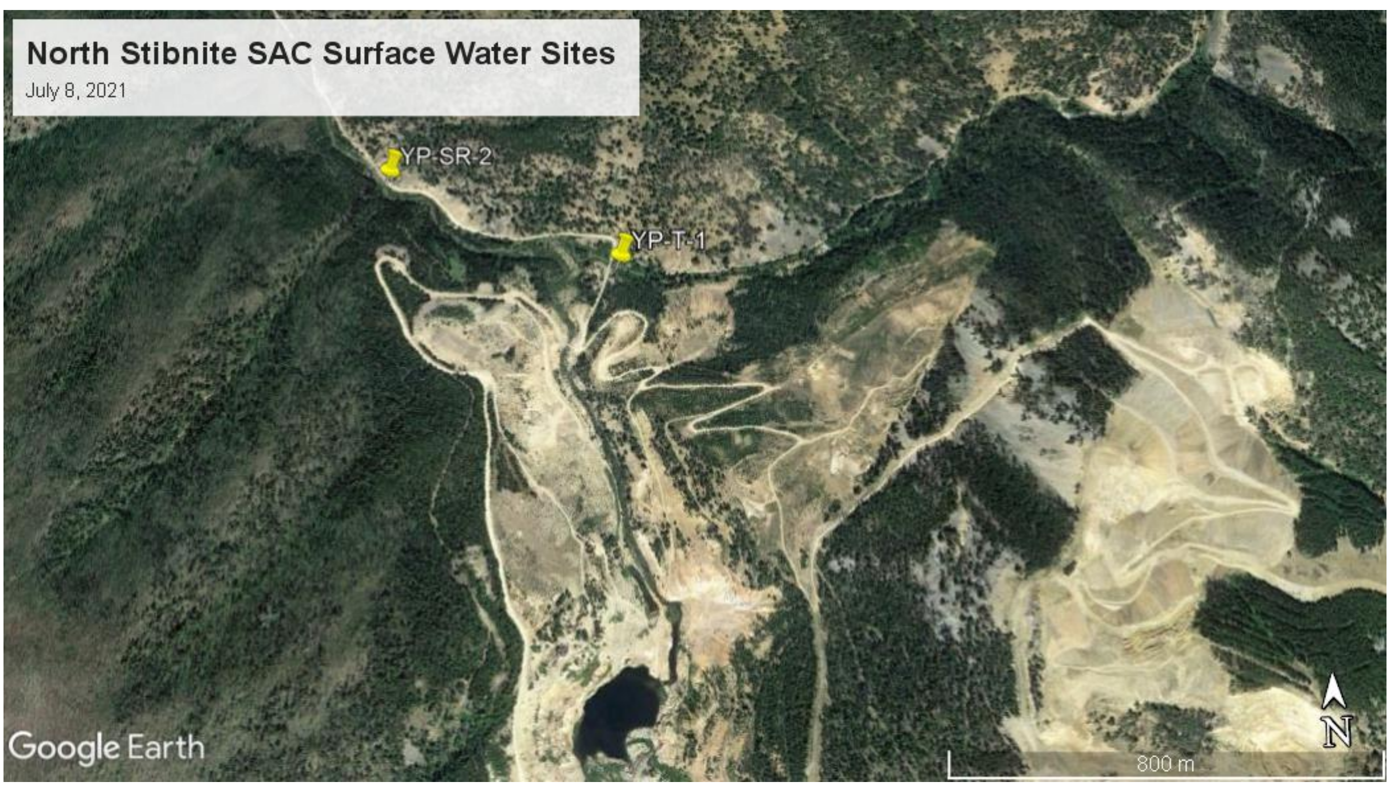
Serrin, B. (2019). *Groundwater Quality Supplemental Baseline Study Work Plan*. Retrieved from 671 E. Riverpark Lane, Suite 200, Boise, ID 83706:

Serrin, B. (2020). *Quality Assurance Project Plan and Surface Water Quality Sampling Plan for the Stibnite Gold Project (QAPP-SWQSP)*. Retrieved from 405 South 8th St., STe. 201, Boise, Idaho:

6. Appendices.



Appendix 1. Surface water sampling sites at the South Stibnite location



Appendix 2. Surface water sampling locations at the North Stibnite location

Appendix 3. Groundwater sampling locations at the South Stibnite location

Appendix 4. Groundwater sampling locations at the North Stibnite location