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Technical Report Overview

Report: Regional Calcite Monitoring Program 2021 Annual Report

Overview: This report presents the 2021 results of the calcite monitoring program required under Permit 107517. This report summarizes the degree and extent of calcite formation in specific stream reaches within the Elk Valley watershed.

This report was prepared for Teck by Lotic Environmental Ltd.

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Teck Coal Ltd.
Regional Calcite Monitoring Program

2021 Annual Report

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Definitions

- AMP – Adaptive management plan.
- Cp – Calcite presence score. A binary metric of calcite presence where a score of 0 is not present and 1 is present.
- Cp' – Calcite proportional presence score. A refinement of Cp that incorporates a measure of the area of a particle covered by calcite: 0 = not present, 0.1 = 10% covered, 0.2 = 20% covered…0.9 = 90% covered, and 1 = 100% covered.
- Cc – Calcite concretion. A measure of the degree to which a particle is fused to adjacent particles by calcite: 0 = no concretion; 1 = concreted but movable by hand; 2 = concreted and immobile by hand.
- CI – Calcite index score. The sum of calcite presence (C_p) and calcite concretion (C_c) for an individual stone.
- Degree – The amount of calcite deposition estimated by the level of concretion.
- Eligible treatment reach – A reach that exceeds the site performance objective (Permit 107517) of a calcite concretion score of 0.5.
- EMC – Environmental monitoring committee.
- EVWQP – Elk Valley water quality plan.
- Exposed – Stream locations with mine-influenced water; used to contrast the reference sites to.
- Extent – The spatial coverage of calcite deposition expressed as an area covered at a specific location or linear coverage over a stream length.
- Habitat unit – A distinct channel unit possessing homogeneous hydraulic and geomorphological characteristics (e.g., riffle, pool, glide, cascade).
- KUs – Key uncertainties.
- MQs – Management questions.
- Reach – A relatively homogeneous section of stream in terms of channel morphology, riparian cover and flow.
- Reference – Stream location without mine-influenced water; used to contrast the exposed sites to.
- Sampling unit – A single unit used to describe a larger entity. For example, a site could be considered the sampling unit for estimating the average calcite coverage over an entire reach.
- Segment – Aggregation of adjacent reaches that have similar calcite indices identified from previous sampling and have the same exposure to mining.
- Site – A location within a reach where observations of calcite deposition were made. These are replicate observations (sample units) within the treatment unit (reach).

Executive Summary

Teck Coal Ltd. (Teck) has been documenting calcite occurrence in waterways downstream of its coal mine operations since 2008 (Berdusco 2009). Although naturally occurring, the degree and extent of calcite formation can increase because of open pit mine runoff (Teck 2017). In 2013, a Regional Calcite Monitoring Program was implemented throughout the Elk Valley. This program has developed a comprehensive, regional database of calcite and has been designed to satisfy the requirements for Environmental Management Act Permit 107517.

The Regional Calcite Monitoring Program field manual was updated in 2021 to address potential sources of variability encountered when conducting calcite monitoring (Gordon and Robinson 2021). Updates included how to assess calcite on unique substrates of fines (sand, silt, clay), pure calcite, and moss. The field manual was also updated in regards to calcite identification and to include general guidelines for identification of calcite presence.

Data collection continued to trial a new calcite presence metric (Cp'). Field methods included a mandatory 100-particle pebble count at each site and the standardization of the number of sites per reach to three. It also included additional reference reaches to determine how well the current program was documenting calcite in reference areas. To increase data consistency across field crews collecting data for multiple Teck monitoring programs, a pre-field training workshop was conducted to review quality control procedures and data collection standards.

Sampling followed the proposed study design with the addition of more reference reaches. Results of the reference reach assessment suggests that the program was adequately describing reference conditions in the study area. Consideration will be given to which, if any, of these new reaches will be formally added to the program in an ongoing basis.

As in previous years, calcite index was reported to be increasing in 2021, however the overall rates of change since 2013 were lower than previously reported (Zathey et al. 2021). Distinctly different slopes can be seen in calcite index values from 2013 to 2017/18 and then after 2017/18 to present. Also noted was the number of reaches with significant linear trends remaining unchanged from 2020 and few reaches with step-wise changes. Collectively these different assessments point towards a reduction in the rate of increase of calcite index throughout the valley. The role of streamflow continues to be presented a key factor in the trends observed from 2013-2021. Streamflow is thought to influence the calcite index through erosion of existing deposition and when new substrate becomes deposited instream from bank erosion and overall sediment transport. A conceptual dataset was presented to discuss this hypothesis with the inclusion of a theoretical equilibrium. Because the hypothesis incorporates flow as a single, large event, it remains challenging to assess with the environmental conditions that have been experienced in the region since 2013.

Pre-field training and standardization of methods appears to be effective at reducing inter-crew variability both within the regional calcite program and between Teck monitoring programs. The ability for training and methods to reduce variability appears to be reaching a value that may be the level of resolution that can be achieved with the pebble counts and within the variability of calcite at a location. The new calcite presence metric (Cp') again shows promise at both further reducing sampling error (beyond training) and through improved predictability between of calcite concretion from calcite presence.

1 Introduction

Teck Coal Ltd. (Teck) has been documenting calcite occurrence in waterways downstream of its coal mine operations since 2008 (Berdusco 2009). Although naturally occurring, the degree and extent of calcite formation can increase because of open pit mine runoff (Teck 2017). In 2013, a Regional Calcite Monitoring Program was implemented throughout the Elk Valley. This program has developed a comprehensive, regional database of calcite and has been designed to satisfy the requirements for Environmental Management Act Permit 107517.

The Regional Calcite Monitoring Program continues to detect changes in calcite within the Elk Valley. Data from this monitoring program are being used in follow-up assessments in attempt to describe the relationships between calcite deposition, water quality, hydrology, and the extent of watershed disturbance. Given the potential for calcite to be influenced by multiple variables concurrently and in different ways, continued monitoring is vital to understanding how mining is contributing to this issue.

The Regional Calcite Monitoring program continues to evolve since inception in 2013. The 2021 Program sampled a relatively large number of reaches and stream kilometers. This is due in part to a return to reach-based sampling as a design basis and efforts made to assess the accuracy of how well reference conditions are being described.

Teck continues to work on managing calcite to remain in regulatory compliance with calcite site performance objectives (SPOs). There are currently three operational calcite management programs within the Elk Valley (water treatment on lower Greenhills Creek (Teck 2020), Line Creek, and Swift and Cataract creeks). Physical habitat rehabilitation projects are also within design phases for Greenhills Creek and Clode Creek. Water treatment and habitat rehabilitation are two mitigative actions within the larger Calcite Management Plan (Teck 2019). In December 2021, Teck developed and implemented early warning triggers to help manage calcite risk within the Elk Valley.

1.1 Linkage to Adaptive Management

As required in Permit 107517 Section 10, Teck has developed an Adaptive Management Plan (AMP) to support implementation of the Elk Valley Water Quality Plan (EVWQP) to achieve water quality targets (including calcite), to protect human health and the environment, and where necessary, to facilitate continuous improvement of water quality in the Elk Valley. Following an adaptive management framework, the AMP identifies six Management Questions (MQs) that are re-evaluated at regular intervals. The need for early warning triggers (as well as for calcite early warning triggers specifically) also have been identified for specific MQs, which if reached, initiate action under the AMP Response Framework. The AMP also identifies Key Uncertainties (KUs) that must be reduced to fill gaps in current understanding and support the EVWQP objectives.

The results presented in this report provide information relevant to one of the six MQs and address many of the key uncertainties identified in the AMP. Calcite monitoring data along with data collected from other programs are used to re-evaluate the answer to MQ 4 (“Is calcite being managed effectively to meet site performance objectives and to protect the aquatic ecosystem?”). The key uncertainties of MQ4 are listed in Table 1. Results from this report will be used to develop calcite early warning triggers. Reaching a trigger, or an answer of “no” or “uncertain” to a Management Question, would lead to actions under the Response Framework in the AMP.

Table 1. Management Question 4 Key Uncertainties (Teck 2021).

Key Uncertainty	Key Uncertainty
4.1	Are the calcite SPOs protective of fish and aquatic life?
4.2	What are the most effective management methods for calcite?
4.3	Are there interrelationships with calcite and select constituents of interest in surface water that need to be considered for calcite management?
4.4	Can early-warning trigger (EWTs) be established for calcite that support calcite management?

1.2 Program Objectives

Key objectives of the Elk Valley Calcite Monitoring Program are to:

1. Document the extent and degree of calcite deposition in streams downstream of Teck's coal operations (e.g., streams influenced by mining, calcite treatment, water treatment and in reference streams).
2. Satisfy the requirements for annual calcite monitoring in Environmental Management Act Permit 107517 (Table 2).
3. Provide data to support the re-evaluation of Management Question 4 ("Is calcite being managed effectively to meet site performance objectives and protect aquatic ecosystem health?") and Key Uncertainties in Permit 107517 as they relate to calcite.

Table 2. Permit 107517 annual reporting requirements (Section 9.7).

Requirement	Description	Report Section
i	A map of monitoring locations	Appendix 4
ii	A summary of background information on that year's Program, including discussion of Program modifications relative to previous years	2.1, 2.5 &2.6
iii	Results of stream selection reassessment – highlight streams added/removed	2.4&2.5
iv	Summary of where sampling followed the methodology in the monitoring plan document, and details where sampling deviated from the approved methodology	2.5 & Appendix 3
v	Statement of results for the period over which sampling was conducted	3.3
vi	Reference to the raw data, provided as appendices	3.3
vii	General discussion of observations, including summary tables of sites with increasing and decreasing deposition indices	3.3
viii	Interpretation of location, extent, and any other observations	3.3
ix	A summary of any QA/QC issues during the year	3.1
x	Recommendations for sites to add, sites to remove, modifications to methodology, monitoring frequency adjustments	4, 5, Appendix 11
xi	A statistical evaluation of monitoring data to evaluate the presence of short and long term calcite related trends in the Elk Valley main stems and select tributaries	3.3

2 Methods

2.1 Field manual review and update

Following a recommendation in the 2020 regional calcite monitoring report (Zathey et al. 2021), the existing field manual (Robinson and Atherton 2016) was reviewed and updated to reflect the current program. The 2021 field sampling manual (Gordon and Robinson 2021) is provided in Appendix 1. A summary of key updates is provided below.

Key updates were made to address potential sources of variability encountered when conducting calcite monitoring for any of Teck's monitoring programs. During past calcite training workshops, variability was noted in how crews were assessing less common stream substrates. Fines (sand, silt, clay), pure calcite, and moss are less common substrates that crews may encounter when sampling for calcite. Identification and classification of calcite can be challenging among these substrates. The manual was updated to standardize how each of these substrate types will be assessed. Another area of important updates was in regard to calcite identification. Variability between crews has also been noted when attempting to identify calcite presence at low levels (e.g., CI <0.5). Presence of certain algae and fine sediments can confound observations. The 2021 sampling manual was updated to include some general guidelines for identification of calcite presence.

Other manual updates included:

1. Trial of new calcite presence metric (Cp') – Calcite presence will be recorded using bins representing 10% increments of surficial calcite coverage of an individual particle. These data are collected in a way that allows for this proportional method to retain the ability to report as the binary "yes/no" presence as done in all years prior to 2020. See Zathey et al. (2021) for a more comprehensive discussion on this trial;
2. Replacement of an initial calcite inspection with a mandatory 100-particle pebble count at each site.
3. Standardization of the number of sites per reach, three (3) sites where reach length is >300 m, one (1) site when reach length is <300 m.
4. Updated QA/QC to include:
    a. Field sampler training and documentation of attendance.
    b. Duplicate sampling of 10% of sites.
    c. Preliminary entry and review of current year's data against previous years to identify potential anomalies.

2.2 Calcite training workshop

Two pre-field training workshops were completed prior to sampling for regional crew members, as well as other programs (spawning suitability and regional and local aquatic effects monitoring programs). Crews met in the field to review methods and field manual updates. Focus was given to potential sources of variability and the proportional calcite method. A list of attendees of each workshop is provided in Appendix 2.

2.3 Reference condition assessment

Feedback was received from the EMC inquiring how well the current program was documenting calcite in reference areas. To address this uncertainty, additional reference areas were sampled in 2021 and the results were used to determine if the larger set of reference areas would provide a similar condition to the historical dataset (2013-2020). The list of historical reference reaches (N=11) was evaluated, and 15 additional reaches were included in the 2021 program (Table 3 and Figure 1). Preferred criteria used to select the additional reference reaches were:

- Within the Elk River watershed
- Free of upstream mining (current or historical)
- Free of any other disturbances (ford crossings, municipal inputs, etc)
- Of a magnitude similar to those in the exposed reach category
- Alignment with other programs (e.g., RAEMP/LAEMP)

Table 3. Summary of reference reaches sampled in 2021.

MU	Strata	Stream	Reach*
MU-1	Tributary	Chauncey	CHAU1
	Tributary	East Dry	ETRI1
	Tributary	Ewin	EWIN1
	Mainstem	Fording	FORD12
	Tributary	Henretta	HENR3
	Tributary	Toddhunter	TODH1
MU-2	Tributary	Grace	GRAC1
	Tributary	South Line	SLINE2
MU-3	Tributary	Aldridge	ALDR1
	Tributary	Bingay	BING1
	Mainstem	Elk	ELKR15
	Tributary	Forsythe	FORS1
	Tributary	RG_UCWER	RG_UCWER1
	Tributary	Weigert	WEIG1
MU-4	Tributary	Alexander	ALEX1
	Tributary	Alexander	ALEX3
	Tributary	Alexander	ALEX8
	Tributary	Andy Good	ANDY1
	Tributary	Grave	GRAV3
	Tributary	Leach	RG_LE1
	Mainstem	Michel	MICH5
MU-5	Tributary	Drinkwater	DRIN1
	Tributary	Hartley	HART2
	Tributary	Lizard	LIZA1
	Tributary	McCool	MCOO1
	Tributary	Morrissey	MORI1

*Green highlighting indicates reaches new to the program in 2021.

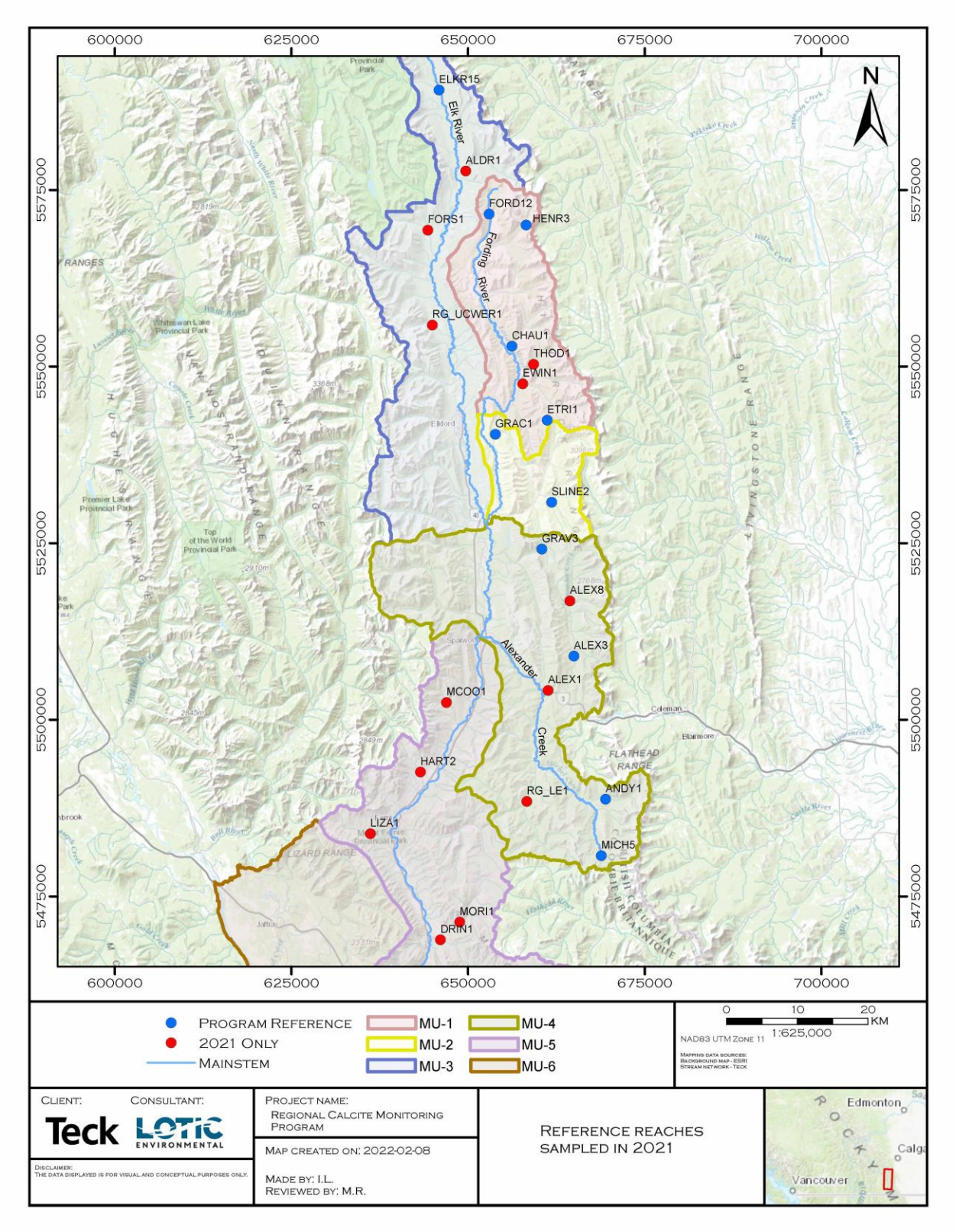


Figure 1. Regional Calcite Monitoring Program study area and reference reach locations.

Mean calcite index (CI) values were plotted for references reaches over the full dataset from 2013-2021 to show interannual variability. An overall mean CI value for reference areas was also calculated (CI_{ref}) from the 2013-2021 dataset. Using only 2021, a mean CI_{ref} was calculated for the historical reaches (N=11) and the complete 2021 list (N=26). These were compared to one another and to the long-term record and mean. Good agreement between the reference condition described from the historical reaches (N=11) and the complete 2021 list (N=26) would suggest that the historical reaches are accurately describing reference condition in the study area. A final recommendation of reference reaches going forward would also include adequacy in spatial distribution (e.g., balance of coverage). A review of available surficial geology did not yield any information that could be used to assess reference reach suitability.

2.4 Study area

Until 2021, the regional calcite monitoring program study area existed as the Elk River watershed upstream of Fernie, BC. This area includes each of Teck's four mining operations in the Elk Valley, namely Fording River Operations (FRO), Greenhills Operations (GHO), Line Creek Operations (LCO), Elkview Operations (EVO), as well as Coal Mountain Mine (CMm) that transferred into Care and Maintenance (an operational mine status) part way through 2019. With the expansion of sampling in reference areas, the 2021 Study Area extended further downstream to the confluence of the Elk River and Morrissey Creek; approximately 15 kilometers downstream of Fernie (Figure 1).

2.5 Sample Locations

As recommended by Zathey et al. (2021), sampling returned to a reach-by-reach sampling approach to maintain a more comprehensive calcite dataset. While the indicator reach approach did improve sampling efficiency, the potential for gaps in the monitoring record was considered a risk not offset by the gains in efficiency. Also recommend, and discussed in Section 2.1, was the standardization of three sites per reach where reach length is >300 m.

Monitoring in 2021 occurred at 346 sites covering 174 stream reaches. The study design originally proposed 339 sites. The net difference of 7 sites came from 47 sites added and 40 removed. Forty-five sites were added for the reference condition assessment and two sites added back into the program as permit requirements (STR-14 was incorrectly removed from the program, but needed to remain to meet the requirements of Sparwood Ridge Monitoring Program as stated in a letter from Ministry of Environment (2016)). Of the 40 sites removed, 31 were removed as they provided >3 sites per reach, 3 sites were previously removed but erroneously included into the 2021 study design (located on Bodie Creek – Reach 2 and Pengelly Creek), and 6 were removed as they were no longer required as result of a change in project assessment requirements (Grace Creek reaches 2 and 3 were originally included as "potentially" impacted during LCO Phase II baseline assessment and are no longer needed. Monitoring of Grace Creek Reach 1 continues for reference reach purposes).

All deviations from the 2021 study design are listed in Appendix 3 along with the reason for the change. Sample locations are mapped in Appendix 4.

2.6 Field methods

Field sampling was completed between August 23 to October 22, 2021. Methods followed the calcite field sampling manual. A modified Wolman pebble count (Wolman 1954) was used to randomly select stones for inspection of calcite. At each site, 100 individual rocks (or substrate) were sampled over approximately 100 m, a distance that included multiple habitat units. Calcite concretion and presence were recorded for each of the 100 counts. Presence was recorded in the field as proportional presence (Cp'), but converted in the office to also provide the traditional calcite presence metric (Cp) (Zathey et al. 2021).

2.7 Data analysis

2.7.1 Calcite metrics

Three standard metrics were calculated from inspection of all 100 counts:

$$\text{Cp} = \text{Calcite Presence} = \frac{\text{Sum of stones presence scores}}{\text{Number of stones counted}}$$

$$\text{Cc} = \text{Calcite Concretion} = \frac{\text{Sum of stones concretion scores}}{\text{Number of stones counted}}$$

$$\text{CI} = \text{Calcite Index} = \text{Cp} + \text{Cc}$$

Also calculated from pebble count data were the proportional calcite presence (Cp') and the resulting Calcite Index using Cp' (CI').

$$\text{Cp}' = \text{Proportional Calcite Presence}' = \frac{\text{Sum of stones proportional presence scores}}{\text{Number of stones counted}}$$

$$\text{CI}' = \text{Calcite Index} = \text{Cp}' + \text{Cc}$$

2.7.2 Data quality assurance

Data quality assurance procedures follow those outlined in the 2021 field sampling manual. As per Gordon and Robinson (2021):

1. Crews will attend the annual calcite training course held at the beginning of the field season. At a minimum, all crew leads who will be conducting calcite sampling will attend the annual calcite training course. All crew members will be encouraged to attend the training course. This will ensure each crew is familiar with different types of calcite and sampling procedures. As well, a crew calibration day will occur at the start of the regional program. Attendance will be documented in the annual regional calcite monitoring report.
2. To assess inter-crew variability, 10% of sites will be randomly selected for duplicate sampling by second crew. Results were compared following 2020 methods.
3. Encourage communication between crew members completing different tasks (sampling versus recording) over the course of the entire project. Doing so is likely to reduce crew member variability, thereby resulting in improved data quality and consistency.

4. Data collection forms will be reviewed for completeness before leaving the sampling location and signed off at the end of each field day by the crew lead.
5. Data collection forms will be scanned and submitted to the Project Manager or designate daily. These data will be used to calculate a preliminary calcite index score and compare to previous records. Large deviations from previous years (>0.5 CI difference) will be investigated and potentially resampled by a second crew.
6. Following data entry into Lotic's digital form, values will be assessed for accuracy using a computer script developed from R Programming Language. This will check that cells contain acceptable values (e.g., calcite presence score can only be 0, 0.1, 0.2…. 1); concreted scores can only be 0, 1, or 2; concreted score must be 0 if calcite presence is 0); habitat unit type can only be R (riffle), P (pool), G (glide), C (cascade). Cells that had errors or were blank were flagged and corrected.

2.7.3 General calcite distribution

Results were presented by four stream categories (Table 4). Sites on the Elk, Michel and Fording Rivers were considered mainstem. All other streams were classified as tributaries. Reaches were also classified as reference or exposed relative to upstream mine influence.

The style of presenting general calcite distribution was modified in 2021 to align with that of the data driven metrics. Calcite Index and Calcite Concretion values were presented in stacked column graphs with values representing stream kilometers, as opposed to percentage of stream kilometers as presented in previous reports. Stream kilometers were summarized into six CI bins (0-0.25, >0.25-0.5, >0.5-1.0, >1.0-2.0, and >2.0-3.0) with smaller bins at lower values to provide increase resolution within the range of where SPO's and potential early warning triggers occur. Cc bins used were 0, >0-0.25, >0.25-0.5, >0.5-1, >1-1.5, and >1.5-2.0. Trends were qualitatively described.

Table 4. The number of reaches in mainstem or tributary in exposed or reference conditions.

Strata	Exposed	Reference
Mainstem	21 reaches	3 reaches
Tributary	79 reaches	23 reaches

Mean calcite index scores for each reach were mapped to illustrate the spatial distribution of calcite relative to each of the mines. These maps show the mean calcite index value for reaches sampled in 2020 (Appendix 5). Values in the brackets next to each reach are the mean reach values for calcite index or calcite concretion.

2.7.3.1 Rate of change in calcite deposition by mine exposure

Analysis of co-variance (ANCOVA) was conducted to investigate whether the rate of change differed between reference and exposed reaches. Linear regression was used to determine if both reference and exposed reaches were significantly increasing.

2.7.3.2 Permit 107517 Site Performance Objectives

Environmental Management Act Permit 107517 provides site performance objectives (SPO) for various water quality variables, including calcite. The Elk Valley Water Quality Plan defines short-term (December 31, 2024) and long-term (December 31, 2029) SPOs for calcite. The short-term objective states that "streams that are fish bearing, provide fish habitat or flow directly into fish bearing streams and are not scheduled by an environmental assessment certificate or mines act permit to be buried" must be managed to a calcite concretion score ≤ 0.5. The concretion scores of all sites were compared to the 2024 SPO of 0.5. All sites that exceed this SPO are listed along with the length of each site to determine total stream kilometers, which will inform the Calcite Management Plan (section 5.1 of Permit 107517).

2.7.4 Trends by reach

Calcite data were assessed at a reach scale for both linear and step-wise changes over time. Linear trends were assessed for CI, Cc, and Cp using Mann-Kendall analysis. This analysis produces a tau value that represents the "strength" of correlation between the calcite test variable and year. A tau of 1 indicates a strong and positive (i.e. increasing) relationship while a value of -1 implies that it is a strong and negative (i.e. decreasing). In order to increase sensitivity of this analysis, we set two alpha values (0.05 and 0.10) to allow for early identification of potential trends. The use of the more liberal alpha value of 0.1 was used in the inaugural years of this Program, but later was found to indicate potential trends that would later become more strongly significant.

Analysis of variance (ANOVA) followed by Tukey's Honestly Significant Difference (HSD) post-hoc analysis was used to analyze the effect of year on mean calcite index values per reach to test for step-wise changes.

2.7.5 Trends in reaches associated with treatment

Three reaches with water quality treatment were further investigated for changes in calcite index relative to the date that treatment began. These reaches and treatment facilities are:

- Greenhills Creek – Reach 1 (GREE1) is downstream of the Lower Greenhills antiscalant module that became operational as of 2017.
- An active water treatment facility was constructed on Line Creek/West Line Creek in 2014 and was intermittently operational from 2014-2018, before becoming fully online in 2018. This facility has the potential to influence Line Creek – Reach 4 (LINE4).
- A temporary antiscalant module was installed to treat the combined flow of Swift and Cataract creeks in 2019. The treated water flows into Fording River – Reach 9. The sub-reach FORD9a will reflect changes downstream of the treated water. The reach upstream of the outfall (FORD9b) will serve as an uninfluenced reference.

CI values were plotted for each of these reaches from 2013-2021. Values were qualitatively assessed relative to the start of treatment to investigate if changes are suspected of occurring. It is expected for this assessment to become quantitative as the period of monitoring post-treatment increases.

2.7.6 Effect of streamflow

The effect of streamflow on calcite has been presented as a potential moderating influence on observed calcite index and as an explanation, at least in part, of the increasing trends of calcite index in both reference and exposed reaches since 2013 (e.g., McCabe and Robinson 2020). A preliminary assessment of flow was completed by Zathey et al. (2021) with inconclusive results. The flow hypothesis was presented as a potential explanation for the watershed-wide increase in calcite being reported over the period of study. The flow hypothesis speculated that the large flood of June 2013 resulted in such substantial sediment mobilization and channel migration throughout the Elk River watershed, that calcite monitoring in 2013 likely documented conditions dissimilar to what would have existed immediately prior to the flood. Furthermore, the calcite index documented at most reaches in 2013 would not have been accurately representing the degree of calcite that should exist at a location based on its water chemistry. In absence of major flood events, the degree and extent of calcite is returning to preflood conditions and conditions in line with the biogeochemical environment of a site.

Key to this hypothesis is the expectation that the response of calcite deposition to stream flow is non-linear. It is expected that flows must exceed some threshold value before the fluvial processes are strong enough to result in a measurable reduction in the amount of calcite present. This is important to understand because without flows exceeding that threshold, a respond to annual streamflow is not likely to be detected. As well, the response is not expected to be a predictive relationship between flows of a given year to calcite index of that year. Flow is expected to affect the rate of change in CI at a location in addition to other factors. In that, CI can still be observed as increasing while also being affected by flow in that the rate of increase may be reduced.

While we do not suspect a flow threshold to have been met since 2013, there is nonetheless interest within Teck and the EMC in assessing the effect of flow on calcite. A similar analysis completed by Zathey et al. (2021) was included in this report. Long-term flow monitoring data from four stations in the watershed were matched with thirteen calcite reaches to provide spatially related flow and calcite data (Table 5). Calcite data were presented as the change in calcite index per year (ΔCI/year). Scatter plots of ΔCI/year versus peak instantaneous discharge were created to quantitively assess the relationship between CI and flow.

Table 5. Flow stations and calcite reaches matched for flow analysis.

Hydrometric station	Calcite reaches
Henretta Creek,	HEN1, HEN2
Fording River near North Tailings Pond (FRNTP)	FORD8, FORD9, FORD10
Fording River at the Mouth	FORD1, FORD2, FORD3, FORD4
Line Creek	LINE1, LINE2, LINE3, LINE4

2.7.7 Effect of habitat unit type

The effect of habitat unit has been questioned as a potential confounding factor when comparing calcite monitoring results between Teck programs. This was assessed in this report using individual pebble counts records where each count is assigned to a habitat unit type during the field surveys. Habitat units can be pool, riffle, glide, cascade – the standard habitat unit classifications used in the provincial level 1 Fish Habitat Assessment procedure (Johnston and Slaney 1996). ANOVA (with Tukey's HSD) was completed to test for a significant effect of habitat unit type on CI, Cc, and Cp. These assessments were only run using reaches that contained at least one glide, pool, and riffle to aim for comparable representation.

2.7.8 Inter-program comparisons

Teck collected calcite data as part of their Regional and Local Aquatic Effects Monitoring Programs (RAEMP/LAEMP) (conducted by Minnow Environmental Ltd) and Spawning Suitability Assessment (conducted by Ecofish) again in 2021. RAEMP/LAEMP programs have the general objective of quantifying effects of mining in local and regional aquatic environments. The Spawning Suitability Assessment aims to describe an effects curve of calcite on Westslope Cutthroat Trout spawning suitability. This provided an additional opportunity to compare the results of these programs to those of the regional monitoring program. Previous inter-program comparisons found moderate agreement between programs. Efforts to standardize data collection methods and conduct training workshops were intended, in part, to reduce inter-program variability, understanding that some methodological differences remain (Table 6). Comparing results allows for an investigation into the effectiveness of the efforts.

Table 6. Summary of spatial scale and general methods by Teck monitoring program.

Program	Scale	Methods
Regional	Reach	100 particle pebble count over a distance covering multiple habitat units present. Three sites sampled within a reach
RAEMP /LAEMP	Habitat unit (Riffle)	100 particle pebble count within a riffle. Three replicate riffles per site.
Spawning suitability	Multiple Habitat Unit	30 particle pebble count in each habitat unit present.

Sample locations from the different programs were spatially paired and plotted on scatterplots with a 1:1 line to visually assess unity. CI values were statistically assessed using linear regression between the following pairs: Regional-RAEMP/LAEMP, Regional-Spawning Suitability, and RAEMP/LAEMP-Spawning Survey. Agreement between programs was considered good when the regression model showed high accuracy ($r^2 \geq 0.8$) and slope of the regression line was close to 1. Results were compared to previous years to determine program results were becoming more comparable. As a final assessment, reach level CI values were plotted to identify specific reaches where notable differences may remain.

Given that larger interprogram differences have historically been between regional and RAEMP/LAEMP data, and that these programs vary the most in methods, the regional program visited 17 RAEMP/LAEMP sites and performed sampling using identical methods to RAEMP/LAEMP sampling in that sampling was only conducted in riffles and three riffles were

sampled in each location. Agreement to the RAEMP/LAEMP results was assessed as described above.

2.7.9 Assessment of the Calcite Index

Zathey et al. (2021) presented a proportional calcite presence (Cp') metric to record presence as a scalable score from 0 to 1 that increased by 0.1 increments where the increments equaled percentage cover of an individual particle. For example, a rock with 10% coverage would receive a Cp' score of 0.1, whereas it would have been scored Cp=1 with the binary Cp (Table 7). Cp' was recommended as a method to decrease intercrew variability by increasing precision at a site level. It has secondarily been presented as a more accurate predictor of calcite concretion; the component of CI related to potential biological effects (Minnow 2016). Cp' may therefore have potential use in early warning trigger development.

The effectiveness of Cp' to reduce intercrew variability was first assessed within the regional program using the 10% of sites will be randomly selected for duplicate sampling. Intercrew differences between crews using CI versus CI' was compared through a paired t-test. This same assessment was then ran using the locations paired in the interprogram, again using paired t-test.

The ability of the two calcite presence metrics (Cp and Cp') to predict Cc was compared by fitting nonlinear models to both sets of data. R^2 values were compared to discuss the predictive ability for Cp and Cp'.

Table 7. Cross-referencing between the old method of calcite presence (Cp) and the new method of calcite presence (Cp') scores.

Cp	Cp'	Percent of particle area covered
0	0	0%
1	0.1	10%
	0.2	20%
	0.3	30%
	0.4	40%
	0.5	50%
	0.6	60%
	0.7	70%
	0.8	80%
	0.9	90%
	1	100%

3 Results

3.1 Data quality assurance

Quality assurance and control was carried out on all data collected for this study. All crew members attended pre-field training.

Crew leads calculated CI scores during the field program to identify sites with notable deviations to historical data and requiring triggered QA sampling. A total of 33 of the 346 sites sampled (9%) triggered the QA sampling threshold of >0.5 change in CI. For 23 of these, the follow-up values were used, as the observations were made by a more experienced crew member. This identified additional crew training opportunity. The remaining 10 sites had comparable results and no change was required.

Next, Data were checked for formatting using an automated R script and corrected prior to analysis.

Finally, thirty (30) randomly selected sites were sampled in duplicate to assess intercrew variability. Very good agreement was found between duplicates ($r^2 = 0.97$), with a mean difference of 0.11 CI. The relationship had a near 1-to-1 fit (y=0.91x+0.02) (Figure 2).

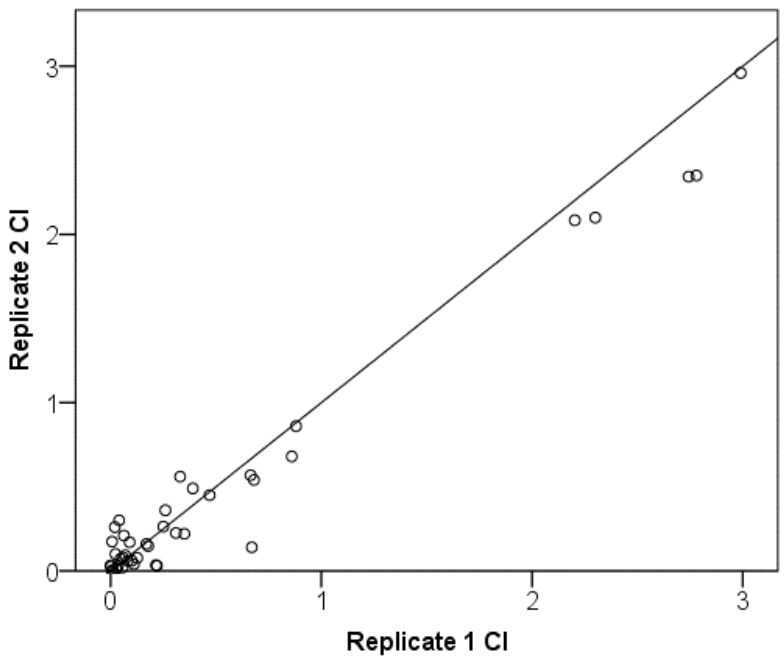


Figure 2. Regression plot of CI values for random quality assessment sites.

3.2 Reference condition assessment

In order to evaluate how representative historical (2013-2020) reference reaches are, the 2021 field program included 15 additional reference locations. In general, reference reaches show relatively comparable values over full program (2013-2021) (Figure 3). The overall mean CI was 0.07 (N=137; SD=0.13; Range= 0.00-0.86). In 2021, sampling all reference reaches (N=26; mean=0.06; SD=0.07) produced similar overall description of reference conditions as that using only standard program reference reaches (N=11; mean=0.06; SD=0.07).

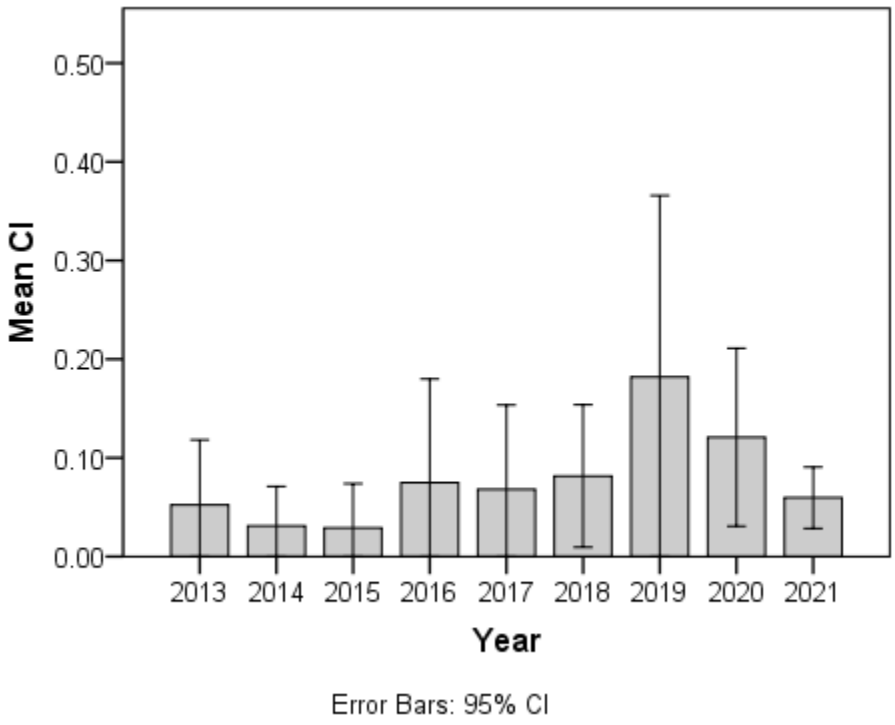


Figure 3. Mean reference reach CI for 2013-2021.

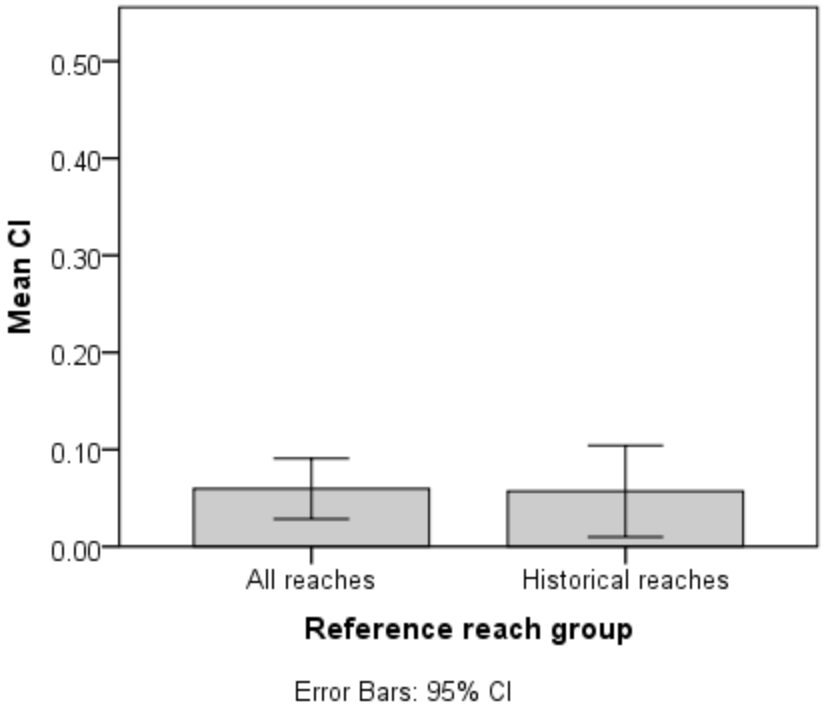


Figure 4. Comparison of Mean CI for all reference reaches sampled (2021 and historical data set respectively).

Spatial coverage of tributary reaches was assessed using Teck's Management Units (MU). Mainstem reference reaches are already included to the extent possible for each of the three mainstems in the program (Elk, Fording, Michel) and not considered in this exercise. Listing reaches by MU showed that the historical reference reach group included multiple reaches in MU's 1, 2 and 4, but none in MU's 3 and 5. MU3 is the unit of the Elk River that extends upstream of the confluence with the Fording River to the headwaters. As there are exposed tributaries in this unit, on the west side of Greenhills Operations, reference tributaries may be valuable to include. MU5 on the contrary lacks exposed tributaries and adding any here may not be necessary.

Table 8. Count of reference reaches by management unit (MU) and reference reach group.

MU	Historical reaches	Reaches added in 2021
1	3	2
2	2	0
3	0	5
4	3	3
5	0	5

3.3 General calcite distribution

The total number of stream kilometers evaluated and mapped in 2021 was 403 km, up from 346 km in 2020 and 353 km in 2019. The increase was almost entirely from the additional reference reaches. A program summary (2013-2021) of calcite index, calcite presence, and calcite concretion values for all reaches (Appendix 6) has been provided.

Generally, calcite index continues to increase in exposed mainstem (Figure 5). Mainstem reaches had the largest number of stream kilometers that exceeded a CI of 1 since the start of the program. However, the increase appears localized. Exposed mainstem reaches that exceeded a CI of 1 in 2021 were FORD 2, 4, 6, and 7. Each of these are downstream of FRO and FORD 2 and 4 are also downstream of GHO. Calcite index of exposed tributary appears stable since approximately 2018. Calcite index remains low in both reference mainstem and tributary, will all values being < 0.25 CI.

Calcite concretion showed a similar pattern in both exposed mainstem and tributary (Figure 6). Both show an overall increase since the start of the program, but relatively little to no change since approximately 2017 to 2018. One mainstem reach to exceed 0.25 Cc was FORD6. Concretion was not detected in any mainstem reference reach in 2021 and did not exceed 0.25 in any tributary reference reach.

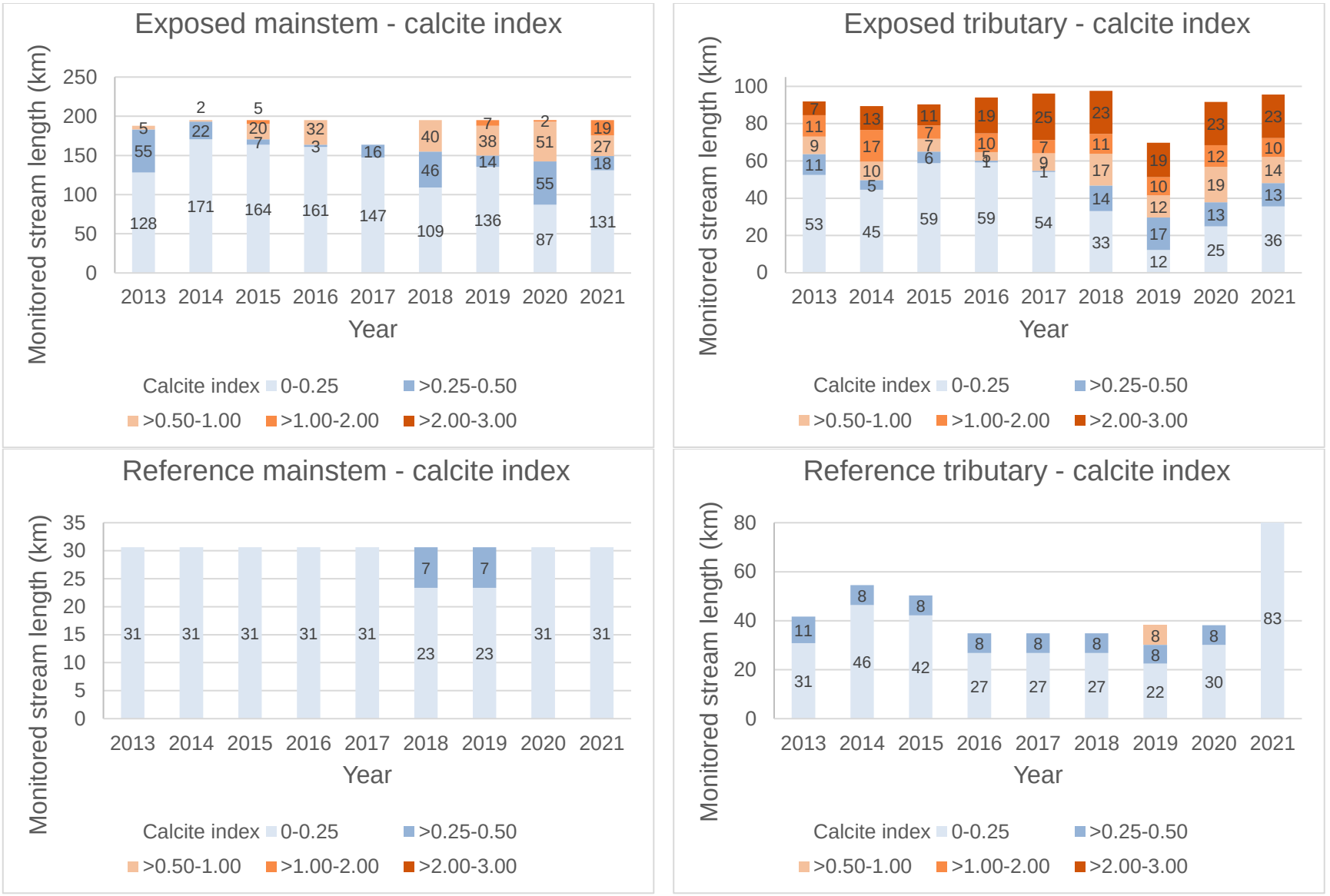


Figure 5. The distribution of calcite index by reach type (exposed/reference), strata (mainstem/tributary), and kilometers.

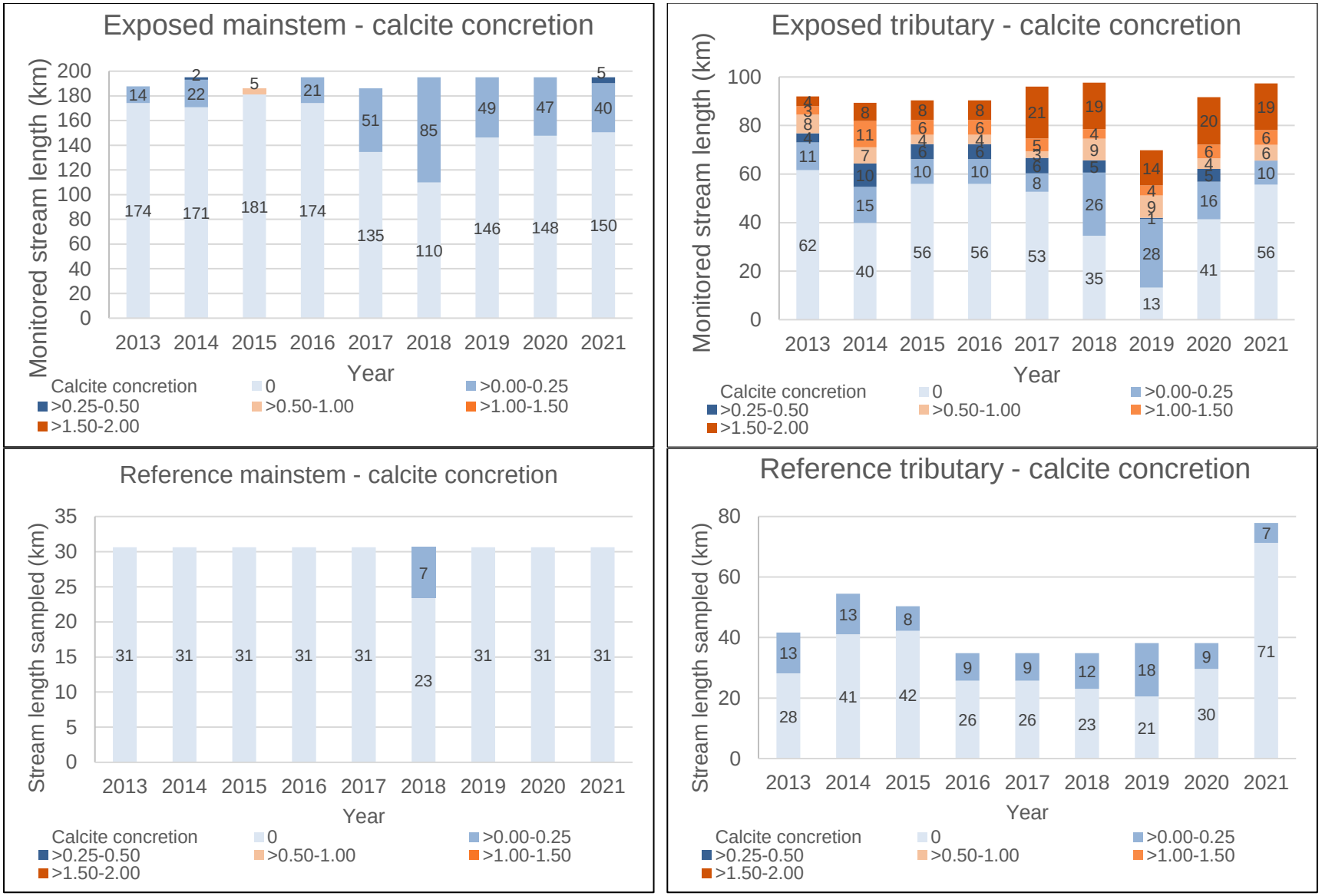


Figure 6. The distribution of calcite concretion by reach kilometers.

3.3.1 Rate of change in calcite deposition by mine exposure

Calcite index was found to have significantly increased since the start of the program (2013-2021) in both exposed ($p<0.001$) and reference ($p=0.05$) reaches. However, using linear regression the rate of increase in both reference and exposed was slightly lower than in 2020 (exposed: 0.07 CI/year; reference: 0.01 CI/year). As well, the interaction term of year by type (exposed or reference) was not significantly suggesting that reference and exposed reaches are increasing at similar rates ($p = 0.794$). These results support the observation of an apparent leveling of rates in recent years in both reference and exposed (Figure 7). While both groups show a general increase since 2013, there appears to be little change since around 2017-2018.

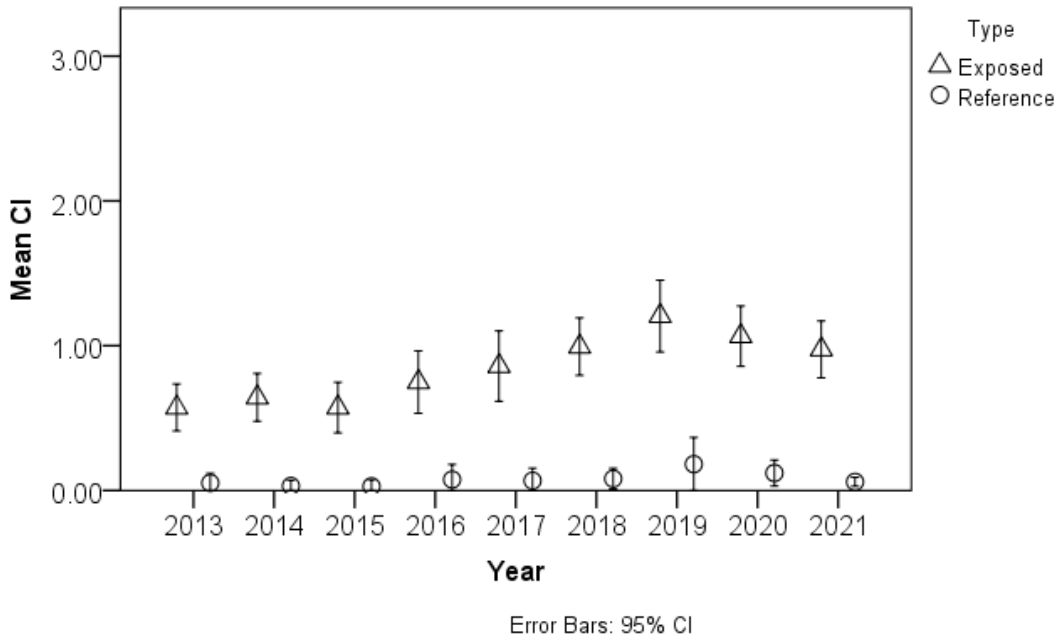


Figure 7. Mean calcite index values over time for exposed and reference sites. Error bars represent 95% confidence intervals.

3.3.2 Permit 107517 Site Performance Objectives

The number of reaches exceeding the 2024 SPO (Cc>0.5) in 2021 (N=29) showed negligible change from 2020 (N=26) (Table 9). Two reaches added to list in 2021 were THOM3 and UTHO. Also on the list are three reaches not listed in 2020 due to indicator reach approach (CORB2, MICK2, MILL2). The total stream length exceeding the 2024 SPO in 2021 was 31.5, which is up slightly from 29.4 in 2020.

Table 9. Exposed reaches with mean calcite concretion scores greater than 0.5.

Type (reference or exposed)	Stream	Reach	Mean Calcite Concretion Score	Stream Length (km)
Exposed	Bodie	BODI3	1.55	0.47
Exposed	Corbin	CORB1	1.72	0.59
Exposed	Corbin	CORB2*	1.96	2.33
Exposed	Dry (EVO)	DRYE1	1.52	0.04
Exposed	Dry (EVO)	DRYE3	1.67	0.48
Exposed	Dry (EVO)	DRYE4	1.57	0.93
Exposed	Erickson	ERIC1	1.71	0.35
Exposed	Erickson	ERIC2	1.91	0.24
Exposed	Erickson	ERIC3	1.94	0.19
Exposed	Erickson	ERIC4	0.60	1.58
Exposed	Gate	GATE2	0.53	1.82
Exposed	Goddard	GODD3	1.83	1.10
Exposed	Greenhills	GREE3	1.68	1.70
Exposed	Greenhills	GREE4	1.70	3.24
Exposed	Kilmamock	KILM1	1.52	1.67
Exposed	Leask	LEAS2	1.69	2.39
Exposed	Mickelson	MICK2*	0.72	1.36
Exposed	Milligan	MILL2*	1.19	0.77
Exposed	North Thompson	NTHO1	1.01	2.00
Exposed	North Wolfram	NWOL1	1.68	2.34
Exposed	Porter	PORT3b	1.29	0.81
Exposed	Site18	SITE	1.49	0.27
Exposed	Smith Pond Outlet	SPOU1	1.35	0.03
Exposed	South Pit	SPIT1	1.15	0.32
Exposed	South Wolfram	SWOL1	1.49	1.85
Exposed	Thompson	THOM3**	0.98	0.53
Exposed	Upper Thompson	UTHO1**	0.62	1.17
Exposed	Wolfram	WOLF2	1.81	0.60
Exposed	Wolfram	WOLF3	1.91	0.34
			Total	31.51

* Not sampled in 2020

** New to list in 2021

3.4 Trends by reach

3.4.1 Mann-Kendall Analysis

Mann-Kendall analysis was run on CI, Cp, and Cc for all reaches where two or more sites were surveyed each year from 2013-2021. A total of 43 reaches were found to have significantly increased in calcite index from 2013-2021, which is the same number reported in 2020. Two reaches were found to have significant decreases from 2013-2021 (PORT3a and LIND1). Thirteen increasing reaches were significant at the α=0.1 level and 30 at the α=0.05 level. Four reaches were reference and 39 exposed. Mann-Kendall results were presented by Teck Management Unit to investigate for any spatial patterns (Table 10). Significant increases were generally well-distributed throughout the study area. However, increases were concentrated on the Fording River in MU1 and 2, and Dry Creek (Line Creek) in MU1.

Forty-eight reaches were found to have significantly increased in Cp since 2013. Only two of those did not have a significant increase in CI. Seventeen reaches had a significant increase in Cc and just one was not detected by the CI assessment. Plots of each metric from 2013 to 2021 are in Appendix 7.

Table 10. Mean CI by Management Unit, Reach and Year.

* Blues cells indicate significant increases (Light blue = sig. increase (α = 0.1) and Dark blue = sig. increase (α = 0.05)) and orange indicate significant decrease (Light orange = sig. decrease (α = 0.1 and Dark orange = sig. decrease (α = 0.05))

MU	Reach	Year								
		2013	2014	2015	2016	2017	2018	2019	2020	2021
MU1	CATA1	3.00	3.00	3.00	3.00	3.00	2.96	.	.	.
MU1	CATA2	1.89	0.64	.	.	.	.	.	.	.
MU1	CATA3	3.00	2.64	2.56	3.00	3.00	2.89	.	.	.
MU1	CHAU1	0.00	0.00	0.00	0.17	0.12	0.12	0.23	0.21	0.18
MU1	CLOW1	.	0.18	0.00	0.50	0.21	0.67	0.69	0.76	0.71
MU1	COUT1	0.00	1.01	1.03	1.21	0.29	1.46	1.28	1.16	1.34
MU1	DRYL1	0.00	0.00	0.00	0.00	0.02	0.57	0.65	0.62	0.74
MU1	DRYL2	0.00	0.00	0.00	0.00	0.00	0.24	0.52	0.60	0.71
MU1	DRYL3	0.00	0.00	0.00	0.00	0.00	0.06	0.16	0.29	0.38
MU1	DRYL4	0.00	.	0.00	0.00	0.00	0.32	0.15	0.30	0.34
MU1	DRYL5	0.00	.	.	.	.	.	.	.	.
MU1	DRYL6	0.00	.	.	.	.	.	.	.	.
MU1	EPOU1	1.90	1.31	0.58	0.20	0.25	0.21	.	.	.
MU1	ETRI1	.	.	.	.	.	.	0.01	0.02	0.00
MU1	EWIN1	.	.	.	.	.	.	.	.	0.21
MU1	FORD5	0.32	0.35	0.53	0.58	0.73	0.70	0.80	0.79	0.92
MU1	FORD6	0.74	0.43	1.53	0.64	0.68	0.79	0.98	0.96	1.19
MU1	FORD7	0.43	0.97	0.55	0.63	.	0.89	0.90	1.09	1.13
MU1	FORD8	0.31	0.49	0.48	0.63	.	0.61	0.90	0.69	0.67
MU1	FORD9a	0.00	0.00	0.00	0.00	0.43	1.04	0.84	0.55	0.46
MU1	FORD9b	0.00	0.00	0.00	0.00	0.11	0.12	0.23	0.21	0.10
MU1	FORD10	0.00	0.00	0.00	0.00	0.32	0.63	0.53	0.52	0.35
MU1	FORD11	0.00	0.00	0.00	0.00	0.32	0.27	0.53	0.18	0.10
MU1	FORD12	0.00	0.00	0.00	0.03	0.11	0.31	0.28	0.15	0.14

MU	Reach	Year								
		2013	2014	2015	2016	2017	2018	2019	2020	2021
MU1	FPON1	0.00	0.03	0.00	0.08	0.20	0.17	0.38	0.48	0.40
MU1	GARD1	0.29	0.70	0.32	0.14	0.60	0.64	0.50	0.60	0.71
MU1	GRAS1	0.00	0.09	0.00	0.04	0.29	0.25	0.38	0.17	0.19
MU1	GREE1	0.35	1.06	0.45	0.86	1.07	0.64	0.66	0.64	0.76
MU1	GREE2	0.60	0.00	.	.	.	.	.	.	.
MU1	GREE3	1.30	2.22	2.46	2.18	2.55	2.49	1.91	2.58	2.68
MU1	GREE4	1.62	2.78	2.80	2.61	2.68	2.74	2.32	2.84	2.67
MU1	GSCH1	.	.	.	.	.	.	.	0.41	0.67
MU1	HENR1	0.00	0.00	0.00	0.00	0.04	0.32	0.40	0.69	0.62
MU1	HENR2	0.00	0.00	0.00	.	.	.	.	.	0.02
MU1	HENR3	0.00	0.00	0.00	0.00	0.04	0.00	0.40	0.20	0.00
MU1	KILM1	2.16	1.64	1.97	2.59	2.77	2.30	2.56	2.47	2.34
MU1	LMOU1	0.00	0.33	0.00	0.15	0.18	0.39	0.88	0.64	0.61
MU1	LMOU2	0.00	0.09	.	.	.	.	.	.	.
MU1	LMOU3	0.00	0.00	0.00	0.15	0.18	0.39	0.88	0.64	.
MU1	LMOU4	0.00	0.00	0.00	0.15	0.18	0.39	0.88	0.64	.
MU1	PORT1	0.92	0.84	0.85	0.75	0.74	0.85	0.85	0.98	0.98
MU1	PORT2	0.11	0.10	.	.	.	.	.	.	.
MU1	PORT3a	2.33	1.34	0.92	0.47	0.57	0.69	0.34	0.48	0.49
MU1	PORT3b	3.00	2.28	2.45	2.46	2.68	2.60	2.53	2.55	2.22
MU1	SPOU1	2.61	2.24	2.24	3.00	2.60	2.45	2.00	2.02	2.35
MU1	SPSE1	0.00	1.50	0.05	0.00	.	.	.	.	.
MU1	SWIF1	2.58	2.18	2.39	2.43	2.45	1.69	1.88	.	.
MU1	SWIF2	0.00	1.04	0.82	2.43	2.45	1.12	1.88	.	.
MU1	TODH1	.	.	.	.	.	.	.	.	0.10
MU2	CPOS1	0.92	0.84	.	.	.	.	.	.	.
MU2	CPOU1	0.93	0.94	.	.	.	.	.	.	.
MU2	FORD1	0.00	0.00	0.00	0.37	0.44	0.23	0.20	0.14	0.43
MU2	FORD2	0.00	0.00	0.00	0.00	0.10	0.13	0.30	0.34	1.09
MU2	FORD3	0.00	0.01	0.00	0.00	0.10	0.49	0.30	0.96	0.85
MU2	FORD4	.	0.05	0.66	0.60	0.84	0.80	1.09	0.88	1.01
MU2	GRAC1	0.31	0.20	0.05	0.09	0.06	0.10	0.19	0.25	0.12
MU2	GRAC2	0.15	0.10	0.10	0.09	0.06	0.06	0.19	0.25	.
MU2	GRAC3	.	0.00	0.00	0.09	0.06	0.00	0.19	0.25	.
MU2	LINE1	0.27	0.00	0.00	0.03	0.00	0.52	0.46	0.76	0.53
MU2	LINE2	0.00	0.00	0.00	0.03	0.00	0.45	0.46	0.52	0.28
MU2	LINE3	0.00	0.00	0.00	0.03	0.00	0.66	0.46	0.48	0.36
MU2	LINE4	0.40	0.27	0.68	0.65	0.66	0.95	0.93	0.70	0.94
MU2	LINE7	0.00	0.00	0.00	0.00	0.00	0.01	.	.	0.00
MU2	SLINE2	0.00	0.00	0.00	0.00	0.00	0.04	0.08	0.05	0.18
MU3	ALDR1	.	.	.	.	.	.	.	.	0.00
MU3	BING1	.	.	.	.	.	.	.	.	0.01
MU3	ELKR11	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.05	0.22
MU3	ELKR12	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.05	0.00
MU3	ELKR15	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.03
MU3	FORS1	.	.	.	.	.	.	.	.	0.00
MU3	LEAS1	0.03	0.17	.	.	.	.	.	.	.
MU3	LEAS2	0.13	1.60	0.24	1.82	2.76	2.60	2.79	2.46	2.69
MU3	MICK1	0.01	0.00	0.00	2.18	1.25	1.23	1.84	1.21	.

MU	Reach	Year								
		2013	2014	2015	2016	2017	2018	2019	2020	2021
MU3	MICK2	0.05	0.00	0.03	2.18	1.25	1.37	1.84	1.22	1.69
MU3	NTHO1	1.24	2.39	1.18	1.54	1.78	1.91	1.56	2.00	1.94
MU3	NWOL1	0.70	1.33	0.21	0.14	2.59	2.44	.	2.71	2.64
MU3	RG_UCWER	.	.	.	.	.	.	.	.	0.00
MU3	SWOL1	1.97	1.97	0.28	1.86	2.05	2.38	2.96	2.52	2.39
MU3	THOM1	0.00	0.00	0.00	0.22	0.83	1.04	1.63	1.29	.
MU3	THOM2	0.08	0.00	0.01	0.22	0.83	0.81	0.82	0.80	1.07
MU3	THOM3	0.00	0.00	0.00	0.22	0.83	1.04	1.63	1.29	1.90
MU3	THOM4	.	.	.	.	.	.	.	0.16	0.19
MU3	UTHO1	.	.	.	.	.	.	.	1.15	1.51
MU3	UTPO1	.	.	.	.	.	.	.	0.52	0.58
MU3	WEIG1	.	.	.	.	.	.	.	.	0.03
MU3	WILN2	.	.	.	0.00	0.00	0.00	.	0.02	0.01
MU3	WILS1	.	.	.	0.00	0.00	0.00	.	.	0.21
MU3	WOL1	.	.	.	0.00	0.00	0.00	0.90	0.01	0.08
MU3	WOLF2	0.27	0.14	0.23	0.69	.	0.88	0.84	2.41	2.80
MU3	WOLF3	2.93	2.07	1.60	2.61	2.80	2.69	2.86	2.95	2.91
MU4	ALEX1	.	.	.	.	.	.	.	.	0.03
MU4	ALEX3	0.48	0.38	0.40	0.46	0.38	0.36	0.86	0.41	0.01
MU4	ALEX8	.	.	.	.	.	.	.	.	0.00
MU4	ANDY1	0.00	0.00	0.00	0.00	0.00	0.04	0.09	0.00	0.05
MU4	AQUE1	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.01
MU4	AQUE2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MU4	AQUE3	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.24
MU4	BALM1	0.00	0.00	0.00	0.00	0.00	0.01	.	0.01	0.00
MU4	BODI1	0.00	0.00	0.00	0.79	0.08	1.22	1.09	1.10	1.22
MU4	BODI2	0.06	0.00	.	.	.	.	.	.	.
MU4	BODI3	1.16	2.47	.	1.77	2.09	2.33	2.58	2.62	2.55
MU4	CARB1	.	0.00	0.00	.	.	.	.	.	.
MU4	CARB2	.	0.00	0.00	.	.	.	.	.	.
MU4	CORB1	1.95	1.71	2.62	2.21	2.74	2.70	2.47	2.45	2.72
MU4	CORB2	2.72	2.68	2.25	2.21	2.74	2.92	2.87	2.45	2.96
MU4	CSEE1	0.00	0.00	0.85	1.40	.	.	.	.	.
MU4	DRYE1	2.23	2.13	2.19	2.51	2.85	2.96	2.19	2.67	2.52
MU4	DRYE2	2.23	0.03	.	.	.	.	.	.	.
MU4	DRYE3	2.20	2.40	2.48	2.51	2.85	2.76	2.25	2.82	2.66
MU4	DRYE4	1.42	1.84	2.37	2.51	2.85	3.00	2.51	2.94	2.56
MU4	ELKR10	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.05	0.21
MU4	ELKR9	0.00	0.00	0.00	0.00	0.00	0.07	0.08	0.08	0.07
MU4	ERIC1	2.29	2.59	2.77	2.36	2.67	2.89	2.90	2.92	2.71
MU4	ERIC2	1.78	2.27	2.58	2.36	2.67	2.50	2.46	2.57	2.87
MU4	ERIC3	2.36	2.60	3.00	2.36	2.67	2.95	2.96	2.91	2.94
MU4	ERIC4	0.62	1.28	1.17	2.36	2.67	1.73	1.74	1.68	1.42
MU4	FELT1	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.01	0.00
MU4	FENN1	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00
MU4	GATE1	0.05	0.05	.	.	.	.	.	.	.
MU4	GATE2	0.29	0.00	0.74	1.47	1.98	1.14	.	1.61	1.46
MU4	GODD1	0.00	0.00	0.00	0.22	0.13	0.35	0.24	0.16	0.04
MU4	GODD2	0.00	0.00	0.00	.	.	2.62	2.52	2.14	.

MU	Reach	Year								
		2013	2014	2015	2016	2017	2018	2019	2020	2021
MU4	GODD3	0.00	1.90	1.97	2.22	2.64	2.62	2.66	2.55	2.76
MU4	GRAV1	0.54	0.72	0.02	0.14	0.24	0.37	0.41	0.28	0.12
MU4	GRAV2	0.23	0.21	0.00	0.14	0.24	0.14	0.41	0.28	0.06
MU4	GRAV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
MU4	HARM1	0.58	1.08	0.07	0.64	0.61	0.80	0.82	0.90	0.76
MU4	HARM2	0.17	0.10	.	.	.	.	.	.	.
MU4	HARM3	0.15	0.28	0.01	0.12	0.03	0.08	0.14	0.12	0.04
MU4	HARM4	0.17	0.70	0.17	0.12	0.03	0.35	0.14	0.12	0.21
MU4	HARM5	0.19	0.56	0.22	0.12	0.03	0.31	0.14	0.12	0.38
MU4	HDSE1	0.52	.	.	.	.	.	.	.	.
MU4	LCSE1	0.39	.	.	.	.	.	.	.	.
MU4	LIND1	0.19	0.26	0.19	0.19	0.15	0.19	.	0.11	0.06
MU4	MICH1	0.31	0.00	0.00	0.00	0.00	0.08	0.04	0.12	0.02
MU4	MICH2	0.05	0.05	0.00	0.00	0.08	0.02	0.04	0.79	0.29
MU4	MICH3	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.45	0.03
MU4	MICH4	0.00	0.00	0.00	0.00	0.01	0.06	0.02	0.07	0.11
MU4	MICH5	0.00	0.00	0.00	0.00	0.01	0.00	0.06	0.03	0.04
MU4	MILL1	0.00	0.00	0.00	1.07	0.36	1.77	.	1.33	.
MU4	MILL2	0.00	0.00	0.00	1.07	1.06	1.18	.	1.33	2.19
MU4	OTTO1	0.30	0.22	0.10	0.23	0.14	0.59	.	0.46	0.49
MU4	OTTO2	0.03	0.00	0.00	.	.	.	.	.	.
MU4	OTTO3	0.02	0.02	0.00	0.23	0.14	0.05	.	0.46	.
MU4	P12S1	0.00	.	.	.	.	.	.	.	.
MU4	PENG1	0.09	0.02	0.02	0.00	0.00	0.00	.	.	.
MU4	QUAL1	0.00	0.00	0.00	0.00	0.00	.	.	.	.
MU4	RG_LE1	.	.	.	.	.	.	.	.	0.00
MU4	SAWM1	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.05	0.01
MU4	SAWM2	0.38	0.54	0.62	0.00	0.00	0.00	.	.	0.00
MU4	SITE	.	.	.	.	3.00	3.00	2.93	2.97	2.49
MU4	SIXM1	0.80	1.19	0.49	0.65	0.95	0.92	.	0.93	0.66
MU4	SIXM2	0.00	.	.	.	.	.	.	.	.
MU4	SNOW1	.	0.00	0.00	.	.	.	.	.	.
MU4	SPIT1	0.00	0.00	1.14	1.59	2.49	2.77	2.43	2.30	2.15
MU4	SPIT2	0.03	0.00	0.00	.	.	.	.	.	.
MU4	SPRI1	0.20	0.11	0.11	0.12	0.13	0.14	0.05	0.04	0.01
MU4	STR02	.	.	.	.	0.68	0.72	.	0.02	0.00
MU4	STR14	.	.	.	.	0.00	0.40	.	.	0.46
MU4	THRE1	0.00	0.00	0.00	0.00	0.00	0.03	.	.	.
MU4	USOS1	0.00	0.00	0.00	0.00	0.00	0.00	.	0.00	0.00
MU4	WHEE1	.	0.00	0.00	.	.	.	.	.	.
MU4	WHEE2	.	0.00	0.00	.	.	.	.	.	.
MU4	WHEE3	.	0.00	0.00	.	.	.	.	.	.
MU5	DRIN1	.	.	.	.	.	.	.	.	0.00
MU5	ELKR8	0.40	0.00	0.00	0.00	0.01	0.28	0.09	0.42	0.19
MU5	HART2	.	.	.	.	.	.	.	.	0.03
MU5	LIZA1	.	.	.	.	.	.	.	.	0.12
MU5	MCOO1	.	.	.	.	.	.	.	.	0.19
MU5	MORI1	.	.	.	.	.	.	.	.	0.00

3.4.2 Analysis of Variance

ANOVA was completed on the same reaches that were eligible for Mann-Kendall analysis. This analysis tested for differences in calcite presence, calcite concretion and calcite index among years within a reach. This analysis was run to detect step-wise changes within the current year of monitoring relative to the year prior.

ANOVA results give no indication of wide-spread step-wise changes in CI from 2020 (Figure 8). Following Tukey's post hoc analysis, three reaches were found to have a significant increase (ELKR10, FORD2, MICK2) and three reaches were reported to have a significant decrease from 2020 (MICH2, MICH3 and ALEX3). Of the significant increases from 2020, both ELKR10 and FORD2 also had significant Mann-Kendall results, however FORD2 has returned significant increases since 2018.

No significant changes in Cc were noted from 2020 to 2021 (Figure 9) Significant decrease in Cp were reported at ALEX3, MICH2, MICH3, while FORD2 had a significant increase from 2020 to 2021. (Figure 10). ANOVA statistics and p-values are listed in Appendix 8.

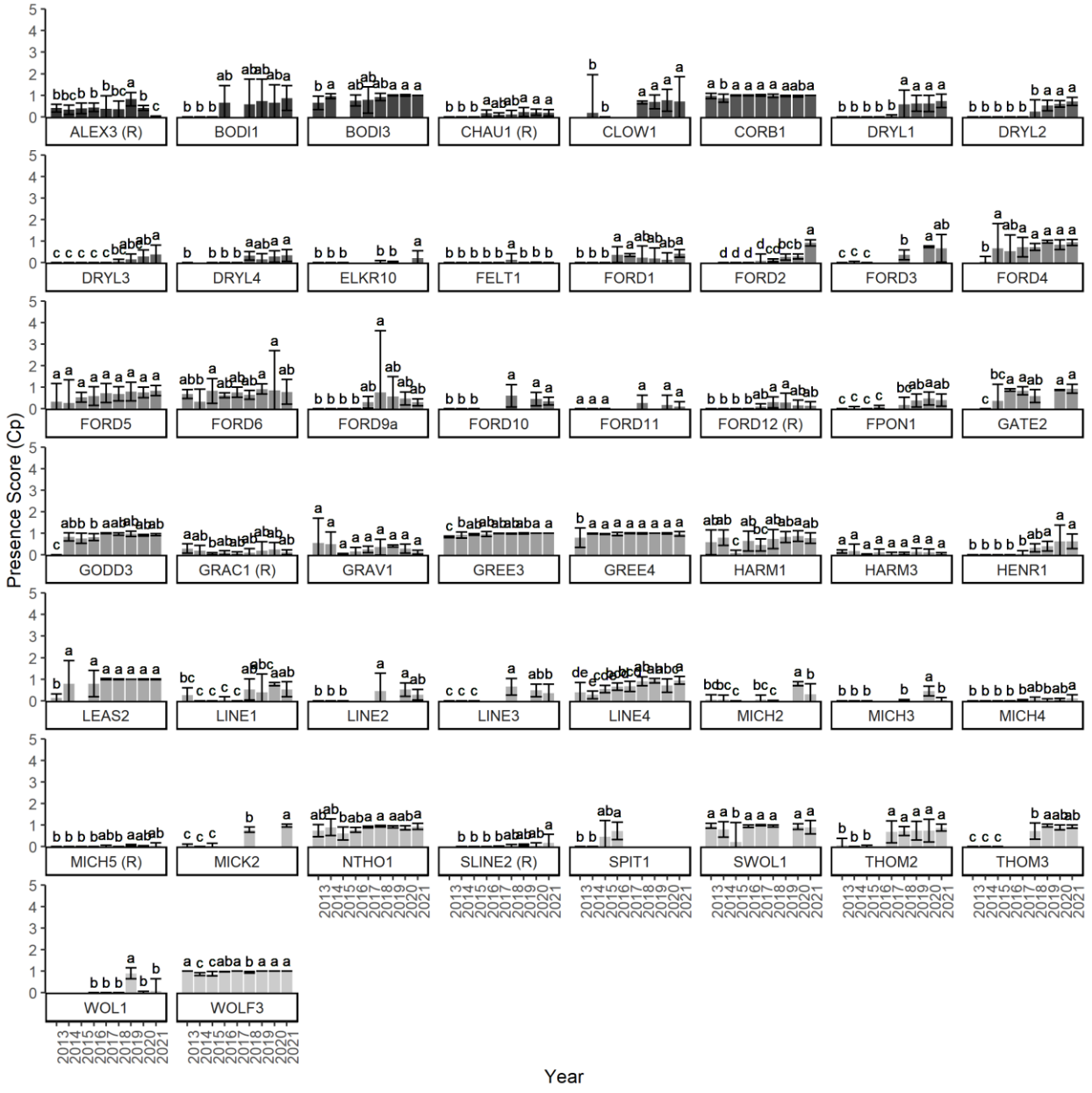


Figure 8. Bar graphs showing results of significant one-way ANOVA tests on calcite presence from 2013-2021 (error bars show 95% confidence intervals). Bars with the same letters denote no significant differences in mean calcite presence among years, within the same reach.

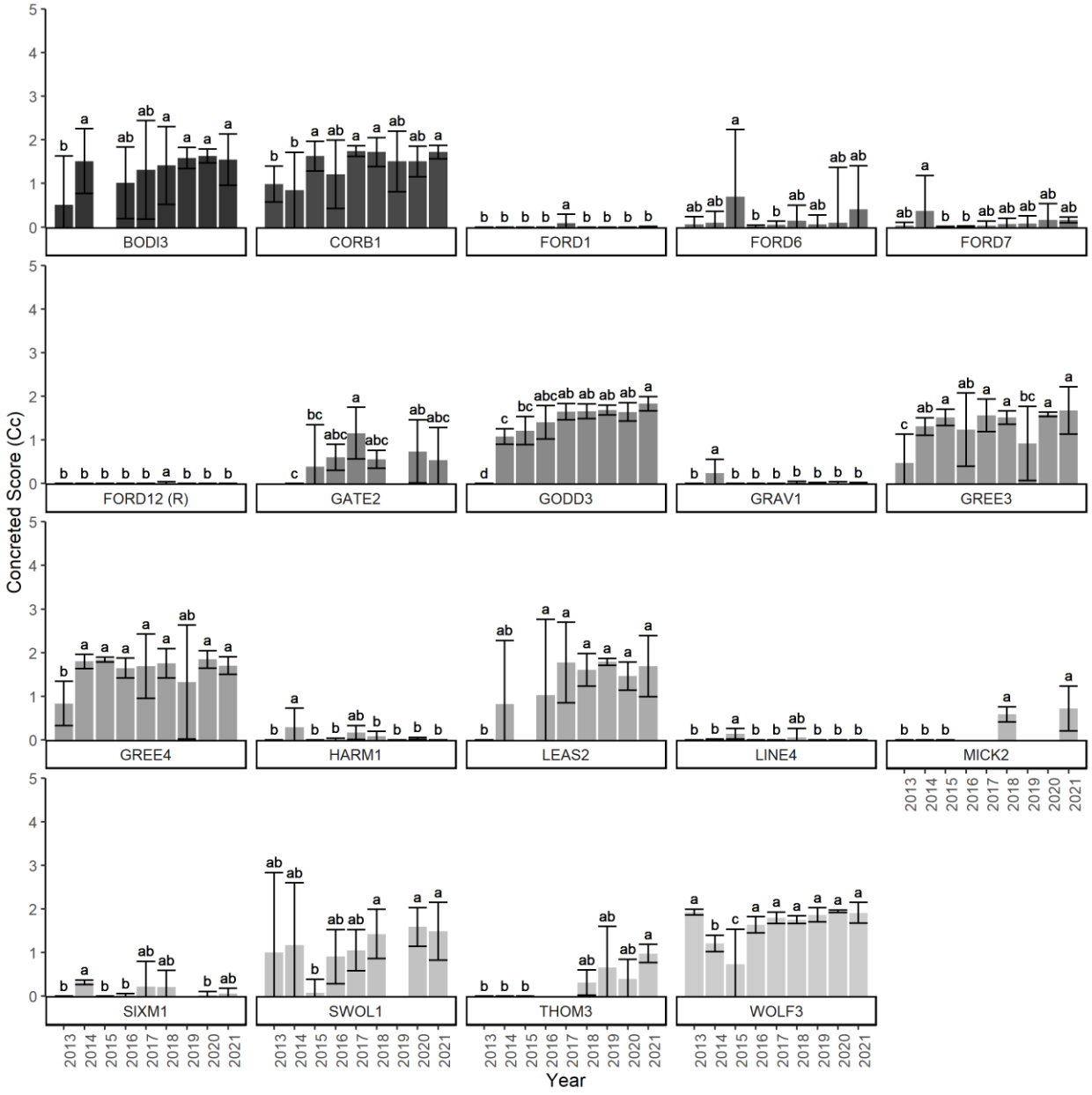


Figure 9. Bar graphs showing results of significant one-way ANOVA tests on calcite concretion from 2013-2021 (error bars show 95% confidence intervals). Same letters on bars denote no significant differences in mean calcite concretion among years, within the same reach.

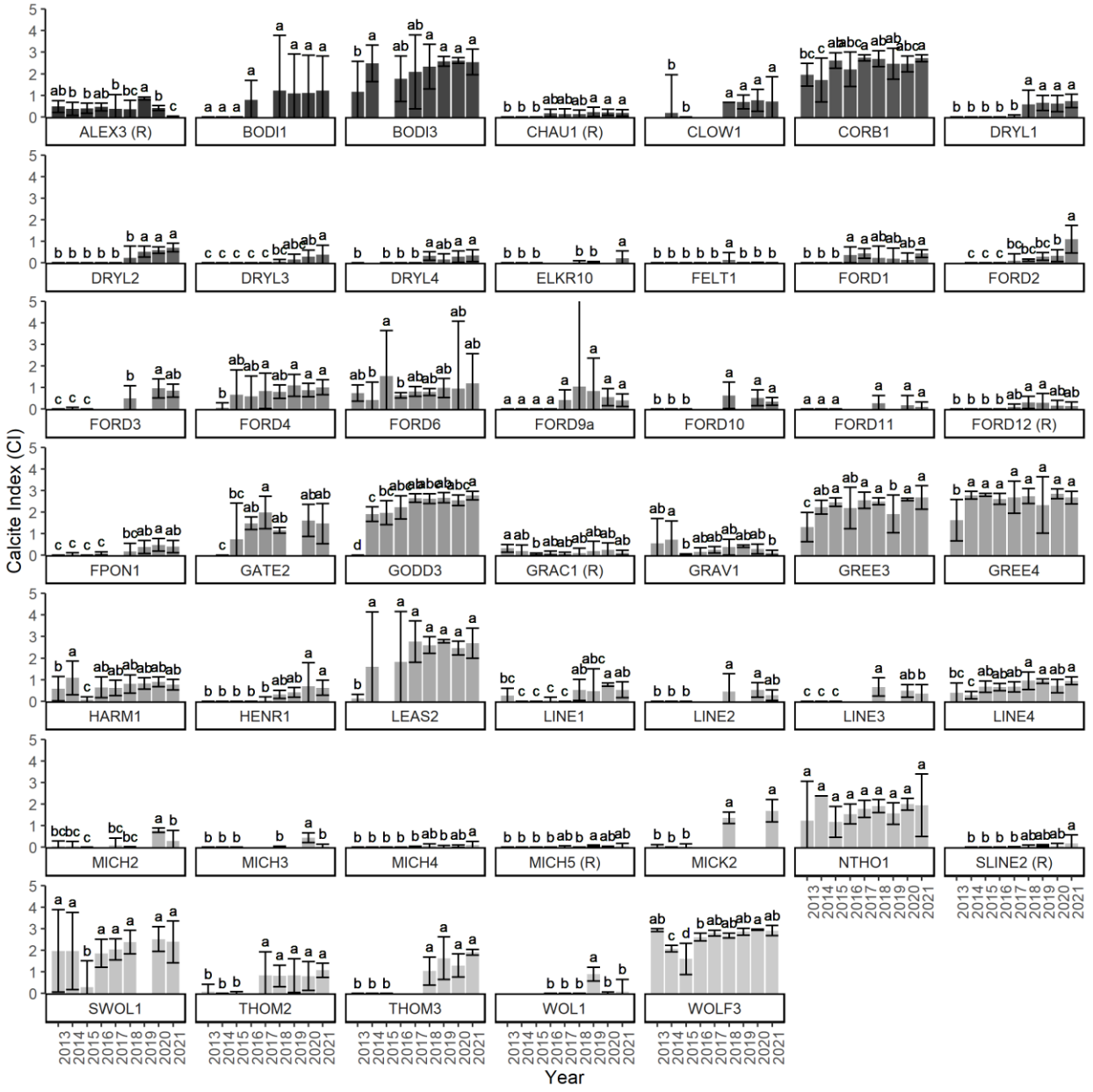


Figure 10. Bar graphs showing results of significant one-way ANOVA tests on calcite index from 2013-2021 (error bars show 95% confidence intervals). Same letters on bars denote no significant differences in mean calcite index among years, within the same reach.

3.5 Trends in reaches associated with treatment

Calcite index values were plotted by year for reaches with upstream water treatment. Treatment began on GREE1 in 2017, LINE4 in 2018, and FORD9a in 2019. In each case, CI appears to flatten and even appears to reduce in the years following commencement of treatment (Figure 11). This trend is similar to that seen in the overall regional CI values. It is unclear to what extent these reaches may be further benefiting from treatment.

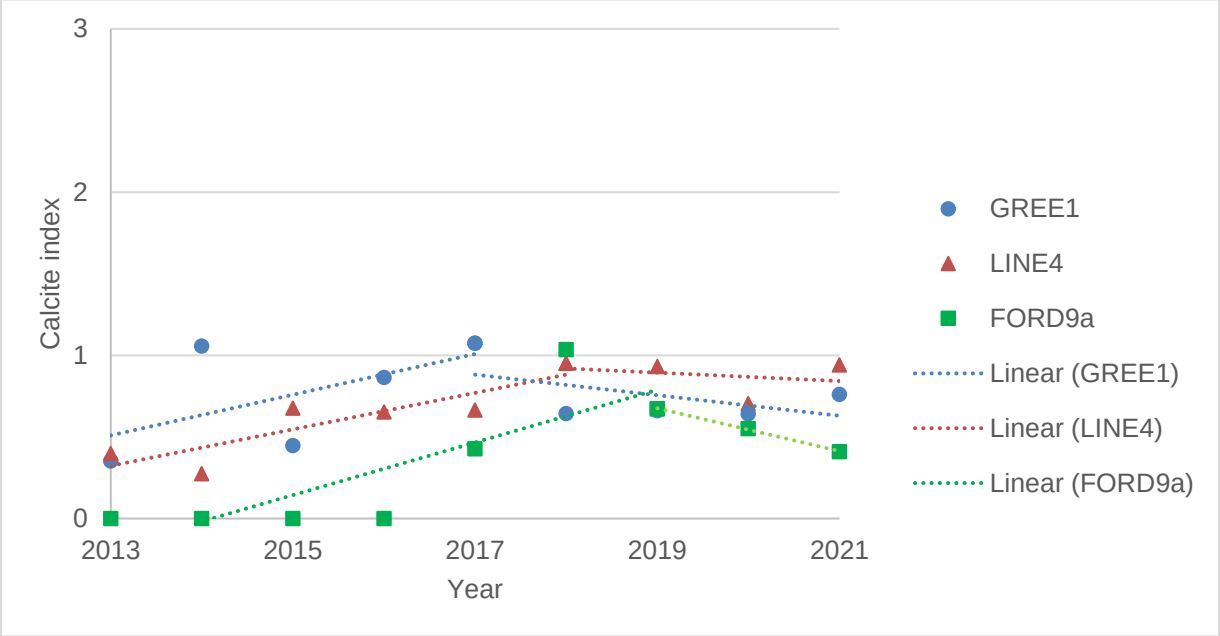


Figure 11. Treated reaches GREE1 (2017), LINE4 (2018), and FORD9a (2019). Lines represent linear trend lines pre and post treatment (date indicates when treatment began).

3.6 Effect of streamflow

Figure 12 shows the annual hydrographs of various regional hydrometric stations in the Elk River watershed. Discharge in 2021 was modest over the region with return intervals of the stations shown below ranging from 1-in-2.0 to 4.4 year return intervals. Regionally, the highest flows since 2013 were observed in 2020, where return intervals averaged approximately a 1-in-9 year event, however caution is needed when interpreting these statistics from the Teck operated stations given the shorter periods of record than Water Survey of Canada. Most stations show low variability over the period of interest, limiting an assessment of the effect of flow. A scatter plot was generated to show ΔCl/year versus peak instantaneous discharge for the four area (Figure 13). Linear fit lines were added to show general trends of each of the four areas. While each area had a generally negative trend, these results are inconclusive. Furthermore, it is not expected that flow has a linear effect on ΔCl/year.

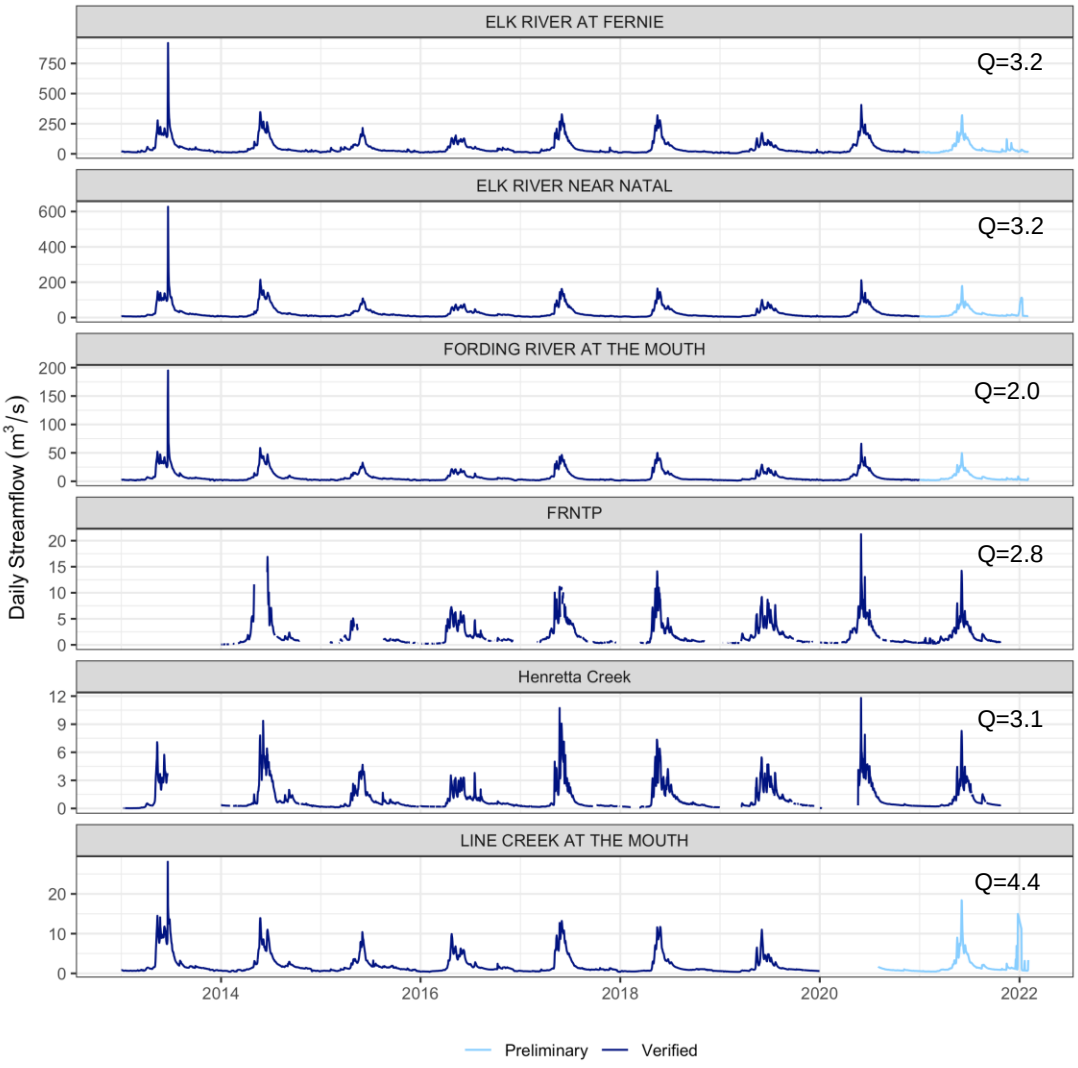


Figure 12. Hydrographs from various hydrometric stations throughout the Elk Valley (2013-2021 where data are available).

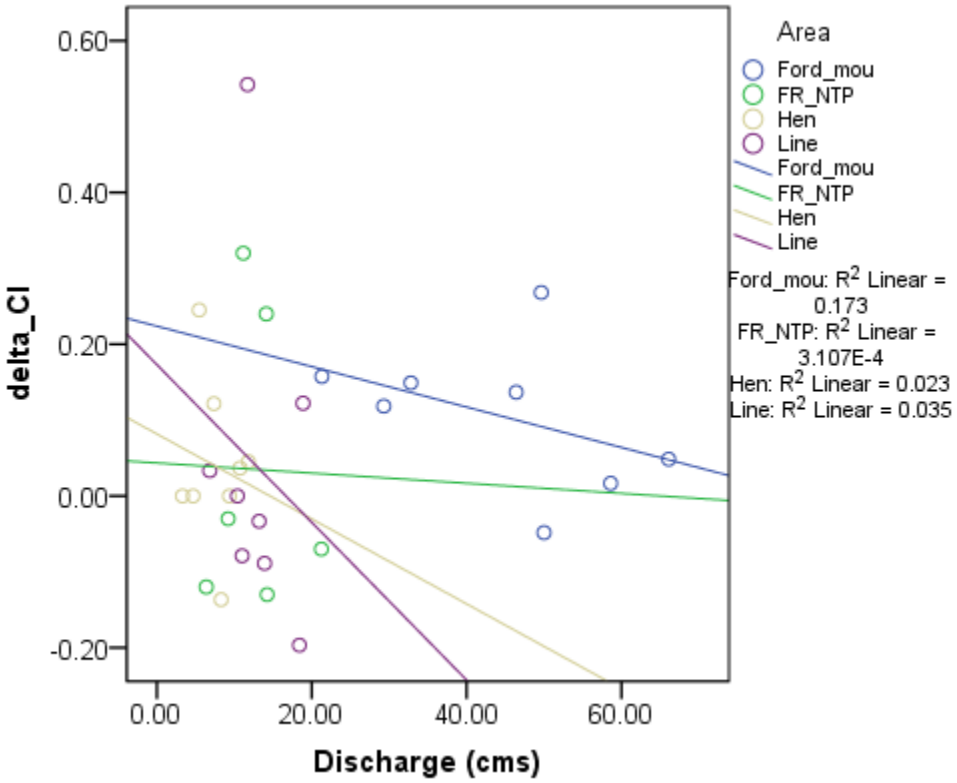


Figure 13. Regression plots of the change in calcite index per year (delta CI/year) for reaches associated with long-term stream gauges.

3.7 Effect of habitat unit type

Sixty-five reaches included pebble counts from at least one pool, riffle, and glide, and were therefore included in this pooled analysis. Together these reaches contributed 164 glides, 116 pools, 174 riffles, and 62 cascades. Habitat unit was found to have a significant effect on calcite index ($p<0.001$; $df=515$). Tukey post hoc analysis indicated that the calcite index in cascades was significantly greater than all other units there were no significant differences in calcite index among pools, glides, or riffles (Figure 14). However, at a reach level, cascades were not significantly higher than other habitat unit types in any of the 65 reaches assessed. These results are consistent with the same analysis in 2020. Overall, the effect of habitat unit on CI appears weak and potentially just an artifact of the observation that cascades may be more prevalent in reaches closer to waster rock and thus are disproportionately more abundant in higher calcite potential reaches. As well, the concept that turbulent habitat units (cascades and riffle) drive off-gasing that promotes calcite deposition is not supported by these results as riffle habitat units continue to not be found different from pools or glides for either calcite index or even calcite presence.

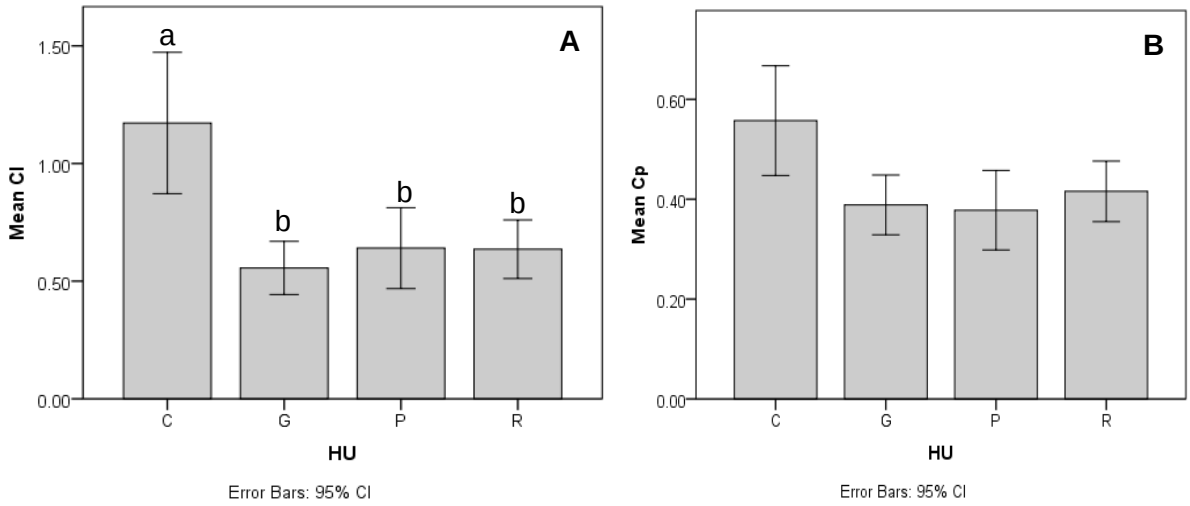


Figure 14. The mean A) calcite index and B) calcite presence values for different habitat units. Groups with different letters represent significant differences in means (α = 0.05). Error bars represent 95% confidence intervals.

3.8 Inter-program comparisons

Regression analysis found all pairings of Teck programs to have good agreement in 2021. R^2 values ranged from 0.85 to 0.96 (Figure 15). The slopes of these relationships were near 1, ranging from 0.79 to 1.06.

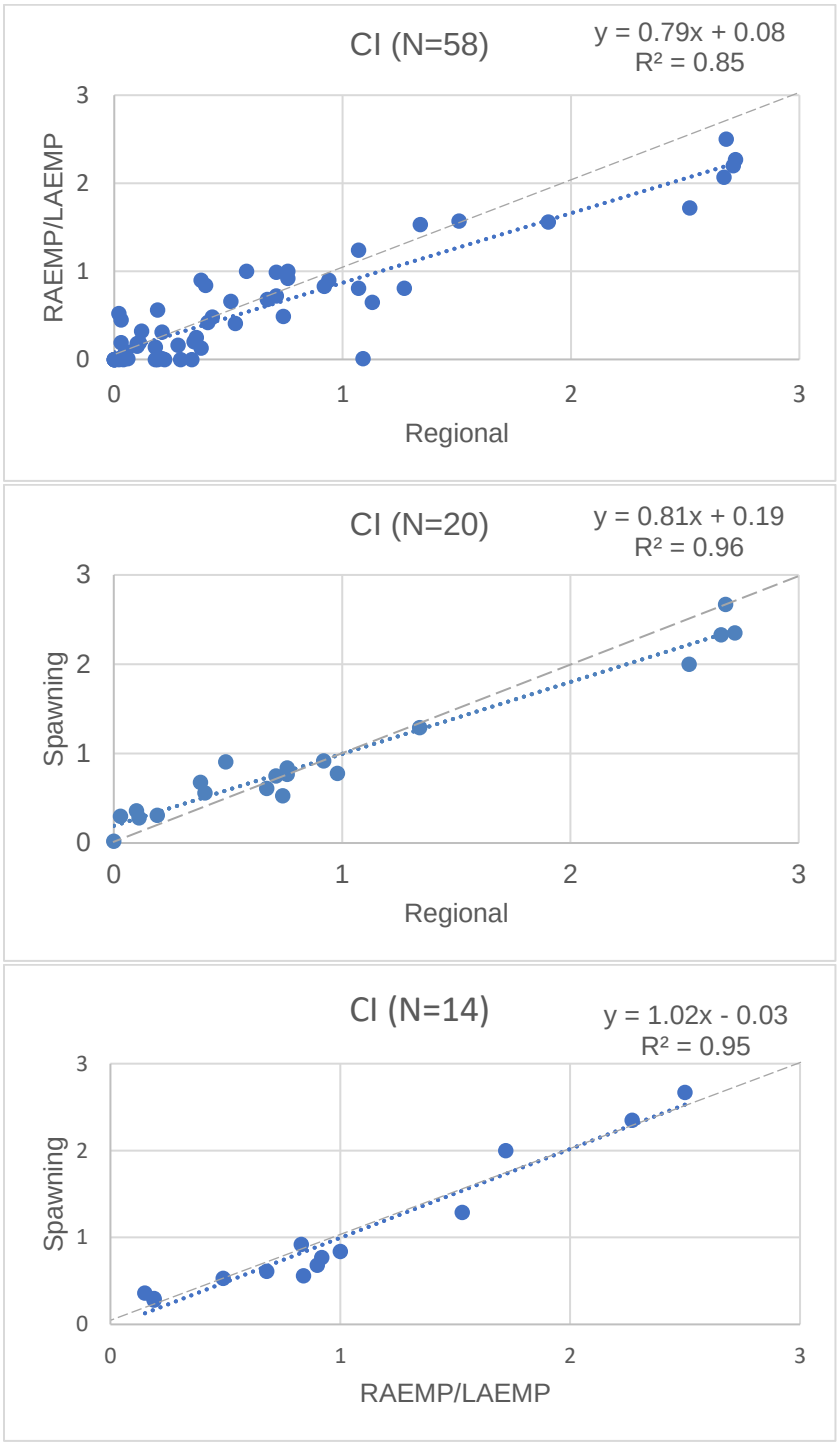


Figure 15. Regression plots of CI by Teck monitoring program (dashed line is 1:1).

The statistics from the 2021 regression analysis suggests a meaningful improvement in the agreement of these programs since the training workshops were implemented in 2019 (Table 11). The Regional-RAEMP/LAEMP pairing provides three years of comparison. Since 2019, agreement of each metric (CI, Cp, and Cc) has been shown to have greatly improved. Similarly, agreement between the Regional-Spawning suitability pairing has also improved since 2019.

Table 11. Program comparison linear regression lines and r^2 values.

Comparison	Metric	Linear regression fit line	2021 r^2	2020 r^2	2019 r^2
Regional-RAEMP/LAEMPs	Calcite presence	y= 0.88x + 0.06	0.67	0.75	0.23
Regional-RAEMP/LAEMPs	Calcite concretion	y= 0.70x - 0.00	0.94	0.71	0.48
Regional-RAEMP/LAEMPs	Calcite index	y= 0.79x + 0.08	0.85	0.77	0.30
Regional-Spawning suitability	Calcite presence	y= 0.69x + 0.23	0.80	0.70	0.53
Regional-Spawning suitability	Calcite concretion	y= 0.81x + 0.03	0.96	0.97	0.93
Regional-Spawning suitability	Calcite index	y= 0.81x + 0.19	0.96	0.95	0.88
RAEMP/LAEMP-Spawning suitability	Calcite presence	y=0.66x + 0.17	0.77	0.65	-
RAEMP/LAEMP-Spawning suitability	Calcite concretion	y= 1.09x + 0.04	0.97	0.93	-
RAEMP/LAEMP-Spawning suitability	Calcite index	y= 1.02x - 0.03	0.95	0.89	-

Historically, the Regional-RAEMP/LAEMP comparison showed the largest disagreement between programs, and while substantially improved in 2021 with an r^2 of 0.85, some reach-level differences remain. Still notable were differences at CORB1, DRYL1, DRYL4, ELKR10, ELKR11, FORD7, GREE4, NTHO1-25 (Figure 16).

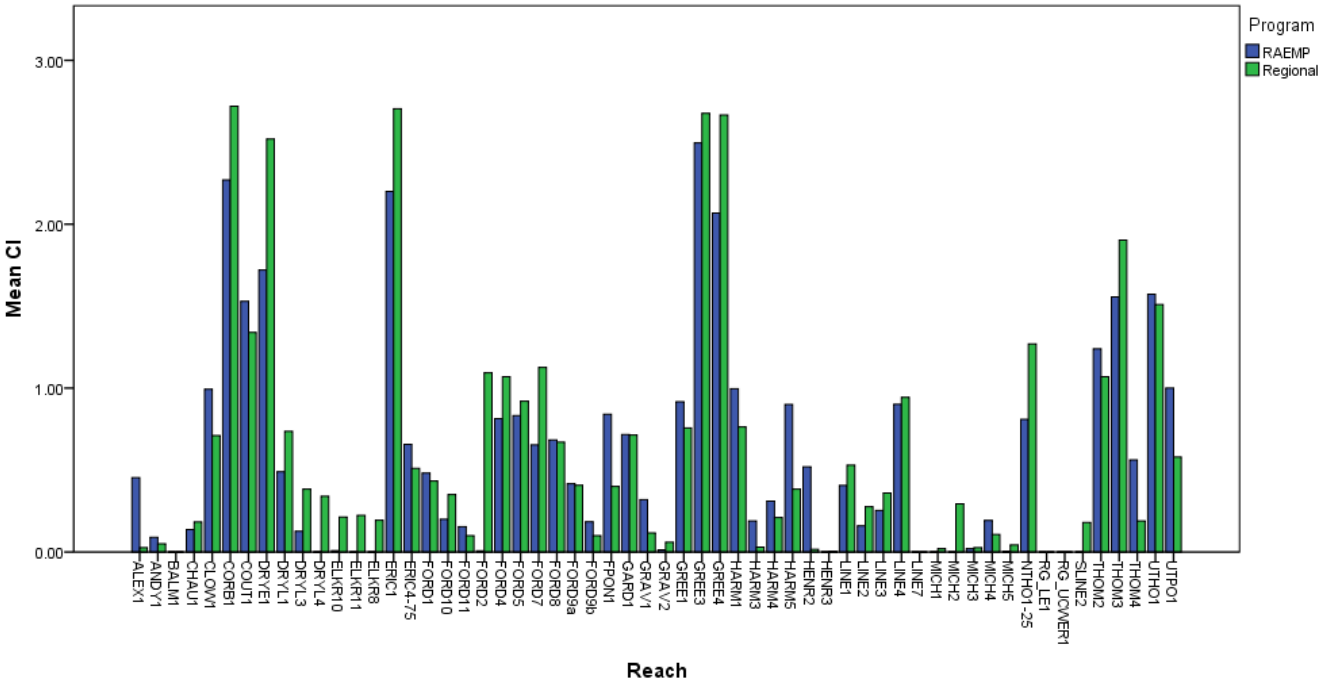


Figure 16. Site-level CI scores for Regional-RAEMP/LAEMPs

The Regional program included sampling at 17 RAEMP sites to directly assess the potential of differences in methods as a source of variability between programs. Here, the Regional program crews follow the same methods used for RAEMP/LAEMP programs by sampling only riffle habitat and three riffles per location. From comparison of r^2 values, there was only a slight improvement in agreement between the two programs when standardizing methods to a single habitat unit type (Figure 17). The mean absolute difference between sampling crews also only slightly increased from a mean difference in CI of 0.21 when using typical regional sampling methods and 0.17 when regional crews followed the RAEMP/LAEMP methods.

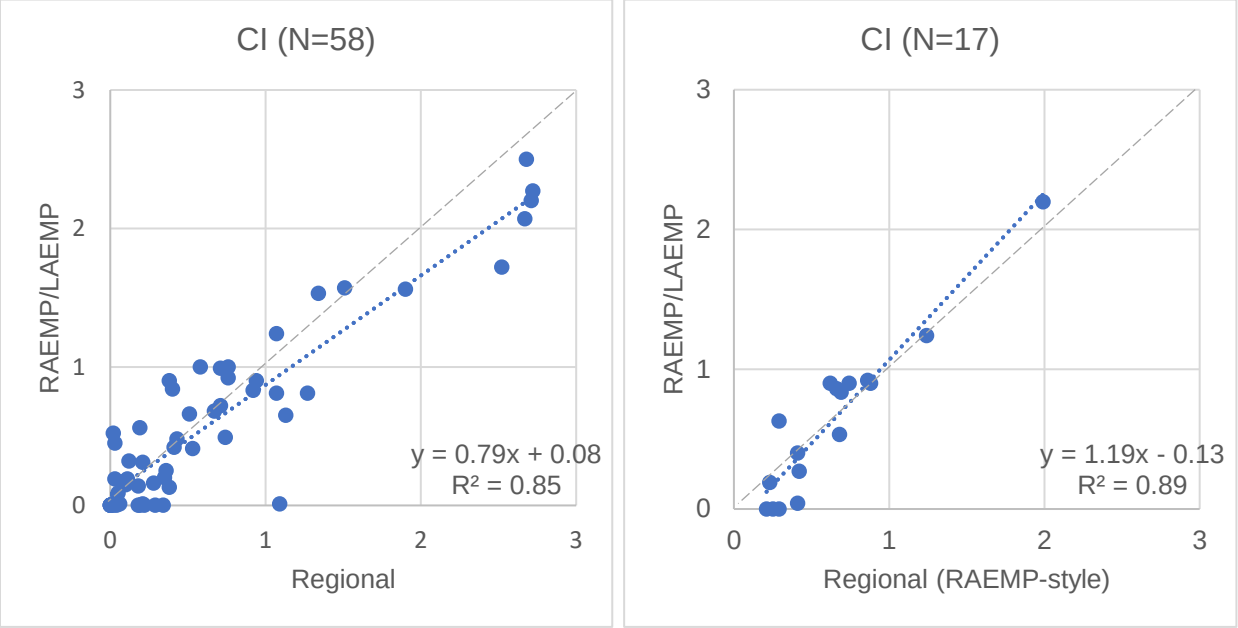


Figure 17. Calcite index scores from sites where Regional and RAEMP/LAEMP sampling overlapped, where (left) regional methods where used and, (right) where regional crews employed RAEMP/LAEMP style methods). Dashed line = 1:1.

3.9 Assessment of the Calcite Index

The effectiveness of Cp' to reduce intercrew variability was assessed by comparing CI to CI' first within the regional program using the 10% of sites randomly selected for duplicate sampling. Crews differed on average by 0.12 CI when using Cp. However, when comparing CI', crews different on average by just 0.05. This decrease in crew sampling error was significant (p=0.04; df=59) (Figure 18). The use of CI' was also found to provide better agreement between RAEMP/LAEMP to Regional and Spawning Suitability to Regional (Figure 19).

The ability of the two calcite presence metrics (Cp and Cp') to predict Cc was compared by fitting nonlinear models to Cc vs Cp and Cc vs Cp' using 2020 and 2021 data. Improvements in r^2 values suggests a Cp' to be substantially better at predicting Cc (Figure 20). The scatter plots show how Cc response earlier to Cp', effectively stretching out the data to provide a more gradual response in Cc to increasing Cp'.

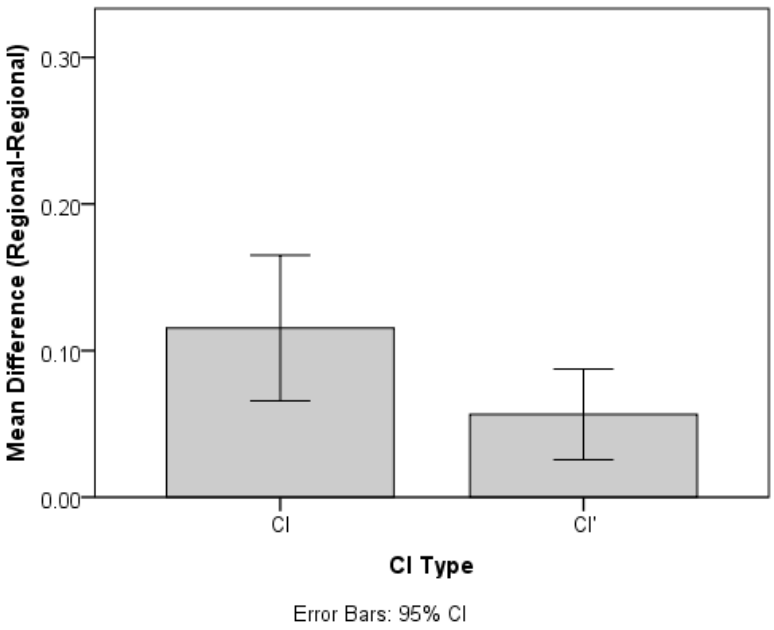


Figure 18. Mean difference in CI between Regional crews when using CI versus CI'.

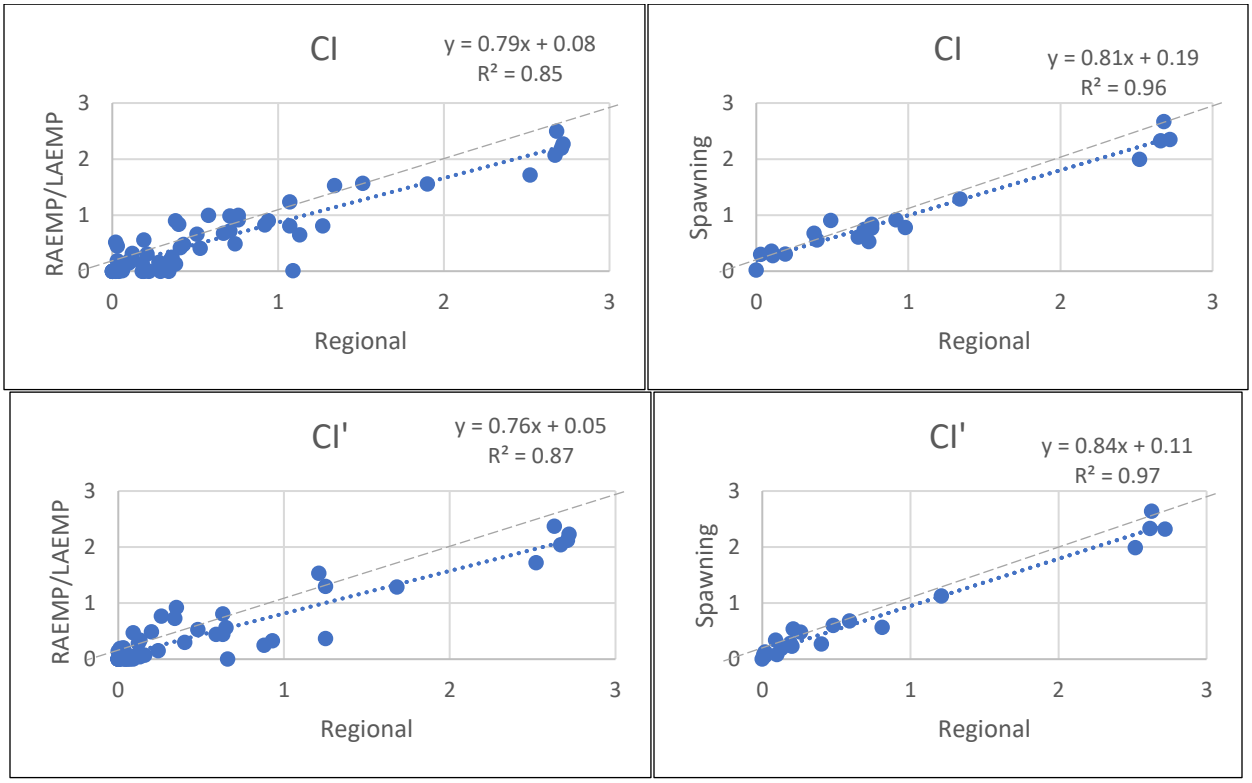
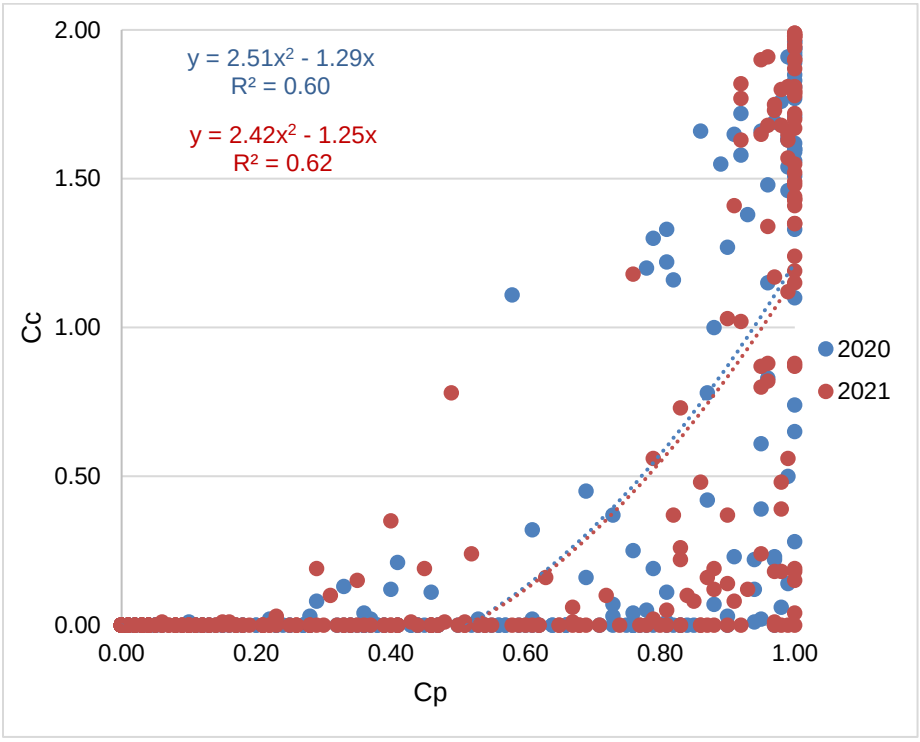


Figure 19. Regression plots of (left) RAEMP/LAEMP versus Regional and (right) Spawning Suitability versus Regional using both CI and CI'.



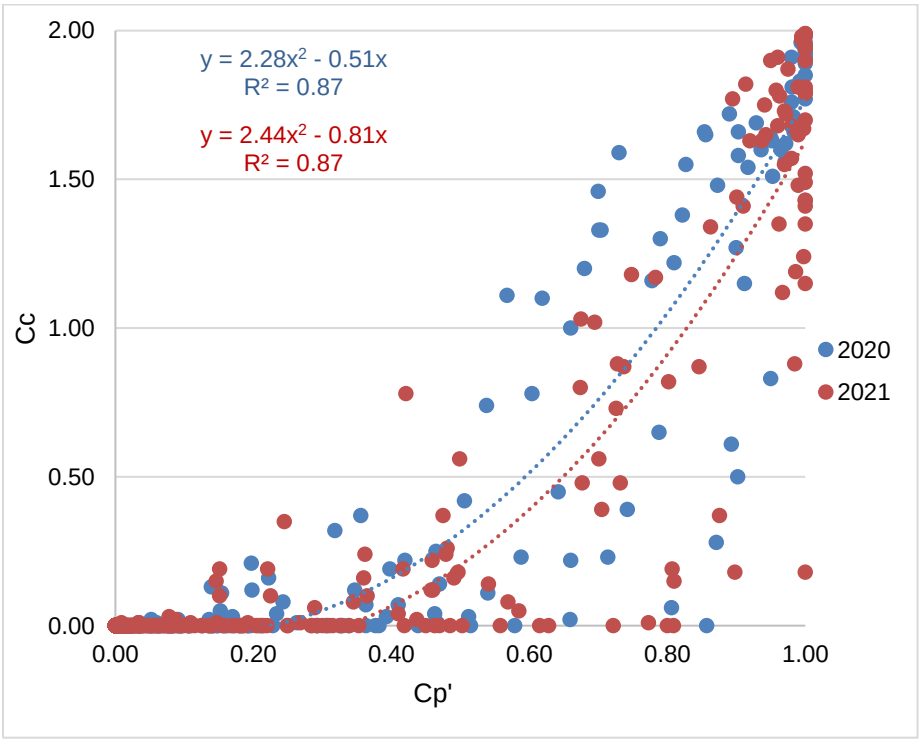


Figure 20. Scatter plots of (top) Cp versus Cc and (bottom) Cp' versus Cc.

4 Discussion

4.1 Calcite trends and effect of streamflow

The 2021 Regional Calcite Monitoring Program was successfully completed as per the scope of work with only minor modification (i.e. addition of potential new reference reaches, removal of sites beyond three per reach. See Appendix 3). The assessment of reference reach condition was added to the scope to address input received from the EMC. The assessment suggests that the historical reference reaches are accurately describing reference condition through the study area. However, an assessment of the spatial distribution found that additional tributary references could be added to MU3.

Calcite deposition has been reported as increasing in both exposed and reference reaches since 2013. This was again reported in 2021, however the overall rates of change since 2013 were lower than reported in 2020. This supports a qualitative observation of a potential levelling off of calcite values around 2017-2018. Distinctly different slopes can be seen in calcite index values from 2013 2017/18 and then after 2017/18 to present. Also noted was the number of reaches with significant linear trends remaining unchanged from 2020 and few reaches with step-wise changes. Collectively these different assessments point towards a reduction in the rate of increase of calcite index throughout the valley.

The occurrence of an asymptote in calcite index fits the flood hypothesis presented in previous reports. The flood hypothesis presents the effect of flow as a temporally discrete effect that must exceed a threshold before becoming detectable with these methods. Below that threshold other factors determine the rate of calcite deposition. Figure 21 provides a visual for this hypothesis where the flood of 2013 disturbed some equilibrium in calcite deposition. This figure demonstrates how at lower flows the annual rate of change in calcite index is likely driven primarily by water quality. As magnitude of a flood increases, the influence of WQ would start to be countered by fluvial processes working to reduce the rate of change of calcite index. Key points to this conceptual model are that: 1.) flow needs to exceed a threshold value before producing detectable results; 2.) this balance between WQ and flow (i.e. delta CI) would be unique for any given year; and 3.) there is likely a theoretical limit (e.g., equilibrium) to the amount of calcite deposited at a site based on water quality alone. The current observations from the Regional Calcite Monitoring program fit with this conceptual model. Flows experienced in 2013 are suspected of causing a watershed wide reduction in CI, relative to pre-flood conditions. The absence of flows exceeding a theoretical threshold since 2013 have allowed calcite index values to increase to what may now be approaching an equilibrium determined by reach level water chemistry. The flow data presented in this report indicate why, regardless of continued monitoring, this hypothesis cannot be fully tested until a larger flow event is observed. Another current limitation of the dataset in regards to the effects of flow is that it does not account for calcite legacy effects (i.e., pre-2013). We cannot test this hypothesis without data prior to the large 2013 flood and/or a large enough flood to surpass a calcite erosion/mobilization threshold. The results of this program support the expected inter-flood calcite response curve proposed in this hypothesis, both in monitoring the response to a single, large flood and the potential asymptote in calcite index.

The role of water quality in calcite deposition is presented as a co-determinant with flow in the degree of calcite at a given location. Factors such as the amount of watershed disturbance and operational changes to water management would also be important when considering calcite deposition. While presented in this discussion, this annual report does not investigate relationships between calcite index and these potential factors. This is however, being completed in a related multivariate analysis (Appendix 10).

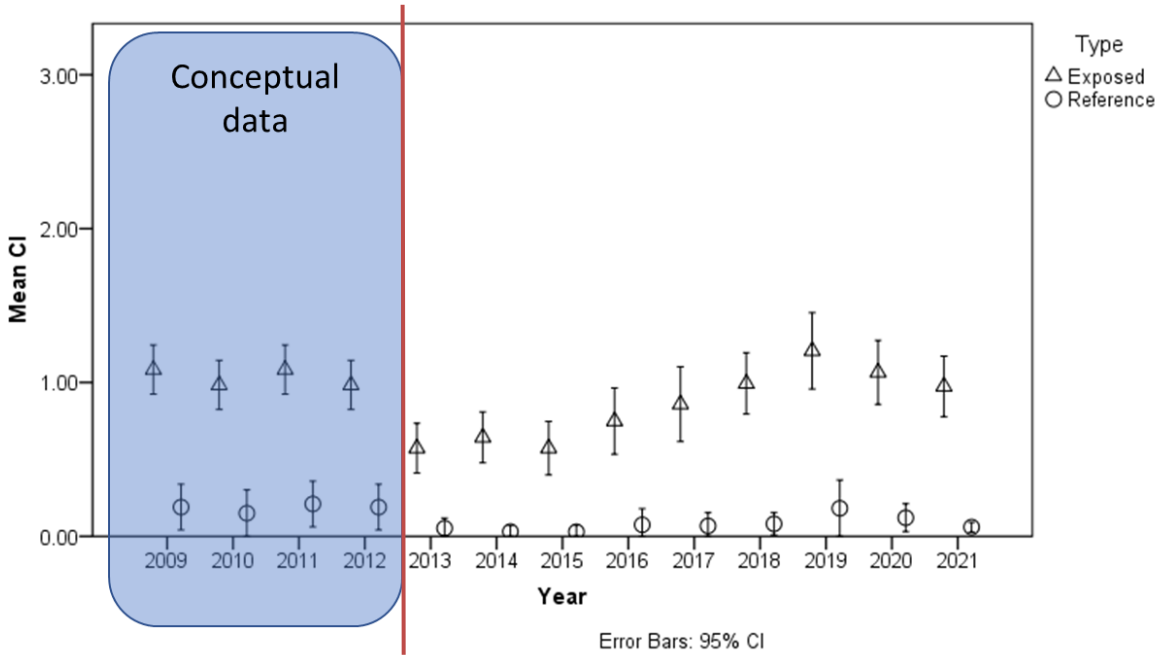


Figure 21. Regional Calcite monitoring data presented with conceptual data pre-2013. Red line approximates timing of 2013 flood.

4.2 Inter-program comparison

Inter-program comparisons are producing much better agreement. Pre-field workshops are likely key to this improvement. While it appears that agreement could further improve with incorporation of Cp', results from this study suggest that accuracy of these methods are limited to 0.1 CI. The random QA assessment completed in the Regional program reported a value near 0.1 CI as the average difference between well-trained crews. As well, when Regional sampling crews followed RAEMP style sampling, presumably controlling for habitat unit affect, the mean difference was also near 0.1 CI. Overall, all programs show good agreement and suggest the continuation of calcite workshops.

The results of the interprogram assessment do not support the idea that methodological differences, namely habitat units sampled, are substantially affecting agreement between programs. Furthermore, they suggest that crew training is a much larger factor than habitat unit. These results are corroborated by the habitat unit assessment that found no consistent difference between turbulent habitat unit types and laminar (the distinction needed to support the off-gasing hypothesis). This is the fourth assessment reproducing these results.

4.3 Assessment of the Calcite Index

Cp' has been found, for a second year, to significantly reduce intercrew variability. Variability was reduced both within the Regional Program and between Teck programs. Incorporating Cp' may be one option remaining to reduce the remaining crew sampling error. From this report, it also appears that Cp' may be a more accurate predictor of Cc, suggesting potential value as an early warning trigger. The strong relationship between Cp and Cp' suggests Cp' more accurately characterizes sites with low calcite than Cp while still retaining the ability to compare to the historical Cp data set (Figure 22).

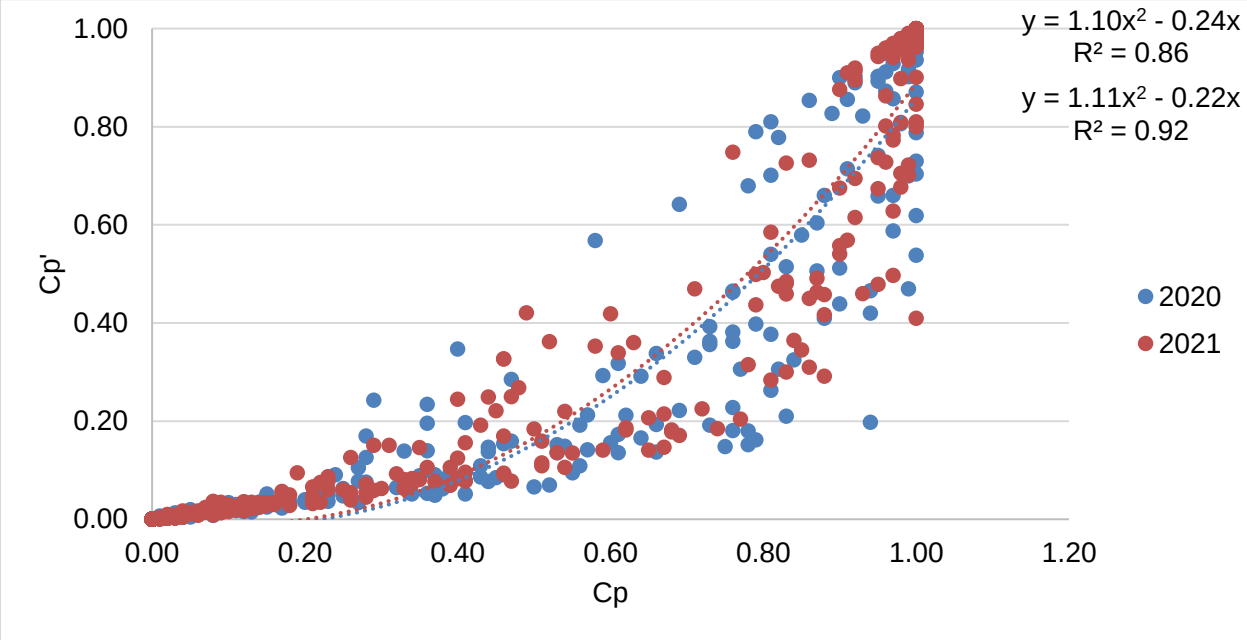


Figure 22. Scatter plot of Cp' versus Cp.

5 Conclusions and Recommendations

Calcite deposition continues to exhibit increasing trends in both mine-influenced and reference streams throughout the study area in the Elk River watershed. While the length of monitoring approaches a decade, and much has been learned from this Program, the main drivers behind the degree of calcite spatially and temporally remains poorly constrained. The overall distribution of calcite by general degree categories (i.e. low, moderate, high) has remained relatively unchanged over the course of Program (2013-2021). In that, reaches reported as high calcite in 2021 have more or less been reported as such since 2013, and likewise for reaches with low calcite in 2021. The multivariate analysis further explores the potential water quality and watershed factors that differentiate a 'high' reach from a 'low' reach.

The role of streamflow will continue to be hypothetical until a larger flood occurs and monitoring conducted. In the interim, continued monitoring is required to determine if calcite levels are moving towards a reach-specific equilibrium. Results since 2018 do suggest this may be occurring. However, the program did have some modifications to methods over the full Program (2013-2021) and additional years, following what now appears to be a robust protocol, will provide more confidence in temporal trends.

The Program continues to be valuable both in providing a robust monitoring protocol for all of Teck's monitoring programs to incorporate and in providing the length of dataset required to better understand the issue of calcite as it related to environmental and mine-related conditions.

We make the following recommendations to the 2022 Regional Calcite Monitoring Program:

1. Assess the roles of environmental (e.g., streamflow, geochemistry) and mine-related (level of disturbance, water treatment) variable on calcite deposition in regard to the flow hypothesis presented. Should the region experience a larger freshet, then monitoring will be used to directly determine if it results in reduction of calcite deposition. In absence of this, this Program should continue to try and explain the trends that are being observed through continued learns (e.g., multivariate analysis) and the potential/likelihood that calcite deposition may be returning to a post-2013 equilibrium.

2. Continue to sample Cp' and include trend analysis for years and reaches with available Cp' data. Complete a comparison of the Cp' results to Cp for the available reaches.

3. Continue with inter-program workshops. However, discontinue regional crews sampling additional RAEMP/LAEMP sites (i.e., only riffle habitat from those programs).

4. Continue with Regional Calcite Monitoring Program quality assurance/quality control protocol.

5. Conduct the Program in 2022 at the same exposed sites sampled and following the same methods used in 2021. Consider starting the program in mid-August.

6. Conduct sampling at the following reference reaches (N=18).

MU	Strata	Stream	Reach
MU-1	Tributary	Chauncey	CHAU1
	Tributary	East Dry	ETRI1
	Tributary	Ewin	EWIN1*
	Mainstem	Fording	FORD12
	Tributary	Henretta	HENR3
	Tributary	Toddhunter	TODH1*
MU-2	Tributary	Grace	GRAC1
	Tributary	South Line	SLINE2
MU-3	Tributary	Bingay	BING1*
	Mainstem	Elk	ELKR15
	Tributary	Forsythe	FORS1*
	Tributary	RG_UCWER	RG_UCWER1*
	Tributary	Weigert	WEIG1*
MU-4	Tributary	Alexander	ALEX3
	Tributary	Andy Good	ANDY1
	Tributary	Grave	GRAV3
	Tributary	Leach	RG_LE1*
	Mainstem	Michel	MICH5
MU-5	None	-	-

* Reaches first sampled in 2021 Program

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7 Appendices

Appendix 1. 2021 Calcite Field Sampling Manual (Gordon and Robinson 2021).

Teck Coal Ltd
Regional Calcite Monitoring Plan

Field Manual

2021 Version
May 2021

Prepared by

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1 Purpose and Scope

This document provides details on the field sampling protocol developed for Teck Coal Ltd. (Teck) Regional Calcite Monitoring Program (2021 update). This monitoring program has been completed annually as part of Teck's overall calcite management strategy since 2013. The results are used to describe the degree and extent of calcite deposition downstream of Teck Coal mine operations and to inform Teck's adaptive management of calcite.

This manual describes how calcite surveys are completed in the field under the Regional Calcite Monitoring program. Annual work plans provide additional detail on what streams/reaches to sample, how many sites to sample within each reach, and where to locate sites within each reach. This manual is intended to act as a reference for field crews. Information on site locations, data analysis, and reporting are not discussed here.

2 Background

There are three metrics pertaining to calcite assessment – calcite presence, calcite concretion, and calcite index. Calcite presence is the amount of calcite on a rock and is currently described by calcite present = 1 or calcite absent = 0. A new method of calcite presence is being trialed, where presence will be described by 10% increments of surficial coverage (0.1, 0.2, 0.3, etc.). For instance, a rock with 50% surficial coverage of calcite on all surfaces would get a score of 0.5. Calcite concretion is the amount of resistance due to calcite formation when picking up a rock from the streambed. Resistance is relative to a reasonable amount of effort an observer uses to remove a rock from the streambed by hand. A score of 0 indicates no resistance, 1 indicates some resistance but still movable, and 2 is non-movable or in other words fully concreted to the streambed. The calcite index score for each rock is the addition of calcite presence and calcite concretion scores and can range from 0-3.

The Regional Calcite Monitoring program has undergone continuous assessment and evaluation to improve its function in describing the degree, extent, and trends of calcite deposition. This has occurred in each annual report, as well as with one major assessment after Year 3 of conducting the program (i.e., 2013-2015 review). The 2021 calcite monitoring protocol manual builds from the existing methods developed in 2013 and 2016. Key updates to the 2021 protocol include:

1. Trial of new calcite presence metric (Cp') – Calcite presence will be recorded using bins representing 10% increments of surficial calcite coverage of an individual particle. These data are collected in a way that allows for this proportional method to be trialed for a second year, while remaining the ability to report as the binary "yes/no" presence as done in all years prior to 2020. See Zathey et al. (2021)[1] for a more comprehensive discussion on this trial;
2. Replacement of an initial calcite inspection with a mandatory 100-particle pebble count at each site;

[1] Zathey, N., Mitchell, S., and M.D. Robinson. 2021. Teck Coal Ltd. 2020 Calcite Monitoring Program Annual Report. Prepared for Teck Coal Ltd. by Lotic Environmental Ltd. 55 pp + appendices.

3. Clarification of how fines, pure calcite, and moss are treated when selected during a pebble count; and,
4. Updates following 2020 Calcite Program audit:
    a. Standardization of the number of sites per reach, three (3) sites where reach length is >300 m, one (1) site when reach length is <300 m. Robinson and Atherton (2016) suggested a variable number of sites per reach (i.e., 1, 3, or 6). The increase to 6 at intermediate Calcite Index values has not produced the intended improvements in monitoring of trends.
    b. Change of site sketch to optional where the sampler requires additional means of conveying a notable field observation.
    c. Continued standardization of collection methods as documented in Section 3 of this manual.
    d. Updated QA/QC to include:
        i. Field sampler training and documentation of attendance.
        ii. Duplicate sampling of 10% of sites.
        iii. Preliminary entry and review of current year's data against previous years to identify potential anomalies.

3 Procedures

These procedures outline the protocol a sampling crew will follow. In some instances, additional analyses of program components were required specifically for this year's update. In particular, the number of rocks sampled per site and the number of sites sampled per reach required additional analyses. The results of these are included in Appendix 2.

All sampling must be completed under a current, approved safe work plan (Teck's EHSC) specific to the mine operation or Teck's regional operating area. Equipment required for this sampling includes:

- Blank Calcite Index Data Sheet, printed on waterproof paper (Appendix 1)
- A calcite scratcher – this could be a rock hammer, a metal ruler, or a small metal ruler.
- Rubber boots or hip/chest waders appropriate to the stream conditions
- Camera and GPS
- Gloves of a suitable length appropriate to the temperature conditions
- Other PPE as appropriate to the field conditions and safety plan

3.1 Site selection

The initial calcite monitoring program proposed a target of three sites sampled per reach, those being at 25, 50, and 75% of the reach length. To address higher within-reach variability at intermediate calcite index score, Robinson and Atherton (2016)[2] proposed increasing the number of sites to six between CI 1-2. Upon reassessment of this requirement, the need for a variable number of sites per reach is now considered unnecessary and produces more inconsistency in data collection than providing benefit (see Appendix 2). As such, sampling in 2021 will return to a

[2] Robinson, M.D. and K. Atherton. 2016. Teck Coal Ltd – 2016-2018 Calcite Monitoring Program. Prepared by Lotic Environmental Ltd. and Teck Coal Ltd.

standard of three sites sampled per reach where the reach length is long enough to permit this without the risk of overlapping sites. This was defined as 300 m long. Reaches less than 300 m long will be sampled with one site.

3.2 Field procedure

Pebble counts will be completed by a two-person crew. Each crew will be led by a person experienced in conducting aquatic habitat surveys. Both crew members will be trained in all tasks of this sampling protocol and may complete any of these throughout the field program. One crew member will be instream sampling rocks (100 in total) and one crew member will be onshore as a recorder. See Appendix 2 for additional information on the need to sample 100 rocks per site. These roles will be identified on the field sampling forms. The following steps will be completed:

1. Familiarize yourself with the location. Review prior site descriptions and calcite score if available. Use maps and GPS coordinates to find the start location to ensure the data is collected from the same location.
2. Examine the stream prior to entering it to conduct the pebble count. Identify the different habitat types[3] (riffle, cascade, pool, and glide) present. Determine the sampling path, a zig zag transect through the stream should cover the entire cross section and all habitat types present. Sampling representative habitat and habitat variability is important. While no minimum sampling distance is required, a sampling path typically covers approximately 100 m.
3. Beginning at the downstream end, the sampler is to enter the stream and haphazardly select substrate to sample by touching the stream bed at the end of their toe with their index finger. The sampler will select substrate within the wetted width of the stream only, dry particles will not be sampled. If the substrate is within the wetted width but exposed to air sample the particle if presence can confidently be determined. Sampling depth is limited to safely wadable water approximately an arm's length deep. The sampler is to determine the substrate type (i.e., rock, fines, moss, calcite) and if:
    a. Rock, and movable, proceed to step 4.
    b. Rock, and too large to remove, determine if calcite is present by attempting to collect scraping from the surface. If calcite presence/absence can be confidently obtained, then proceed to step 4. If the sampler cannot confidently assess calcite presence or concretion, then abandon and proceed to next particle.
    c. Rock with moss coverage, If the shape of the rock can be visually determined through the moss sample the rock, proceed to step 4. If the shape of the underlying substrate cannot be visually determined sample the moss, proceed to Step 3f.
    d. Fines (silt, sand, clay), if there is a thin layer (less than ~1 cm) of sediment on top of a rock, select the underlying rock.
    e. Fines (silt, sand, clay), calcite presence in fines is scored by Cp (0 or 1). If there is a thick layer (greater than ~1 cm) of sediment particle, pinch the fines between thumb and forefinger. If the fines contain obvious calcified conglomerates in loose sediment, then assign sore of = 0 (no concretion) and 1 (presence). If not obviously present, assign 0 (concretion) and 0 (presence). Fines will not be examined for

[3] Habitat units will follow definitions provided in a level 1 fish habitat assessment (Johnston and Slaney 1996).

individual flakes of calcite. Examine the material for a top layer of concreted particles (calcite crust[4]). If crust present, then assign score of = 1 (partial concretion) and 1 (presence). If fines are unable to be removed, then assign = 2 (full concretion) and 1 (presence).

f. Moss, remove portion of moss and determine if calcite is present. Calcite presence in moss is scored by Cp (0 or 1) If calcite deposit is present, then assign score of = 0 (no concretion) and 1 (presence). If not present, assign = 0 (concretion) and 0 (presence). If the moss was removed with calcite-induced resistance assign score of = 1 (partial concretion) and 1 (presence) If moss is fully encrusted and is unable to be removed, assign score of = 2 (full concretion) and 1 (presence).

g. Calcite deposit/pure calcite (mobile or concreted), treat as rock and proceed to step 4

4. The following observations are recorded for each particle (rock or pure calcite) on the pebble count form (Appendix 1):

   a. **Calcite concretion** – Was the particle removed without calcite-induced resistance (0)? Was the particle removed with any noticeable amount of force to overcome calcite-induced resistance (1)? Was the particle non-movable or fully concreted by calcite (2)? Resistance may be caused from factors other than calcite (e.g., embeddedness in fines). Each rock with resistance noted will have the underside of the rock examined for evidence of concretion in the form of a calcite deposit "ring" or smaller particles still attached (Figure 1). For rocks too large to move, examination for concretion can be accomplished by attempts to remove the adjacent movable particles.

Figure 1. Partially Concreted Sample. Note calcite on the left side edge, which has extended beyond the substrate sample.

   b. **Calcite presence** – Examine all sides of the particle selected. Does the individual particle have calcite deposition? No = 0, if yes, record the percent of the rock

[4] A calcite crust is a detectable hardened outer shell that the observer feels their finger break through before touching the underlying fines. A crust can often be extracted by slipping your finger underneath and pinching while lifted up. Once extracted, it can easily be confirmed as calcite crust by being a thin, brittle layer.

surface area covered as a decimal to the nearest 10th percentile (0.1, 0.2 0.3, etc.). If calcite breaks off of the particle while being removed, calcite presence will be determined by the remaining coverage on the particle. Moss and thick deposits of fines are scored as discussed in Step 3.

Calcite presence can be challenging to detect. The most effective measure to address this is for the surveyor to attend annual training hosted by Teck and to have an experienced observer assist with initial surveys to calibrate records of presence. Refer to Section 4 for additional information on determining calcite presence.

c. **Habitat type** – Record habitat type choosing between pool, riffle, glide or cascade. Acceptable habitat unit categories are pool (P), riffle (R), cascade (C), and glide (G). Refer to the level 1 Fish Habitat Assessment Procedure definitions for more clarity (Johnston and Slaney 1996).

5. Complete the calcite field form to document date, site location, coordinates, photo numbers, and type of calcite observed:

   a. Photos are taken facing upstream and downstream of the site sampled. Take two photos of rocks/substrate sampled, one rock with calcite present and one rock with calcite absent (if possible), that best describe conditions of this site. For example, in a site with low levels of calcite, do not choose the rock with highest coverage of calcite, but one that best reflects an average rock. If all rocks have calcite present, chose a variety of calcite coverage. If different forms of calcite are encountered, take additional photos.

   b. Record the dominant and co-dominant types of calcite. Section 5 Forms of calcite, further describes each type of calcite that may be encountered.

6. Calculate the mean for the totals of all 100 rocks to get the site average calcite concretion, calcite presence and calcite index scores. Report the results at the end of each field day for office verification relative to data collected from previous years. If a large discrepancy (i.e. >0.5) is found in the calcite index score compared to previous years a second crew will visit the site for QA/QC to confirm calcite index score.

$$Cp = Calcite\ Presence\ = \frac{Sum\ of\ stones\ presence\ scores}{Number\ of\ \text{stones}\ counted}$$

$$Cc = Calcite\ Concretion = \frac{Sum\ of\ stones\ concretion\ scores}{Number\ of\ stones\ counted}$$

$$CI = Calcite\ Index = Cp + Cc$$

4 General guidelines for calcite presence

Calcite training has been completed for each annual monitoring program since 2013 and more recently, crew leads of the regional program are providing training to other Teck calcite programs. Calcite presence has routinely provided the most variability between crew members and becomes most challenging at low levels of calcite deposition. The following are some general guidelines used to assess whether calcite is present on the surface of the rock being sampled. These are guidelines and no one item is diagnostic:

1. Before sampling, does the streambed have an “orange”, oxidized colour? Most calcite deposits have this colour. However, some can be grey to black.
2. Scratch rock with a metal tool to see if a crust can be removed. Calcite is a brittle mineral that will tend to hold its shape, and will typically leave a white scratch, showing a scale breakup. Many rocks will also scratch but will show minimal depth and lack a scale breakup. Algae is soft and malleable. Calcite and algae are most often confused. Silty conditions can also prove to be confusing. Some rocks will scratch even without calcite present. A scratch alone does not confirm calcite.

Figure 2. (Left) Light thin scratches, no discernible depth or material. No calcite present. (Right) Thick, chalky scratch with depth. Calcified algae

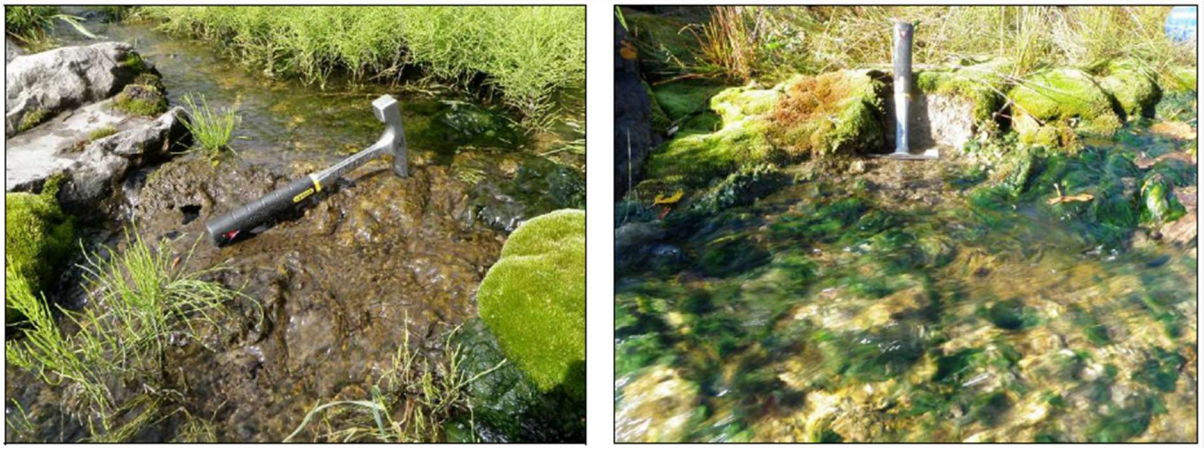
3. Does an appreciable amount of material scrape off the surface? Is there enough to roll between fingers to assess texture? If not, it is unlikely that calcite is present.
4. If you could only choose one, does the material scraped off feel like plant-matter (i.e., smooth, slippery, will roll or form into a ball) or mineral (i.e., gritty, chalky, brittle and/or flakey)?
5. Does the rock possess a firm, elevated “ring” at the interface between the surface exposed to water and the point where the rock entered the interstitial material? Calcite will form a ring here as it becomes more extensive.

5 Forms of calcite

The dominant form of calcite must be recorded on the pebble count form. Below are descriptions and photos of all the types of calcite that may be encountered (forms and definitions from Vast 2013[5]):

[5] Vast. 2013. Calcite Monitoring Program – 2012 Field Assessment (Elk Valley). Prepared for Teck Coal Ltd. Prepared by VAST Resource Solutions. 131 pp.

Calcified algae - lumpy, soft, chalky coating on the substrate of a stream.



Calcareous laminate - an advanced stage of calcified algae. The streambed is hardened into a uniform surface.

Calcified moss/tufa - can range from soft easily broken apart to a solidified mass of moss tufa.

Barrage tufa - barrier-like growths extending cross-channel to block normal water flow.

Calcite scale - a relatively thin, crystalline coating, which is homogenous in texture.

Insect tufa - formed by encrustation of the larval caddis fly cases by calcite precipitation.

6 Training

Anyone collecting calcite index data for the first time is, at a minimum, to review calcite conditions in the field with a more experienced person; to review what calcite is, the diversity of calcite deposits, and how to complete a count. It is recommended for all personnel collecting calcite data to attend the annual training session hosted by Teck. Lotic Environmental will lead the training session on behalf of Teck and will document all attendees in the annual Regional Calcite Monitoring report.

In addition to this, Lotic Environmental will hold its own crew calibration day at the onset of the Regional Calcite Monitoring program. Attendance here will also be documented in the annual Regional Calcite Monitoring report.

7 Quality assurance and quality control (QA/QC)

Data quality will be controlled during the field program by:

1. Attending the annual calcite training course held at the beginning of the field season. At a minimum, all crew leads who will be conducting calcite sampling will attend the annual calcite training course. All crew members will be encouraged to attend the training course. This will ensure each crew is familiar with different types of calcite and sampling procedures. As well, a crew calibration day will occur at the start of the regional program. Attendance will be documented in the annual regional calcite monitoring report.
2. To assess inter-crew variability, 10% of sites will be randomly selected for duplicate sampling by second crew. Results will be compared in the annual report following 2020 methods.
3. Encourage communication between crew members completing different tasks (sampling versus recording) over the course of the entire project. Doing so is likely to reduce crew member variability, thereby resulting in improved data quality and consistency.
4. Data collection forms will be reviewed for completeness before leaving the sampling location and signed off at the end of each field day by the crew lead.
5. Data collection forms will be scanned and submitted to the Project Manager or designate daily. These data will be used to calculate a preliminary calcite index score and compare to previous records. Large deviations from previous years (>0.5 CI difference) will be investigated and potentially resampled by a second crew.
6. Following data entry into Lotic's digital form, values will be assessed for accuracy using a computer script developed from R Programming Language. This will check that cells contain acceptable values (e.g., calcite presence score can only be 0, 0.1, 0.2…. 1); concreted scores can only be 0, 1, or 2; concreted score must be 0 if calcite presence is 0); habitat unit type can only be R, P, G, C. Cells that had errors or were blank were flagged and corrected.

8 Appendices

Appendix 1. Pebble count form.

Appendix 2. Assessment of key protocol components

As part of developing this 2021 field manual, we investigated two specific components of the sampling protocol employed in recent years. These were the number of rocks sampled per site and the number of sites per reach.

Robinson et al. (2016)[6] investigated the effect of reducing the number of rocks sampled by randomly selecting a subset of rock from 10-99 rocks out of the full 100 rock counts. They compared the calcite metric scores of the subsample to the metric scores of the full sample and plotted as the absolute difference versus number of rocks sampled. This was repeated in 2021. The results in 2021 agreed well with Robinson et al. (2016) in showing that the absolute difference increases as the number of rocks sampled decreases (). For each of calcite index, calcite concretion, and calcite presence, reducing the number of rocks sampled to 75 results in approximately 8% difference relative to the full count scores. Reducing the number of rocks sampled to 50 produces between a 12-15% difference. The effect of reducing the number of rocks sampled is considered large and adverse. As such, the number of rocks to be sampled per site should remain as 100 rocks per count.

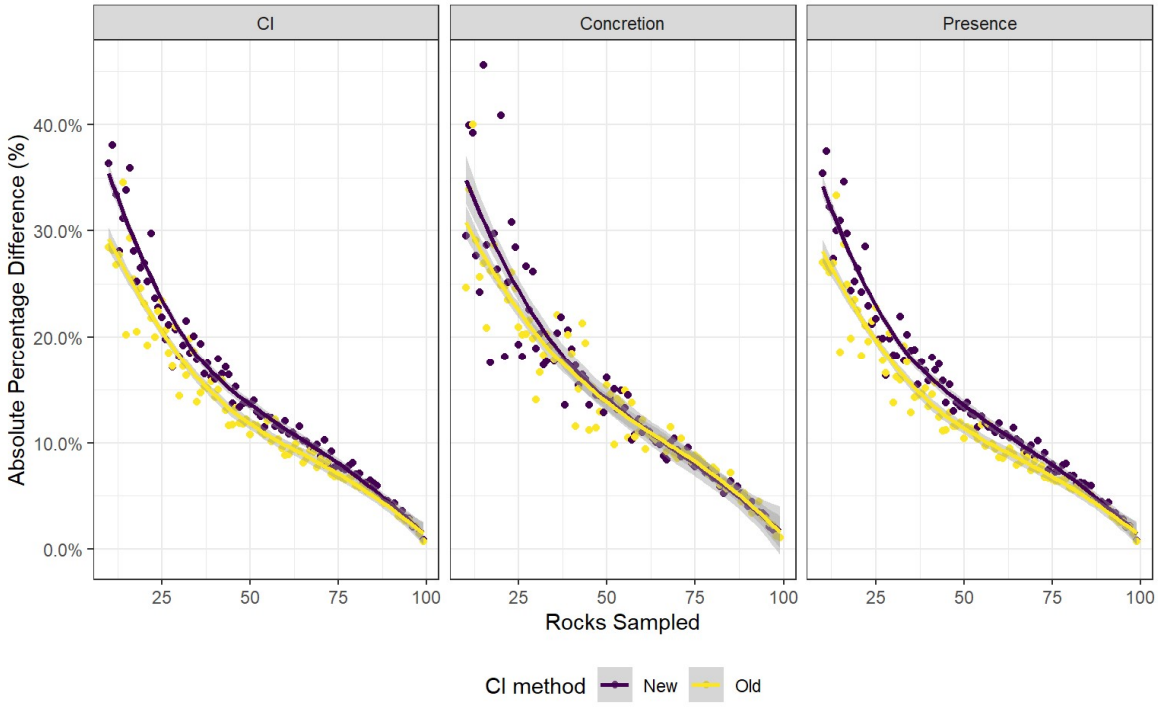


Figure 3. Absolute percentage difference of calcite metric scores by number of rocks subsampled from full 100-rock pebble counts (New = Cp', Old = Cp).

[6] Robinson, M.D. M. Chernos, K. Baranowska, and R.J. MacDonald. 2016. Teck Coal Ltd – Elk Valley 2015 Calcite Monitoring Program Annual Report and Program Assessment. Prepared for Teck Coal Ltd by Lotic Environmental Ltd. 17 pp + appendices.

Also following assessment methods of Robinson et al. (2016), we investigated the relationship of intra-reach variability of Calcite Index (CI) over the range of CI scores (0-3). Similar to 2016, the assessment indicated that within-reach variability of CI to be highest at intermediate CI values. Standard deviation of CI at the reach level was again lowest at the low (i.e., 0) and high (i.e., 3) ends of the CI range. However, different to the previous assessment was the magnitude of this variability (Figure 4). Plotting standard deviation by year shows a continual decrease (i.e., improvement) in standard deviation at the intermediate CI values. This was not able to be detected in the previous assessment give limitations in the length of dataset. This improvement is considered to be substantial enough that the need to increase the number of sites per reach where CI scores were intermediate (i.e., 1-2) is no longer needed. It is recommended that the program return to a standard of three sites per reach where the reach length is long enough to permit this without the risk of overlapping sites. This was defined as 300 m long. Reaches less than 300 m long will be sampled with one site.

The reason for the sequential reduction in within-reach variability over time has not been investigated. One potential explanation is that within-reach variability has decreased as the stream systems return to a pre-2013 flood state. It is possible that in addition to reducing the degree of calcite, the 2013 flood also produced a patchier distribution. Another potential factor is the continued training, standardization, and QA of sampling crews. By continuing to assess and identify sources are observer variability, it is expected that accurate of measurements should have improved in this program that was unique and first trialed in just 2013.

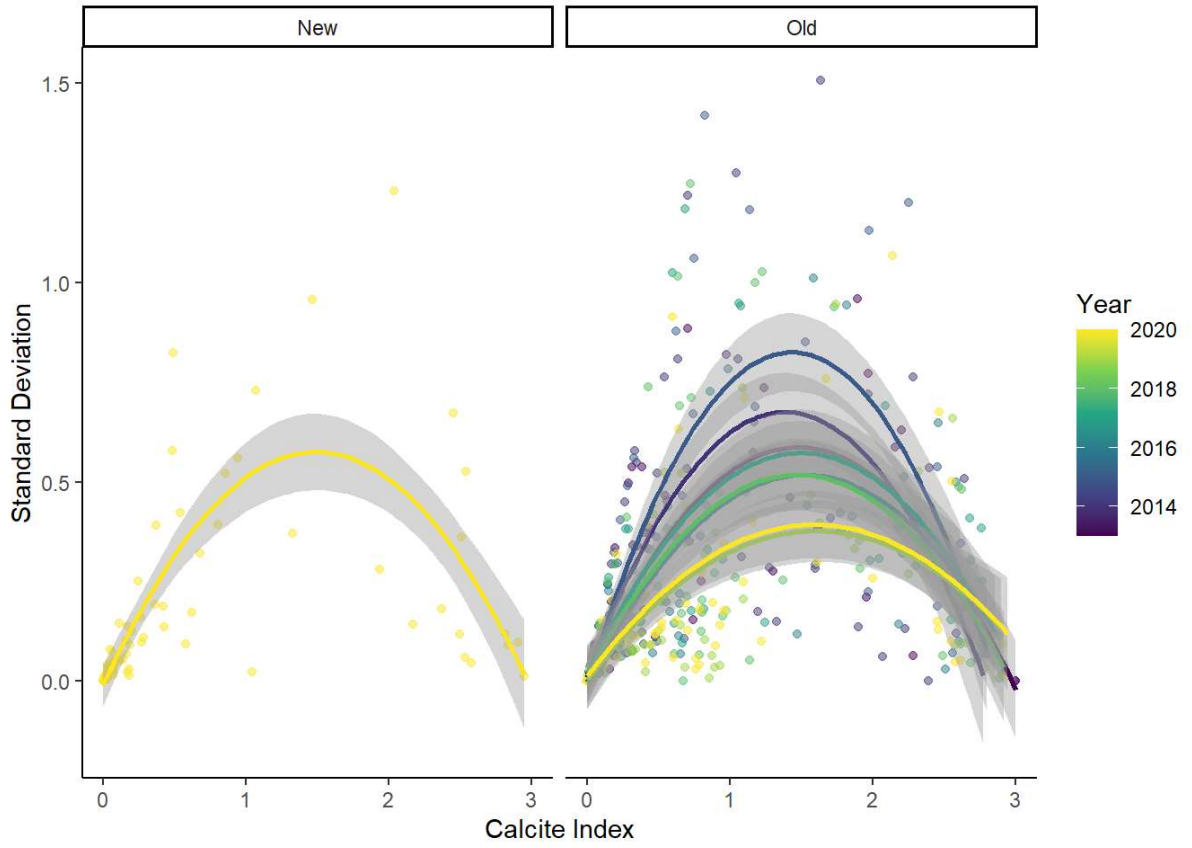


Figure 4. Standard deviation of within-reach calcite index versus calcite index scores.

Appendix 2. Attendees at the 2021 calcite training workshop.

July 26, 2021	Company
Allie Ferguson	Teck
Monica Bartha	Teck
Mike Robinson	Lotic
Mike Marquardson	Ecofish
Aidan Wilson	Ecofish
Alex McClymont	Minnow
Maddy Stokes	Minnow

September 8, 2021	Company
Allie Ferguson	Teck
Monica Bartha	Teck
Jessica Ritz	Teck
Clayton Spytz	Teck
Danika Gerylo	Teck
Mike Pope	Teck
Mike Robinson	Lotic
Nicole Zathey	Lotic
Mia Otto	Lotic
Alex McClymont	Minnow
Dave Hasek	Minnow
Tyler Mehler	Minnow
Carrie Clifford	Minnow
Jess Tester	Minnow
Naresh Gaj	Minnow
Chad Apol	Minnow
Yen Dink	Minnow
Rhiannon Hodgson	Minnow
Emily Dutton	Minnow
Patrick Schnurr	Minnow
Kayla Bailey	Minnow
Brian Derro	Minnow
Katharina Batchelar	Minnow
Amy Wiebe	Minnow
Jennifer Ings	Minnow
Clare Nelligan	Minnow
Robin Vauleau	Minnow
Brianna Barnhart	Minnow
Maddy Stokes	Minnow
Jeremy Benson	VAST
Derek Donald	VAST
Dustin LePage	VAST

October 4, 2021 (internal)	Company
Scott Gordon	Lotic
Rick Smit	Lotic
Emma Thompson	Lotic
Josh Sullivan	Lotic

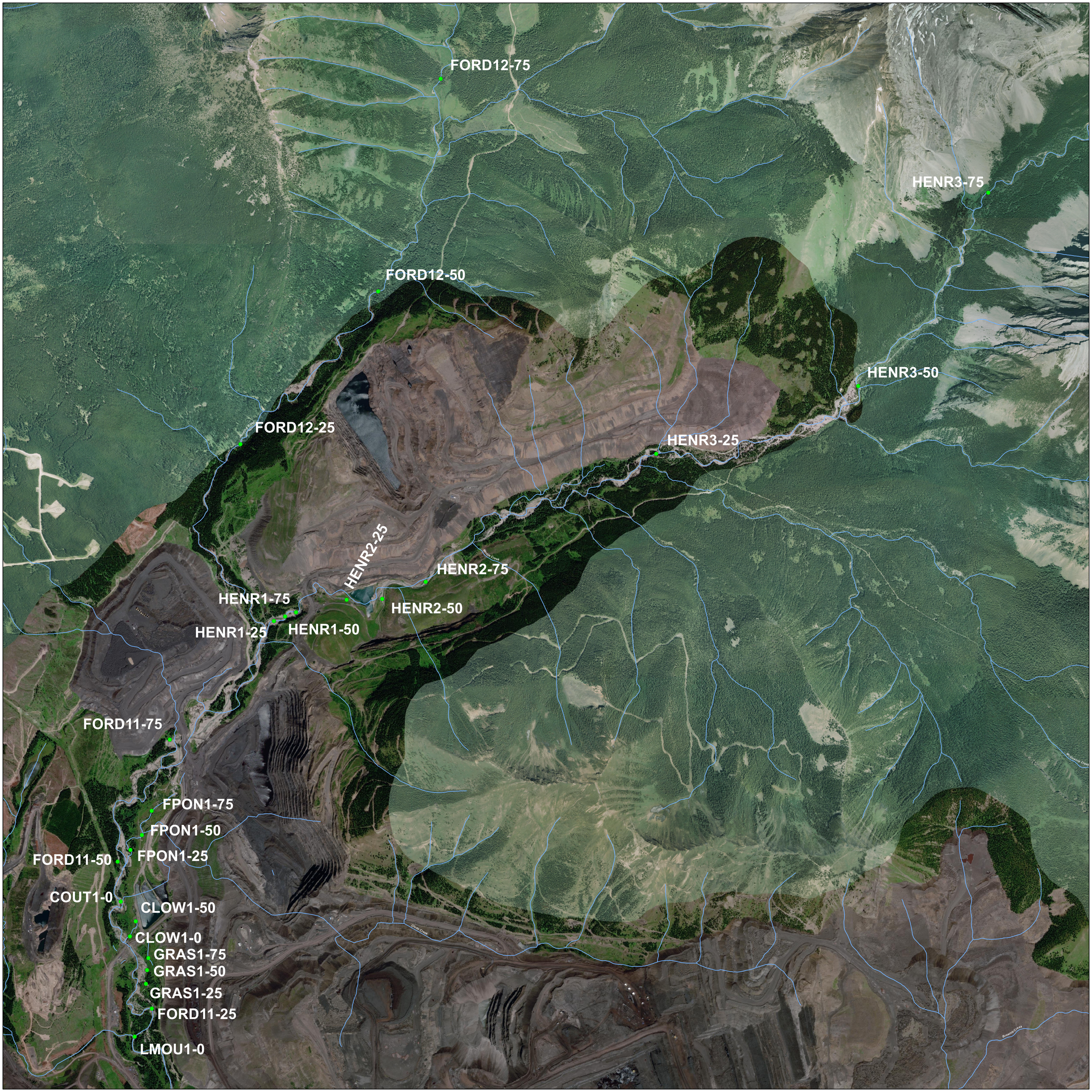
Appendix 3. Reach sampling changes from 2013-2021.

Site	Change	Reason
ALDR1-25	Added	New reference
ALDR1-50	Added	New reference
ALDR1-75	Added	New reference
ALEX1-25	Added	New reference
ALEX1-50	Added	New reference
ALEX1-75	Added	New reference
ALEX8-25	Added	New reference
ALEX8-50	Added	New reference
ALEX8-75	Added	New reference
BING1-25	Added	New reference
BING1-50	Added	New reference
BING1-75	Added	New reference
BODI2-0	Removed	Lentic. Removed in 2015. Incorrectly listed in 2021 workplan
CORB1-37.5	Removed	Number of sites per reach standardized to three.
CORB1-62.5	Removed	Number of sites per reach standardized to three.
CORB1-87.5	Removed	Number of sites per reach standardized to three.
CORB2-12.5	Removed	Number of sites per reach standardized to three.
CORB2-37.5	Removed	Number of sites per reach standardized to three.
CORB2-87.5	Removed	Number of sites per reach standardized to three.
DRIN1-25	Added	New reference
DRIN1-50	Added	New reference
DRIN1-75	Added	New reference
ERIC4-12.5	Removed	Number of sites per reach standardized to three.
ERIC4-37.5	Removed	Number of sites per reach standardized to three.
ERIC4-62.5	Removed	Number of sites per reach standardized to three.
EWIN1-25	Added	New reference
EWIN1-50	Added	New reference
EWIN1-75	Added	New reference
FORD4-62.5	Removed	Number of sites per reach standardized to three.
FORS1-25	Added	New reference
FORS1-50	Added	New reference
FORS1-75	Added	New reference
GRAC2-25	Removed	Change in program assessment requirements.
GRAC2-50	Removed	Change in program assessment requirements.
GRAC2-75	Removed	Change in program assessment requirements.
GRAC3-25	Removed	Change in program assessment requirements.
GRAC3-50	Removed	Change in program assessment requirements.
GRAC3-75	Removed	Change in program assessment requirements.
GREE3-12.5	Removed	Number of sites per reach standardized to three.
GREE3-37.5	Removed	Number of sites per reach standardized to three.
GREE3-62.5	Removed	Number of sites per reach standardized to three.
HART2-25	Added	New reference
HART2-50	Added	New reference
HART2-75	Added	New reference
LIZA1-25	Added	New reference

Site	Change	Reason
LIZA1-50	Added	New reference
LIZA1-75	Added	New reference
MCOO1-25	Added	New reference
MCOO1-50	Added	New reference
MCOO1-75	Added	New reference
MICK1-37.5	Removed	Number of sites per reach standardized to three.
MICK1-62.5	Removed	Number of sites per reach standardized to three.
MICK1-87.5	Removed	Number of sites per reach standardized to three.
MICK2-37.5	Removed	Number of sites per reach standardized to three.
MICK2-62.5	Removed	Number of sites per reach standardized to three.
MICK2-87.5	Removed	Number of sites per reach standardized to three.
MORI1-25	Added	New reference
MORI1-50	Added	New reference
MORI1-75	Added	New reference
MILL2-14.3	Removed	Number of sites per reach standardized to three.
MILL2-29.9	Removed	Number of sites per reach standardized to three.
MILL2-42.6	Removed	Number of sites per reach standardized to three.
MILL2-55.2	Removed	Number of sites per reach standardized to three.
MILL2-71.5	Removed	Number of sites per reach standardized to three.
NTHO1-12.5	Removed	Number of sites per reach standardized to three.
NTHO1-37.5	Removed	Number of sites per reach standardized to three.
NTHO1-62.5	Removed	Number of sites per reach standardized to three.
PENG1-0	Removed	Removed in 2019 due to dry conditions. Incorrectly returned to program.
PENG1-50	Removed	Removed in 2019 due to dry conditions. Incorrectly returned to program.
RG_LE1-25	Added	New reference
RG_LE1-50	Added	New reference
RG_LE1-75	Added	New reference
RG_UCWER1-25	Added	New reference
RG_UCWER1-50	Added	New reference
RG_UCWER1-75	Added	New reference
STR14-50	Added	Incorrectly removed. Required for Sparwood Ridge monitoring.
STR14-75	Added	Incorrectly removed. Required for Sparwood Ridge monitoring.
SWOL1-16	Removed	Number of sites per reach standardized to three.
THOM3-12.5	Removed	Number of sites per reach standardized to three.
THOM3-37.5	Removed	Number of sites per reach standardized to three.
THOM3-62.5	Removed	Number of sites per reach standardized to three.
TODH1-25	Added	New reference
TODH1-50	Added	New reference
TODH1-75	Added	New reference
WEIG1-25	Added	New reference
WEIG1-50	Added	New reference
WEIG1-75	Added	New reference

Appendix 4. Maps of sample sites.

ELKR15-75
Elk River
Gardner Creek
Windy Creek
ELKR15-50
Bingay Creek
ELKR15-25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HENR2-25
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HENR1-25
HENR1-50
FORD11-75
FPON1-75
FPON1-50
FORD11-50
FPON1-25
COUT1-0
CLOW1-50
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GRAS1-75
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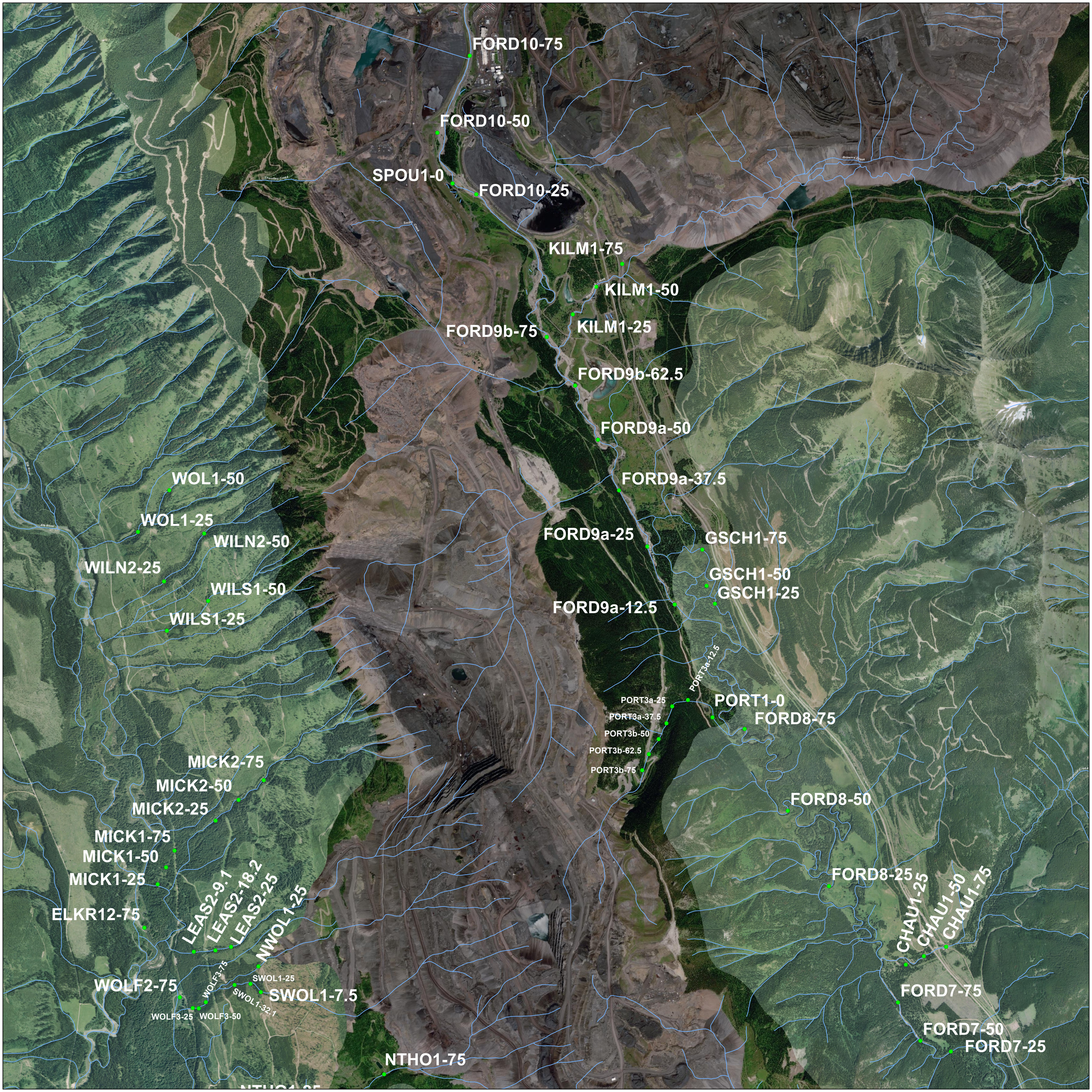
GRAS1-25
FORD11-25
LMOU1-0
Clode Creek
Brownie Creek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FORD9b-62.5
FORD9a-50
FORD9a-37.5
FORD9a-25
FORD9a-12.5
GSCH1-75
GSCH1-50
GSCH1-25
PORT3a-12.5
PORT3a-25
PORT3a-37.5
PORT3b-50
PORT3b-62.5
PORT3b-75
PORT1-0
FORD8-75
FORD8-50
FORD8-25
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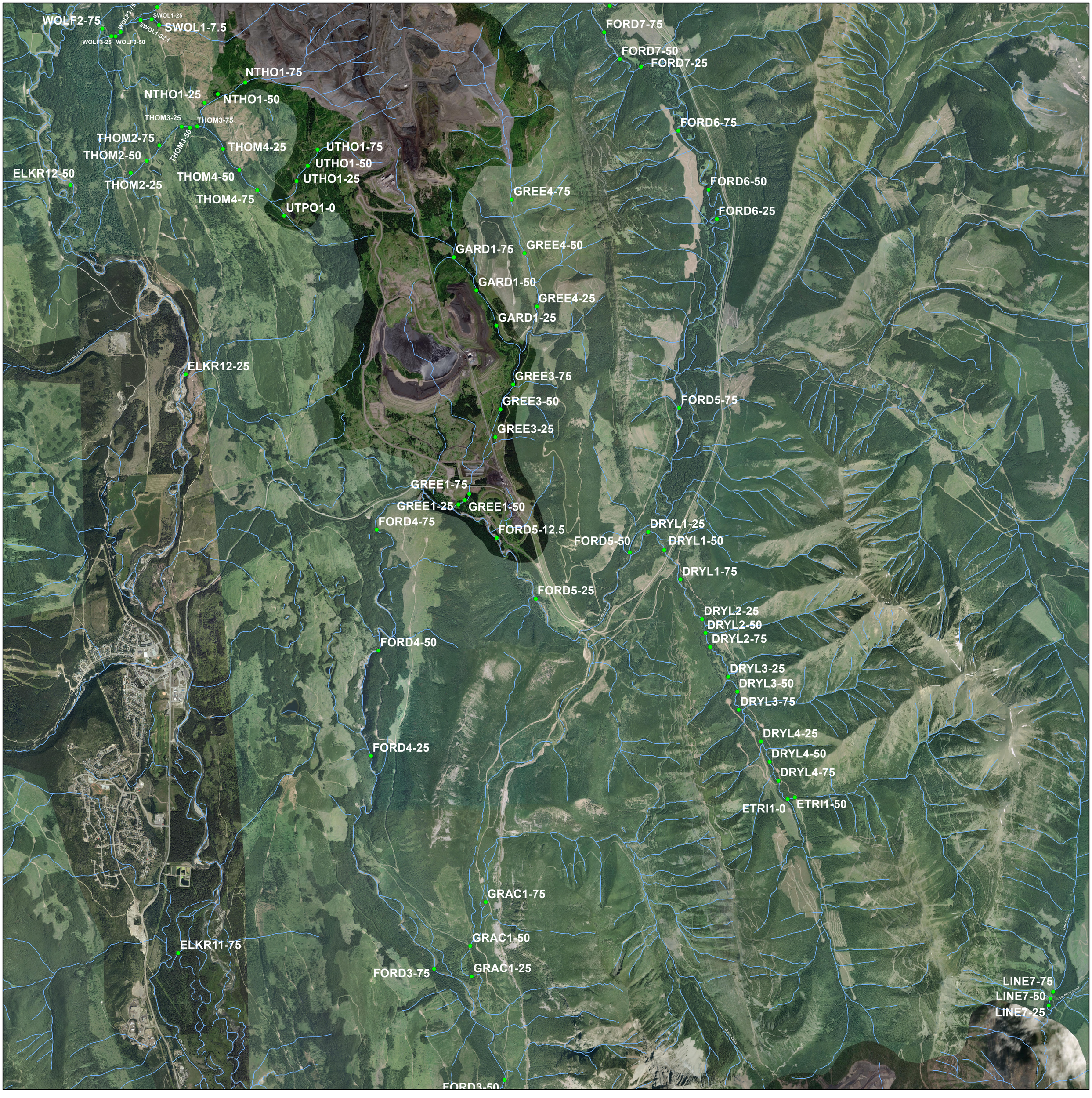
CHAU1-50
CHAU1-75
FORD7-75
FORD7-50
FORD7-25
WOL1-50
WOL1-25
WILN2-50
WILN2-25
WILS1-50
WILS1-25
MICK2-75
MICK2-50
MICK2-25
MICK1-75
MICK1-50
MICK1-25
ELKR12-75
LEAS2-9.1
LEAS2-18.2
LEAS2-25
NWOL1-25
WOLF3-75
SWOL1-25
SWOL1-32.1
SWOL1-7.5
WOLF2-75
WOLF3-25
WOLF3-50
NTHO1-75
Shandley Creek
Smith Creek
Swift Creek
Brownie Creek
Elk River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GREE1-50
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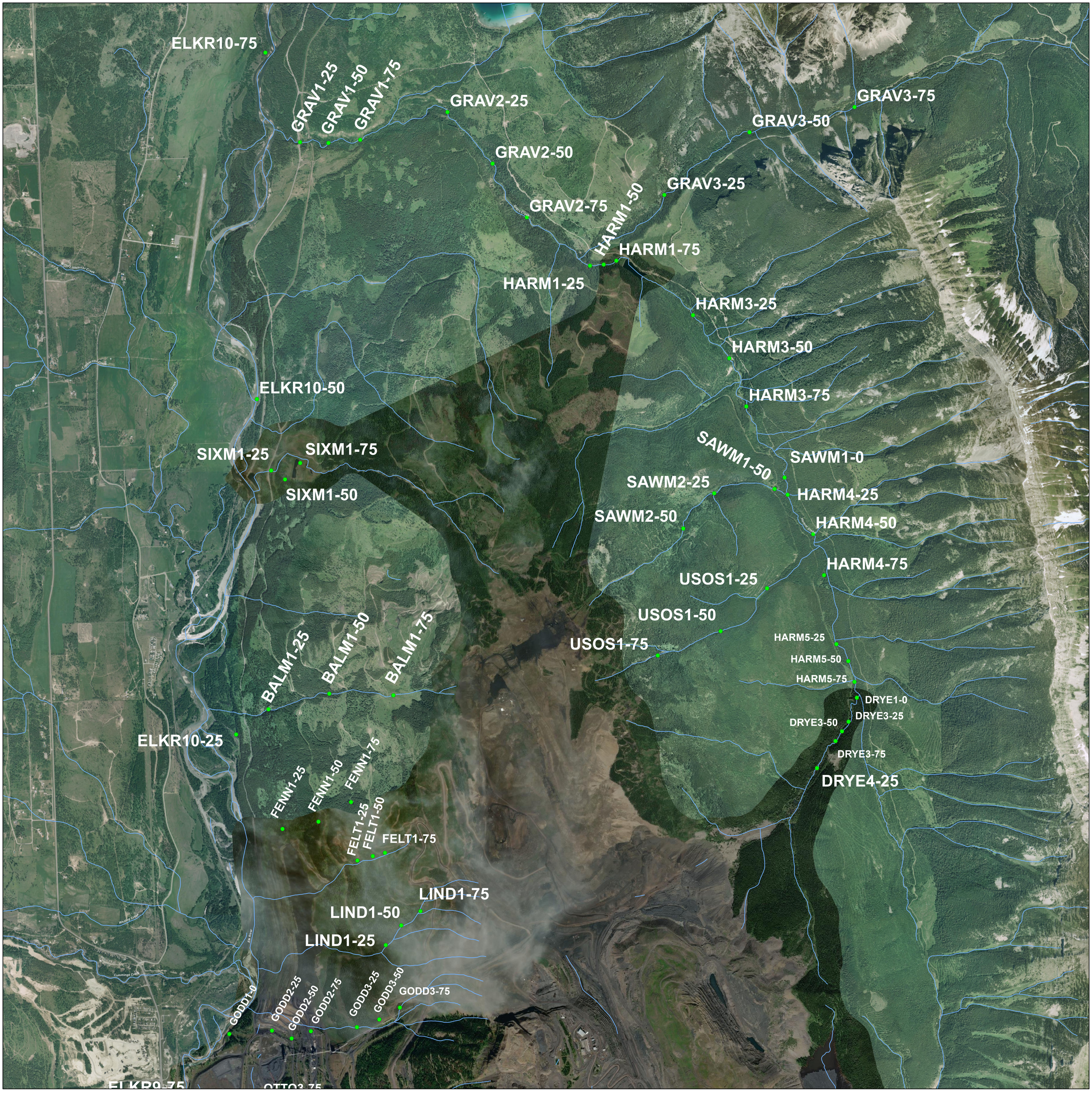
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HARM3-50
HARM3-75
ELKR10-50
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SIXM1-75
SIXM1-50
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SAWM1-0
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SAWM2-50
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USOS1-75
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BALM1-50
BALM1-75
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FENN1-25
FENN1-50
FENN1-75
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FELT1-50
FELT1-75
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LIND1-50
LIND1-25
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GODD2-50
GODD2-75
GODD3-25
GODD3-50
GODD3-75
ELKR9-75
Perry Creek
Whiting Creek
Cummings Creek
Elk River

GODD1-0
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MICH1-75
SITE-18
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BODI1-50
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STR14-50
MICH2-25
STR14-75
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ALEX3-50
MICH2-75
ERIC4-25
SPIT1-0
ERIC3-0
ERIC1-50
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R8-75
ALEX3-25
MICH3-25
Cummings Creek
Elk River
Bodie Creek
Michel Creek
Erickson Creek
Alexander Creek
Graham Creek
Richard Creek
Fir Creek
Summit Creek

ELKR8-75
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MICH3-25
MICH3-50
ELKR8-50
MICH3-75
MICH4-25
MICH4-50
ELKR8-25
Robert Creek
Pit Creek
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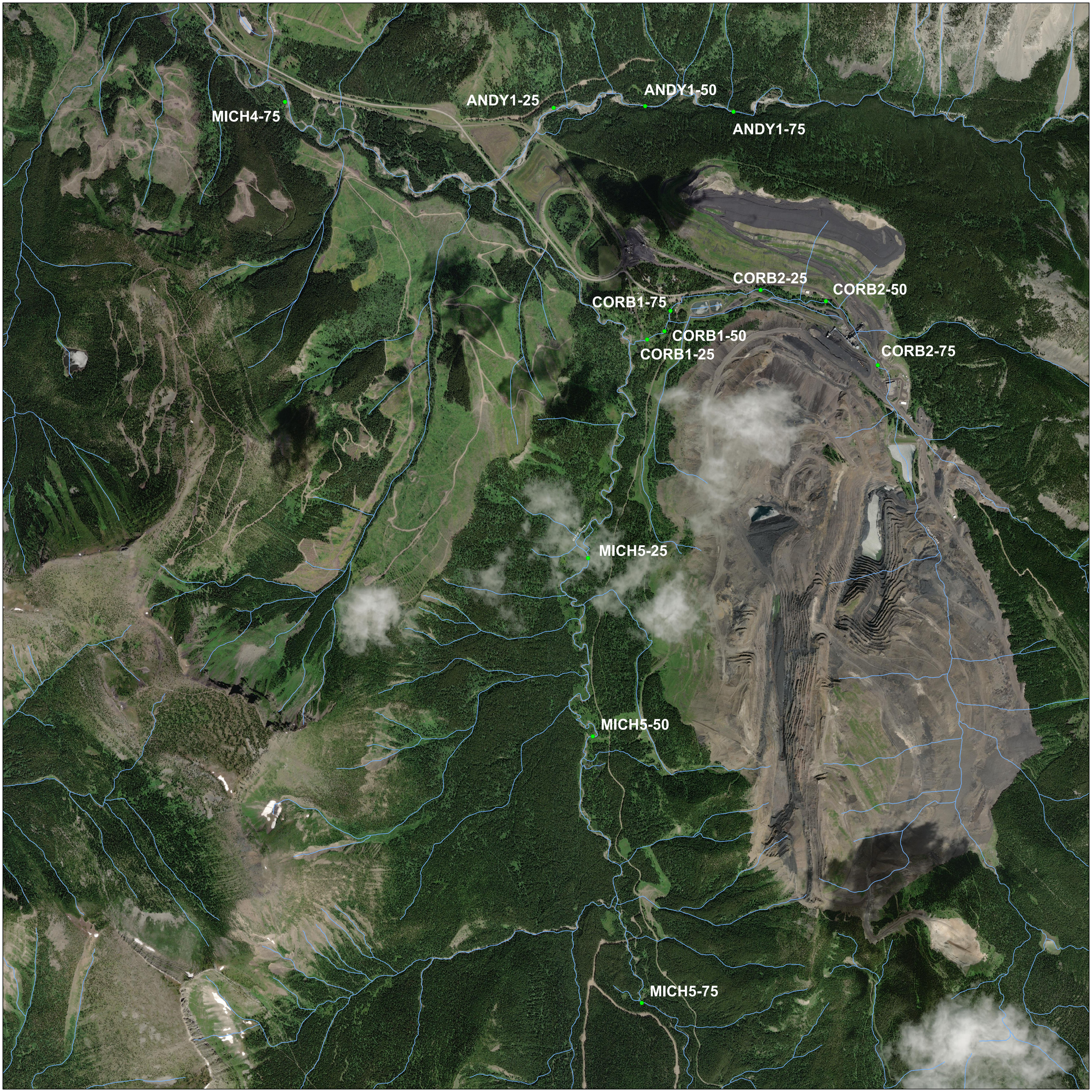
Summit Creek
Michel Creek
Karbon Creek
Erickson Creek
Jimmy Creek
Thirsk Creek
Quin Creek
Martin Creek
Bay Creek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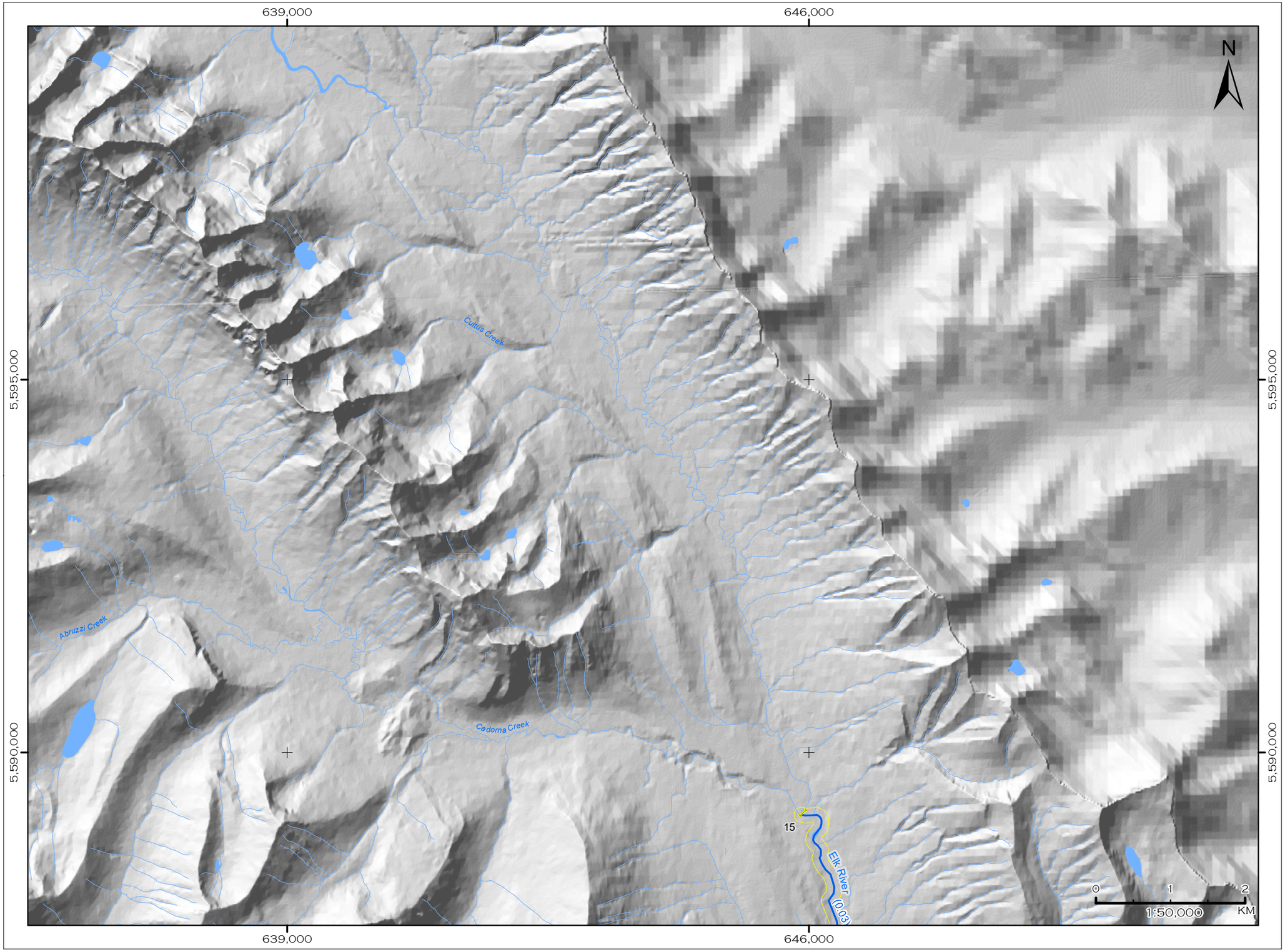
CORB1-50
CORB1-25
CORB2-75
MICH5-25
MICH5-50
MICH5-75

Appendix 5. Reach calcite index distribution maps.

2021 Regional Calcite Monitoring Program - Calcite Index

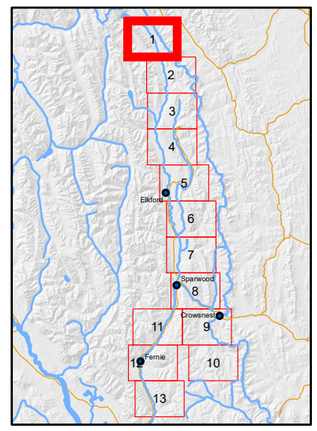
Elk Valley - Map #1



Calcite Index
- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00

Mean Calcite Index Reach Score
- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- Reference Stream
- Reach Break
- Water Network
- Road - Regional and Main
- Railway
- Teck Coal Operations

Elk Valley Index Map



Client: Teck

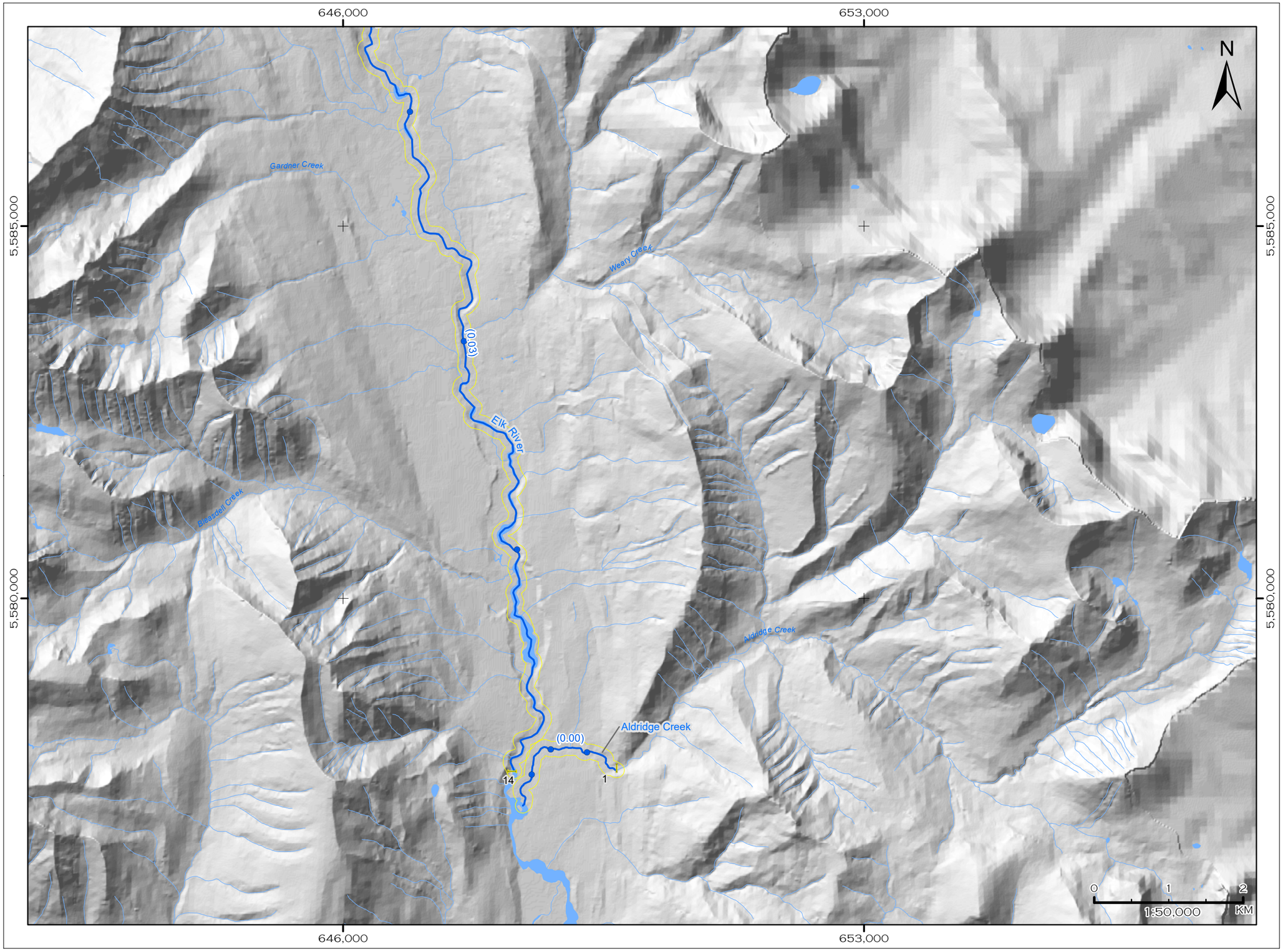
Mapping by: Lotic Environmental

Data Sources:
- Teck Coal Operations - Teck (2020)
- Stream / River - Teck Water Network
- Road and Railway - Teck Transportation
- Hillshade - Teck

Date Last Revised: February 15, 2021

2021 Regional Calcite Monitoring Program - Calcite Index

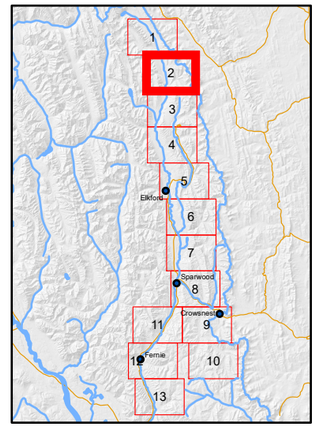
Elk Valley - Map #2



Calcite Index
- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00

Mean Calcite Index Reach Score
- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- Reference Stream
- Reach Break
- Water Network
- Road - Regional and Main
- Railway
- Teck Coal Operations

Elk Valley Index Map



Client: Teck

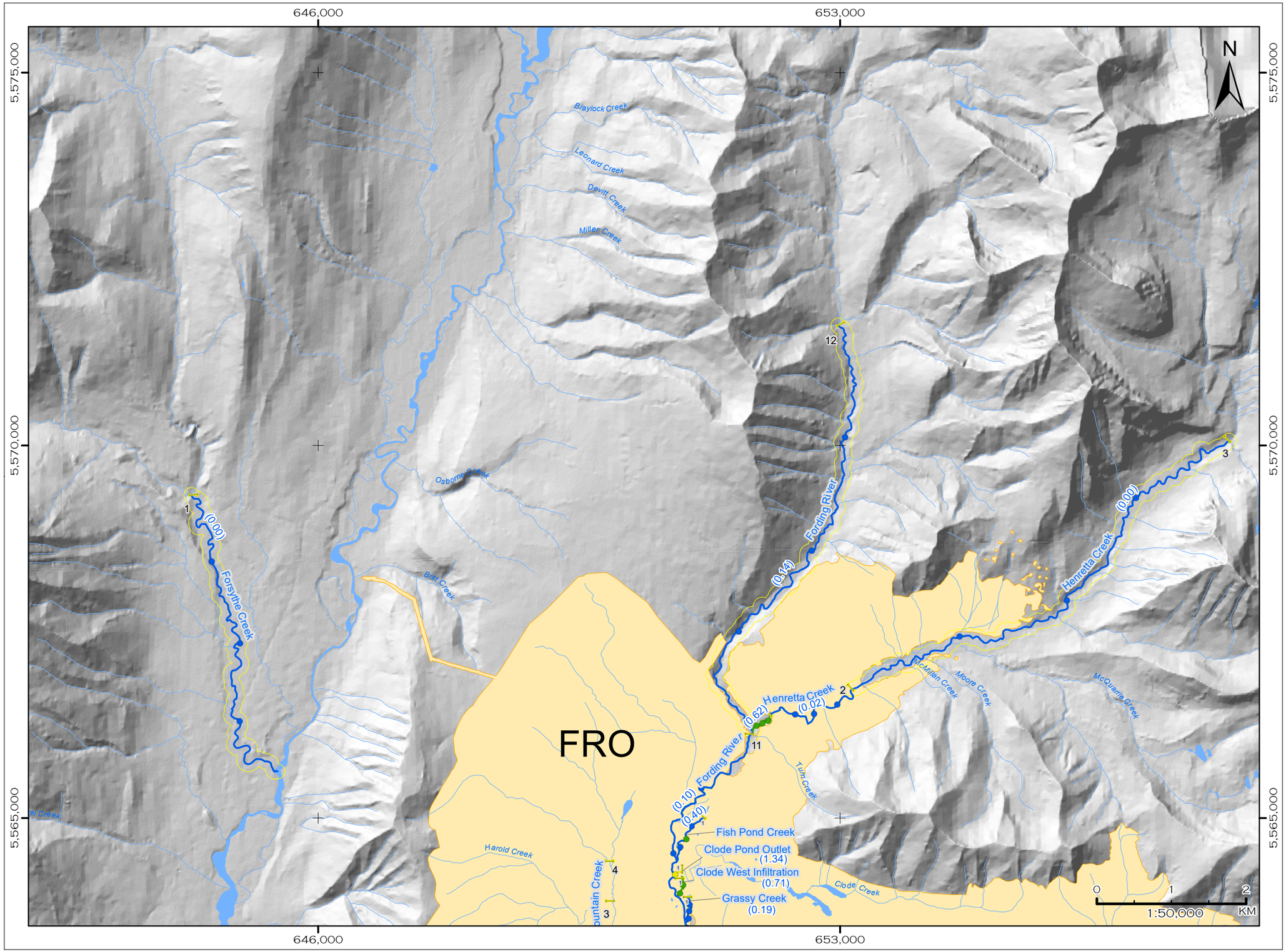
Mapping by: Lotic Environmental

Data Sources:
- Teck Coal Operations - Teck (2020)
- Stream / River - Teck Water Network
- Road and Railway - Teck Transportation
- Hillshade - Teck

Date Last Revised: February 15, 2021

2021 Regional Calcite Monitoring Program - Calcite Index

Elk Valley - Map #3



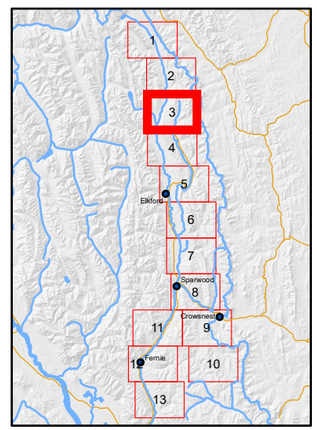
Calcite Index

- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00

Mean Calcite Index Reach Score

- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- Reference Stream
- Reach Break
- Water Network
- Road - Regional and Main
- Railway
- Teck Coal Operations

Elk Valley Index Map



Client: Teck

Mapping by: Lotic Environmental

Data Sources:
- Teck Coal Operations - Teck (2020)
- Stream / River - Teck Water Network
- Road and Railway - Teck Transportation
- Hillshade - Teck

Date Last Revised: February 15, 2021

2021 Regional Calcite Monitoring Program - Calcite Index

Elk Valley - Map #4

646,000 653,000 5,560,000 5,555,000

FRO

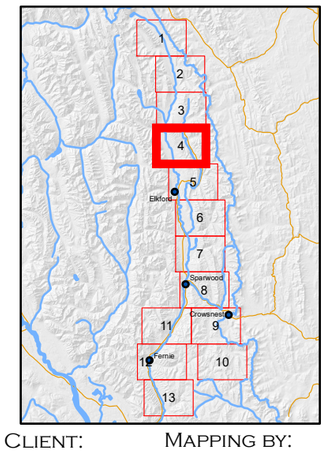
GHO

N

Bingay Creek (0.01)
Lowe Creek
Shandley Creek
Shandley Ck
Smith Ponds Outlet (2.35)
Eagle Pond Outlet
(0.67)
(0.10)
(0.35)
Lake M
Chandrea Creek
Jason Creek
Heather Creek
Blackmore Creek
Blake Creek
Swift Ck
North Fork Swift Ck
Middle Fork Swift Ck
South Fork Swift Ck
Swift Creek
9a
9b
Kilmarnock Creek
(0.10)
(2.34)
Blackwood Creek
Blackstone
Blackrill Creek
Brownie Creek
Kilmarnock Creek
Castle Creek
Casino Creek
Caspel Creek
Castlet Creek
Cascade Creek
Cast Creek
Br. F Creek
(0.08) Wolf Creek
Willow Cr. North (0.01)
Willow Cr. South (0.21)
Wilde Cr.
Wade Cr.
Cougar Cr.
Nohyame Cr.
(0.00)
RG. UCWER
Frying Pan Ck
Mickelson Creek
(1.69)
(1.19)
(2.69) Leask Creek
Leask Cr.
North Wolfram Creek
(2.64)
(2.91)
(2.80)
(2.39)
South Wolfram Creek
Wolfram Creek
North Thompson Creek
(1.94)
Cataract Creek
Greenhouse side channel
Fording River (0.41)
(0.67)
(0.49)
(0.98) Fording River
(2.22)
3a
3b
Porter Creek
(0.67)
Chauncey Creek
(0.18)
Fording River
(1.13)
Chauncey Creek

0 1 2 KM
1:50,000

Elk Valley Index Map



Calcite Index
- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00

Mean Calcite Index Reach Score
- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- Reference Stream
- Reach Break
- Water Network
- Road - Regional and Main
- Railway
- Teck Coal Operations

Client: Teck

Mapping by: Lotic Environmental

Data Sources:
- Teck Coal Operations - Teck (2020)
- Stream / River - Teck Water Network
- Road and Railway - Teck Transportation
- Hillshade - Teck

Date Last Revised: February 15, 2021

2021 Regional Calcite Monitoring Program - Calcite Index

Elk Valley - Map #5

653,000 660,000 5,550,000 5,545,000 5,540,000

N

Thompson Creek (1.07) (1.90) (0.19) Thompson Cr. (0.58) Upper Thompson Cr. (1.51) Upper Thompson Cr. North Upper Thompson Pond Outlet Upper Thompson Cousins Cr. (0.00) Bay 9 Ditch Fort Creek Ditch Hawk Toe Seep Greenhills Creek Gardine Creek (0.71) (2.67) W.seep (2.68) (0.76) Fording River (0.92) (1.01) (0.85) (0.12) GHO (1.19) Greenhills Creek (0.10) Toothunter Creek Toothunter East Fork Cr. Ewin Creek (0.21) Ewin Creek Ewin Slide Drain (0.74) (0.71) (0.38) Dry Creek - LCO (0.34) (0.00) East Dry Creek Grace Creek LCO Elkford Elk River (0.22) Bolvin Creek

0 1 2 KM 1:50,000

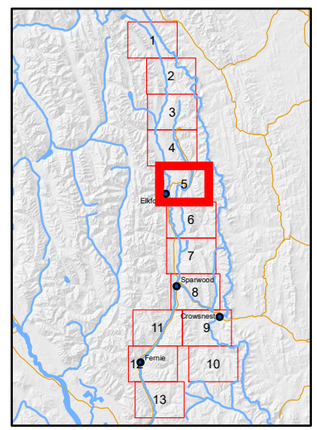
Calcite Index

- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00

Mean Calcite Index Reach Score

- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- Reference Stream
- Reach Break
- Water Network
- Road - Regional and Main
- Railway
- Teck Coal Operations

Elk Valley Index Map



Client: Teck

Mapping by: Lotic Environmental

Data Sources:
- Teck Coal Operations - Teck (2020)
- Stream / River - Teck Water Network
- Road and Railway - Teck Transportation
- Hillshade - Teck

Date Last Revised: February 15, 2021

2021 Regional Calcite Monitoring Program - Calcite Index

Elk Valley - Map #6

653,000 660,000 5,535,000 5,530,000

N

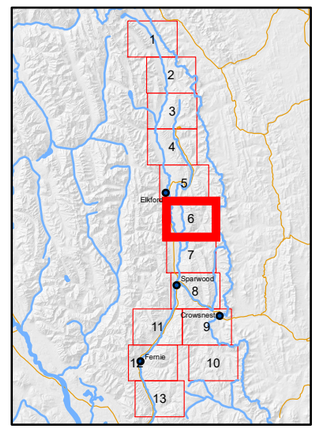
LCO

Grace Creek (0.12)
(0.85)
(0.22)
Elk River
Fording River
Grace Creek
3
Line Creek - LCO
Line Creek
7
6
(0.00)
WLCb1
WLCb2
WLCb3
WLCb4a
WLCb4b
WLCb5
West Line Creek
Line Creek
4
(0.94)
Contingency Pond Seep
1
1
3
1
South Line Creek
(0.18)
2
Contingency Pond Outlet
Line Creek (0.36)
2
Line Creek
(0.28)
South Line Creek
Weigert Creek
(0.03)
1
(1.09)
Fording River
1
(0.53) Line Creek
1
(0.43)
10
LCO
0 1 2
1:50,000 KM

Calcite Index
- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00

Mean Calcite Index Reach Score
- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- Reference Stream
- Reach Break
- Water Network
- Road - Regional and Main
- Railway
- Teck Coal Operations

Elk Valley Index Map



Client: Teck

Mapping by: Lotic Environmental

Data Sources:
- Teck Coal Operations - Teck (2020)
- Stream / River - Teck Water Network
- Road and Railway - Teck Transportation
- Hillshade - Teck

Date Last Revised: February 15, 2021

2021 Regional Calcite Monitoring Program - Calcite Index

Elk Valley - Map #7

653,000 660,000

5,525,000 5,520,000

LCO

EVO

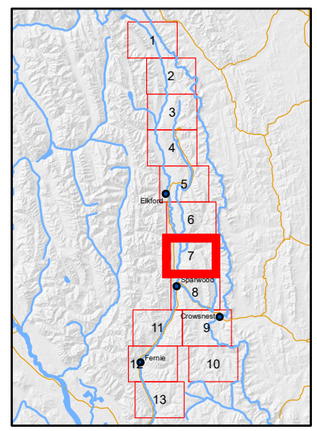
Grave Lake

N

Calcite Index
- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00

Mean Calcite Index Reach Score
- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- Reference Stream
- Reach Break
- Water Network
- Road - Regional and Main
- Railway
- Teck Coal Operations

Elk Valley Index Map



Client: Teck

Mapping by: LOTIC Environmental

Data Sources:
- Teck Coal Operations - Teck (2020)
- Stream / River - Teck Water Network
- Road and Railway - Teck Transportation
- Hillshade - Teck

Date Last Revised: February 15, 2021

0 1 2 KM

1:50,000

2021 Regional Calcite Monitoring Program - Calcite Index

Elk Valley - Map #8

653,000 660,000 5,515,000 5,510,000 5,505,000

N

EVO

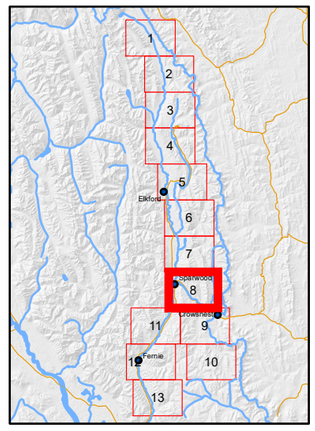
Cummings Creek
Lindsay Creek
Lindsay Creek
(0.06)
CCR Seep
(0.21)
Goddard Creek
(2.76)
(0.04)
Pit Rd 12 Seep
Cossarini Creek
Domestic License
Lagoon C Seep
Otto Creek
(0.07)
(0.49)
Aqueduct Creek
Spring Creek
Qualteri Creek
Michel Creek
Elk River
(0.01)
(0.00)
(0.01)
(0.24)
Sparwood
(0.02)
(0.16)
Site 18 Creek
(2.49)
Bodie Creek
(1.22)
(2.55)
Natal West Highwall
Gate Creek
(1.46)
South Gate Creek
Thresher Creek
Stream 02
(0.00)
Stream 14
(0.46)
Bodie Creek
Crahan Creek
(0.29)
Milligan Creek
(2.19)
South Pit
(2.15)
(2.94)
(2.71)
(2.87)
(0.03)
(0.03)
Alexander Creek
Lower Alexander Creek
Robert Creek
Fir Creek
Thresher Creek
Michel Creek
Erickson Creek
(1.42)
Alexander Creek
(0.01)
Alexander Creek
Erickson Creek
West Fork
Bodie Creek
Erickson Creek

0 1 2 KM
1:50,000

Calcite Index
- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00

Mean Calcite Index Reach Score
- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- Reference Stream
- Reach Break
- Water Network
- Road - Regional and Main
- Railway
- Teck Coal Operations

Elk Valley Index Map



Client: Teck

Mapping by: LOTIC Environmental

Data Sources:
- Teck Coal Operations - Teck (2020)
- Stream / River - Teck Water Network
- Road and Railway - Teck Transportation
- Hillshade - Teck

Date Last Revised: February 15, 2021

2021 Regional Calcite Monitoring Program - Calcite Index

Elk Valley - Map #9

660,000 667,000

5,500,000 5,495,000

Michel Creek (0.03) Alexander Creek (0.01) Summit Creek Crowsnest Wheeler Creek SnowSlide Creek Carbon Creek Leach Creek (0.00) (0.11) Michel Creek

1 2 3

N

0 1 2 KM

1:50,000

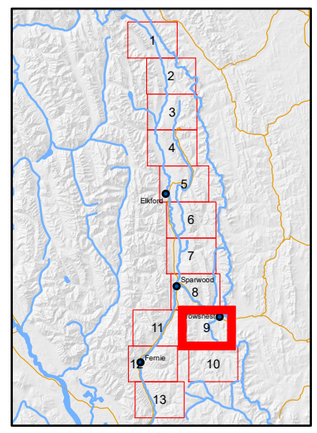
Calcite Index

- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00

Mean Calcite Index Reach Score

- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- Reference Stream
- Reach Break
- Water Network
- Road - Regional and Main
- Railway
- Teck Coal Operations

Elk Valley Index Map



Client: Teck

Mapping by: Lotic Environmental

Data Sources:
- Teck Coal Operations - Teck (2020)
- Stream / River - Teck Water Network
- Road and Railway - Teck Transportation
- Hillshade - Teck

Date Last Revised: February 15, 2021

2021 Regional Calcite Monitoring Program - Calcite Index

Elk Valley - Map #10

660,000 667,000

5,490,000 5,485,000 5,480,000

N

Leach Creek (0.00) (0.11) Tent Creek Andy Good Creek (0.05) Andy Goode Creek Michel Creek Corbin Creek (2.72) (2.96) Scrubby Creek Pengelly Creek Marten Creek Leach Creek 34 Pit Pipe 37Pit Pipe Carbon Creek (0.04) Michel Creek

CMO

0 1 2 KM

1:50,000

660,000 667,000

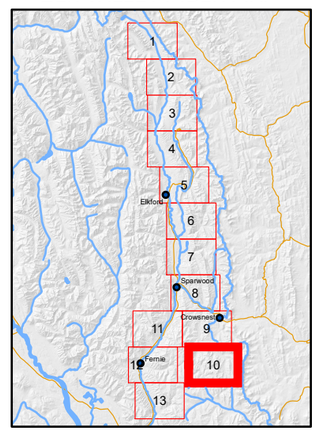
Calcite Index

- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00

Mean Calcite Index Reach Score

- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- Reference Stream
- Reach Break
- Water Network
- Road - Regional and Main
- Railway
- Teck Coal Operations

Elk Valley Index Map



Client: Teck

Mapping by: Lotic Environmental

Data Sources:
- Teck Coal Operations - Teck (2020)
- Stream / River - Teck Water Network
- Road and Railway - Teck Transportation
- Hillshade - Teck

Date Last Revised: February 15, 2021

2021 Regional Calcite Monitoring Program - Calcite Index

Elk Valley - Map #11

639,000 646,000 653,000

5,500,000 5,495,000

N

McCool Creek 1 McCool Creek (0.19)

East Sulphur Creek

Olivia Creek Ervine Creek Labelle Creek Hosmer Creek Harley Creek Thorne Creek Dock Creek Murdoch Creek Harley Creek 1 (0.03) Elk River Quar Creek (0.19) Martin Creek

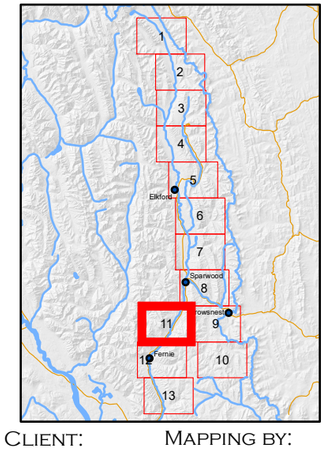
0 1 2 KM

1:50,000

Calcite Index
- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00

Mean Calcite Index Reach Score
- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- Reference Stream
- Reach Break
- Water Network
- Road - Regional and Main
- Railway
- Teck Coal Operations

Elk Valley Index Map



Client: Teck

Mapping by: LOTIC Environmental

Data Sources:
- Teck Coal Operations - Teck (2020)
- Stream / River - Teck Water Network
- Road and Railway - Teck Transportation
- Hillshade - Teck

Date Last Revised: February 15, 2021

2021 Regional Calcite Monitoring Program - Calcite Index

Elk Valley - Map #12

639,000 646,000

5,490,000 5,485,000 5,480,000

N

Hartley Creek (0.03)

Bedgrey Creek

Fairy Creek

Elk River

(0.19)

7

Mutz Creek

Fernie

1

(0.12)

Lizard Creek

Brewery Creek

Coal Creek

Coking Creek

0 1 2 KM

1:50,000

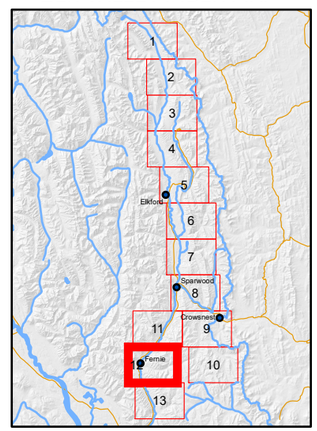
Calcite Index

- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00

Mean Calcite Index Reach Score

- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- Reference Stream
- Reach Break
- Water Network
- Road - Regional and Main
- Railway
- Teck Coal Operations

Elk Valley Index Map



Client: Teck

Mapping by: Lotic Environmental

Data Sources:
- Teck Coal Operations - Teck (2020)
- Stream / River - Teck Water Network
- Road and Railway - Teck Transportation
- Hillshade - Teck

Date Last Revised: February 15, 2021

2021 Regional Calcite Monitoring Program - Calcite Index

Elk Valley - Map #13

639,000 646,000 653,000

5,475,000

5,470,000

N

Morrissey Creek

Morrissey Creek (0.00)

Drinkwater Creek (0.00)

Tunnel Creek

0 1 2 KM

1:50,000

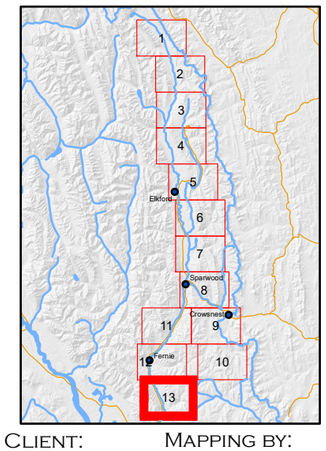
Calcite Index

- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00

Mean Calcite Index Reach Score

- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- Reference Stream
- Reach Break
- Water Network
- Road - Regional and Main
- Railway
- Teck Coal Operations

Elk Valley Index Map



Client: Teck

Mapping by: Lotic Environmental

Data Sources:
- Teck Coal Operations - Teck (2020)
- Stream / River - Teck Water Network
- Road and Railway - Teck Transportation
- Hillshade - Teck

Date Last Revised: February 15, 2021

Appendix 6. Calcite index, calcite presence, and calcite concretion for all reaches from 2013-2021.

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2013	Reference	Alexander	ALEX3	0.48	0.40	0.08
Tributary	2013	Reference	Andy Good	ANDY1	0.00	0.00	0.00
Tributary	2013	Exposed	Aqueduct	AQUE1	0.00	0.00	0.00
Tributary	2013	Exposed	Aqueduct	AQUE2	0.00	0.00	0.00
Tributary	2013	Exposed	Aqueduct	AQUE3	0.00	0.00	0.00
Tributary	2013	Exposed	Balmer	BALM1	0.00	0.00	0.00
Tributary	2013	Exposed	Bodie	BODI1	0.00	0.00	0.00
Tributary	2013	Exposed	Bodie	BODI2	0.06	0.06	0.00
Tributary	2013	Exposed	Bodie	BODI3	1.16	0.65	0.51
Tributary	2013	Exposed	Cataract	CATA1	3.00	1.00	2.00
Tributary	2013	Exposed	Cataract	CATA2	1.89	1.00	0.89
Tributary	2013	Exposed	Cataract	CATA3	3.00	1.00	2.00
Tributary	2013	Reference	Chauncey	CHAU1	0.00	0.00	0.00
Tributary	2013	Exposed	Corbin	CORB1	1.95	0.97	0.99
Tributary	2013	Exposed	Corbin	CORB2	2.72	0.98	1.74
Tributary	2013	Exposed	Clode Outlet	COUT1	0.00	0.00	0.00
Tributary	2013	Exposed	Contingency Pond Seep	CPOS1	0.92	0.92	0.00
Tributary	2013	Exposed	Contingency Pond Outlet	CPOU1	0.93	0.93	0.00
Tributary	2013	Exposed	CCR Seep	CSEE1	0.00	0.00	0.00
Tributary	2013	Exposed	Dry - EVO	DRYE1	2.23	0.85	1.38
Tributary	2013	Exposed	Dry - EVO	DRYE2	2.23	0.85	1.38
Tributary	2013	Exposed	Dry - EVO	DRYE3	2.20	0.85	1.35
Tributary	2013	Exposed	Dry - EVO	DRYE4	1.42	0.75	0.68
Tributary	2013	Reference	Dry - LCO	DRYL1	0.00	0.00	0.00
Tributary	2013	Reference	Dry - LCO	DRYL2	0.00	0.00	0.00
Tributary	2013	Reference	Dry - LCO	DRYL3	0.00	0.00	0.00
Tributary	2013	Reference	Dry - LCO	DRYL4	0.00	0.00	0.00
Tributary	2013	Reference	Dry - LCO	DRYL5	0.00	0.00	0.00
Tributary	2013	Reference	Dry - LCO	DRYL6	0.00	0.00	0.00
Mainstem	2013	Exposed	Elk	ELKR10	0.00	0.00	0.00
Mainstem	2013	Exposed	Elk	ELKR11	0.00	0.00	0.00
Mainstem	2013	Exposed	Elk	ELKR12	0.00	0.00	0.00
Mainstem	2013	Reference	Elk	ELKR15	0.00	0.00	0.00
Mainstem	2013	Exposed	Elk	ELKR8	0.40	0.40	0.00

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Mainstem	2013	Exposed	Elk	ELKR9	0.00	0.00	0.00
Tributary	2013	Exposed	Eagle Pond Outlet	EPOU1	1.90	1.00	0.90
Tributary	2013	Exposed	Erickson	ERIC1	2.29	0.99	1.30
Tributary	2013	Exposed	Erickson	ERIC2	1.78	0.88	0.90
Tributary	2013	Exposed	Erickson	ERIC3	2.36	0.96	1.40
Tributary	2013	Exposed	Erickson	ERIC4	0.62	0.53	0.09
Tributary	2013	Exposed	Feltham	FELT1	0.00	0.00	0.00
Tributary	2013	Exposed	Fennelon	FENN1	0.00	0.00	0.00
Mainstem	2013	Exposed	Fording	FORD1	0.00	0.00	0.00
Mainstem	2013	Exposed	Fording	FORD10	0.00	0.00	0.00
Mainstem	2013	Exposed	Fording	FORD11	0.00	0.00	0.00
Mainstem	2013	Reference	Fording	FORD12	0.00	0.00	0.00
Mainstem	2013	Exposed	Fording	FORD2	0.00	0.00	0.00
Mainstem	2013	Exposed	Fording	FORD3	0.00	0.00	0.00
Mainstem	2013	Exposed	Fording	FORD5	0.32	0.32	0.00
Mainstem	2013	Exposed	Fording	FORD6	0.74	0.68	0.06
Mainstem	2013	Exposed	Fording	FORD7	0.43	0.40	0.03
Mainstem	2013	Exposed	Fording	FORD8	0.31	0.30	0.01
Mainstem	2021	Exposed	Fording	FORD9b	0.10	0.10	0.00
Tributary	2013	Exposed	Fish Pond	FPON1	0.00	0.00	0.00
Tributary	2013	Exposed	Gardine	GARD1	0.29	0.29	0.00
Tributary	2013	Exposed	Gate	GATE1	0.05	0.05	0.00
Tributary	2013	Exposed	Gate	GATE2	0.29	0.26	0.03
Tributary	2013	Exposed	Goddard	GODD1	0.00	0.00	0.00
Tributary	2013	Exposed	Goddard	GODD2	0.00	0.00	0.00
Tributary	2013	Exposed	Goddard	GODD3	0.00	0.00	0.00
Tributary	2013	Reference	Grace	GRAC1	0.31	0.29	0.02
Tributary	2013	Reference	Grace	GRAC2	0.15	0.15	0.01
Tributary	2013	Exposed	Grassy	GRAS1	0.00	0.00	0.00
Tributary	2013	Exposed	Grave	GRAV1	0.54	0.54	0.00
Tributary	2013	Exposed	Grave	GRAV2	0.23	0.23	0.00
Tributary	2013	Reference	Grave	GRAV3	0.00	0.00	0.00
Tributary	2013	Exposed	Greenhills	GREE1	0.35	0.35	0.01
Tributary	2013	Exposed	Greenhills	GREE2	0.60	0.60	0.00

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2013	Exposed	Greenhills	GREE3	1.30	0.83	0.47
Tributary	2013	Exposed	Greenhills	GREE4	1.62	0.79	0.83
Tributary	2013	Exposed	Harmer	HARM1	0.58	0.58	0.00
Tributary	2013	Exposed	Harmer	HARM2	0.17	0.17	0.00
Tributary	2013	Exposed	Harmer	HARM3	0.15	0.15	0.00
Tributary	2013	Exposed	Harmer	HARM4	0.17	0.16	0.01
Tributary	2013	Exposed	Harmer	HARM5	0.19	0.19	0.00
Tributary	2013	Exposed	Harmer Dump Seep	HDSE1	0.52	0.49	0.03
Tributary	2013	Exposed	Henretta	HENR1	0.00	0.00	0.00
Tributary	2013	Exposed	Henretta	HENR2	0.00	0.00	0.00
Tributary	2013	Reference	Henretta	HENR3	0.00	0.00	0.00
Tributary	2013	Exposed	Kilmamock	KILM1	2.16	0.83	1.33
Tributary	2013	Exposed	Lagoon C Seep	LCSE1	0.39	0.39	0.00
Tributary	2013	Exposed	Leask	LEAS1	0.03	0.03	0.00
Tributary	2013	Exposed	Leask	LEAS2	0.13	0.13	0.00
Tributary	2013	Exposed	Lindsay	LIND1	0.19	0.19	0.00
Tributary	2013	Exposed	Line	LINE1	0.27	0.27	0.00
Tributary	2013	Exposed	Line	LINE2	0.00	0.00	0.00
Tributary	2013	Exposed	Line	LINE3	0.00	0.00	0.00
Tributary	2013	Exposed	Line	LINE4	0.40	0.40	0.00
Tributary	2013	Reference	Line	LINE7	0.00	0.00	0.00
Tributary	2013	Exposed	Lake Mountain	LMOU1	0.00	0.00	0.00
Tributary	2013	Exposed	Lake Mountain	LMOU2	0.00	0.00	0.00
Tributary	2013	Exposed	Lake Mountain	LMOU3	0.00	0.00	0.00
Tributary	2013	Exposed	Lake Mountain	LMOU4	0.00	0.00	0.00
Mainstem	2013	Exposed	Michel	MICH1	0.31	0.31	0.00
Mainstem	2013	Exposed	Michel	MICH2	0.05	0.05	0.00
Mainstem	2013	Exposed	Michel	MICH3	0.00	0.00	0.00
Mainstem	2013	Exposed	Michel	MICH4	0.00	0.00	0.00
Mainstem	2013	Reference	Michel	MICH5	0.00	0.00	0.00
Tributary	2013	Exposed	Mickelson	MICK1	0.01	0.01	0.00
Tributary	2013	Exposed	Mickelson	MICK2	0.05	0.05	0.00
Tributary	2013	Exposed	Milligan	MILL1	0.00	0.00	0.00
Tributary	2013	Exposed	Milligan	MILL2	0.00	0.00	0.00

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2013	Exposed	North Thompson	NTHO1	1.24	0.74	0.50
Tributary	2013	Exposed	North Wolfram	NWOL1	0.70	0.45	0.25
Tributary	2013	Exposed	Otto	OTTO1	0.30	0.30	0.00
Tributary	2013	Exposed	Otto	OTTO2	0.03	0.03	0.00
Tributary	2013	Exposed	Otto	OTTO3	0.02	0.01	0.01
Tributary	2013	Exposed	Pit Road 12 Seep	P12S1	0.00	0.00	0.00
Tributary	2013	Exposed	Pengelly	PENG1	0.09	0.09	0.00
Tributary	2013	Exposed	Porter	PORT1	0.92	0.78	0.14
Tributary	2013	Exposed	Porter	PORT2	0.11	0.05	0.06
Tributary	2013	Exposed	Porter	PORT3a	2.33	0.92	1.41
Tributary	2013	Exposed	Porter	PORT3b	3.00	1.00	2.00
Tributary	2013	Exposed	Qualteri	QUAL1	0.00	0.00	0.00
Tributary	2013	Exposed	Sawmill	SAWM1	0.00	0.00	0.00
Tributary	2013	Exposed	Sawmill	SAWM2	0.38	0.38	0.00
Tributary	2013	Exposed	Sixmile	SIXM1	0.80	0.80	0.00
Tributary	2013	Exposed	Sixmile	SIXM2	0.00	0.00	0.00
Tributary	2013	Reference	South Line	SLINE2	0.00	0.00	0.00
Tributary	2013	Exposed	South Pit	SPIT1	0.00	0.00	0.00
Tributary	2013	Exposed	South Pit	SPIT2	0.03	0.02	0.01
Tributary	2013	Exposed	Smith Ponds Outlet	SPOU1	2.61	0.89	1.72
Tributary	2013	Exposed	Spring	SPRI1	0.20	0.20	0.00
Tributary	2013	Exposed	South Pond Seep	SPSE1	0.00	0.00	0.00
Tributary	2013	Exposed	Swift	SWIF1	2.58	0.87	1.71
Tributary	2013	Exposed	Swift	SWIF2	0.00	0.00	0.00
Tributary	2013	Exposed	South Wolfram	SWOL1	1.97	0.97	1.00
Tributary	2013	Exposed	Thompson	THOM1	0.00	0.00	0.00
Tributary	2013	Exposed	Thompson	THOM2	0.08	0.07	0.01
Tributary	2013	Exposed	Thompson	THOM3	0.00	0.00	0.00
Tributary	2013	Exposed	Thresher	THRE1	0.00	0.00	0.00
Tributary	2013	Exposed	Unnamed South of Sawmill	USOS1	0.00	0.00	0.00
Tributary	2013	Exposed	Wolfram	WOLF2	0.27	0.25	0.02
Tributary	2013	Exposed	Wolfram	WOLF3	2.93	1.00	1.93
Tributary	2014	Reference	Alexander	ALEX3	0.38	0.33	0.05
Tributary	2014	Reference	Andy Good	ANDY1	0.00	0.00	0.00

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2014	Exposed	Aqueduct	AQUE1	0.00	0.00	0.00
Tributary	2014	Exposed	Aqueduct	AQUE2	0.00	0.00	0.00
Tributary	2014	Exposed	Aqueduct	AQUE3	0.00	0.00	0.00
Tributary	2014	Exposed	Balmer	BALM1	0.00	0.00	0.00
Tributary	2014	Exposed	Bodie	BODI1	0.00	0.00	0.00
Tributary	2014	Exposed	Bodie	BODI2	0.00	0.00	0.00
Tributary	2014	Exposed	Bodie	BODI3	2.47	0.96	1.51
Tributary	2014	Exposed	CCR Seep	CSEE1	0.00	0.00	0.00
Tributary	2014	Reference	Carbon	CARB1	0.00	0.00	0.00
Tributary	2014	Reference	Carbon	CARB2	0.00	0.00	0.00
Tributary	2014	Exposed	Cataract	CATA1	3.00	1.00	2.00
Tributary	2014	Exposed	Cataract	CATA2	0.64	0.27	0.37
Tributary	2014	Exposed	Cataract	CATA3	2.64	0.88	1.76
Tributary	2014	Reference	Chauncey	CHAU1	0.00	0.00	0.00
Tributary	2014	Exposed	Clode Pond Outlet	COUT1	1.01	0.65	0.36
Tributary	2014	Exposed	Clode West Infiltration	CLOW1	0.18	0.18	0.00
Tributary	2014	Exposed	Contingency Pond Outlet	CPOU1	0.94	0.94	0.00
Tributary	2014	Exposed	Contingency Pond Seep	CPOS1	0.84	0.84	0.00
Tributary	2014	Exposed	Corbin	CORB1	1.71	0.86	0.84
Tributary	2014	Exposed	Corbin	CORB2	2.68	1.00	1.68
Tributary	2014	Exposed	Dry (EVO)	DRYE1	2.13	0.97	1.16
Tributary	2014	Exposed	Dry (EVO)	DRYE2	0.03	0.03	0.00
Tributary	2014	Exposed	Dry (EVO)	DRYE3	2.40	0.81	1.59
Tributary	2014	Exposed	Dry (EVO)	DRYE4	1.84	0.62	1.22
Tributary	2014	Reference	Dry (LCO)	DRYL1	0.00	0.00	0.00
Tributary	2014	Reference	Dry (LCO)	DRYL2	0.00	0.00	0.00
Tributary	2014	Reference	Dry (LCO)	DRYL3	0.00	0.00	0.00
Tributary	2014	Exposed	Eagle Pond Outlet	EPOU1	1.31	0.58	0.73
Mainstem	2014	Exposed	Elk	ELKR10	0.00	0.00	0.00
Mainstem	2014	Exposed	Elk	ELKR11	0.00	0.00	0.00
Mainstem	2014	Exposed	Elk	ELKR12	0.00	0.00	0.00
Mainstem	2014	Reference	Elk	ELKR15	0.00	0.00	0.00
Mainstem	2014	Exposed	Elk	ELKR8	0.00	0.00	0.00
Mainstem	2014	Exposed	Elk	ELKR9	0.00	0.00	0.00

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2014	Exposed	Erickson	ERIC1	2.59	0.98	1.61
Tributary	2014	Exposed	Erickson	ERIC2	2.27	0.92	1.35
Tributary	2014	Exposed	Erickson	ERIC3	2.60	1.00	1.60
Tributary	2014	Exposed	Erickson	ERIC4	1.28	0.83	0.44
Tributary	2014	Exposed	Feltham	FELT1	0.00	0.00	0.00
Tributary	2014	Exposed	Fennelon	FENN1	0.00	0.00	0.00
Tributary	2014	Exposed	Fish Pond	FPON1	0.03	0.03	0.00
Mainstem	2014	Exposed	Fording	FORD1	0.00	0.00	0.00
Mainstem	2014	Exposed	Fording	FORD10	0.00	0.00	0.00
Mainstem	2014	Exposed	Fording	FORD11	0.00	0.00	0.00
Mainstem	2014	Reference	Fording	FORD12	0.00	0.00	0.00
Mainstem	2014	Exposed	Fording	FORD2	0.00	0.00	0.00
Mainstem	2014	Exposed	Fording	FORD3	0.01	0.01	0.00
Mainstem	2014	Exposed	Fording	FORD4	0.05	0.05	0.00
Mainstem	2014	Exposed	Fording	FORD5	0.35	0.28	0.07
Mainstem	2014	Exposed	Fording	FORD6	0.43	0.33	0.10
Mainstem	2014	Exposed	Fording	FORD7	0.97	0.60	0.37
Mainstem	2014	Exposed	Fording	FORD8	0.49	0.44	0.05
Mainstem	2021	Exposed	Fording	FORD9a	0.41	0.30	0.11
Tributary	2014	Exposed	Gardine	GARD1	0.70	0.31	0.40
Tributary	2014	Exposed	Gate	GATE1	0.05	0.05	0.00
Tributary	2014	Exposed	Gate	GATE2	0.00	0.00	0.00
Tributary	2014	Exposed	Goddard	GODD1	0.00	0.00	0.00
Tributary	2014	Exposed	Goddard	GODD2	0.00	0.00	0.00
Tributary	2014	Exposed	Goddard	GODD3	1.90	0.82	1.07
Tributary	2014	Reference	Grace	GRAC1	0.20	0.18	0.02
Tributary	2014	Reference	Grace	GRAC2	0.10	0.09	0.01
Tributary	2014	Reference	Grace	GRAC3	0.00	0.00	0.00
Tributary	2014	Exposed	Grassy	GRAS1	0.09	0.07	0.01
Tributary	2014	Exposed	Grave	GRAV1	0.72	0.49	0.23
Tributary	2014	Exposed	Grave	GRAV2	0.21	0.15	0.06
Tributary	2014	Reference	Grave	GRAV3	0.00	0.00	0.00
Tributary	2014	Exposed	Greenhills	GREE1	1.06	0.64	0.41
Tributary	2014	Exposed	Greenhills	GREE2	0.00	0.00	0.00

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2014	Exposed	Greenhills	GREE3	2.22	0.92	1.31
Tributary	2014	Exposed	Greenhills	GREE4	2.78	0.98	1.80
Tributary	2014	Exposed	Harmer	HARM1	1.08	0.79	0.29
Tributary	2014	Exposed	Harmer	HARM2	0.10	0.10	0.00
Tributary	2014	Exposed	Harmer	HARM3	0.28	0.16	0.12
Tributary	2014	Exposed	Harmer	HARM4	0.70	0.41	0.29
Tributary	2014	Exposed	Harmer	HARM5	0.56	0.40	0.16
Tributary	2014	Exposed	Henretta	HENR1	0.00	0.00	0.00
Tributary	2014	Exposed	Henretta	HENR2	0.00	0.00	0.00
Tributary	2014	Reference	Henretta	HENR3	0.00	0.00	0.00
Tributary	2014	Exposed	Kilmamock	KILM1	1.64	0.59	1.05
Tributary	2014	Exposed	Lake Mountain	LMOU1	0.33	0.28	0.06
Tributary	2014	Exposed	Lake Mountain	LMOU2	0.09	0.05	0.04
Tributary	2014	Exposed	Lake Mountain	LMOU3	0.00	0.00	0.00
Tributary	2014	Exposed	Lake Mountain	LMOU4	0.00	0.00	0.00
Tributary	2014	Exposed	Leask	LEAS1	0.17	0.10	0.07
Tributary	2014	Exposed	Leask	LEAS2	1.60	0.79	0.82
Tributary	2014	Exposed	Lindsay	LIND1	0.26	0.23	0.03
Tributary	2014	Exposed	Line	LINE1	0.00	0.00	0.00
Tributary	2014	Exposed	Line	LINE2	0.00	0.00	0.00
Tributary	2014	Exposed	Line	LINE3	0.00	0.00	0.00
Tributary	2014	Exposed	Line	LINE4	0.27	0.27	0.00
Tributary	2014	Reference	Line	LINE7	0.00	0.00	0.00
Mainstem	2014	Exposed	Michel	MICH1	0.00	0.00	0.00
Mainstem	2014	Exposed	Michel	MICH2	0.05	0.05	0.00
Mainstem	2014	Exposed	Michel	MICH3	0.00	0.00	0.00
Mainstem	2014	Exposed	Michel	MICH4	0.00	0.00	0.00
Mainstem	2014	Reference	Michel	MICH5	0.00	0.00	0.00
Tributary	2014	Exposed	Mickelson	MICK1	0.00	0.00	0.00
Tributary	2014	Exposed	Mickelson	MICK2	0.00	0.00	0.00
Tributary	2014	Exposed	Milligan	MILL1	0.00	0.00	0.00
Tributary	2014	Exposed	Milligan	MILL2	0.00	0.00	0.00
Tributary	2014	Exposed	North Thompson	NTHO1	2.39	0.90	1.49
Tributary	2014	Exposed	North Wolfram	NWOL1	1.33	0.76	0.57

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2014	Exposed	Otto	OTTO1	0.22	0.20	0.02
Tributary	2014	Exposed	Otto	OTTO2	0.00	0.00	0.00
Tributary	2014	Exposed	Otto	OTTO3	0.02	0.02	0.01
Tributary	2014	Exposed	Pengally	PENG1	0.02	0.02	0.00
Tributary	2014	Exposed	Porter	PORT1	0.84	0.78	0.06
Tributary	2014	Exposed	Porter	PORT2	0.10	0.10	0.00
Tributary	2014	Exposed	Porter	PORT3a	1.34	0.94	0.40
Tributary	2014	Exposed	Porter	PORT3b	2.28	0.92	1.37
Tributary	2014	Exposed	Qualteri	QUAL1	0.00	0.00	0.00
Tributary	2014	Exposed	Sawmill	SAWM1	0.00	0.00	0.00
Tributary	2014	Exposed	Sawmill	SAWM2	0.54	0.31	0.24
Tributary	2014	Exposed	Six Mile	SIXM1	1.19	0.88	0.32
Tributary	2014	Exposed	Smith Pond Outlet	SPOU1	2.24	0.85	1.39
Tributary	2014	Reference	Snowslide	SNOW1	0.00	0.00	0.00
Tributary	2014	Reference	South Line	SLINE2	0.00	0.00	0.00
Tributary	2014	Exposed	South Pit	SPIT1	0.00	0.00	0.00
Tributary	2014	Exposed	South Pit	SPIT2	0.00	0.00	0.00
Tributary	2014	Exposed	South Pond Seep	SPSE1	1.50	0.50	1.00
Tributary	2014	Exposed	South Wolfram Creek	SWOL1	1.97	0.80	1.17
Tributary	2014	Exposed	Spring	SPRI1	0.11	0.11	0.00
Tributary	2014	Exposed	Swift	SWIF1	2.18	0.91	1.27
Tributary	2014	Exposed	Swift	SWIF2	1.04	0.46	0.58
Tributary	2014	Exposed	Thompson	THOM1	0.00	0.00	0.00
Tributary	2014	Exposed	Thompson	THOM2	0.00	0.00	0.00
Tributary	2014	Exposed	Thompson	THOM3	0.00	0.00	0.00
Tributary	2014	Exposed	Thresher	THRE1	0.00	0.00	0.00
Tributary	2014	Exposed	Unnamed South of Sawmill	USOS1	0.00	0.00	0.00
Tributary	2014	Reference	Wheeler	WHEE1	0.00	0.00	0.00
Tributary	2014	Reference	Wheeler	WHEE2	0.00	0.00	0.00
Tributary	2014	Reference	Wheeler	WHEE3	0.00	0.00	0.00
Tributary	2014	Exposed	Wolfram	WOLF2	0.14	0.08	0.06
Tributary	2014	Exposed	Wolfram	WOLF3	2.07	0.86	1.21
Tributary	2015	Reference	Alexander	ALEX3	0.40	0.39	0.01
Tributary	2015	Reference	Andy Good	ANDY1	0.00	0.00	0.00

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2015	Exposed	Aqueduct	AQUE1	0.00	0.00	0.00
Tributary	2015	Exposed	Aqueduct	AQUE2	0.00	0.00	0.00
Tributary	2015	Exposed	Aqueduct	AQUE3	0.00	0.00	0.00
Tributary	2015	Exposed	Balmer	BALM1	0.00	0.00	0.00
Tributary	2015	Exposed	Bodie	BODI1	0.00	0.00	0.00
Tributary	2015	Exposed	CCR Seep	CSEE1	0.85	0.31	0.54
Tributary	2015	Reference	Carbon	CARB1	0.00	0.00	0.00
Tributary	2015	Reference	Carbon	CARB2	0.00	0.00	0.00
Tributary	2015	Exposed	Cataract	CATA1	3.00	1.00	2.00
Tributary	2015	Exposed	Cataract	CATA3	2.56	0.99	1.58
Tributary	2015	Reference	Chauncey	CHAU1	0.00	0.00	0.00
Tributary	2015	Exposed	Clode Pond Outlet	COUT1	1.03	0.87	0.16
Tributary	2015	Exposed	Clode West Infiltration	CLOW1	0.00	0.00	0.00
Tributary	2015	Exposed	Corbin	CORB1	2.62	0.99	1.63
Tributary	2015	Exposed	Corbin	CORB2	2.25	0.83	1.42
Tributary	2015	Exposed	Dry (EVO)	DRYE1	2.19	0.94	1.25
Tributary	2015	Exposed	Dry (EVO)	DRYE3	2.48	0.92	1.56
Tributary	2015	Exposed	Dry (EVO)	DRYE4	2.37	0.94	1.43
Tributary	2015	Exposed	Dry (LCO)	DRYL1	0.00	0.00	0.00
Tributary	2015	Exposed	Dry (LCO)	DRYL2	0.00	0.00	0.00
Tributary	2015	Exposed	Dry (LCO)	DRYL3	0.00	0.00	0.00
Tributary	2015	Exposed	Dry (LCO)	DRYL4	0.00	0.00	0.00
Tributary	2015	Exposed	Eagle Pond Outlet	EPOU1	0.58	0.26	0.32
Mainstem	2015	Exposed	Elk	ELKR10	0.00	0.00	0.00
Mainstem	2015	Exposed	Elk	ELKR11	0.00	0.00	0.00
Mainstem	2015	Exposed	Elk	ELKR12	0.00	0.00	0.00
Mainstem	2015	Reference	Elk	ELKR15	0.00	0.00	0.00
Mainstem	2015	Exposed	Elk	ELKR8	0.00	0.00	0.00
Mainstem	2015	Exposed	Elk	ELKR9	0.00	0.00	0.00
Tributary	2015	Exposed	Erickson	ERIC1	2.77	0.96	1.82
Tributary	2015	Exposed	Erickson	ERIC2	2.58	0.90	1.68
Tributary	2015	Exposed	Erickson	ERIC3	3.00	1.00	2.00
Tributary	2015	Exposed	Erickson	ERIC4	1.17	0.71	0.46
Tributary	2015	Exposed	Feltham	FELT1	0.00	0.00	0.00

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2015	Exposed	Fennelon	FENN1	0.00	0.00	0.00
Tributary	2015	Exposed	Fish Pond	FPON1	0.00	0.00	0.00
Mainstem	2015	Exposed	Fording	FORD1	0.00	0.00	0.00
Mainstem	2015	Exposed	Fording	FORD10	0.00	0.00	0.00
Mainstem	2015	Exposed	Fording	FORD11	0.00	0.00	0.00
Mainstem	2015	Reference	Fording	FORD12	0.00	0.00	0.00
Mainstem	2015	Exposed	Fording	FORD2	0.00	0.00	0.00
Mainstem	2015	Exposed	Fording	FORD3	0.00	0.00	0.00
Mainstem	2015	Exposed	Fording	FORD4	0.66	0.66	0.00
Mainstem	2015	Exposed	Fording	FORD5	0.53	0.53	0.00
Mainstem	2015	Exposed	Fording	FORD6	1.53	0.83	0.70
Mainstem	2015	Exposed	Fording	FORD7	0.55	0.55	0.00
Mainstem	2015	Exposed	Fording	FORD8	0.48	0.47	0.01
Mainstem	2013	Exposed	Fording	FORD9	0.00	0.00	0.00
Tributary	2015	Exposed	Gardine	GARD1	0.32	0.27	0.06
Tributary	2015	Exposed	Gate	GATE2	0.74	0.36	0.38
Tributary	2015	Exposed	Goddard	GODD1	0.00	0.00	0.00
Tributary	2015	Exposed	Goddard	GODD2	0.00	0.00	0.00
Tributary	2015	Exposed	Goddard	GODD3	1.97	0.76	1.21
Tributary	2015	Reference	Grace	GRAC1	0.05	0.05	0.00
Tributary	2015	Reference	Grace	GRAC2	0.10	0.10	0.00
Tributary	2015	Reference	Grace	GRAC3	0.00	0.00	0.00
Tributary	2015	Exposed	Grassy	GRAS1	0.00	0.00	0.00
Tributary	2015	Exposed	Grave	GRAV1	0.02	0.02	0.00
Tributary	2015	Exposed	Grave	GRAV2	0.00	0.00	0.00
Tributary	2015	Reference	Grave	GRAV3	0.00	0.00	0.00
Tributary	2015	Exposed	Greenhills	GREE1	0.45	0.41	0.04
Tributary	2015	Exposed	Greenhills	GREE3	2.46	0.94	1.52
Tributary	2015	Exposed	Greenhills	GREE4	2.80	0.96	1.84
Tributary	2015	Exposed	Harmer	HARM1	0.07	0.07	0.00
Tributary	2015	Exposed	Harmer	HARM3	0.01	0.01	0.00
Tributary	2015	Exposed	Harmer	HARM4	0.17	0.17	0.00
Tributary	2015	Exposed	Harmer	HARM5	0.22	0.22	0.00
Tributary	2015	Exposed	Henretta	HENR1	0.00	0.00	0.00

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2015	Exposed	Henretta	HENR2	0.00	0.00	0.00
Tributary	2015	Reference	Henretta	HENR3	0.00	0.00	0.00
Tributary	2015	Exposed	Kilmamock	KILM1	1.97	0.69	1.28
Tributary	2015	Exposed	Lake Mountain	LMOU1	0.00	0.00	0.00
Tributary	2015	Exposed	Lake Mountain	LMOU3	0.00	0.00	0.00
Tributary	2015	Exposed	Lake Mountain	LMOU4	0.00	0.00	0.00
Tributary	2015	Exposed	Leask	LEAS2	0.24	0.24	0.00
Tributary	2015	Exposed	Lindsay	LIND1	0.19	0.17	0.02
Tributary	2015	Exposed	Line	LINE1	0.00	0.00	0.00
Tributary	2015	Exposed	Line	LINE2	0.00	0.00	0.00
Tributary	2015	Exposed	Line	LINE3	0.00	0.00	0.00
Tributary	2015	Exposed	Line	LINE4	0.68	0.54	0.14
Tributary	2015	Reference	Line	LINE7	0.00	0.00	0.00
Mainstem	2015	Exposed	Michel	MICH1	0.00	0.00	0.00
Mainstem	2015	Exposed	Michel	MICH2	0.00	0.00	0.00
Mainstem	2015	Exposed	Michel	MICH3	0.00	0.00	0.00
Mainstem	2015	Exposed	Michel	MICH4	0.00	0.00	0.00
Mainstem	2015	Reference	Michel	MICH5	0.00	0.00	0.00
Tributary	2015	Exposed	Mickelson	MICK1	0.00	0.00	0.00
Tributary	2015	Exposed	Mickelson	MICK2	0.03	0.03	0.00
Tributary	2015	Exposed	Milligan	MILL1	0.00	0.00	0.00
Tributary	2015	Exposed	Milligan	MILL2	0.00	0.00	0.00
Tributary	2015	Exposed	North Thompson	NTHO1	1.18	0.61	0.57
Tributary	2015	Exposed	North Wolfram	NWOL1	0.21	0.17	0.04
Tributary	2015	Exposed	Otto	OTTO1	0.10	0.10	0.00
Tributary	2015	Exposed	Otto	OTTO2	0.00	0.00	0.00
Tributary	2015	Exposed	Otto	OTTO3	0.00	0.00	0.00
Tributary	2015	Exposed	Pengally	PENG1	0.02	0.02	0.00
Tributary	2015	Exposed	Porter	PORT1	0.85	0.62	0.23
Tributary	2015	Exposed	Porter	PORT3a	0.92	0.59	0.33
Tributary	2015	Exposed	Porter	PORT3b	2.45	0.88	1.57
Tributary	2015	Exposed	Qualteri	QUAL1	0.00	0.00	0.00
Tributary	2015	Exposed	Sawmill	SAWM1	0.00	0.00	0.00
Tributary	2015	Exposed	Sawmill	SAWM2	0.62	0.31	0.32

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2015	Exposed	Six Mile	SIXM1	0.49	0.49	0.00
Tributary	2015	Exposed	Smith Pond Outlet	SPOU1	2.24	0.85	1.39
Tributary	2015	Reference	Snowslide	SNOW1	0.00	0.00	0.00
Tributary	2015	Reference	South Line	SLINE2	0.00	0.00	0.00
Tributary	2015	Exposed	South Pit	SPIT1	1.14	0.47	0.68
Tributary	2015	Exposed	South Pit	SPIT2	0.00	0.00	0.00
Tributary	2015	Exposed	South Pond Seep	SPSE1	0.10	0.08	0.02
Tributary	2015	Exposed	South Wolfram Creek	SWOL1	0.28	0.21	0.07
Tributary	2015	Exposed	Spring	SPRI1	0.11	0.11	0.00
Tributary	2015	Exposed	Swift	SWIF1	2.39	0.86	1.53
Tributary	2015	Exposed	Swift	SWIF2	0.82	0.31	0.51
Tributary	2015	Exposed	Thompson	THOM1	0.00	0.00	0.00
Tributary	2015	Exposed	Thompson	THOM2	0.01	0.01	0.00
Tributary	2015	Exposed	Thompson	THOM3	0.00	0.00	0.00
Tributary	2015	Exposed	Thresher	THRE1	0.00	0.00	0.00
Tributary	2015	Exposed	Unnamed South of Sawmill	USOS1	0.00	0.00	0.00
Tributary	2015	Reference	Wheeler	WHEE1	0.00	0.00	0.00
Tributary	2015	Reference	Wheeler	WHEE2	0.00	0.00	0.00
Tributary	2015	Reference	Wheeler	WHEE3	0.00	0.00	0.00
Tributary	2015	Exposed	Wolfram	WOLF2	0.23	0.21	0.02
Tributary	2015	Exposed	Wolfram	WOLF3	1.60	0.87	0.73
Tributary	2015	Exposed	South Pond Seep	SPSE1	0.00	0.00	0.00
Tributary	2016	Reference	Alexander	ALEX3	0.46	0.44	0.02
Tributary	2016	Reference	Andy Good	ANDY1	0.00	0.00	0.00
Tributary	2016	Exposed	Aqueduct	AQUE1	0.00	0.00	0.00
Tributary	2016	Exposed	Balmer	BALM1	0.00	0.00	0.00
Tributary	2016	Exposed	Bodie	BODI1	0.79	0.65	0.14
Tributary	2016	Exposed	Bodie	BODI3	1.77	0.76	1.01
Tributary	2016	Exposed	CCR Seep	CSEE1	1.40	0.82	0.58
Tributary	2016	Exposed	Cataract	CATA1	3.00	1.00	2.00
Tributary	2016	Reference	Chauncey	CHAU1	0.17	0.16	0.01
Tributary	2016	Exposed	Clode Pond Outlet	COUT1	1.21	0.96	0.25
Tributary	2016	Exposed	Clode West Infiltration	CLOW1	0.50	0.50	0.00
Tributary	2016	Exposed	Corbin	CORB1	2.21	1.00	1.21

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2016	Exposed	Dry (EVO)	DRYE3	2.51	0.96	1.54
Tributary	2016	Exposed	Dry (LCO)	DRYL1	0.00	0.00	0.00
Tributary	2016	Exposed	Dry (LCO)	DRYL2	0.00	0.00	0.00
Tributary	2016	Exposed	Dry (LCO)	DRYL3	0.00	0.00	0.00
Tributary	2016	Exposed	Dry (LCO)	DRYL4	0.00	0.00	0.00
Tributary	2016	Exposed	Eagle Pond Outlet	EPOU1	0.20	0.14	0.06
Mainstem	2016	Exposed	Elk	ELKR12	0.00	0.00	0.00
Mainstem	2016	Reference	Elk	ELKR15	0.00	0.00	0.00
Mainstem	2016	Exposed	Elk	ELKR8	0.00	0.00	0.00
Mainstem	2016	Exposed	Elk	ELKR9	0.00	0.00	0.00
Tributary	2016	Exposed	Erickson	ERIC1	2.36	0.93	1.43
Tributary	2016	Exposed	Feltham	FELT1	0.00	0.00	0.00
Tributary	2016	Exposed	Fennelon	FENN1	0.00	0.00	0.00
Tributary	2016	Exposed	Fish Pond	FPON1	0.08	0.08	0.00
Mainstem	2016	Exposed	Fording	FORD1	0.37	0.37	0.00
Mainstem	2016	Reference	Fording	FORD12	0.03	0.03	0.00
Mainstem	2016	Exposed	Fording	FORD2	0.00	0.00	0.00
Mainstem	2016	Exposed	Fording	FORD4	0.60	0.54	0.06
Mainstem	2016	Exposed	Fording	FORD5	0.58	0.58	0.00
Mainstem	2016	Exposed	Fording	FORD6	0.64	0.62	0.02
Mainstem	2016	Exposed	Fording	FORD7	0.63	0.63	0.01
Mainstem	2014	Exposed	Fording	FORD9	0.00	0.00	0.00
Tributary	2016	Exposed	Gardine	GARD1	0.14	0.12	0.02
Tributary	2016	Exposed	Gate	GATE2	1.47	0.87	0.60
Tributary	2016	Exposed	Goddard	GODD1	0.22	0.20	0.02
Tributary	2016	Exposed	Goddard	GODD3	2.22	0.82	1.40
Tributary	2016	Reference	Grace	GRAC1	0.09	0.09	0.00
Tributary	2016	Exposed	Grassy	GRAS1	0.04	0.03	0.01
Tributary	2016	Exposed	Grave	GRAV1	0.14	0.14	0.00
Tributary	2016	Reference	Grave	GRAV3	0.00	0.00	0.00
Tributary	2016	Exposed	Greenhills	GREE1	0.86	0.59	0.27
Tributary	2016	Exposed	Greenhills	GREE3	2.18	0.95	1.23
Tributary	2016	Exposed	Greenhills	GREE4	2.61	0.96	1.64
Tributary	2016	Exposed	Harmer	HARM1	0.64	0.64	0.01

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2016	Exposed	Harmer	HARM3	0.12	0.11	0.01
Tributary	2016	Exposed	Henretta	HENR1	0.00	0.00	0.00
Tributary	2016	Exposed	Kilmamock	KILM1	2.59	0.95	1.64
Tributary	2016	Exposed	Lake Mountain	LMOU1	0.15	0.15	0.00
Tributary	2016	Exposed	Leask	LEAS2	1.82	0.79	1.02
Tributary	2016	Exposed	Lindsay	LIND1	0.19	0.18	0.02
Tributary	2016	Exposed	Line	LINE1	0.03	0.03	0.00
Tributary	2016	Exposed	Line	LINE4	0.65	0.65	0.00
Tributary	2016	Reference	Line	LINE7	0.00	0.00	0.00
Mainstem	2016	Exposed	Michel	MICH1	0.00	0.00	0.00
Mainstem	2016	Exposed	Michel	MICH4	0.00	0.00	0.00
Mainstem	2016	Reference	Michel	MICH5	0.00	0.00	0.00
Tributary	2016	Exposed	Mickelson	MICK1	2.18	0.96	1.22
Tributary	2016	Exposed	Milligan	MILL2	1.07	0.59	0.48
Tributary	2016	Exposed	North Thompson	NTHO1	1.54	0.77	0.77
Tributary	2016	Exposed	North Wolfram	NWOL1	0.14	0.14	0.00
Tributary	2016	Exposed	Otto	OTTO1	0.23	0.21	0.02
Tributary	2016	Exposed	Pengally	PENG1	0.00	0.00	0.00
Tributary	2016	Exposed	Porter	PORT1	0.75	0.75	0.00
Tributary	2016	Exposed	Porter	PORT3a	0.47	0.45	0.02
Tributary	2016	Exposed	Porter	PORT3b	2.46	0.90	1.55
Tributary	2016	Exposed	Qualteri	QUAL1	0.00	0.00	0.00
Tributary	2016	Exposed	Sawmill	SAWM1	0.00	0.00	0.00
Tributary	2016	Exposed	Sawmill	SAWM2	0.00	0.00	0.00
Tributary	2016	Exposed	Six Mile	SIXM1	0.65	0.63	0.02
Tributary	2016	Exposed	Smith Pond Outlet	SPOU1	3.00	1.00	2.00
Tributary	2016	Reference	South Line	SLINE2	0.00	0.00	0.00
Tributary	2016	Exposed	South Pit	SPIT1	1.59	0.73	0.85
Tributary	2016	Exposed	South Pond Seep	SPSE1	0.00	0.00	0.00
Tributary	2016	Exposed	South Wolfram Creek	SWOL1	1.86	0.95	0.91
Tributary	2016	Exposed	Spring	SPRI1	0.12	0.12	0.00
Tributary	2016	Exposed	Swift	SWIF1	2.43	0.95	1.48
Tributary	2016	Exposed	Thompson	THOM1	0.22	0.22	0.00
Tributary	2016	Exposed	Thresher	THRE1	0.00	0.00	0.00

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2016	Exposed	Unnamed South of Sawmill	USOS1	0.00	0.00	0.00
Tributary	2016	Exposed	Willow North	WILN2	0.00	0.00	0.00
Tributary	2016	Exposed	Willow South	WILS1	0.00	0.00	0.00
Tributary	2016	Exposed	Wolf	WOL1	0.00	0.00	0.00
Tributary	2016	Exposed	Wolfram	WOLF2	0.69	0.49	0.20
Tributary	2016	Exposed	Wolfram	WOLF3	2.61	0.97	1.64
Tributary	2017	Reference	Alexander	ALEX3	0.38	0.37	0.01
Tributary	2017	Reference	Andy Good	ANDY1	0.00	0.00	0.00
Tributary	2017	Exposed	Aqueduct	AQUE1	0.00	0.00	0.00
Tributary	2017	Exposed	Balmer	BALM1	0.00	0.00	0.00
Tributary	2017	Exposed	Bodie	BODI1	0.08	0.06	0.01
Tributary	2017	Exposed	Bodie	BODI3	2.09	0.78	1.31
Tributary	2017	Exposed	Cataract	CATA1	3.00	1.00	2.00
Tributary	2017	Reference	Chauncey	CHAU1	0.12	0.08	0.04
Tributary	2017	Exposed	Clode Pond Outlet	COUT1	0.29	0.24	0.05
Tributary	2017	Exposed	Clode West Infiltration	CLOW1	0.21	0.21	0.00
Tributary	2017	Exposed	Corbin	CORB1	2.74	0.99	1.74
Tributary	2017	Exposed	Dry (EVO)	DRYE3	2.85	1.00	1.85
Tributary	2017	Exposed	Dry (LCO)	DRYL1	0.02	0.02	0.00
Tributary	2017	Exposed	Dry (LCO)	DRYL2	0.00	0.00	0.00
Tributary	2017	Exposed	Dry (LCO)	DRYL3	0.00	0.00	0.00
Tributary	2017	Exposed	Dry (LCO)	DRYL4	0.00	0.00	0.00
Tributary	2017	Exposed	Eagle Pond Outlet	EPOU1	0.25	0.21	0.04
Mainstem	2017	Exposed	Elk	ELKR12	0.00	0.00	0.00
Mainstem	2017	Reference	Elk	ELKR15	0.00	0.00	0.00
Mainstem	2017	Exposed	Elk	ELKR8	0.01	0.01	0.00
Mainstem	2017	Exposed	Elk	ELKR9	0.00	0.00	0.00
Tributary	2017	Exposed	Erickson	ERIC1	2.67	0.94	1.73
Tributary	2017	Exposed	Feltham	FELT1	0.00	0.00	0.00
Tributary	2017	Exposed	Fennelon	FENN1	0.00	0.00	0.00
Tributary	2017	Exposed	Fish Pond	FPON1	0.20	0.20	0.00
Mainstem	2017	Exposed	Fording	FORD1	0.44	0.35	0.09
Mainstem	2017	Reference	Fording	FORD12	0.11	0.11	0.00
Mainstem	2017	Exposed	Fording	FORD2	0.10	0.09	0.00

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Mainstem	2017	Exposed	Fording	FORD4	0.84	0.72	0.12
Mainstem	2017	Exposed	Fording	FORD5	0.73	0.73	0.00
Mainstem	2017	Exposed	Fording	FORD6	0.68	0.64	0.05
Mainstem	2015	Exposed	Fording	FORD9	0.00	0.00	0.00
Tributary	2017	Exposed	Gardine	GARD1	0.60	0.31	0.28
Tributary	2017	Exposed	Gate	GATE2	1.98	0.83	1.15
Tributary	2017	Exposed	Goddard	GODD1	0.13	0.13	0.00
Tributary	2017	Exposed	Goddard	GODD3	2.64	0.99	1.65
Tributary	2017	Reference	Grace	GRAC1	0.06	0.06	0.00
Tributary	2017	Exposed	Grassy	GRAS1	0.29	0.18	0.11
Tributary	2017	Exposed	Grave	GRAV1	0.24	0.24	0.00
Tributary	2017	Reference	Grave	GRAV3	0.00	0.00	0.00
Tributary	2017	Exposed	Greenhills	GREE1	1.07	0.66	0.42
Tributary	2017	Exposed	Greenhills	GREE4	2.68	1.00	1.69
Tributary	2017	Exposed	Harmer	HARM1	0.61	0.45	0.16
Tributary	2017	Exposed	Harmer	HARM3	0.03	0.03	0.00
Tributary	2017	Exposed	Henretta	HENR1	0.04	0.04	0.00
Tributary	2017	Exposed	Kilmamock	KILM1	2.77	0.96	1.81
Tributary	2017	Exposed	Lake Mountain	LMOU1	0.18	0.18	0.00
Tributary	2017	Exposed	Leask	LEAS2	2.76	0.99	1.77
Tributary	2017	Exposed	Lindsay	LIND1	0.15	0.12	0.03
Tributary	2017	Exposed	Line	LINE1	0.00	0.00	0.00
Tributary	2017	Exposed	Line	LINE4	0.66	0.66	0.00
Tributary	2017	Reference	Line	LINE7	0.00	0.00	0.00
Mainstem	2017	Exposed	Michel	MICH1	0.00	0.00	0.00
Mainstem	2017	Exposed	Michel	MICH2	0.08	0.05	0.03
Mainstem	2017	Exposed	Michel	MICH4	0.01	0.01	0.00
Mainstem	2017	Reference	Michel	MICH5	0.01	0.01	0.00
Tributary	2017	Exposed	Mickelson	MICK1	1.25	0.93	0.32
Tributary	2017	Exposed	Milligan	MILL1	0.36	0.21	0.15
Tributary	2017	Exposed	Milligan	MILL2	1.06	0.52	0.54
Tributary	2017	Exposed	North Thompson	NTHO1	1.78	0.91	0.87
Tributary	2017	Exposed	North Wolfram	NWOL1	2.59	0.97	1.62
Tributary	2017	Exposed	Otto	OTTO1	0.14	0.12	0.02

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2017	Exposed	Pengally	PENG1	0.00	0.00	0.00
Tributary	2017	Exposed	Porter	PORT1	0.74	0.74	0.00
Tributary	2017	Exposed	Porter	PORT3a	0.57	0.40	0.16
Tributary	2017	Exposed	Porter	PORT3b	2.68	0.94	1.74
Tributary	2017	Exposed	Qualteri	QUAL1	0.00	0.00	0.00
Tributary	2017	Exposed	Sawmill	SAWM1	0.00	0.00	0.00
Tributary	2017	Exposed	Sawmill	SAWM2	0.00	0.00	0.00
Tributary	2017	Exposed	Site18	SITE	3.00	1.00	2.00
Tributary	2017	Exposed	Six Mile	SIXM1	0.95	0.73	0.22
Tributary	2017	Exposed	Smith Pond Outlet	SPOU1	2.60	0.94	1.66
Tributary	2017	Reference	South Line	SLINE2	0.00	0.00	0.00
Tributary	2017	Exposed	South Pit	SPIT1	2.49	0.90	1.59
Tributary	2017	Exposed	South Wolfram Creek	SWOL1	2.05	0.99	1.05
Tributary	2017	Exposed	Spring	SPRI1	0.13	0.12	0.01
Tributary	2017	Exposed	Stream 02	STR02	0.68	0.24	0.44
Tributary	2017	Exposed	Stream 14	STR14	0.00	0.00	0.00
Tributary	2017	Exposed	Swift	SWIF1	2.45	0.98	1.47
Tributary	2017	Exposed	Thompson	THOM2	0.83	0.69	0.15
Tributary	2017	Exposed	Thresher	THRE1	0.00	0.00	0.00
Tributary	2017	Exposed	Unnamed South of Sawmill	USOS1	0.00	0.00	0.00
Tributary	2017	Exposed	Willow North	WILN2	0.00	0.00	0.00
Tributary	2017	Exposed	Willow South	WILS1	0.00	0.00	0.00
Tributary	2017	Exposed	Wolf	WOL1	0.00	0.00	0.00
Tributary	2017	Exposed	Wolfram	WOLF3	2.80	1.00	1.80
Tributary	2017	Exposed	Greenhills	GREE3	2.55	0.99	1.56
Tributary	2018	Reference	Alexander	ALEX3	0.36	0.34	0.02
Tributary	2018	Reference	Andy Good	ANDY1	0.04	0.04	0.00
Tributary	2018	Exposed	Aqueduct	AQUE1	0.03	0.02	0.01
Tributary	2018	Exposed	Aqueduct	AQUE2	0.00	0.00	0.00
Tributary	2018	Exposed	Aqueduct	AQUE3	0.14	0.14	0.00
Tributary	2018	Exposed	Balmer	BALM1	0.01	0.01	0.00
Tributary	2018	Exposed	Bodie	BODI1	1.22	0.59	0.64
Tributary	2018	Reference	Chauncey	CHAU1	0.12	0.11	0.01
Tributary	2018	Exposed	Bodie	BODI3	2.33	0.92	1.41

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2018	Exposed	Cataract	CATA1	2.96	1.00	1.96
Tributary	2018	Exposed	Cataract	CATA3	2.89	1.00	1.89
Tributary	2018	Exposed	Clode West Infiltration	CLOW1	0.67	0.67	0.01
Tributary	2018	Exposed	Corbin	CORB1	2.70	0.98	1.72
Tributary	2018	Exposed	Corbin	CORB2	2.92	1.00	1.92
Tributary	2018	Exposed	Clode Pond Outlet	COUT1	1.46	0.91	0.55
Tributary	2018	Exposed	Dry (EVO)	DRYE1	2.96	1.00	1.96
Mainstem	2018	Exposed	Elk	ELKR10	0.03	0.03	0.00
Mainstem	2018	Exposed	Elk	ELKR11	0.00	0.00	0.00
Mainstem	2018	Exposed	Elk	ELKR12	0.00	0.00	0.00
Mainstem	2018	Reference	Elk	ELKR15	0.02	0.02	0.00
Mainstem	2018	Exposed	Elk	ELKR8	0.28	0.26	0.01
Mainstem	2018	Exposed	Elk	ELKR9	0.07	0.07	0.00
Tributary	2018	Exposed	Dry (EVO)	DRYE3	2.76	1.00	1.76
Tributary	2018	Exposed	Dry (EVO)	DRYE4	3.00	1.00	2.00
Tributary	2018	Exposed	Dry (LCO)	DRYL1	0.57	0.57	0.00
Mainstem	2018	Exposed	Fording	FORD1	0.23	0.23	0.00
Mainstem	2018	Exposed	Fording	FORD10	0.63	0.60	0.03
Mainstem	2018	Exposed	Fording	FORD11	0.27	0.27	0.00
Mainstem	2018	Reference	Fording	FORD12	0.31	0.30	0.01
Mainstem	2018	Exposed	Fording	FORD2	0.13	0.12	0.01
Mainstem	2018	Exposed	Fording	FORD3	0.49	0.37	0.12
Mainstem	2018	Exposed	Fording	FORD4	0.80	0.73	0.07
Mainstem	2018	Exposed	Fording	FORD5	0.70	0.69	0.01
Mainstem	2018	Exposed	Fording	FORD6	0.79	0.64	0.14
Mainstem	2018	Exposed	Fording	FORD7	0.89	0.82	0.07
Mainstem	2018	Exposed	Fording	FORD8	0.61	0.61	0.00
Mainstem	2016	Exposed	Fording	FORD9	0.00	0.00	0.00
Tributary	2018	Exposed	Dry (LCO)	DRYL2	0.24	0.24	0.00
Tributary	2018	Exposed	Dry (LCO)	DRYL3	0.06	0.06	0.00
Tributary	2018	Exposed	Dry (LCO)	DRYL4	0.32	0.32	0.00
Tributary	2018	Reference	Grace	GRAC1	0.10	0.09	0.01
Tributary	2018	Reference	Grace	GRAC2	0.06	0.06	0.00
Tributary	2018	Reference	Grace	GRAC3	0.00	0.00	0.00

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2018	Exposed	Eagle Pond Outlet	EPOU1	0.21	0.21	0.00
Tributary	2018	Exposed	Erickson	ERIC1	2.89	0.99	1.90
Tributary	2018	Reference	Grave	GRAV3	0.00	0.00	0.00
Tributary	2018	Exposed	Erickson	ERIC2	2.50	0.90	1.60
Tributary	2018	Exposed	Erickson	ERIC3	2.95	1.00	1.95
Tributary	2018	Exposed	Erickson	ERIC4	1.73	0.85	0.88
Tributary	2018	Exposed	Feltham	FELT1	0.15	0.14	0.01
Tributary	2018	Reference	Henretta	HENR3	0.00	0.00	0.00
Tributary	2018	Exposed	Fennelon	FENN1	0.02	0.02	0.00
Tributary	2018	Exposed	Fish Pond	FPON1	0.17	0.17	0.01
Tributary	2018	Exposed	Gardine	GARD1	0.64	0.34	0.29
Tributary	2018	Exposed	Gate	GATE2	1.14	0.59	0.55
Tributary	2018	Reference	Line	LINE7	0.01	0.01	0.00
Mainstem	2018	Exposed	Michel	MICH1	0.08	0.08	0.00
Mainstem	2018	Exposed	Michel	MICH2	0.02	0.02	0.00
Mainstem	2018	Exposed	Michel	MICH3	0.01	0.01	0.00
Mainstem	2018	Exposed	Michel	MICH4	0.06	0.06	0.00
Mainstem	2018	Reference	Michel	MICH5	0.00	0.00	0.00
Tributary	2018	Exposed	Goddard	GODD1	0.35	0.35	0.00
Tributary	2018	Exposed	Goddard	GODD2	2.62	0.99	1.63
Tributary	2018	Exposed	Goddard	GODD3	2.62	0.96	1.66
Tributary	2018	Exposed	Grassy	GRAS1	0.25	0.16	0.09
Tributary	2018	Exposed	Grave	GRAV1	0.37	0.35	0.02
Tributary	2018	Exposed	Grave	GRAV2	0.14	0.14	0.00
Tributary	2018	Exposed	Greenhills	GREE1	0.64	0.44	0.20
Tributary	2018	Exposed	Greenhills	GREE3	2.49	0.98	1.51
Tributary	2018	Exposed	Greenhills	GREE4	2.74	0.99	1.75
Tributary	2018	Reference	South Line	SLINE2	0.04	0.04	0.00
Tributary	2018	Exposed	Harmer	HARM1	0.80	0.73	0.08
Tributary	2018	Exposed	Harmer	HARM3	0.08	0.06	0.02
Tributary	2018	Exposed	Harmer	HARM4	0.35	0.30	0.05
Tributary	2018	Exposed	Harmer	HARM5	0.31	0.29	0.01
Tributary	2018	Exposed	Henretta	HENR1	0.32	0.32	0.00
Tributary	2018	Exposed	Kilmamock	KILM1	2.30	0.91	1.40

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2018	Exposed	Leask	LEAS2	2.60	0.99	1.61
Tributary	2018	Exposed	Lindsay	LIND1	0.19	0.19	0.00
Tributary	2018	Exposed	Line	LINE1	0.52	0.52	0.00
Tributary	2018	Exposed	Line	LINE2	0.45	0.45	0.00
Tributary	2018	Exposed	Line	LINE3	0.66	0.65	0.01
Tributary	2018	Exposed	Line	LINE4	0.95	0.90	0.05
Tributary	2018	Exposed	Lake Mountain	LMOU1	0.39	0.39	0.00
Tributary	2018	Exposed	Mickelson	MICK1	1.23	0.82	0.40
Tributary	2018	Exposed	Mickelson	MICK2	1.37	0.79	0.58
Tributary	2018	Exposed	Milligan	MILL1	1.77	0.90	0.87
Tributary	2018	Exposed	Milligan	MILL2	1.18	0.56	0.62
Tributary	2018	Exposed	North Thompson	NTHO1	1.91	0.95	0.96
Tributary	2018	Exposed	North Wolfram	NWOL1	2.44	0.90	1.54
Tributary	2018	Exposed	Otto	OTTO1	0.59	0.56	0.03
Tributary	2018	Exposed	Otto	OTTO3	0.05	0.05	0.00
Tributary	2018	Exposed	Pengally	PENG1	0.00	0.00	0.00
Tributary	2018	Exposed	Pengally	PENG1	0.00	0.00	0.00
Tributary	2018	Exposed	Porter	PORT1	0.85	0.79	0.06
Tributary	2018	Exposed	Porter	PORT3a	0.69	0.56	0.13
Tributary	2018	Exposed	Porter	PORT3b	2.60	0.97	1.63
Tributary	2018	Exposed	Sawmill	SAWM1	0.01	0.01	0.00
Tributary	2018	Exposed	Sawmill	SAWM2	0.00	0.00	0.00
Tributary	2018	Exposed	Site18	SITE	3.00	1.00	2.00
Tributary	2018	Exposed	Six Mile	SIXM1	0.92	0.72	0.21
Tributary	2018	Exposed	South Pit	SPIT1	2.77	1.00	1.77
Tributary	2018	Exposed	Smith Pond Outlet	SPOU1	2.45	0.91	1.54
Tributary	2018	Exposed	Spring	SPRI1	0.14	0.14	0.00
Tributary	2018	Exposed	Stream 02	STR02	0.72	0.25	0.47
Tributary	2018	Exposed	Stream 14	STR14	0.40	0.34	0.06
Tributary	2018	Exposed	Swift	SWIF1	1.69	0.85	0.84
Tributary	2018	Exposed	Swift	SWIF2	1.12	0.87	0.25
Tributary	2018	Exposed	South Wolfram Creek	SWOL1	2.38	0.95	1.43
Tributary	2018	Exposed	Thompson	THOM2	0.81	0.73	0.08
Tributary	2018	Exposed	Thompson	THOM3	1.04	0.73	0.31

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2018	Exposed	Thresher	THRE1	0.03	0.02	0.01
Tributary	2018	Exposed	Unnamed South of Sawmill	USOS1	0.00	0.00	0.00
Tributary	2018	Exposed	Willow North	WILN2	0.00	0.00	0.00
Tributary	2018	Exposed	Willow South	WILS1	0.00	0.00	0.00
Tributary	2018	Exposed	Wolf	WOL1	0.00	0.00	0.00
Tributary	2018	Exposed	Wolfram	WOLF2	0.88	0.36	0.52
Tributary	2018	Exposed	Wolfram	WOLF3	2.69	0.94	1.75
Tributary	2019	Reference	Alexander	ALEX3	0.86	0.82	0.04
Tributary	2019	Reference	Andy Good	ANDY1	0.09	0.09	0.00
Tributary	2019	Exposed	Aqueduct	AQUE1	0.00	0.00	0.00
Tributary	2019	Exposed	Bodie	BODI1	1.09	0.73	0.36
Tributary	2019	Exposed	Bodie	BODI3	2.58	0.99	1.59
Tributary	2019	Reference	Chauncey	CHAU1	0.23	0.22	0.01
Tributary	2019	Exposed	Clode Pond Outlet	COUT1	1.28	0.90	0.38
Tributary	2019	Exposed	Clode West Infiltration	CLOW1	0.69	0.69	0.00
Tributary	2019	Exposed	Corbin	CORB1	2.47	0.96	1.51
Tributary	2019	Exposed	Corbin	CORB2	2.87	0.99	1.88
Tributary	2019	Exposed	Dry (EVO)	DRYE1	2.19	0.99	1.20
Tributary	2019	Exposed	Dry (EVO)	DRYE3	2.25	1.00	1.25
Tributary	2019	Exposed	Dry (EVO)	DRYE4	2.51	1.00	1.51
Tributary	2019	Exposed	Dry (LCO)	DRYL1	0.65	0.62	0.03
Tributary	2019	Exposed	Dry (LCO)	DRYL2	0.52	0.52	0.00
Tributary	2019	Exposed	Dry (LCO)	DRYL3	0.16	0.16	0.00
Tributary	2019	Exposed	Dry (LCO)	DRYL4	0.15	0.15	0.00
Tributary	2019	Reference	East Dry	ETRI1	0.01	0.01	0.00
Mainstem	2019	Exposed	Elk	ELKR10	0.01	0.01	0.00
Mainstem	2019	Exposed	Elk	ELKR12	0.03	0.03	0.00
Mainstem	2019	Reference	Elk	ELKR15	0.02	0.02	0.00
Mainstem	2019	Exposed	Elk	ELKR8	0.09	0.09	0.00
Mainstem	2019	Exposed	Elk	ELKR9	0.08	0.08	0.00
Tributary	2019	Exposed	Erickson	ERIC1	2.90	1.00	1.90
Tributary	2019	Exposed	Erickson	ERIC2	2.46	0.94	1.52
Tributary	2019	Exposed	Erickson	ERIC3	2.96	1.00	1.96
Tributary	2019	Exposed	Erickson	ERIC4	1.74	0.94	0.81

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2019	Exposed	Feltham	FELT1	0.00	0.00	0.00
Tributary	2019	Exposed	Fennelon	FENN1	0.02	0.02	0.00
Tributary	2019	Exposed	Fish Pond	FPON1	0.38	0.38	0.00
Mainstem	2019	Exposed	Fording	FORD1	0.20	0.20	0.00
Mainstem	2019	Reference	Fording	FORD12	0.28	0.28	0.00
Mainstem	2019	Exposed	Fording	FORD2	0.30	0.27	0.03
Mainstem	2019	Exposed	Fording	FORD4	1.09	0.98	0.12
Mainstem	2019	Exposed	Fording	FORD5	0.80	0.80	0.00
Mainstem	2019	Exposed	Fording	FORD6	0.98	0.92	0.06
Mainstem	2019	Exposed	Fording	FORD7	0.90	0.82	0.08
Mainstem	2017	Exposed	Fording	FORD9	0.32	0.23	0.09
Tributary	2019	Exposed	Gardine	GARD1	0.50	0.50	0.01
Tributary	2019	Exposed	Goddard	GODD1	0.24	0.24	0.00
Tributary	2019	Exposed	Goddard	GODD2	2.52	0.98	1.54
Tributary	2019	Exposed	Goddard	GODD3	2.66	0.97	1.69
Tributary	2019	Reference	Grace	GRAC1	0.19	0.19	0.01
Tributary	2019	Exposed	Grassy	GRAS1	0.38	0.26	0.12
Tributary	2019	Exposed	Grave	GRAV1	0.41	0.40	0.00
Tributary	2019	Reference	Grave	GRAV3	0.00	0.00	0.00
Tributary	2019	Exposed	Greenhills	GREE1	0.66	0.57	0.09
Tributary	2019	Exposed	Greenhills	GREE3	1.91	0.99	0.92
Tributary	2019	Exposed	Greenhills	GREE4	2.32	1.00	1.32
Tributary	2019	Exposed	Harmer	HARM1	0.82	0.82	0.00
Tributary	2019	Exposed	Harmer	HARM3	0.14	0.13	0.00
Tributary	2019	Exposed	Henretta	HENR1	0.40	0.40	0.00
Tributary	2019	Exposed	Kilmamock	KILM1	2.56	0.91	1.65
Tributary	2019	Exposed	Lake Mountain	LMOU1	0.88	0.88	0.00
Tributary	2019	Exposed	Leask	LEAS2	2.79	1.00	1.79
Tributary	2019	Exposed	Line	LINE1	0.46	0.39	0.07
Tributary	2019	Exposed	Line	LINE4	0.93	0.93	0.00
Mainstem	2019	Exposed	Michel	MICH1	0.04	0.04	0.00
Mainstem	2019	Exposed	Michel	MICH4	0.02	0.02	0.00
Mainstem	2019	Reference	Michel	MICH5	0.06	0.06	0.00
Tributary	2019	Exposed	Mickelson	MICK1	1.84	0.98	0.86

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2019	Exposed	North Thompson	NTHO1	1.56	0.92	0.64
Tributary	2019	Exposed	Porter	PORT1	0.85	0.85	0.00
Tributary	2019	Exposed	Porter	PORT3a	0.34	0.33	0.01
Tributary	2019	Exposed	Porter	PORT3b	2.53	0.98	1.55
Tributary	2019	Exposed	Sawmill	SAWM1	0.00	0.00	0.00
Tributary	2019	Exposed	Site18	SITE	2.93	1.00	1.93
Tributary	2019	Exposed	Smith Pond Outlet	SPOU1	2.00	0.91	1.09
Tributary	2019	Reference	South Line	SLINE2	0.08	0.08	0.00
Tributary	2019	Exposed	South Pit	SPIT1	2.43	1.00	1.43
Tributary	2019	Exposed	SouthWolfram	SWOL1	2.96	1.00	1.96
Tributary	2019	Exposed	Spring	SPRI1	0.05	0.05	0.00
Tributary	2019	Exposed	Swift	SWIF1	1.88	0.97	0.91
Tributary	2019	Exposed	Thompson	THOM2	0.82	0.74	0.08
Tributary	2019	Exposed	Thompson	THOM3	1.63	0.97	0.66
Tributary	2019	Exposed	Wolf	WOL1	0.90	0.89	0.01
Tributary	2019	Exposed	Wolfram	WOLF2	0.84	0.78	0.06
Tributary	2019	Exposed	Wolfram	WOLF3	2.86	1.00	1.86
Tributary	2020	Reference	Alexander	ALEX3	0.41	0.41	0.00
Tributary	2020	Reference	Andy Good	ANDY1	0.00	0.00	0.00
Tributary	2020	Exposed	Aqueduct	AQUE1	0.00	0.00	0.00
Tributary	2020	Exposed	Balmer	BALM1	0.01	0.01	0.00
Tributary	2020	Exposed	Bodie	BODI1	1.10	0.65	0.45
Tributary	2020	Exposed	Bodie	BODI3	2.62	0.99	1.63
Tributary	2020	Reference	Chauncey	CHAU1	0.21	0.21	0.00
Tributary	2020	Exposed	Clode West Infiltration	CLOW1	0.76	0.76	0.00
Tributary	2020	Exposed	Corbin	CORB1	2.45	0.95	1.51
Tributary	2020	Exposed	Clode Pond Outlet	COUT1	1.16	0.87	0.29
Tributary	2020	Exposed	Dry (EVO)	DRYE1	2.67	1.00	1.67
Tributary	2020	Exposed	Dry (EVO)	DRYE3	2.82	1.00	1.82
Tributary	2020	Exposed	Dry (EVO)	DRYE4	2.94	1.00	1.94
Tributary	2020	Exposed	Dry (LCO)	DRYL1	0.62	0.62	0.00
Tributary	2020	Exposed	Dry (LCO)	DRYL2	0.60	0.60	0.00
Tributary	2020	Exposed	Dry (LCO)	DRYL3	0.29	0.29	0.00
Tributary	2020	Exposed	Dry (LCO)	DRYL4	0.30	0.30	0.00

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Mainstem	2020	Exposed	Elk	ELKR10	0.05	0.05	0.00
Mainstem	2020	Exposed	Elk	ELKR12	0.05	0.05	0.00
Mainstem	2020	Reference	Elk	ELKR15	0.00	0.00	0.00
Mainstem	2020	Exposed	Elk	ELKR8	0.42	0.42	0.00
Mainstem	2020	Exposed	Elk	ELKR9	0.08	0.08	0.00
Tributary	2020	Exposed	Erickson	ERIC1	2.92	1.00	1.92
Tributary	2020	Exposed	Erickson	ERIC2	2.57	0.95	1.62
Tributary	2020	Exposed	Erickson	ERIC3	2.91	0.99	1.92
Tributary	2020	Exposed	Erickson	ERIC4	1.68	0.90	0.78
Tributary	2020	Reference	East Dry	ETRI1	0.02	0.02	0.00
Tributary	2020	Exposed	Feltham	FELT1	0.01	0.01	0.00
Tributary	2020	Exposed	Fennelon	FENN1	0.00	0.00	0.00
Mainstem	2020	Exposed	Fording	FORD1	0.14	0.14	0.00
Mainstem	2020	Exposed	Fording	FORD10	0.52	0.45	0.07
Mainstem	2020	Exposed	Fording	FORD11	0.18	0.18	0.00
Mainstem	2020	Reference	Fording	FORD12	0.15	0.15	0.00
Mainstem	2020	Exposed	Fording	FORD2	0.34	0.28	0.05
Mainstem	2020	Exposed	Fording	FORD3	0.96	0.74	0.22
Mainstem	2020	Exposed	Fording	FORD4	0.88	0.84	0.04
Mainstem	2020	Exposed	Fording	FORD5	0.79	0.76	0.03
Mainstem	2020	Exposed	Fording	FORD6	0.96	0.86	0.10
Mainstem	2020	Exposed	Fording	FORD7	1.09	0.93	0.17
Mainstem	2020	Exposed	Fording	FORD8	0.69	0.69	0.00
Mainstem	2018	Exposed	Fording	FORD9	0.73	0.55	0.18
Tributary	2020	Exposed	Fish Pond	FPON1	0.48	0.48	0.00
Tributary	2020	Exposed	Gardine	GARD1	0.60	0.38	0.22
Tributary	2020	Exposed	Gate	GATE2	1.61	0.87	0.73
Tributary	2020	Exposed	Goddard	GODD1	0.16	0.16	0.00
Tributary	2020	Exposed	Goddard	GODD2	2.14	0.82	1.31
Tributary	2020	Exposed	Goddard	GODD3	2.55	0.91	1.64
Tributary	2020	Reference	Grace	GRAC1	0.25	0.24	0.01
Tributary	2020	Exposed	Grassy	GRAS1	0.17	0.16	0.02
Tributary	2020	Exposed	Grave	GRAV1	0.28	0.27	0.01
Tributary	2020	Reference	Grave	GRAV3	0.01	0.01	0.00

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2020	Exposed	Greenhills	GREE1	0.64	0.51	0.13
Tributary	2020	Exposed	Greenhills	GREE3	2.58	1.00	1.58
Tributary	2020	Exposed	Greenhills	GREE4	2.84	0.99	1.84
Tributary	2020	Exposed	Greenhouse side channel	GSCH1	0.41	0.41	0.00
Tributary	2020	Exposed	Harmer	HARM1	0.90	0.87	0.03
Tributary	2020	Exposed	Harmer	HARM3	0.12	0.12	0.00
Tributary	2020	Exposed	Henretta	HENR1	0.69	0.62	0.08
Tributary	2020	Reference	Henretta	HENR3	0.20	0.20	0.00
Tributary	2020	Exposed	Kilmarnock	KILM1	2.47	0.86	1.61
Tributary	2020	Exposed	Leask	LEAS2	2.46	1.00	1.46
Tributary	2020	Exposed	Lindsay	LIND1	0.11	0.11	0.00
Tributary	2020	Exposed	Line	LINE1	0.76	0.76	0.00
Tributary	2020	Exposed	Line	LINE2	0.52	0.51	0.01
Tributary	2020	Exposed	Line	LINE3	0.48	0.48	0.00
Tributary	2020	Exposed	Line	LINE4	0.70	0.70	0.00
Tributary	2020	Exposed	Lake Mountain	LMOU1	0.64	0.64	0.00
Mainstem	2020	Exposed	Michel	MICH1	0.12	0.12	0.00
Mainstem	2020	Exposed	Michel	MICH2	0.79	0.79	0.00
Mainstem	2020	Exposed	Michel	MICH3	0.45	0.45	0.00
Mainstem	2020	Exposed	Michel	MICH4	0.07	0.07	0.00
Mainstem	2020	Reference	Michel	MICH5	0.03	0.03	0.00
Tributary	2020	Exposed	Mickelson	MICK1	1.22	0.84	0.38
Tributary	2020	Exposed	Milligan	MILL1	1.33	0.82	0.51
Tributary	2020	Exposed	North Thompson	NTHO1	2.00	0.87	1.13
Tributary	2020	Exposed	North Wolfram	NWOL1	2.71	1.00	1.71
Tributary	2020	Exposed	Otto	OTTO1	0.46	0.46	0.00
Tributary	2020	Exposed	Porter	PORT1	0.98	0.98	0.00
Tributary	2020	Exposed	Porter	PORT3a	0.48	0.47	0.00
Tributary	2020	Exposed	Porter	PORT3b	2.55	0.94	1.61
Tributary	2020	Exposed	Sawmill	SAWM1	0.05	0.05	0.00
Tributary	2020	Exposed	Site18	SITE	2.97	1.00	1.97
Tributary	2020	Exposed	Six Mile	SIXM1	0.93	0.91	0.02
Tributary	2020	Reference	South Line	SLINE2	0.05	0.05	0.00
Tributary	2020	Exposed	South Pit	SPIT1	2.30	0.95	1.35

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2020	Exposed	Smith Pond Outlet	SPOU1	2.02	1.00	1.02
Tributary	2020	Exposed	Spring	SPRI1	0.04	0.04	0.00
Tributary	2020	Exposed	Stream 02	STR02	0.02	0.02	0.00
Tributary	2020	Exposed	SouthWolfram	SWOL1	2.52	0.93	1.59
Tributary	2020	Exposed	Thompson	THOM2	0.80	0.75	0.06
Tributary	2020	Exposed	Thompson	THOM3	1.29	0.89	0.40
Tributary	2020	Exposed	Thompson	THOM4	0.16	0.16	0.00
Tributary	2020	Exposed	Unnamed Trib South of Sawmill	USOS1	0.00	0.00	0.00
Tributary	2020	Exposed	Upper Thompson	UTHO1	1.15	0.87	0.28
Tributary	2020	Exposed	Upper Thompson Pond Outlet	UTPO1	0.52	0.40	0.12
Tributary	2020	Exposed	North Willow	WILN2	0.02	0.02	0.00
Tributary	2020	Exposed	Wolf	WOL1	0.01	0.01	0.00
Tributary	2020	Exposed	Wolfram	WOLF2	2.41	0.90	1.51
Tributary	2020	Exposed	Wolfram	WOLF3	2.95	1.00	1.95
Tributary	2021	Reference	Aldridge	ALDR1	0.00	0.00	0.00
Tributary	2021	Reference	Alexander	ALEX1	0.03	0.02	0.00
Tributary	2021	Reference	Alexander	ALEX3	0.01	0.01	0.00
Tributary	2021	Reference	Alexander	ALEX8	0.00	0.00	0.00
Tributary	2021	Reference	Andy Good	ANDY1	0.05	0.05	0.00
Tributary	2021	Exposed	Aqueduct	AQUE1	0.01	0.01	0.00
Tributary	2021	Exposed	Aqueduct	AQUE2	0.00	0.00	0.00
Tributary	2021	Exposed	Aqueduct	AQUE3	0.24	0.24	0.00
Tributary	2021	Exposed	Balmer	BALM1	0.00	0.00	0.00
Tributary	2021	Reference	Bingay	BING1	0.01	0.01	0.00
Tributary	2021	Exposed	Bodie	BODI1	1.22	0.87	0.35
Tributary	2021	Exposed	Bodie	BODI3	2.55	1.00	1.55
Tributary	2021	Reference	Chauncey	CHAU1	0.18	0.18	0.00
Tributary	2021	Exposed	Clode Pond Outlet	COUT1	1.34	0.86	0.48
Tributary	2021	Exposed	Clode West Infiltration	CLOW1	0.71	0.71	0.00
Tributary	2021	Exposed	Corbin	CORB1	2.72	1.00	1.72
Tributary	2021	Exposed	Corbin	CORB2	2.96	1.00	1.96
Tributary	2021	Reference	Drinkwater	DRIN1	0.00	0.00	0.00
Tributary	2021	Exposed	Dry (EVO)	DRYE1	2.52	1.00	1.52
Tributary	2021	Exposed	Dry (EVO)	DRYE3	2.66	0.99	1.67

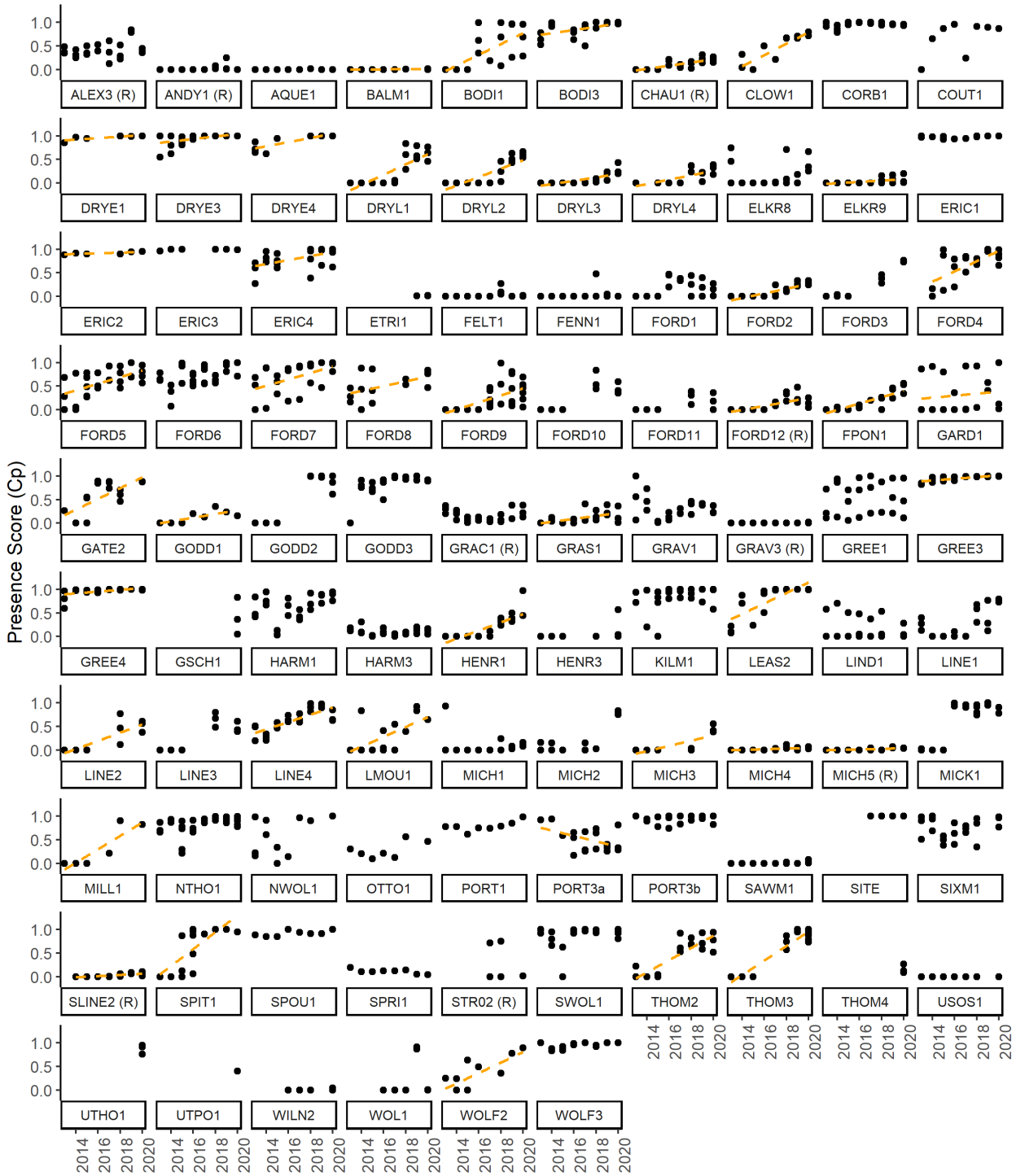
Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2021	Exposed	Dry (EVO)	DRYE4	2.56	0.99	1.57
Tributary	2021	Exposed	Dry (LCO)	DRYL1	0.74	0.74	0.00
Tributary	2021	Exposed	Dry (LCO)	DRYL2	0.71	0.71	0.00
Tributary	2021	Exposed	Dry (LCO)	DRYL3	0.38	0.38	0.00
Tributary	2021	Exposed	Dry (LCO)	DRYL4	0.34	0.34	0.00
Tributary	2021	Reference	East Dry	ETRI1	0.00	0.00	0.00
Mainstem	2021	Exposed	Elk	ELKR10	0.21	0.21	0.00
Mainstem	2021	Exposed	Elk	ELKR11	0.22	0.22	0.00
Mainstem	2021	Exposed	Elk	ELKR12	0.00	0.00	0.00
Mainstem	2021	Reference	Elk	ELKR15	0.03	0.03	0.00
Mainstem	2021	Exposed	Elk	ELKR8	0.19	0.19	0.00
Mainstem	2021	Exposed	Elk	ELKR9	0.07	0.07	0.00
Tributary	2021	Exposed	Erickson	ERIC1	2.71	1.00	1.71
Tributary	2021	Exposed	Erickson	ERIC2	2.87	0.96	1.91
Tributary	2021	Exposed	Erickson	ERIC3	2.94	1.00	1.94
Tributary	2021	Exposed	Erickson	ERIC4	1.42	0.83	0.60
Tributary	2021	Reference	Ewin	EWIN1	0.21	0.21	0.00
Tributary	2021	Exposed	Feltham	FELT1	0.00	0.00	0.00
Tributary	2021	Exposed	Fennelon	FENN1	0.00	0.00	0.00
Tributary	2021	Exposed	Fish Pond	FPON1	0.40	0.40	0.00
Mainstem	2021	Exposed	Fording	FORD1	0.43	0.43	0.00
Mainstem	2021	Exposed	Fording	FORD10	0.35	0.35	0.00
Mainstem	2021	Exposed	Fording	FORD11	0.10	0.10	0.00
Mainstem	2021	Reference	Fording	FORD12	0.14	0.14	0.00
Mainstem	2021	Exposed	Fording	FORD2	1.09	0.92	0.17
Mainstem	2021	Exposed	Fording	FORD3	0.85	0.68	0.18
Mainstem	2021	Exposed	Fording	FORD4	1.01	0.94	0.06
Mainstem	2021	Exposed	Fording	FORD5	0.92	0.84	0.08
Mainstem	2021	Exposed	Fording	FORD6	1.19	0.78	0.41
Mainstem	2021	Exposed	Fording	FORD7	1.13	0.97	0.16
Mainstem	2021	Exposed	Fording	FORD8	0.67	0.67	0.00
Mainstem	2019	Exposed	Fording	FORD9	0.53	0.40	0.13
Mainstem	2020	Exposed	Fording	FORD9	0.44	0.39	0.05
Tributary	2021	Reference	Forsythe	FORS1	0.00	0.00	0.00

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2021	Exposed	Gardine	GARD1	0.71	0.32	0.39
Tributary	2021	Exposed	Gate	GATE2	1.46	0.93	0.53
Tributary	2021	Exposed	Goddard	GODD1	0.04	0.04	0.00
Tributary	2021	Exposed	Goddard	GODD3	2.76	0.93	1.83
Tributary	2021	Reference	Grace	GRAC1	0.12	0.12	0.00
Tributary	2021	Exposed	Grassy	GRAS1	0.19	0.19	0.00
Tributary	2021	Exposed	Grave	GRAV1	0.12	0.11	0.00
Tributary	2021	Exposed	Grave	GRAV2	0.06	0.06	0.00
Tributary	2021	Reference	Grave	GRAV3	0.00	0.00	0.00
Tributary	2021	Exposed	Greenhills	GREE1	0.76	0.68	0.08
Tributary	2021	Exposed	Greenhills	GREE3	2.68	1.00	1.68
Tributary	2021	Exposed	Greenhills	GREE4	2.67	0.97	1.70
Tributary	2021	Exposed	Greenhouse side channel	GSCH1	0.67	0.67	0.00
Tributary	2021	Exposed	Harmer	HARM1	0.76	0.76	0.00
Tributary	2021	Exposed	Harmer	HARM3	0.04	0.04	0.00
Tributary	2021	Exposed	Harmer	HARM4	0.21	0.21	0.00
Tributary	2021	Exposed	Harmer	HARM5	0.38	0.38	0.00
Tributary	2021	Reference	Hartley	HART2	0.03	0.03	0.00
Tributary	2021	Exposed	Henretta	HENR1	0.62	0.62	0.00
Tributary	2021	Exposed	Henretta	HENR2	0.02	0.02	0.00
Tributary	2021	Reference	Henretta	HENR3	0.00	0.00	0.00
Tributary	2021	Exposed	Kilmamock	KILM1	2.34	0.82	1.52
Tributary	2021	Exposed	Lake Mountain	LMOU1	0.61	0.61	0.00
Tributary	2021	Reference	Leach	RG_LE1	0.00	0.00	0.00
Tributary	2021	Exposed	Leask	LEAS2	2.69	1.00	1.69
Tributary	2021	Exposed	Lindsay	LIND1	0.06	0.06	0.00
Tributary	2021	Exposed	Line	LINE1	0.53	0.52	0.01
Tributary	2021	Exposed	Line	LINE2	0.28	0.28	0.00
Tributary	2021	Exposed	Line	LINE3	0.36	0.36	0.00
Tributary	2021	Exposed	Line	LINE4	0.94	0.94	0.00
Tributary	2021	Exposed	Line	LINE7	0.00	0.00	0.00
Tributary	2021	Exposed	Liver Pool Outfall	LIVE1	2.55	1.00	1.55
Tributary	2021	Reference	Lizard	LIZA1	0.12	0.12	0.00
Tributary	2021	Reference	McCool	MCOO1	0.19	0.14	0.05

Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Mainstem	2021	Exposed	Michel	MICH1	0.02	0.02	0.00
Mainstem	2021	Exposed	Michel	MICH2	0.29	0.29	0.00
Mainstem	2021	Exposed	Michel	MICH3	0.03	0.03	0.00
Mainstem	2021	Exposed	Michel	MICH4	0.11	0.11	0.00
Mainstem	2021	Reference	Michel	MICH5	0.04	0.04	0.00
Tributary	2020	Exposed	Mickelson	MICK1	1.19	0.82	0.37
Tributary	2021	Exposed	Mickelson	MICK2	1.69	0.98	0.72
Tributary	2021	Exposed	Milligan	MILL2	2.19	1.00	1.19
Tributary	2021	Reference	Morrissey	MORI1	0.00	0.00	0.00
Tributary	2021	Exposed	North Thompson	NTHO1	1.94	0.94	1.01
Tributary	2021	Exposed	North Willow	WILN2	0.01	0.01	0.00
Tributary	2021	Exposed	North Wolfram	NWOL1	2.64	0.96	1.68
Tributary	2021	Exposed	Otto	OTTO1	0.49	0.48	0.01
Tributary	2021	Exposed	Porter	PORT1	0.98	0.98	0.00
Tributary	2021	Exposed	Porter	PORT3a	0.49	0.48	0.01
Tributary	2021	Exposed	Porter	PORT3b	2.22	0.93	1.29
Tributary	2021	Reference	RG_UCWER	RG_UCWER1	0.00	0.00	0.00
Tributary	2021	Exposed	Sawmill	SAWM1	0.01	0.01	0.00
Tributary	2021	Exposed	Sawmill	SAWM2	0.00	0.00	0.00
Tributary	2021	Exposed	Site18	SITE	2.49	1.00	1.49
Tributary	2021	Exposed	Six Mile	SIXM1	0.66	0.60	0.05
Tributary	2021	Exposed	Smith Pond Outlet	SPOU1	2.35	1.00	1.35
Tributary	2021	Reference	South Line	SLINE2	0.18	0.18	0.00
Tributary	2021	Exposed	South Pit	SPIT1	2.15	1.00	1.15
Tributary	2021	Exposed	South Willow	WILS1	0.21	0.16	0.05
Tributary	2021	Exposed	South Wolfram	SWOL1	2.39	0.90	1.49
Tributary	2021	Exposed	Spring	SPRI1	0.01	0.01	0.00
Tributary	2021	Exposed	Stream 02	STR02	0.00	0.00	0.00
Tributary	2021	Exposed	Stream 14	STR14	0.46	0.46	0.00
Tributary	2021	Exposed	Thompson	THOM2	1.07	0.88	0.19
Tributary	2021	Exposed	Thompson	THOM3	1.90	0.93	0.98
Tributary	2021	Exposed	Thompson	THOM4	0.19	0.19	0.00
Tributary	2021	Reference	Toddhunter	TODH1	0.10	0.10	0.00
Tributary	2021	Exposed	Unnamed Trib South of Sawmill	USOS1	0.00	0.00	0.00

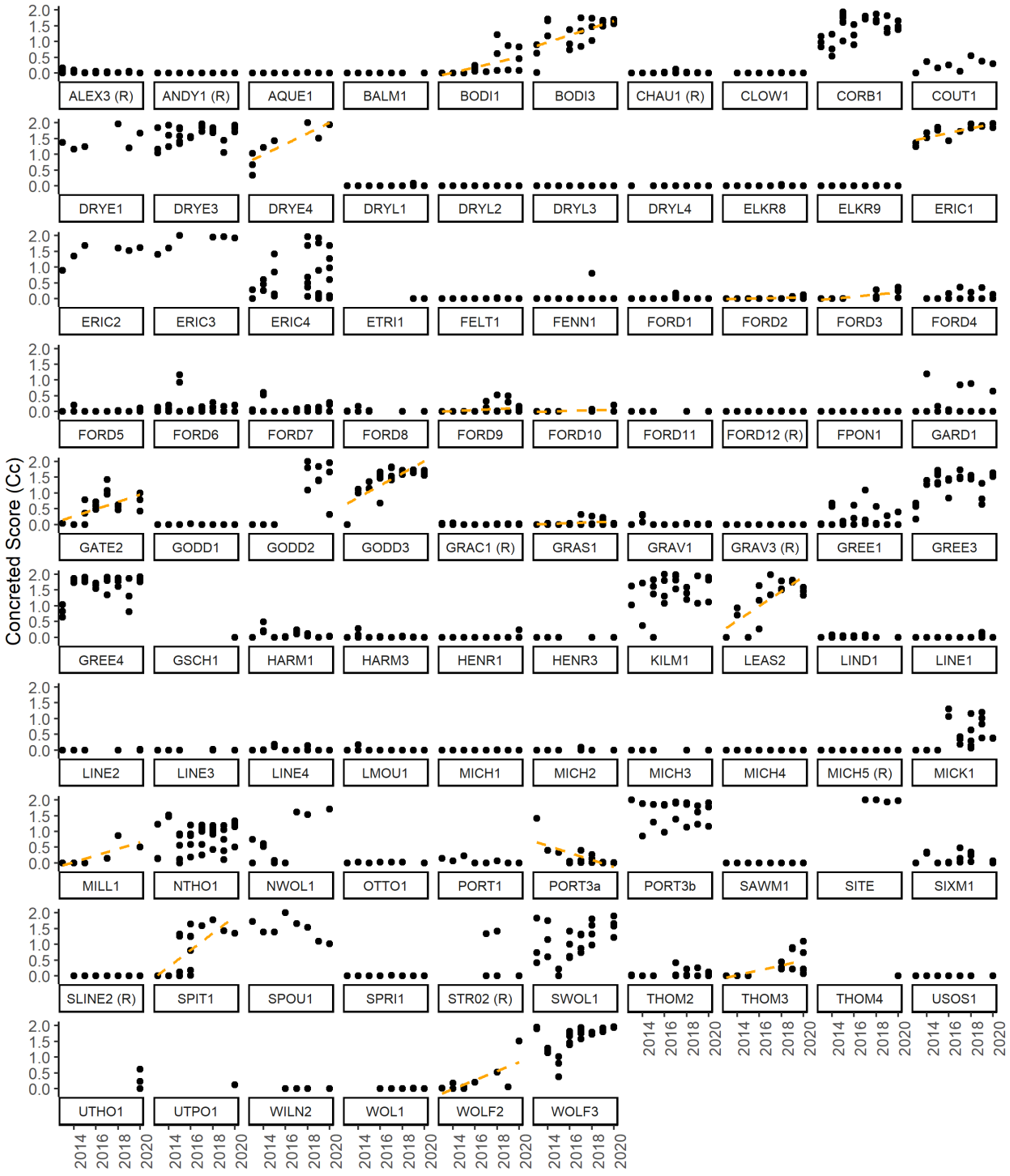
Strata	Year	Type	Stream	Reach	CI	Cp	Cc
Tributary	2021	Exposed	Upper Thompson	UTHO1	1.51	0.89	0.62
Tributary	2021	Exposed	Upper Thompson Pond Outlet	UTPO1	0.58	0.58	0.00
Tributary	2021	Reference	Weigert	WEIG1	0.03	0.03	0.00
Tributary	2021	Exposed	Wolf	WOL1	0.08	0.08	0.00
Tributary	2021	Exposed	Wolfram	WOLF2	2.80	0.99	1.81
Tributary	2021	Exposed	Wolfram	WOLF3	2.91	1.00	1.91

Appendix 7. Plots of the calcite presence, concretion and index by year for reaches in 2021 with trends evaluated by Mann-Kendall analysis.



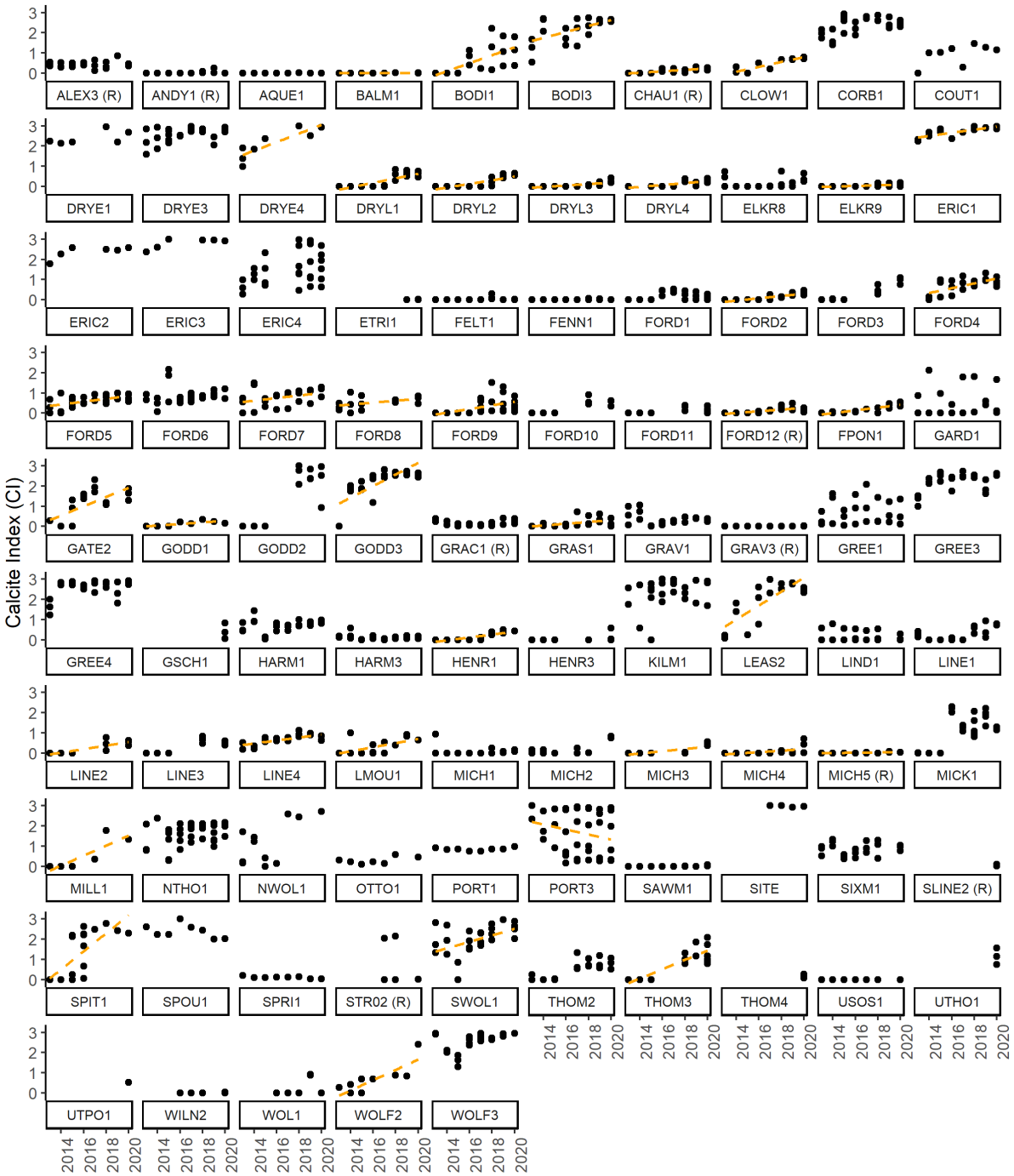
Trends were evaluated using Mann-Kendall non-parametric test.

Orange lines are trends significant at $p < 0.10$



Trends were evaluated using Mann-Kendall non-parametric test.

Orange lines are trends significant at $p < 0.10$



Trends were evaluated using Mann-Kendall non-parametric test.

Orange lines are trends significant at $p < 0.10$

Appendix 8. 2021 ANOVA results by reach.

Reach	df	p.value
ALEX3	8	0.00
ANDY1	8	0.26
AQUE3	4	0.51
BALM1	1	0.16
BODI1	7	0.00
BODI3	7	0.01
CHAU1	8	0.00
CLOW1	5	0.00
CORB1	8	0.00
CORB2	5	0.83
DRYE3	8	0.28
DRYL1	8	0.00
DRYL2	8	0.00
DRYL3	8	0.00
DRYL4	7	0.00
ELKR10	5	0.00
ELKR11	4	0.51
ELKR12	7	0.07
ELKR15	7	0.13
ELKR8	8	0.11
ELKR9	8	0.21
ERIC1	6	0.40
ERIC4	6	0.06
FELT1	8	0.01
FENN1	6	0.48
FORD1	8	0.00
FORD10	5	0.00
FORD11	5	0.03
FORD12	8	0.00
FORD2	7	0.00
FORD3	5	0.00
FORD4	7	0.00
FORD5	8	0.04
FORD6	8	0.01
FORD7	8	0.42
FORD8	5	0.46
FORD9a	8	0.00
FORD9b	3	0.73
FPON1	7	0.00
GARD1	8	1.00
GATE2	6	0.00
GODD3	8	0.00
GRAC1	8	0.02
GRAS1	8	0.22
GRAV1	8	0.04
GRAV2	4	0.08
GRAV3	8	0.51
GREE1	8	0.96

Reach	df	p.value
GREE3	8	0.00
GREE4	8	0.01
GSCH1	1	0.48
HARM1	8	0.00
HARM3	8	0.04
HARM4	4	0.27
HARM5	4	0.67
HENR1	8	0.00
HENR2	3	0.44
KILM1	8	0.61
LEAS2	7	0.00
LIND1	7	0.99
LINE1	8	0.00
LINE2	5	0.00
LINE3	5	0.00
LINE4	8	0.00
LMOU1	5	0.05
MICH1	8	0.54
MICH2	6	0.00
MICH3	5	0.00
MICH4	8	0.00
MICH5	8	0.01
MICK2	4	0.00
MILL2	2	0.99
NTHO1	8	0.00
NWOL1	2	0.36
PORT3a	5	0.90
PORT3b	8	0.90
SAWM1	5	0.35
SAWM2	6	0.59
SIXM1	7	0.28
SLINE2	7	0.02
SPIT1	3	0.02
SWOL1	7	0.00
THOM2	7	0.00
THOM3	6	0.00
THOM4	1	0.83
UTHO1	1	0.88
WILN2	4	0.54
WILS1	3	0.48
WOL1	5	0.00
WOLF2	1	0.59
WOLF3	8	0.00

Appendix 9. Calcite presence (Cp) and new calcite presence (Cp'), and associated calcite indices.

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2020	Cp	ALEX3	ALEX3-25	0.00	0.45	0.45
2020	Cp	ALEX3	ALEX3-50	0.00	0.41	0.41
2020	Cp	ALEX3	ALEX3-75	0.00	0.36	0.36
2020	Cp	ANDY1	ANDY1-25	0.00	0.00	0.00
2020	Cp	ANDY1	ANDY1-50	0.00	0.00	0.00
2020	Cp	ANDY1	ANDY1-75	0.00	0.00	0.00
2020	Cp	BALM1	BALM1-25	0.00	0.01	0.01
2020	Cp	BALM1	BALM1-50	0.00	0.02	0.02
2020	Cp	BALM1	BALM1-75	0.00	0.00	0.00
2020	Cp	BODI1	BODI1-25	0.08	0.29	0.37
2020	Cp	BODI1	BODI1-50	0.83	0.96	1.79
2020	Cp	BODI1	BODI1-75	0.45	0.69	1.14
2020	Cp	BODI3	BODI3-25	1.69	0.97	2.66
2020	Cp	BODI3	BODI3-50	1.64	0.99	2.63
2020	Cp	BODI3	BODI3-75	1.56	1.00	2.56
2020	Cp	CHAU1	CHAU1-25	0.00	0.15	0.15
2020	Cp	CHAU1	CHAU1-50	0.00	0.21	0.21
2020	Cp	CHAU1	CHAU1-75	0.00	0.27	0.27
2020	Cp	CORB1	CORB1-25	1.38	0.93	2.31
2020	Cp	CORB1	CORB1-50	1.66	0.95	2.61
2020	Cp	CORB1	CORB1-75	1.48	0.96	2.44
2020	Cp	DRYE3	DRYE3-25	1.93	1.00	2.93
2020	Cp	DRYE3	DRYE3-50	1.83	1.00	2.83
2020	Cp	DRYE3	DRYE3-75	1.71	1.00	2.71
2020	Cp	DRYL1	DRYL1-25	0.00	0.46	0.46
2020	Cp	DRYL1	DRYL1-50	0.00	0.76	0.76
2020	Cp	DRYL1	DRYL1-75	0.00	0.64	0.64
2020	Cp	DRYL2	DRYL2-25	0.00	0.60	0.60
2020	Cp	DRYL2	DRYL2-50	0.00	0.66	0.66
2020	Cp	DRYL2	DRYL2-75	0.00	0.54	0.54
2020	Cp	DRYL3	DRYL3-25	0.00	0.43	0.43
2020	Cp	DRYL3	DRYL3-50	0.00	0.20	0.20
2020	Cp	DRYL3	DRYL3-75	0.00	0.23	0.23
2020	Cp	DRYL4	DRYL4-25	0.00	0.39	0.39
2020	Cp	DRYL4	DRYL4-50	0.00	0.18	0.18
2020	Cp	DRYL4	DRYL4-75	0.00	0.32	0.32
2020	Cp	ELKR12	ELKR12-25	0.00	0.05	0.05
2020	Cp	ELKR12	ELKR12-50	0.00	0.00	0.00
2020	Cp	ELKR12	ELKR12-75	0.00	0.11	0.11
2020	Cp	ELKR15	ELKR15-25	0.00	0.00	0.00
2020	Cp	ELKR15	ELKR15-50	0.00	0.00	0.00
2020	Cp	ELKR15	ELKR15-75	0.00	0.00	0.00
2020	Cp	ELKR8	ELKR8-25	0.00	0.34	0.34
2020	Cp	ELKR8	ELKR8-50	0.00	0.66	0.66
2020	Cp	ELKR8	ELKR8-75	0.00	0.25	0.25
2020	Cp	ELKR9	ELKR9-25	0.00	0.01	0.01
2020	Cp	ELKR9	ELKR9-50	0.00	0.03	0.03

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2020	Cp	ELKR9	ELKR9-75	0.00	0.20	0.20
2020	Cp	FELT1	FELT1-25	0.00	0.01	0.01
2020	Cp	FELT1	FELT1-50	0.00	0.02	0.02
2020	Cp	FELT1	FELT1-75	0.00	0.00	0.00
2020	Cp	FPON1	FPON1-25	0.00	0.56	0.56
2020	Cp	FPON1	FPON1-50	0.00	0.53	0.53
2020	Cp	FPON1	FPON1-75	0.00	0.34	0.34
2020	Cp	FORD1	FORD1-25	0.00	0.15	0.15
2020	Cp	FORD1	FORD1-50	0.00	0.01	0.01
2020	Cp	FORD1	FORD1-75	0.00	0.27	0.27
2020	Cp	FORD10	FORD10-25	0.21	0.41	0.62
2020	Cp	FORD10	FORD10-50	0.00	0.35	0.35
2020	Cp	FORD10	FORD10-75	0.00	0.59	0.59
2020	Cp	FORD11	FORD11-25	0.00	0.36	0.36
2020	Cp	FORD11	FORD11-50	0.00	0.18	0.18
2020	Cp	FORD11	FORD11-75	0.00	0.00	0.00
2020	Cp	FORD12	FORD12-25	0.00	0.14	0.14
2020	Cp	FORD12	FORD12-50	0.00	0.25	0.25
2020	Cp	FORD12	FORD12-75	0.00	0.05	0.05
2020	Cp	FORD2	FORD2-25	0.00	0.24	0.24
2020	Cp	FORD2	FORD2-50	0.03	0.28	0.31
2020	Cp	FORD2	FORD2-75	0.13	0.33	0.46
2020	Cp	FORD3	FORD3-25	0.25	0.76	1.01
2020	Cp	FORD3	FORD3-50	0.03	0.73	0.76
2020	Cp	FORD3	FORD3-75	0.37	0.73	1.10
2020	Cp	FORD4	FORD4-12.5	0.14	0.99	1.13
2020	Cp	FORD4	FORD4-50	0.00	0.90	0.90
2020	Cp	FORD4	FORD4-62.5	0.00	0.66	0.66
2020	Cp	FORD4	FORD4-75	0.00	0.82	0.82
2020	Cp	FORD5	FORD5-12.5	0.00	0.71	0.71
2020	Cp	FORD5	FORD5-25	0.00	0.57	0.57
2020	Cp	FORD5	FORD5-50	0.01	0.94	0.95
2020	Cp	FORD5	FORD5-75	0.11	0.81	0.92
2020	Cp	FORD7	FORD7-25	0.22	0.97	1.19
2020	Cp	FORD7	FORD7-50	0.00	0.81	0.81
2020	Cp	FORD7	FORD7-75	0.28	1.00	1.28
2020	Cp	FORD8	FORD8-25	0.00	0.47	0.47
2020	Cp	FORD8	FORD8-50	0.00	0.76	0.76
2020	Cp	FORD8	FORD8-75	0.00	0.84	0.84
2020	Cp	FORD9	FORD9-12.5	0.02	0.53	0.55
2020	Cp	FORD9	FORD9-25	0.16	0.69	0.85
2020	Cp	FORD9	FORD9-37.5	0.11	0.46	0.57
2020	Cp	FORD9	FORD9-50	0.00	0.23	0.23
2020	Cp	FORD9	FORD9-62.5	0.00	0.36	0.36
2020	Cp	FORD9	FORD9-75	0.00	0.06	0.06
2020	Cp	GARD1	GARD1-25	0.65	1.00	1.65
2020	Cp	GARD1	GARD1-50	0.00	0.12	0.12

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2020	Cp	GARD1	GARD1-75	0.00	0.02	0.02
2020	Cp	GATE2	GATE2-25	0.42	0.87	1.29
2020	Cp	GATE2	GATE2-50	1.00	0.88	1.88
2020	Cp	GATE2	GATE2-75	0.78	0.87	1.65
2020	Cp	GODD2	GODD2-25	0.32	0.61	0.93
2020	Cp	GODD2	GODD2-50	1.96	1.00	2.96
2020	Cp	GODD2	GODD2-75	1.66	0.86	2.52
2020	Cp	GODD3	GODD3-25	1.65	0.91	2.56
2020	Cp	GODD3	GODD3-50	1.55	0.89	2.44
2020	Cp	GODD3	GODD3-75	1.72	0.92	2.64
2020	Cp	GRAC1	GRAC1-25	0.02	0.22	0.24
2020	Cp	GRAC1	GRAC1-50	0.00	0.38	0.38
2020	Cp	GRAC1	GRAC1-75	0.00	0.13	0.13
2020	Cp	GRAS1	GRAS1-25	0.04	0.36	0.40
2020	Cp	GRAS1	GRAS1-50	0.00	0.01	0.01
2020	Cp	GRAS1	GRAS1-75	0.01	0.10	0.11
2020	Cp	GRAV1	GRAV1-25	0.01	0.22	0.23
2020	Cp	GRAV1	GRAV1-50	0.02	0.37	0.39
2020	Cp	GRAV1	GRAV1-75	0.00	0.23	0.23
2020	Cp	GRAV3	GRAV3-25	0.00	0.00	0.00
2020	Cp	GRAV3	GRAV3-50	0.00	0.00	0.00
2020	Cp	GRAV3	GRAV3-75	0.00	0.02	0.02
2020	Cp	GREE1	GREE1-25	0.00	0.47	0.47
2020	Cp	GREE1	GREE1-50	0.00	0.11	0.11
2020	Cp	GREE1	GREE1-75	0.39	0.95	1.34
2020	Cp	GREE3	GREE3-12.5	1.60	1.00	2.60
2020	Cp	GREE3	GREE3-25	1.51	1.00	2.51
2020	Cp	GREE3	GREE3-37.5	1.63	0.99	2.62
2020	Cp	GREE3	GREE3-50	1.60	1.00	2.60
2020	Cp	GREE3	GREE3-62.5	1.54	0.99	2.53
2020	Cp	GREE3	GREE3-75	1.62	1.00	2.62
2020	Cp	GREE4	GREE4-25	1.92	1.00	2.92
2020	Cp	GREE4	GREE4-50	1.85	1.00	2.85
2020	Cp	GREE4	GREE4-75	1.76	0.98	2.74
2020	Cp	GSCH1	GSCH1-25	0.00	0.83	0.83
2020	Cp	GSCH1	GSCH1-50	0.00	0.36	0.36
2020	Cp	GSCH1	GSCH1-75	0.00	0.05	0.05
2020	Cp	HARM1	HARM1-25	0.04	0.76	0.80
2020	Cp	HARM1	HARM1-50	0.03	0.90	0.93
2020	Cp	HARM1	HARM1-75	0.02	0.95	0.97
2020	Cp	HARM3	HARM3-25	0.00	0.17	0.17
2020	Cp	HARM3	HARM3-50	0.00	0.05	0.05
2020	Cp	HARM3	HARM3-75	0.00	0.13	0.13
2020	Cp	HENR1	HENR1-25	0.23	0.97	1.20
2020	Cp	HENR1	HENR1-50	0.00	0.44	0.44
2020	Cp	HENR1	HENR1-75	0.00	0.44	0.44
2020	Cp	HENR3	HENR3-25	0.00	0.57	0.57

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2020	Cp	HENR3	HENR3-50	0.00	0.04	0.04
2020	Cp	HENR3	HENR3-75	0.00	0.00	0.00
2020	Cp	KILM1	KILM1-25	1.81	1.00	2.81
2020	Cp	KILM1	KILM1-50	1.91	0.99	2.90
2020	Cp	KILM1	KILM1-75	1.11	0.58	1.69
2020	Cp	LEAS2	LEAS2-18.2	1.59	1.00	2.59
2020	Cp	LEAS2	LEAS2-25	1.46	0.99	2.45
2020	Cp	LEAS2	LEAS2-9.1	1.33	1.00	2.33
2020	Cp	LIND1	LIND1-25	0.00	0.28	0.28
2020	Cp	LIND1	LIND1-50	0.00	0.04	0.04
2020	Cp	LIND1	LIND1-75	0.00	0.00	0.00
2020	Cp	LINE1	LINE1-25	0.00	0.76	0.76
2020	Cp	LINE1	LINE1-50	0.00	0.79	0.79
2020	Cp	LINE1	LINE1-75	0.00	0.73	0.73
2020	Cp	LINE2	LINE2-25	0.00	0.56	0.56
2020	Cp	LINE2	LINE2-50	0.02	0.61	0.63
2020	Cp	LINE2	LINE2-75	0.00	0.37	0.37
2020	Cp	LINE3	LINE3-25	0.00	0.43	0.43
2020	Cp	LINE3	LINE3-50	0.00	0.61	0.61
2020	Cp	LINE3	LINE3-75	0.00	0.39	0.39
2020	Cp	LINE4	LINE4-25	0.00	0.85	0.85
2020	Cp	LINE4	LINE4-50	0.00	0.62	0.62
2020	Cp	LINE4	LINE4-75	0.00	0.64	0.64
2020	Cp	MICH1	MICH1-25	0.00	0.16	0.16
2020	Cp	MICH1	MICH1-50	0.00	0.12	0.12
2020	Cp	MICH1	MICH1-75	0.00	0.08	0.08
2020	Cp	MICH2	MICH2-25	0.00	0.78	0.78
2020	Cp	MICH2	MICH2-50	0.00	0.83	0.83
2020	Cp	MICH2	MICH2-75	0.00	0.75	0.75
2020	Cp	MICH3	MICH3-25	0.00	0.38	0.38
2020	Cp	MICH3	MICH3-50	0.00	0.55	0.55
2020	Cp	MICH3	MICH3-75	0.00	0.41	0.41
2020	Cp	MICH4	MICH4-50	0.00	0.50	0.50
2020	Cp	MICH4	MICH4-75	0.00	0.44	0.44
2020	Cp	MICH5	MICH5-25	0.00	0.04	0.04
2020	Cp	MICH5	MICH5-50	0.00	0.03	0.03
2020	Cp	MICH5	MICH5-75	0.00	0.03	0.03
2020	Cp	NTHO1	NTHO1-12.5	1.33	0.81	2.14
2020	Cp	NTHO1	NTHO1-25	1.20	0.78	1.98
2020	Cp	NTHO1	NTHO1-37.5	1.30	0.79	2.09
2020	Cp	NTHO1	NTHO1-50	1.27	0.90	2.17
2020	Cp	NTHO1	NTHO1-62.5	1.15	0.96	2.11
2020	Cp	NTHO1	NTHO1-75	0.50	0.99	1.49
2020	Cp	PORT3a	PORT3a-12.5	0.00	0.33	0.33
2020	Cp	PORT3a	PORT3a-25	0.01	0.81	0.82
2020	Cp	PORT3a	PORT3a-37.5	0.00	0.28	0.28
2020	Cp	PORT3b	PORT3b-50	1.16	0.82	1.98

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2020	Cp	PORT3b	PORT3b-62.5	1.77	1.00	2.77
2020	Cp	PORT3b	PORT3b-75	1.91	1.00	2.91
2020	Cp	SIXM1	SIXM1-25	0.06	0.98	1.04
2020	Cp	SIXM1	SIXM1-50	0.00	0.77	0.77
2020	Cp	SIXM1	SIXM1-75	0.00	0.97	0.97
2020	Cp	SLINE2	SLINE2-25	0.00	0.11	0.11
2020	Cp	SLINE2	SLINE2-50	0.00	0.03	0.03
2020	Cp	SLINE2	SLINE2-75	0.00	0.02	0.02
2020	Cp	SWOL1	SWOL1-16	1.89	1.00	2.89
2020	Cp	SWOL1	SWOL1-25	1.58	0.92	2.50
2020	Cp	SWOL1	SWOL1-32.1	1.66	0.99	2.65
2020	Cp	SWOL1	SWOL1-7.5	1.22	0.81	2.03
2020	Cp	THOM2	THOM2-25	0.05	0.78	0.83
2020	Cp	THOM2	THOM2-50	0.00	0.52	0.52
2020	Cp	THOM2	THOM2-75	0.12	0.94	1.06
2020	Cp	THOM3	THOM3-12.5	0.74	1.00	1.74
2020	Cp	THOM3	THOM3-25	1.10	1.00	2.10
2020	Cp	THOM3	THOM3-37.5	0.19	0.79	0.98
2020	Cp	THOM3	THOM3-50	0.07	0.73	0.80
2020	Cp	THOM3	THOM3-62.5	0.22	0.94	1.16
2020	Cp	THOM3	THOM3-75	0.07	0.88	0.95
2020	Cp	THOM4	THOM4-25	0.00	0.27	0.27
2020	Cp	THOM4	THOM4-50	0.00	0.12	0.12
2020	Cp	THOM4	THOM4-75	0.00	0.09	0.09
2020	Cp	USOS1	USOS1-25	0.00	0.00	0.00
2020	Cp	USOS1	USOS1-50	0.00	0.00	0.00
2020	Cp	USOS1	USOS1-75	0.00	0.00	0.00
2020	Cp	UTHO1	UTHO1-25	0.23	0.91	1.14
2020	Cp	UTHO1	UTHO1-50	0.00	0.76	0.76
2020	Cp	UTHO1	UTHO1-75	0.61	0.95	1.56
2020	Cp	UTPO1	UTPO1-0	0.12	0.40	0.52
2020	Cp	WOLF3	WOLF3-25	1.94	1.00	2.94
2020	Cp	WOLF3	WOLF3-50	1.96	1.00	2.96
2020	Cp	WOLF3	WOLF3-75	1.94	1.00	2.94
2020	Cp'	ALEX3	ALEX3-25	0.00	0.09	0.09
2020	Cp'	ALEX3	ALEX3-50	0.00	0.08	0.08
2020	Cp'	ALEX3	ALEX3-75	0.00	0.05	0.05
2020	Cp'	ANDY1	ANDY1-25	0.00	0.00	0.00
2020	Cp'	ANDY1	ANDY1-50	0.00	0.00	0.00
2020	Cp'	ANDY1	ANDY1-75	0.00	0.00	0.00
2020	Cp'	BALM1	BALM1-25	0.00	0.00	0.00
2020	Cp'	BALM1	BALM1-50	0.00	0.00	0.00
2020	Cp'	BALM1	BALM1-75	0.00	0.00	0.00
2020	Cp'	BODI1	BODI1-25	0.08	0.24	0.32
2020	Cp'	BODI1	BODI1-50	0.83	0.95	1.78
2020	Cp'	BODI1	BODI1-75	0.45	0.64	1.09
2020	Cp'	BODI3	BODI3-25	1.69	0.93	2.62

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2020	Cp'	BODI3	BODI3-50	1.64	0.95	2.59
2020	Cp'	BODI3	BODI3-75	1.56	0.97	2.53
2020	Cp'	CHAU1	CHAU1-25	0.00	0.03	0.03
2020	Cp'	CHAU1	CHAU1-50	0.00	0.04	0.04
2020	Cp'	CHAU1	CHAU1-75	0.00	0.03	0.03
2020	Cp'	CORB1	CORB1-25	1.38	0.82	2.20
2020	Cp'	CORB1	CORB1-50	1.66	0.90	2.56
2020	Cp'	CORB1	CORB1-75	1.48	0.87	2.35
2020	Cp'	DRYE3	DRYE3-25	1.93	1.00	2.93
2020	Cp'	DRYE3	DRYE3-50	1.83	0.99	2.82
2020	Cp'	DRYE3	DRYE3-75	1.71	0.98	2.69
2020	Cp'	DRYL1	DRYL1-25	0.00	0.09	0.09
2020	Cp'	DRYL1	DRYL1-50	0.00	0.23	0.23
2020	Cp'	DRYL1	DRYL1-75	0.00	0.17	0.17
2020	Cp'	DRYL2	DRYL2-25	0.00	0.16	0.16
2020	Cp'	DRYL2	DRYL2-50	0.00	0.19	0.19
2020	Cp'	DRYL2	DRYL2-75	0.00	0.15	0.15
2020	Cp'	DRYL3	DRYL3-25	0.00	0.11	0.11
2020	Cp'	DRYL3	DRYL3-50	0.00	0.04	0.04
2020	Cp'	DRYL3	DRYL3-75	0.00	0.05	0.05
2020	Cp'	DRYL4	DRYL4-25	0.00	0.10	0.10
2020	Cp'	DRYL4	DRYL4-50	0.00	0.03	0.03
2020	Cp'	DRYL4	DRYL4-75	0.00	0.07	0.07
2020	Cp'	ELKR12	ELKR12-25	0.00	0.01	0.01
2020	Cp'	ELKR12	ELKR12-50	0.00	0.00	0.00
2020	Cp'	ELKR12	ELKR12-75	0.00	0.02	0.02
2020	Cp'	ELKR15	ELKR15-25	0.00	0.00	0.00
2020	Cp'	ELKR15	ELKR15-50	0.00	0.00	0.00
2020	Cp'	ELKR15	ELKR15-75	0.00	0.00	0.00
2020	Cp'	ELKR8	ELKR8-25	0.00	0.05	0.05
2020	Cp'	ELKR8	ELKR8-50	0.00	0.14	0.14
2020	Cp'	ELKR8	ELKR8-75	0.00	0.05	0.05
2020	Cp'	ELKR9	ELKR9-25	0.00	0.00	0.00
2020	Cp'	ELKR9	ELKR9-50	0.00	0.00	0.00
2020	Cp'	ELKR9	ELKR9-75	0.00	0.04	0.04
2020	Cp'	FELT1	FELT1-25	0.00	0.00	0.00
2020	Cp'	FELT1	FELT1-50	0.00	0.00	0.00
2020	Cp'	FELT1	FELT1-75	0.00	0.00	0.00
2020	Cp'	FPON1	FPON1-25	0.00	0.19	0.19
2020	Cp'	FPON1	FPON1-50	0.00	0.14	0.14
2020	Cp'	FPON1	FPON1-75	0.00	0.08	0.08
2020	Cp'	FORD1	FORD1-25	0.00	0.05	0.05
2020	Cp'	FORD1	FORD1-50	0.00	0.01	0.01
2020	Cp'	FORD1	FORD1-75	0.00	0.11	0.11
2020	Cp'	FORD10	FORD10-25	0.21	0.20	0.41
2020	Cp'	FORD10	FORD10-50	0.00	0.09	0.09
2020	Cp'	FORD10	FORD10-75	0.00	0.29	0.29

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2020	Cp'	FORD11	FORD11-25	0.00	0.14	0.14
2020	Cp'	FORD11	FORD11-50	0.00	0.04	0.04
2020	Cp'	FORD11	FORD11-75	0.00	0.00	0.00
2020	Cp'	FORD12	FORD12-25	0.00	0.04	0.04
2020	Cp'	FORD12	FORD12-50	0.00	0.06	0.06
2020	Cp'	FORD12	FORD12-75	0.00	0.01	0.01
2020	Cp'	FORD2	FORD2-25	0.00	0.09	0.09
2020	Cp'	FORD2	FORD2-50	0.03	0.17	0.20
2020	Cp'	FORD2	FORD2-75	0.13	0.14	0.27
2020	Cp'	FORD3	FORD3-25	0.25	0.47	0.72
2020	Cp'	FORD3	FORD3-50	0.03	0.39	0.42
2020	Cp'	FORD3	FORD3-75	0.37	0.36	0.73
2020	Cp'	FORD4	FORD4-12.5	0.14	0.47	0.61
2020	Cp'	FORD4	FORD4-50	0.00	0.44	0.44
2020	Cp'	FORD4	FORD4-62.5	0.00	0.34	0.34
2020	Cp'	FORD4	FORD4-75	0.00	0.31	0.31
2020	Cp'	FORD5	FORD5-12.5	0.00	0.33	0.33
2020	Cp'	FORD5	FORD5-25	0.00	0.21	0.21
2020	Cp'	FORD5	FORD5-50	0.01	0.47	0.48
2020	Cp'	FORD5	FORD5-75	0.11	0.54	0.65
2020	Cp'	FORD7	FORD7-25	0.22	0.66	0.88
2020	Cp'	FORD7	FORD7-50	0.00	0.38	0.38
2020	Cp'	FORD7	FORD7-75	0.28	0.87	1.15
2020	Cp'	FORD8	FORD8-25	0.00	0.16	0.16
2020	Cp'	FORD8	FORD8-50	0.00	0.36	0.36
2020	Cp'	FORD8	FORD8-75	0.00	0.33	0.33
2020	Cp'	FORD9	FORD9-12.5	0.02	0.15	0.17
2020	Cp'	FORD9	FORD9-25	0.16	0.22	0.38
2020	Cp'	FORD9	FORD9-37.5	0.11	0.15	0.26
2020	Cp'	FORD9	FORD9-50	0.00	0.06	0.06
2020	Cp'	FORD9	FORD9-62.5	0.00	0.10	0.10
2020	Cp'	FORD9	FORD9-75	0.00	0.02	0.02
2020	Cp'	GARD1	GARD1-25	0.65	0.79	1.44
2020	Cp'	GARD1	GARD1-50	0.00	0.02	0.02
2020	Cp'	GARD1	GARD1-75	0.00	0.00	0.00
2020	Cp'	GATE2	GATE2-25	0.42	0.51	0.93
2020	Cp'	GATE2	GATE2-50	1.00	0.66	1.66
2020	Cp'	GATE2	GATE2-75	0.78	0.60	1.38
2020	Cp'	GODD2	GODD2-25	0.32	0.32	0.64
2020	Cp'	GODD2	GODD2-50	1.96	0.99	2.95
2020	Cp'	GODD2	GODD2-75	1.66	0.85	2.51
2020	Cp'	GODD3	GODD3-25	1.65	0.86	2.51
2020	Cp'	GODD3	GODD3-50	1.55	0.83	2.38
2020	Cp'	GODD3	GODD3-75	1.72	0.89	2.61
2020	Cp'	GRAC1	GRAC1-25	0.02	0.05	0.07
2020	Cp'	GRAC1	GRAC1-50	0.00	0.08	0.08
2020	Cp'	GRAC1	GRAC1-75	0.00	0.02	0.02

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2020	Cp'	GRAS1	GRAS1-25	0.04	0.23	0.27
2020	Cp'	GRAS1	GRAS1-50	0.00	0.01	0.01
2020	Cp'	GRAS1	GRAS1-75	0.01	0.03	0.04
2020	Cp'	GRAV1	GRAV1-25	0.01	0.06	0.07
2020	Cp'	GRAV1	GRAV1-50	0.02	0.09	0.11
2020	Cp'	GRAV1	GRAV1-75	0.00	0.04	0.04
2020	Cp'	GRAV3	GRAV3-25	0.00	0.00	0.00
2020	Cp'	GRAV3	GRAV3-50	0.00	0.00	0.00
2020	Cp'	GRAV3	GRAV3-75	0.00	0.00	0.00
2020	Cp'	GREE1	GREE1-25	0.00	0.29	0.29
2020	Cp'	GREE1	GREE1-50	0.00	0.03	0.03
2020	Cp'	GREE1	GREE1-75	0.39	0.74	1.13
2020	Cp'	GREE3	GREE3-12.5	1.60	0.94	2.54
2020	Cp'	GREE3	GREE3-25	1.51	0.95	2.46
2020	Cp'	GREE3	GREE3-37.5	1.63	0.95	2.58
2020	Cp'	GREE3	GREE3-50	1.60	0.97	2.57
2020	Cp'	GREE3	GREE3-62.5	1.54	0.92	2.46
2020	Cp'	GREE3	GREE3-75	1.62	0.97	2.59
2020	Cp'	GREE4	GREE4-25	1.92	1.00	2.92
2020	Cp'	GREE4	GREE4-50	1.85	1.00	2.85
2020	Cp'	GREE4	GREE4-75	1.76	0.98	2.74
2020	Cp'	GSCH1	GSCH1-25	0.00	0.52	0.52
2020	Cp'	GSCH1	GSCH1-50	0.00	0.20	0.20
2020	Cp'	GSCH1	GSCH1-75	0.00	0.02	0.02
2020	Cp'	HARM1	HARM1-25	0.04	0.46	0.50
2020	Cp'	HARM1	HARM1-50	0.03	0.51	0.54
2020	Cp'	HARM1	HARM1-75	0.02	0.66	0.68
2020	Cp'	HARM3	HARM3-25	0.00	0.02	0.02
2020	Cp'	HARM3	HARM3-50	0.00	0.01	0.01
2020	Cp'	HARM3	HARM3-75	0.00	0.02	0.02
2020	Cp'	HENR1	HENR1-25	0.23	0.59	0.82
2020	Cp'	HENR1	HENR1-50	0.00	0.14	0.14
2020	Cp'	HENR1	HENR1-75	0.00	0.15	0.15
2020	Cp'	HENR3	HENR3-25	0.00	0.14	0.14
2020	Cp'	HENR3	HENR3-50	0.00	0.01	0.01
2020	Cp'	HENR3	HENR3-75	0.00	0.00	0.00
2020	Cp'	KILM1	KILM1-25	1.81	0.98	2.79
2020	Cp'	KILM1	KILM1-50	1.91	0.98	2.89
2020	Cp'	KILM1	KILM1-75	1.11	0.57	1.68
2020	Cp'	LEAS2	LEAS2-18.2	1.59	0.73	2.32
2020	Cp'	LEAS2	LEAS2-25	1.46	0.70	2.16
2020	Cp'	LEAS2	LEAS2-9.1	1.33	0.70	2.03
2020	Cp'	LIND1	LIND1-25	0.00	0.08	0.08
2020	Cp'	LIND1	LIND1-50	0.00	0.01	0.01
2020	Cp'	LIND1	LIND1-75	0.00	0.00	0.00
2020	Cp'	LINE1	LINE1-25	0.00	0.18	0.18
2020	Cp'	LINE1	LINE1-50	0.00	0.16	0.16

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2020	Cp'	LINE1	LINE1-75	0.00	0.19	0.19
2020	Cp'	LINE2	LINE2-25	0.00	0.11	0.11
2020	Cp'	LINE2	LINE2-50	0.02	0.14	0.16
2020	Cp'	LINE2	LINE2-75	0.00	0.05	0.05
2020	Cp'	LINE3	LINE3-25	0.00	0.09	0.09
2020	Cp'	LINE3	LINE3-50	0.00	0.17	0.17
2020	Cp'	LINE3	LINE3-75	0.00	0.08	0.08
2020	Cp'	LINE4	LINE4-25	0.00	0.58	0.58
2020	Cp'	LINE4	LINE4-50	0.00	0.21	0.21
2020	Cp'	LINE4	LINE4-75	0.00	0.29	0.29
2020	Cp'	MICH1	MICH1-25	0.00	0.03	0.03
2020	Cp'	MICH1	MICH1-50	0.00	0.02	0.02
2020	Cp'	MICH1	MICH1-75	0.00	0.01	0.01
2020	Cp'	MICH2	MICH2-25	0.00	0.18	0.18
2020	Cp'	MICH2	MICH2-50	0.00	0.21	0.21
2020	Cp'	MICH2	MICH2-75	0.00	0.15	0.15
2020	Cp'	MICH3	MICH3-25	0.00	0.06	0.06
2020	Cp'	MICH3	MICH3-50	0.00	0.10	0.10
2020	Cp'	MICH3	MICH3-75	0.00	0.05	0.05
2020	Cp'	MICH4	MICH4-50	0.00	0.07	0.07
2020	Cp'	MICH4	MICH4-75	0.00	0.08	0.08
2020	Cp'	MICH5	MICH5-25	0.00	0.00	0.00
2020	Cp'	MICH5	MICH5-50	0.00	0.01	0.01
2020	Cp'	MICH5	MICH5-75	0.00	0.00	0.00
2020	Cp'	NTHO1	NTHO1-12.5	1.33	0.70	2.03
2020	Cp'	NTHO1	NTHO1-25	1.20	0.68	1.88
2020	Cp'	NTHO1	NTHO1-37.5	1.30	0.79	2.09
2020	Cp'	NTHO1	NTHO1-50	1.27	0.90	2.17
2020	Cp'	NTHO1	NTHO1-62.5	1.15	0.91	2.06
2020	Cp'	NTHO1	NTHO1-75	0.50	0.90	1.40
2020	Cp'	PORT3a	PORT3a-12.5	0.00	0.08	0.08
2020	Cp'	PORT3a	PORT3a-25	0.01	0.26	0.27
2020	Cp'	PORT3a	PORT3a-37.5	0.00	0.13	0.13
2020	Cp'	PORT3b	PORT3b-50	1.16	0.78	1.94
2020	Cp'	PORT3b	PORT3b-62.5	1.77	1.00	2.77
2020	Cp'	PORT3b	PORT3b-75	1.91	1.00	2.91
2020	Cp'	SIXM1	SIXM1-25	0.06	0.81	0.87
2020	Cp'	SIXM1	SIXM1-50	0.00	0.31	0.31
2020	Cp'	SIXM1	SIXM1-75	0.00	0.86	0.86
2020	Cp'	SLINE2	SLINE2-25	0.00	0.02	0.02
2020	Cp'	SLINE2	SLINE2-50	0.00	0.01	0.01
2020	Cp'	SLINE2	SLINE2-75	0.00	0.00	0.00
2020	Cp'	SWOL1	SWOL1-16	1.89	1.00	2.89
2020	Cp'	SWOL1	SWOL1-25	1.58	0.90	2.48
2020	Cp'	SWOL1	SWOL1-32.1	1.66	0.98	2.64
2020	Cp'	SWOL1	SWOL1-7.5	1.22	0.81	2.03
2020	Cp'	THOM2	THOM2-25	0.05	0.15	0.20

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2020	Cp'	THOM2	THOM2-50	0.00	0.07	0.07
2020	Cp'	THOM2	THOM2-75	0.12	0.20	0.32
2020	Cp'	THOM3	THOM3-12.5	0.74	0.54	1.28
2020	Cp'	THOM3	THOM3-25	1.10	0.62	1.72
2020	Cp'	THOM3	THOM3-37.5	0.19	0.40	0.59
2020	Cp'	THOM3	THOM3-50	0.07	0.36	0.43
2020	Cp'	THOM3	THOM3-62.5	0.22	0.42	0.64
2020	Cp'	THOM3	THOM3-75	0.07	0.41	0.48
2020	Cp'	THOM4	THOM4-25	0.00	0.08	0.08
2020	Cp'	THOM4	THOM4-50	0.00	0.02	0.02
2020	Cp'	THOM4	THOM4-75	0.00	0.02	0.02
2020	Cp'	USOS1	USOS1-25	0.00	0.00	0.00
2020	Cp'	USOS1	USOS1-50	0.00	0.00	0.00
2020	Cp'	USOS1	USOS1-75	0.00	0.00	0.00
2020	Cp'	UTHO1	UTHO1-25	0.23	0.71	0.94
2020	Cp'	UTHO1	UTHO1-50	0.00	0.38	0.38
2020	Cp'	UTHO1	UTHO1-75	0.61	0.89	1.50
2020	Cp'	UTPO1	UTPO1-0	0.12	0.35	0.47
2020	Cp'	WOLF3	WOLF3-25	1.94	1.00	2.94
2020	Cp'	WOLF3	WOLF3-50	1.96	1.00	2.96
2020	Cp'	WOLF3	WOLF3-75	1.94	1.00	2.94
2021	Cp'	ALDR1	ALDR1-25	0.00	0.00	0.00
2021	Cp'	ALDR1	ALDR1-50	0.00	0.00	0.00
2021	Cp'	ALDR1	ALDR1-75	0.00	0.00	0.00
2021	Cp'	ALEX1	ALEX1-25	0.00	0.00	0.00
2021	Cp'	ALEX1	ALEX1-50	0.01	0.01	0.02
2021	Cp'	ALEX1	ALEX1-75	0.00	0.00	0.00
2021	Cp'	ALEX3	ALEX3-25	0.00	0.01	0.01
2021	Cp'	ALEX3	ALEX3-50	0.00	0.00	0.00
2021	Cp'	ALEX3	ALEX3-75	0.00	0.00	0.00
2021	Cp'	ALEX8	ALEX8-25	0.00	0.00	0.00
2021	Cp'	ALEX8	ALEX8-50	0.00	0.00	0.00
2021	Cp'	ALEX8	ALEX8-75	0.00	0.00	0.00
2021	Cp'	ANDY1	ANDY1-25	0.00	0.00	0.00
2021	Cp'	ANDY1	ANDY1-50	0.00	0.00	0.00
2021	Cp'	ANDY1	ANDY1-75	0.00	0.02	0.02
2021	Cp'	AQUE1	AQUE1-0	0.00	0.00	0.00
2021	Cp'	AQUE2	AQUE2-0	0.00	0.00	0.00
2021	Cp'	AQUE2	AQUE2-50	0.00	0.00	0.00
2021	Cp'	AQUE3	AQUE3-25	0.00	0.00	0.00
2021	Cp'	AQUE3	AQUE3-50	0.00	0.02	0.02
2021	Cp'	AQUE3	AQUE3-75	0.00	0.17	0.17
2021	Cp'	BALM1	BALM1-25	0.00	0.00	0.00
2021	Cp'	BALM1	BALM1-50	0.00	0.00	0.00
2021	Cp'	BALM1	BALM1-75	0.00	0.00	0.00
2021	Cp'	BING1	BING1-25	0.00	0.00	0.00
2021	Cp'	BING1	BING1-50	0.00	0.00	0.00

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2021	Cp'	BING1	BING1-75	0.00	0.00	0.00
2021	Cp'	BODI1	BODI1-25	0.00	0.42	0.42
2021	Cp'	BODI1	BODI1-50	0.88	0.99	1.87
2021	Cp'	BODI1	BODI1-75	0.18	1.00	1.18
2021	Cp'	BODI3	BODI3-25	1.48	0.99	2.47
2021	Cp'	BODI3	BODI3-50	1.35	0.96	2.31
2021	Cp'	BODI3	BODI3-75	1.81	1.00	2.81
2021	Cp'	CHAU1	CHAU1-25	0.00	0.02	0.02
2021	Cp'	CHAU1	CHAU1-50	0.01	0.03	0.04
2021	Cp'	CHAU1	CHAU1-75	0.00	0.06	0.06
2021	Cp'	COUT1	COUT1-0	0.48	0.73	1.21
2021	Cp'	CLOW1	CLOW1-0	0.00	0.50	0.50
2021	Cp'	CLOW1	CLOW1-50	0.00	0.18	0.18
2021	Cp'	CORB1	CORB1-25	1.70	1.00	2.70
2021	Cp'	CORB1	CORB1-50	1.79	1.00	2.79
2021	Cp'	CORB1	CORB1-75	1.67	1.00	2.67
2021	Cp'	CORB2	CORB2-25	1.90	1.00	2.90
2021	Cp'	CORB2	CORB2-50	1.99	1.00	2.99
2021	Cp'	CORB2	CORB2-75	1.98	1.00	2.98
2021	Cp'	DRIN1	DRIN1-25	0.00	0.00	0.00
2021	Cp'	DRIN1	DRIN1-50	0.00	0.00	0.00
2021	Cp'	DRIN1	DRIN1-75	0.00	0.00	0.00
2021	Cp'	DRYE1	DRYE1-0	1.52	1.00	2.52
2021	Cp'	DRYE3	DRYE3-25	1.90	1.00	2.90
2021	Cp'	DRYE3	DRYE3-50	1.78	0.96	2.74
2021	Cp'	DRYE3	DRYE3-75	1.34	0.86	2.20
2021	Cp'	DRYE4	DRYE4-25	1.57	0.98	2.55
2021	Cp'	DRYL1	DRYL1-25	0.00	0.18	0.18
2021	Cp'	DRYL1	DRYL1-50	0.00	0.29	0.29
2021	Cp'	DRYL1	DRYL1-75	0.00	0.14	0.14
2021	Cp'	DRYL2	DRYL2-25	0.00	0.20	0.20
2021	Cp'	DRYL2	DRYL2-50	0.00	0.19	0.19
2021	Cp'	DRYL2	DRYL2-75	0.00	0.19	0.19
2021	Cp'	DRYL3	DRYL3-25	0.00	0.14	0.14
2021	Cp'	DRYL3	DRYL3-50	0.00	0.06	0.06
2021	Cp'	DRYL3	DRYL3-75	0.00	0.05	0.05
2021	Cp'	DRYL4	DRYL4-25	0.00	0.13	0.13
2021	Cp'	DRYL4	DRYL4-50	0.00	0.03	0.03
2021	Cp'	DRYL4	DRYL4-75	0.00	0.10	0.10
2021	Cp'	ETRI1	ETRI1-0	0.00	0.00	0.00
2021	Cp'	ETRI1	ETRI1-50	0.00	0.00	0.00
2021	Cp'	ELKR10	ELKR10-25	0.00	0.01	0.01
2021	Cp'	ELKR10	ELKR10-50	0.00	0.04	0.04
2021	Cp'	ELKR10	ELKR10-75	0.00	0.08	0.08
2021	Cp'	ELKR11	ELKR11-25	0.00	0.22	0.22
2021	Cp'	ELKR11	ELKR11-50	0.00	0.00	0.00
2021	Cp'	ELKR11	ELKR11-75	0.00	0.00	0.00

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2021	Cp'	ELKR12	ELKR12-25	0.00	0.00	0.00
2021	Cp'	ELKR12	ELKR12-50	0.00	0.00	0.00
2021	Cp'	ELKR12	ELKR12-75	0.00	0.00	0.00
2021	Cp'	ELKR15	ELKR15-25	0.00	0.00	0.00
2021	Cp'	ELKR15	ELKR15-50	0.00	0.00	0.00
2021	Cp'	ELKR15	ELKR15-75	0.00	0.00	0.00
2021	Cp'	ELKR8	ELKR8-25	0.00	0.03	0.03
2021	Cp'	ELKR8	ELKR8-50	0.00	0.00	0.00
2021	Cp'	ELKR8	ELKR8-75	0.00	0.08	0.08
2021	Cp'	ELKR9	ELKR9-25	0.00	0.03	0.03
2021	Cp'	ELKR9	ELKR9-50	0.00	0.02	0.02
2021	Cp'	ELKR9	ELKR9-75	0.00	0.00	0.00
2021	Cp'	ERIC1	ERIC1-0	1.43	1.00	2.43
2021	Cp'	ERIC1	ERIC1-50	1.98	1.00	2.98
2021	Cp'	ERIC2	ERIC2-0	1.91	0.96	2.87
2021	Cp'	ERIC3	ERIC3-0	1.94	1.00	2.94
2021	Cp'	ERIC4	ERIC4-25	1.75	0.94	2.69
2021	Cp'	ERIC4	ERIC4-50	0.04	0.41	0.45
2021	Cp'	ERIC4	ERIC4-75	0.00	0.12	0.12
2021	Cp'	EWIN1	EWIN1-25	0.00	0.08	0.08
2021	Cp'	EWIN1	EWIN1-50	0.00	0.07	0.07
2021	Cp'	EWIN1	EWIN1-75	0.00	0.02	0.02
2021	Cp'	FELT1	FELT1-25	0.00	0.00	0.00
2021	Cp'	FELT1	FELT1-50	0.00	0.00	0.00
2021	Cp'	FELT1	FELT1-75	0.00	0.00	0.00
2021	Cp'	FENN1	FENN1-50	0.00	0.00	0.00
2021	Cp'	FPON1	FPON1-25	0.00	0.16	0.16
2021	Cp'	FPON1	FPON1-50	0.00	0.16	0.16
2021	Cp'	FPON1	FPON1-75	0.00	0.07	0.07
2021	Cp'	FORD1	FORD1-25	0.00	0.11	0.11
2021	Cp'	FORD1	FORD1-50	0.01	0.19	0.20
2021	Cp'	FORD1	FORD1-75	0.00	0.18	0.18
2021	Cp'	FORD10	FORD10-25	0.00	0.06	0.06
2021	Cp'	FORD10	FORD10-50	0.00	0.06	0.06
2021	Cp'	FORD10	FORD10-75	0.00	0.22	0.22
2021	Cp'	FORD10	FORD10-86	0.00	0.25	0.25
2021	Cp'	FORD10	FORD10-89	0.00	0.07	0.07
2021	Cp'	FORD11	FORD11-25	0.00	0.05	0.05
2021	Cp'	FORD11	FORD11-50	0.00	0.02	0.02
2021	Cp'	FORD11	FORD11-75	0.00	0.00	0.00
2021	Cp'	FORD12	FORD12-25	0.00	0.05	0.05
2021	Cp'	FORD12	FORD12-50	0.00	0.04	0.04
2021	Cp'	FORD12	FORD12-75	0.00	0.02	0.02
2021	Cp'	FORD2	FORD2-25	0.00	0.31	0.31
2021	Cp'	FORD2	FORD2-50	0.12	0.46	0.58
2021	Cp'	FORD2	FORD2-75	0.39	0.71	1.10
2021	Cp'	FORD3	FORD3-25	0.08	0.57	0.65

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2021	Cp'	FORD3	FORD3-50	0.10	0.23	0.33
2021	Cp'	FORD3	FORD3-75	0.35	0.25	0.60
2021	Cp'	FORD4	FORD4-25	0.18	0.90	1.08
2021	Cp'	FORD4	FORD4-50	0.01	0.77	0.78
2021	Cp'	FORD5	FORD5-12.5	0.00	0.46	0.46
2021	Cp'	FORD5	FORD5-25	0.16	0.49	0.65
2021	Cp'	FORD5	FORD5-50	0.00	0.72	0.72
2021	Cp'	FORD5	FORD5-75	0.16	0.36	0.52
2021	Cp'	FORD6	FORD6-25	0.24	0.36	0.60
2021	Cp'	FORD6	FORD6-50	0.87	0.74	1.61
2021	Cp'	FORD6	FORD6-75	0.12	0.46	0.58
2021	Cp'	FORD7	FORD7-25	0.19	0.81	1.00
2021	Cp'	FORD7	FORD7-50	0.14	0.54	0.68
2021	Cp'	FORD7	FORD7-75	0.15	0.81	0.96
2021	Cp'	FORD8	FORD8-25	0.00	0.25	0.25
2021	Cp'	FORD8	FORD8-50	0.00	0.47	0.47
2021	Cp'	FORD8	FORD8-75	0.00	0.49	0.49
2021	Cp'	FORD9a	FORD9a-12.5	0.03	0.08	0.11
2021	Cp'	FORD9a	FORD9a-25	0.19	0.22	0.41
2021	Cp'	FORD9a	FORD9a-37.5	0.19	0.15	0.34
2021	Cp'	FORD9a	FORD9a-50	0.02	0.09	0.11
2021	Cp'	FORD9b	FORD9b-62.5	0.00	0.02	0.02
2021	Cp'	FORD9b	FORD9b-75	0.00	0.02	0.02
2021	Cp'	FORS1	FORS1-25	0.00	0.00	0.00
2021	Cp'	FORS1	FORS1-50	0.00	0.00	0.00
2021	Cp'	FORS1	FORS1-75	0.00	0.00	0.00
2021	Cp'	GARD1	GARD1-25	1.17	0.78	1.95
2021	Cp'	GARD1	GARD1-50	0.00	0.00	0.00
2021	Cp'	GARD1	GARD1-75	0.00	0.00	0.00
2021	Cp'	GATE2	GATE2-25	0.22	0.46	0.68
2021	Cp'	GATE2	GATE2-50	0.82	0.80	1.62
2021	Cp'	GATE2	GATE2-75	0.56	0.70	1.26
2021	Cp'	GODD1	GODD1-0	0.00	0.01	0.01
2021	Cp'	GODD3	GODD3-25	1.82	0.91	2.73
2021	Cp'	GODD3	GODD3-50	1.90	0.95	2.85
2021	Cp'	GODD3	GODD3-75	1.77	0.90	2.67
2021	Cp'	GRAC1	GRAC1-25	0.00	0.04	0.04
2021	Cp'	GRAC1	GRAC1-50	0.00	0.04	0.04
2021	Cp'	GRAC1	GRAC1-75	0.00	0.01	0.01
2021	Cp'	GRAS1	GRAS1-25	0.00	0.17	0.17
2021	Cp'	GRAS1	GRAS1-50	0.00	0.04	0.04
2021	Cp'	GRAS1	GRAS1-75	0.00	0.01	0.01
2021	Cp'	GRAV1	GRAV1-25	0.00	0.01	0.01
2021	Cp'	GRAV1	GRAV1-50	0.01	0.03	0.04
2021	Cp'	GRAV1	GRAV1-75	0.00	0.04	0.04
2021	Cp'	GRAV2	GRAV2-25	0.00	0.01	0.01
2021	Cp'	GRAV2	GRAV2-50	0.00	0.02	0.02

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2021	Cp'	GRAV2	GRAV2-75	0.00	0.00	0.00
2021	Cp'	GRAV3	GRAV3-25	0.00	0.00	0.00
2021	Cp'	GRAV3	GRAV3-50	0.00	0.00	0.00
2021	Cp'	GRAV3	GRAV3-75	0.00	0.00	0.00
2021	Cp'	GREE1	GREE1-25	0.05	0.59	0.64
2021	Cp'	GREE1	GREE1-50	0.00	0.13	0.13
2021	Cp'	GREE1	GREE1-75	0.18	0.50	0.68
2021	Cp'	GREE3	GREE3-25	1.44	0.90	2.34
2021	Cp'	GREE3	GREE3-50	1.87	0.98	2.85
2021	Cp'	GREE3	GREE3-75	1.72	0.97	2.69
2021	Cp'	GREE4	GREE4-25	1.63	0.92	2.55
2021	Cp'	GREE4	GREE4-50	1.79	1.00	2.79
2021	Cp'	GREE4	GREE4-75	1.68	0.98	2.66
2021	Cp'	GSCH1	GSCH1-25	0.00	0.62	0.62
2021	Cp'	GSCH1	GSCH1-50	0.00	0.56	0.56
2021	Cp'	GSCH1	GSCH1-75	0.00	0.10	0.10
2021	Cp'	HARM1	HARM1-25	0.00	0.21	0.21
2021	Cp'	HARM1	HARM1-50	0.00	0.30	0.30
2021	Cp'	HARM1	HARM1-75	0.00	0.28	0.28
2021	Cp'	HARM3	HARM3-25	0.00	0.01	0.01
2021	Cp'	HARM3	HARM3-50	0.00	0.01	0.01
2021	Cp'	HARM3	HARM3-75	0.00	0.00	0.00
2021	Cp'	HARM4	HARM4-25	0.00	0.01	0.01
2021	Cp'	HARM4	HARM4-50	0.00	0.04	0.04
2021	Cp'	HARM4	HARM4-75	0.00	0.09	0.09
2021	Cp'	HARM5	HARM5-25	0.00	0.18	0.18
2021	Cp'	HARM5	HARM5-50	0.00	0.09	0.09
2021	Cp'	HARM5	HARM5-75	0.00	0.00	0.00
2021	Cp'	HART2	HART2-25	0.00	0.00	0.00
2021	Cp'	HART2	HART2-50	0.00	0.01	0.01
2021	Cp'	HART2	HART2-75	0.00	0.00	0.00
2021	Cp'	HENR1	HENR1-25	0.00	0.32	0.32
2021	Cp'	HENR1	HENR1-50	0.00	0.14	0.14
2021	Cp'	HENR1	HENR1-75	0.00	0.14	0.14
2021	Cp'	HENR2	HENR2-25	0.00	0.01	0.01
2021	Cp'	HENR2	HENR2-50	0.00	0.00	0.00
2021	Cp'	HENR2	HENR2-75	0.00	0.00	0.00
2021	Cp'	HENR3	HENR3-25	0.00	0.00	0.00
2021	Cp'	HENR3	HENR3-50	0.00	0.00	0.00
2021	Cp'	HENR3	HENR3-75	0.00	0.00	0.00
2021	Cp'	KILM1	KILM1-25	1.97	1.00	2.97
2021	Cp'	KILM1	KILM1-50	1.80	0.96	2.76
2021	Cp'	KILM1	KILM1-75	0.78	0.42	1.20
2021	Cp'	LMOU1	LMOU1-0	0.00	0.34	0.34
2021	Cp'	RG_LE1	RG_LE1-25	0.00	0.00	0.00
2021	Cp'	RG_LE1	RG_LE1-50	0.00	0.02	0.02
2021	Cp'	RG_LE1	RG_LE1-75	0.00	0.00	0.00

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2021	Cp'	LEAS2	LEAS2-18.2	1.99	1.00	2.99
2021	Cp'	LEAS2	LEAS2-25	1.43	1.00	2.43
2021	Cp'	LEAS2	LEAS2-9.1	1.65	0.99	2.64
2021	Cp'	LIND1	LIND1-25	0.00	0.03	0.03
2021	Cp'	LIND1	LIND1-50	0.00	0.00	0.00
2021	Cp'	LIND1	LIND1-75	0.00	0.00	0.00
2021	Cp'	LINE1	LINE1-25	0.00	0.07	0.07
2021	Cp'	LINE1	LINE1-50	0.01	0.11	0.12
2021	Cp'	LINE1	LINE1-75	0.01	0.15	0.16
2021	Cp'	LINE2	LINE2-25	0.00	0.08	0.08
2021	Cp'	LINE2	LINE2-50	0.00	0.06	0.06
2021	Cp'	LINE2	LINE2-75	0.00	0.05	0.05
2021	Cp'	LINE3	LINE3-25	0.00	0.04	0.04
2021	Cp'	LINE3	LINE3-50	0.00	0.11	0.11
2021	Cp'	LINE3	LINE3-75	0.00	0.09	0.09
2021	Cp'	LINE4	LINE4-25	0.00	0.80	0.80
2021	Cp'	LINE4	LINE4-50	0.00	0.63	0.63
2021	Cp'	LINE4	LINE4-75	0.00	0.45	0.45
2021	Cp'	LINE7	LINE7-50	0.00	0.00	0.00
2021	Cp'	LINE7	LINE7-75	0.00	0.00	0.00
2021	Cp'	LIVE1	LIVE1-0	1.55	0.97	2.52
2021	Cp'	LIZA1	LIZA1-25	0.00	0.04	0.04
2021	Cp'	LIZA1	LIZA1-50	0.00	0.02	0.02
2021	Cp'	LIZA1	LIZA1-75	0.00	0.00	0.00
2021	Cp'	MCOO1	MCOO1-25	0.15	0.15	0.30
2021	Cp'	MCOO1	MCOO1-50	0.00	0.01	0.01
2021	Cp'	MCOO1	MCOO1-75	0.00	0.01	0.01
2021	Cp'	MICH1	MICH1-25	0.00	0.01	0.01
2021	Cp'	MICH1	MICH1-50	0.00	0.00	0.00
2021	Cp'	MICH1	MICH1-75	0.00	0.00	0.00
2021	Cp'	MICH2	MICH2-25	0.00	0.01	0.01
2021	Cp'	MICH2	MICH2-50	0.00	0.08	0.08
2021	Cp'	MICH2	MICH2-75	0.00	0.08	0.08
2021	Cp'	MICH3	MICH3-25	0.00	0.00	0.00
2021	Cp'	MICH3	MICH3-50	0.00	0.01	0.01
2021	Cp'	MICH3	MICH3-75	0.00	0.00	0.00
2021	Cp'	MICH4	MICH4-25	0.00	0.03	0.03
2021	Cp'	MICH4	MICH4-50	0.00	0.01	0.01
2021	Cp'	MICH4	MICH4-75	0.00	0.03	0.03
2021	Cp'	MICH5	MICH5-25	0.00	0.02	0.02
2021	Cp'	MICH5	MICH5-50	0.00	0.01	0.01
2021	Cp'	MICH5	MICH5-75	0.00	0.00	0.00
2021	Cp'	MICK1	MICK1-75	0.37	0.48	0.85
2021	Cp'	MICK2	MICK2-25	0.48	0.68	1.16
2021	Cp'	MICK2	MICK2-50	0.87	0.85	1.72
2021	Cp'	MICK2	MICK2-75	0.80	0.67	1.47
2021	Cp'	MILL2	MILL2-0	1.19	0.99	2.18

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2021	Cp'	MORI1	MORI1-25	0.00	0.00	0.00
2021	Cp'	MORI1	MORI1-50	0.00	0.00	0.00
2021	Cp'	MORI1	MORI1-75	0.00	0.00	0.00
2021	Cp'	NTHO1	NTHO1-25	0.37	0.88	1.25
2021	Cp'	NTHO1	NTHO1-50	1.41	0.91	2.32
2021	Cp'	NTHO1	NTHO1-75	1.24	1.00	2.24
2021	Cp'	WILN2	WILN2-25	0.00	0.00	0.00
2021	Cp'	WILN2	WILN2-50	0.00	0.00	0.00
2021	Cp'	NWOL1	NWOL1-25	1.68	0.96	2.64
2021	Cp'	OTTO1	OTTO1-0	0.01	0.27	0.28
2021	Cp'	PORT1	PORT1-0	0.00	0.81	0.81
2021	Cp'	PORT3a	PORT3a-12.5	0.00	0.11	0.11
2021	Cp'	PORT3a	PORT3a-25	0.02	0.44	0.46
2021	Cp'	PORT3a	PORT3a-37.5	0.00	0.05	0.05
2021	Cp'	PORT3b	PORT3b-50	0.73	0.73	1.46
2021	Cp'	PORT3b	PORT3b-62.5	1.41	1.00	2.41
2021	Cp'	PORT3b	PORT3b-75	1.73	0.97	2.70
2021	Cp'	UCWE1	UCWE1-25	0.00	0.00	0.00
2021	Cp'	UCWE1	UCWE1-50	0.00	0.00	0.00
2021	Cp'	UCWE1	UCWE1-75	0.00	0.00	0.00
2021	Cp'	SAWM1	SAWM1-0	0.00	0.00	0.00
2021	Cp'	SAWM1	SAWM1-50	0.00	0.00	0.00
2021	Cp'	SAWM2	SAWM2-25	0.00	0.00	0.00
2021	Cp'	SAWM2	SAWM2-50	0.00	0.00	0.00
2021	Cp'	SITE	SITE-18	1.49	1.00	2.49
2021	Cp'	SIXM1	SIXM1-25	0.10	0.37	0.47
2021	Cp'	SIXM1	SIXM1-50	0.00	0.06	0.06
2021	Cp'	SIXM1	SIXM1-75	0.06	0.29	0.35
2021	Cp'	SPOU1	SPOU1-0	1.35	1.00	2.35
2021	Cp'	SLINE2	SLINE2-25	0.00	0.08	0.08
2021	Cp'	SLINE2	SLINE2-50	0.00	0.06	0.06
2021	Cp'	SLINE2	SLINE2-75	0.00	0.00	0.00
2021	Cp'	SPIT1	SPIT1-0	1.15	1.00	2.15
2021	Cp'	WILS1	WILS1-25	0.00	0.00	0.00
2021	Cp'	WILS1	WILS1-50	0.10	0.15	0.25
2021	Cp'	SWOL1	SWOL1-25	1.63	0.94	2.57
2021	Cp'	SWOL1	SWOL1-32.1	1.65	0.94	2.59
2021	Cp'	SWOL1	SWOL1-7.5	1.18	0.75	1.93
2021	Cp'	SPRI1	SPRI1-0	0.00	0.00	0.00
2021	Cp'	STRO2	STRO2-50	0.00	0.33	0.33
2021	Cp'	STRO2	STRO2-75	0.00	0.00	0.00
2021	Cp'	STR14	STR14-25	0.00	0.33	0.33
2021	Cp'	THOM2	THOM2-25	0.08	0.35	0.43
2021	Cp'	THOM2	THOM2-50	0.24	0.48	0.72
2021	Cp'	THOM2	THOM2-75	0.26	0.48	0.74
2021	Cp'	THOM3	THOM3-25	1.03	0.68	1.71
2021	Cp'	THOM3	THOM3-50	0.88	0.73	1.61

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2021	Cp'	THOM3	THOM3-75	1.02	0.70	1.72
2021	Cp'	THOM4	THOM4-25	0.00	0.08	0.08
2021	Cp'	THOM4	THOM4-50	0.00	0.02	0.02
2021	Cp'	THOM4	THOM4-75	0.00	0.00	0.00
2021	Cp'	TODH1	TODH1-25	0.00	0.02	0.02
2021	Cp'	TODH1	TODH1-50	0.00	0.02	0.02
2021	Cp'	TODH1	TODH1-75	0.00	0.03	0.03
2021	Cp'	USOS1	USOS1-25	0.00	0.00	0.00
2021	Cp'	USOS1	USOS1-50	0.00	0.00	0.00
2021	Cp'	USOS1	USOS1-75	0.00	0.00	0.00
2021	Cp'	UTHO1	UTHO1-25	0.56	0.50	1.06
2021	Cp'	UTHO1	UTHO1-50	0.19	0.42	0.61
2021	Cp'	UTHO1	UTHO1-75	1.12	0.97	2.09
2021	Cp'	UTPO1	UTPO1-0	0.00	0.35	0.35
2021	Cp'	WEIG1	WEIG1-25	0.00	0.01	0.01
2021	Cp'	WEIG1	WEIG1-50	0.00	0.01	0.01
2021	Cp'	WEIG1	WEIG1-75	0.00	0.00	0.00
2021	Cp'	WOL1	WOL1-25	0.00	0.01	0.01
2021	Cp'	WOL1	WOL1-50	0.00	0.02	0.02
2021	Cp'	WOLF2	WOLF2-75	1.81	0.99	2.80
2021	Cp'	WOLF3	WOLF3-25	1.98	1.00	2.98
2021	Cp'	WOLF3	WOLF3-50	1.80	1.00	2.80
2021	Cp'	WOLF3	WOLF3-75	1.95	1.00	2.95
2021	Cp	ALDR1	ALDR1-25	0.00	0.00	0.00
2021	Cp	ALDR1	ALDR1-50	0.00	0.00	0.00
2021	Cp	ALDR1	ALDR1-75	0.00	0.00	0.00
2021	Cp	ALEX1	ALEX1-25	0.00	0.01	0.01
2021	Cp	ALEX1	ALEX1-50	0.01	0.06	0.07
2021	Cp	ALEX1	ALEX1-75	0.00	0.00	0.00
2021	Cp	ALEX3	ALEX3-25	0.00	0.02	0.02
2021	Cp	ALEX3	ALEX3-50	0.00	0.01	0.01
2021	Cp	ALEX3	ALEX3-75	0.00	0.00	0.00
2021	Cp	ALEX8	ALEX8-25	0.00	0.00	0.00
2021	Cp	ALEX8	ALEX8-50	0.00	0.00	0.00
2021	Cp	ALEX8	ALEX8-75	0.00	0.00	0.00
2021	Cp	ANDY1	ANDY1-25	0.00	0.01	0.01
2021	Cp	ANDY1	ANDY1-50	0.00	0.03	0.03
2021	Cp	ANDY1	ANDY1-75	0.00	0.11	0.11
2021	Cp	AQUE1	AQUE1-0	0.00	0.01	0.01
2021	Cp	AQUE2	AQUE2-0	0.00	0.00	0.00
2021	Cp	AQUE2	AQUE2-50	0.00	0.00	0.00
2021	Cp	AQUE3	AQUE3-25	0.00	0.00	0.00
2021	Cp	AQUE3	AQUE3-50	0.00	0.04	0.04
2021	Cp	AQUE3	AQUE3-75	0.00	0.69	0.69
2021	Cp	BALM1	BALM1-25	0.00	0.00	0.00
2021	Cp	BALM1	BALM1-50	0.00	0.00	0.00
2021	Cp	BALM1	BALM1-75	0.00	0.00	0.00

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2021	Cp	BING1	BING1-25	0.00	0.00	0.00
2021	Cp	BING1	BING1-50	0.00	0.01	0.01
2021	Cp	BING1	BING1-75	0.00	0.03	0.03
2021	Cp	BODI1	BODI1-25	0.00	0.60	0.60
2021	Cp	BODI1	BODI1-50	0.88	1.00	1.88
2021	Cp	BODI1	BODI1-75	0.18	1.00	1.18
2021	Cp	BODI3	BODI3-25	1.48	1.00	2.48
2021	Cp	BODI3	BODI3-50	1.35	1.00	2.35
2021	Cp	BODI3	BODI3-75	1.81	1.00	2.81
2021	Cp	CHAU1	CHAU1-25	0.00	0.13	0.13
2021	Cp	CHAU1	CHAU1-50	0.01	0.16	0.17
2021	Cp	CHAU1	CHAU1-75	0.00	0.25	0.25
2021	Cp	COUT1	COUT1-0	0.48	0.86	1.34
2021	Cp	CLOW1	CLOW1-0	0.00	0.80	0.80
2021	Cp	CLOW1	CLOW1-50	0.00	0.62	0.62
2021	Cp	CORB1	CORB1-25	1.70	1.00	2.70
2021	Cp	CORB1	CORB1-50	1.79	1.00	2.79
2021	Cp	CORB1	CORB1-75	1.67	1.00	2.67
2021	Cp	CORB2	CORB2-25	1.90	1.00	2.90
2021	Cp	CORB2	CORB2-50	1.99	1.00	2.99
2021	Cp	CORB2	CORB2-75	1.98	1.00	2.98
2021	Cp	DRIN1	DRIN1-25	0.00	0.00	0.00
2021	Cp	DRIN1	DRIN1-50	0.00	0.00	0.00
2021	Cp	DRIN1	DRIN1-75	0.00	0.00	0.00
2021	Cp	DRYE1	DRYE1-0	1.52	1.00	2.52
2021	Cp	DRYE3	DRYE3-25	1.90	1.00	2.90
2021	Cp	DRYE3	DRYE3-50	1.78	1.00	2.78
2021	Cp	DRYE3	DRYE3-75	1.34	0.96	2.30
2021	Cp	DRYE4	DRYE4-25	1.57	0.99	2.56
2021	Cp	DRYL1	DRYL1-25	0.00	0.68	0.68
2021	Cp	DRYL1	DRYL1-50	0.00	0.88	0.88
2021	Cp	DRYL1	DRYL1-75	0.00	0.65	0.65
2021	Cp	DRYL2	DRYL2-25	0.00	0.77	0.77
2021	Cp	DRYL2	DRYL2-50	0.00	0.74	0.74
2021	Cp	DRYL2	DRYL2-75	0.00	0.62	0.62
2021	Cp	DRYL3	DRYL3-25	0.00	0.59	0.59
2021	Cp	DRYL3	DRYL3-50	0.00	0.28	0.28
2021	Cp	DRYL3	DRYL3-75	0.00	0.28	0.28
2021	Cp	DRYL4	DRYL4-25	0.00	0.40	0.40
2021	Cp	DRYL4	DRYL4-50	0.00	0.21	0.21
2021	Cp	DRYL4	DRYL4-75	0.00	0.41	0.41
2021	Cp	ETRI1	ETRI1-0	0.00	0.00	0.00
2021	Cp	ETRI1	ETRI1-50	0.00	0.00	0.00
2021	Cp	ELKR10	ELKR10-25	0.00	0.08	0.08
2021	Cp	ELKR10	ELKR10-50	0.00	0.21	0.21
2021	Cp	ELKR10	ELKR10-75	0.00	0.35	0.35
2021	Cp	ELKR11	ELKR11-25	0.00	0.67	0.67

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2021	Cp	ELKR11	ELKR11-50	0.00	0.00	0.00
2021	Cp	ELKR11	ELKR11-75	0.00	0.00	0.00
2021	Cp	ELKR12	ELKR12-25	0.00	0.00	0.00
2021	Cp	ELKR12	ELKR12-50	0.00	0.00	0.00
2021	Cp	ELKR12	ELKR12-75	0.00	0.00	0.00
2021	Cp	ELKR15	ELKR15-25	0.00	0.03	0.03
2021	Cp	ELKR15	ELKR15-50	0.00	0.02	0.02
2021	Cp	ELKR15	ELKR15-75	0.00	0.03	0.03
2021	Cp	ELKR8	ELKR8-25	0.00	0.18	0.18
2021	Cp	ELKR8	ELKR8-50	0.00	0.00	0.00
2021	Cp	ELKR8	ELKR8-75	0.00	0.40	0.40
2021	Cp	ELKR9	ELKR9-25	0.00	0.10	0.10
2021	Cp	ELKR9	ELKR9-50	0.00	0.12	0.12
2021	Cp	ELKR9	ELKR9-75	0.00	0.00	0.00
2021	Cp	ERIC1	ERIC1-0	1.43	1.00	2.43
2021	Cp	ERIC1	ERIC1-50	1.98	1.00	2.98
2021	Cp	ERIC2	ERIC2-0	1.91	0.96	2.87
2021	Cp	ERIC3	ERIC3-0	1.94	1.00	2.94
2021	Cp	ERIC4	ERIC4-25	1.75	0.97	2.72
2021	Cp	ERIC4	ERIC4-50	0.04	1.00	1.04
2021	Cp	ERIC4	ERIC4-75	0.00	0.51	0.51
2021	Cp	EWIN1	EWIN1-25	0.00	0.22	0.22
2021	Cp	EWIN1	EWIN1-50	0.00	0.34	0.34
2021	Cp	EWIN1	EWIN1-75	0.00	0.07	0.07
2021	Cp	FELT1	FELT1-25	0.00	0.00	0.00
2021	Cp	FELT1	FELT1-50	0.00	0.00	0.00
2021	Cp	FELT1	FELT1-75	0.00	0.00	0.00
2021	Cp	FENN1	FENN1-50	0.00	0.00	0.00
2021	Cp	FPON1	FPON1-25	0.00	0.41	0.41
2021	Cp	FPON1	FPON1-50	0.00	0.51	0.51
2021	Cp	FPON1	FPON1-75	0.00	0.28	0.28
2021	Cp	FORD1	FORD1-25	0.00	0.36	0.36
2021	Cp	FORD1	FORD1-50	0.01	0.43	0.44
2021	Cp	FORD1	FORD1-75	0.00	0.50	0.50
2021	Cp	FORD10	FORD10-25	0.00	0.33	0.33
2021	Cp	FORD10	FORD10-50	0.00	0.23	0.23
2021	Cp	FORD10	FORD10-75	0.00	0.54	0.54
2021	Cp	FORD10	FORD10-86	0.00	0.44	0.44
2021	Cp	FORD10	FORD10-89	0.00	0.21	0.21
2021	Cp	FORD11	FORD11-25	0.00	0.18	0.18
2021	Cp	FORD11	FORD11-50	0.00	0.12	0.12
2021	Cp	FORD11	FORD11-75	0.00	0.00	0.00
2021	Cp	FORD12	FORD12-25	0.00	0.21	0.21
2021	Cp	FORD12	FORD12-50	0.00	0.14	0.14
2021	Cp	FORD12	FORD12-75	0.00	0.06	0.06
2021	Cp	FORD2	FORD2-25	0.00	0.86	0.86
2021	Cp	FORD2	FORD2-50	0.12	0.93	1.05

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2021	Cp	FORD2	FORD2-75	0.39	0.98	1.37
2021	Cp	FORD3	FORD3-25	0.08	0.91	0.99
2021	Cp	FORD3	FORD3-50	0.10	0.72	0.82
2021	Cp	FORD3	FORD3-75	0.35	0.40	0.75
2021	Cp	FORD4	FORD4-25	0.18	0.98	1.16
2021	Cp	FORD4	FORD4-50	0.01	0.97	0.98
2021	Cp	FORD4	FORD4-75	0.00	0.88	0.88
2021	Cp	FORD5	FORD5-12.5	0.00	0.87	0.87
2021	Cp	FORD5	FORD5-25	0.16	0.87	1.03
2021	Cp	FORD5	FORD5-50	0.00	0.99	0.99
2021	Cp	FORD5	FORD5-75	0.16	0.63	0.79
2021	Cp	FORD6	FORD6-25	0.24	0.52	0.76
2021	Cp	FORD6	FORD6-50	0.87	0.95	1.82
2021	Cp	FORD6	FORD6-75	0.12	0.88	1.00
2021	Cp	FORD7	FORD7-25	0.19	1.00	1.19
2021	Cp	FORD7	FORD7-50	0.14	0.90	1.04
2021	Cp	FORD7	FORD7-75	0.15	1.00	1.15
2021	Cp	FORD8	FORD8-25	0.00	0.47	0.47
2021	Cp	FORD8	FORD8-50	0.00	0.71	0.71
2021	Cp	FORD8	FORD8-75	0.00	0.83	0.83
2021	Cp	FORD9a	FORD9a-12.5	0.03	0.23	0.26
2021	Cp	FORD9a	FORD9a-25	0.19	0.45	0.64
2021	Cp	FORD9a	FORD9a-37.5	0.19	0.29	0.48
2021	Cp	FORD9a	FORD9a-50	0.02	0.23	0.25
2021	Cp	FORD9b	FORD9b-62.5	0.00	0.10	0.10
2021	Cp	FORD9b	FORD9b-75	0.00	0.10	0.10
2021	Cp	FORS1	FORS1-25	0.00	0.00	0.00
2021	Cp	FORS1	FORS1-50	0.00	0.00	0.00
2021	Cp	FORS1	FORS1-75	0.00	0.00	0.00
2021	Cp	GARD1	GARD1-25	1.17	0.97	2.14
2021	Cp	GARD1	GARD1-50	0.00	0.00	0.00
2021	Cp	GARD1	GARD1-75	0.00	0.00	0.00
2021	Cp	GATE2	GATE2-25	0.22	0.83	1.05
2021	Cp	GATE2	GATE2-50	0.82	0.96	1.78
2021	Cp	GATE2	GATE2-75	0.56	0.99	1.55
2021	Cp	GODD1	GODD1-0	0.00	0.04	0.04
2021	Cp	GODD3	GODD3-25	1.82	0.92	2.74
2021	Cp	GODD3	GODD3-50	1.90	0.95	2.85
2021	Cp	GODD3	GODD3-75	1.77	0.92	2.69
2021	Cp	GRAC1	GRAC1-25	0.00	0.09	0.09
2021	Cp	GRAC1	GRAC1-50	0.00	0.17	0.17
2021	Cp	GRAC1	GRAC1-75	0.00	0.09	0.09
2021	Cp	GRAS1	GRAS1-25	0.00	0.46	0.46
2021	Cp	GRAS1	GRAS1-50	0.00	0.08	0.08
2021	Cp	GRAS1	GRAS1-75	0.00	0.04	0.04
2021	Cp	GRAV1	GRAV1-25	0.00	0.07	0.07
2021	Cp	GRAV1	GRAV1-50	0.01	0.15	0.16

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2021	Cp	GRAV1	GRAV1-75	0.00	0.12	0.12
2021	Cp	GRAV2	GRAV2-25	0.00	0.04	0.04
2021	Cp	GRAV2	GRAV2-50	0.00	0.10	0.10
2021	Cp	GRAV2	GRAV2-75	0.00	0.04	0.04
2021	Cp	GRAV3	GRAV3-25	0.00	0.00	0.00
2021	Cp	GRAV3	GRAV3-50	0.00	0.00	0.00
2021	Cp	GRAV3	GRAV3-75	0.00	0.00	0.00
2021	Cp	GREE1	GREE1-25	0.05	0.81	0.86
2021	Cp	GREE1	GREE1-50	0.00	0.26	0.26
2021	Cp	GREE1	GREE1-75	0.18	0.97	1.15
2021	Cp	GREE3	GREE3-25	1.44	1.00	2.44
2021	Cp	GREE3	GREE3-50	1.87	1.00	2.87
2021	Cp	GREE3	GREE3-75	1.72	1.00	2.72
2021	Cp	GREE4	GREE4-25	1.63	0.92	2.55
2021	Cp	GREE4	GREE4-50	1.79	1.00	2.79
2021	Cp	GREE4	GREE4-75	1.68	0.98	2.66
2021	Cp	GSCH1	GSCH1-25	0.00	0.92	0.92
2021	Cp	GSCH1	GSCH1-50	0.00	0.90	0.90
2021	Cp	GSCH1	GSCH1-75	0.00	0.19	0.19
2021	Cp	HARM1	HARM1-25	0.00	0.65	0.65
2021	Cp	HARM1	HARM1-50	0.00	0.83	0.83
2021	Cp	HARM1	HARM1-75	0.00	0.81	0.81
2021	Cp	HARM3	HARM3-25	0.00	0.03	0.03
2021	Cp	HARM3	HARM3-50	0.00	0.06	0.06
2021	Cp	HARM3	HARM3-75	0.00	0.02	0.02
2021	Cp	HARM4	HARM4-25	0.00	0.04	0.04
2021	Cp	HARM4	HARM4-50	0.00	0.13	0.13
2021	Cp	HARM4	HARM4-75	0.00	0.46	0.46
2021	Cp	HARM5	HARM5-25	0.00	0.68	0.68
2021	Cp	HARM5	HARM5-50	0.00	0.46	0.46
2021	Cp	HARM5	HARM5-75	0.00	0.01	0.01
2021	Cp	HART2	HART2-25	0.00	0.00	0.00
2021	Cp	HART2	HART2-50	0.00	0.08	0.08
2021	Cp	HART2	HART2-75	0.00	0.00	0.00
2021	Cp	HENR1	HENR1-25	0.00	0.78	0.78
2021	Cp	HENR1	HENR1-50	0.00	0.55	0.55
2021	Cp	HENR1	HENR1-75	0.00	0.53	0.53
2021	Cp	HENR2	HENR2-25	0.00	0.05	0.05
2021	Cp	HENR2	HENR2-50	0.00	0.00	0.00
2021	Cp	HENR2	HENR2-75	0.00	0.00	0.00
2021	Cp	HENR3	HENR3-25	0.00	0.00	0.00
2021	Cp	HENR3	HENR3-50	0.00	0.01	0.01
2021	Cp	HENR3	HENR3-75	0.00	0.00	0.00
2021	Cp	KILM1	KILM1-25	1.97	1.00	2.97
2021	Cp	KILM1	KILM1-50	1.80	0.98	2.78
2021	Cp	KILM1	KILM1-75	0.78	0.49	1.27
2021	Cp	LMOU1	LMOU1-0	0.00	0.61	0.61

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2021	Cp	RG_LE1	RG_LE1-25	0.00	0.00	0.00
2021	Cp	RG_LE1	RG_LE1-50	0.00	0.00	0.00
2021	Cp	RG_LE1	RG_LE1-75	0.00	0.00	0.00
2021	Cp	LEAS2	LEAS2-18.2	1.99	1.00	2.99
2021	Cp	LEAS2	LEAS2-25	1.43	1.00	2.43
2021	Cp	LEAS2	LEAS2-9.1	1.65	0.99	2.64
2021	Cp	LIND1	LIND1-25	0.00	0.15	0.15
2021	Cp	LIND1	LIND1-50	0.00	0.02	0.02
2021	Cp	LIND1	LIND1-75	0.00	0.00	0.00
2021	Cp	LINE1	LINE1-25	0.00	0.39	0.39
2021	Cp	LINE1	LINE1-50	0.01	0.51	0.52
2021	Cp	LINE1	LINE1-75	0.01	0.67	0.68
2021	Cp	LINE2	LINE2-25	0.00	0.37	0.37
2021	Cp	LINE2	LINE2-50	0.00	0.29	0.29
2021	Cp	LINE2	LINE2-75	0.00	0.17	0.17
2021	Cp	LINE3	LINE3-25	0.00	0.22	0.22
2021	Cp	LINE3	LINE3-50	0.00	0.54	0.54
2021	Cp	LINE3	LINE3-75	0.00	0.32	0.32
2021	Cp	LINE4	LINE4-25	0.00	1.00	1.00
2021	Cp	LINE4	LINE4-50	0.00	0.97	0.97
2021	Cp	LINE4	LINE4-75	0.00	0.86	0.86
2021	Cp	LINE7	LINE7-50	0.00	0.00	0.00
2021	Cp	LINE7	LINE7-75	0.00	0.00	0.00
2021	Cp	LIVE1	LIVE1-0	1.55	1.00	2.55
2021	Cp	LIZA1	LIZA1-25	0.00	0.26	0.26
2021	Cp	LIZA1	LIZA1-50	0.00	0.10	0.10
2021	Cp	LIZA1	LIZA1-75	0.00	0.00	0.00
2021	Cp	MCOO1	MCOO1-25	0.15	0.35	0.50
2021	Cp	MCOO1	MCOO1-50	0.00	0.03	0.03
2021	Cp	MCOO1	MCOO1-75	0.00	0.04	0.04
2021	Cp	MICH1	MICH1-25	0.00	0.04	0.04
2021	Cp	MICH1	MICH1-50	0.00	0.02	0.02
2021	Cp	MICH1	MICH1-75	0.00	0.00	0.00
2021	Cp	MICH2	MICH2-25	0.00	0.08	0.08
2021	Cp	MICH2	MICH2-50	0.00	0.33	0.33
2021	Cp	MICH2	MICH2-75	0.00	0.47	0.47
2021	Cp	MICH3	MICH3-25	0.00	0.00	0.00
2021	Cp	MICH3	MICH3-50	0.00	0.08	0.08
2021	Cp	MICH3	MICH3-75	0.00	0.00	0.00
2021	Cp	MICH4	MICH4-25	0.00	0.16	0.16
2021	Cp	MICH4	MICH4-50	0.00	0.03	0.03
2021	Cp	MICH4	MICH4-75	0.00	0.13	0.13
2021	Cp	MICH5	MICH5-25	0.00	0.10	0.10
2021	Cp	MICH5	MICH5-50	0.00	0.03	0.03
2021	Cp	MICH5	MICH5-75	0.00	0.00	0.00
2021	Cp	MICK1	MICK1-75	0.37	0.82	1.19
2021	Cp	MICK2	MICK2-25	0.48	0.98	1.46

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2021	Cp	MICK2	MICK2-50	0.87	1.00	1.87
2021	Cp	MICK2	MICK2-75	0.80	0.95	1.75
2021	Cp	MILL2	MILL2-0	1.19	1.00	2.19
2021	Cp	MORI1	MORI1-25	0.00	0.00	0.00
2021	Cp	MORI1	MORI1-50	0.00	0.00	0.00
2021	Cp	MORI1	MORI1-75	0.00	0.00	0.00
2021	Cp	NTHO1	NTHO1-25	0.37	0.90	1.27
2021	Cp	NTHO1	NTHO1-50	1.41	0.91	2.32
2021	Cp	NTHO1	NTHO1-75	1.24	1.00	2.24
2021	Cp	WILN2	WILN2-25	0.00	0.01	0.01
2021	Cp	WILN2	WILN2-50	0.00	0.00	0.00
2021	Cp	NWOL1	NWOL1-25	1.68	0.96	2.64
2021	Cp	OTTO1	OTTO1-0	0.01	0.48	0.49
2021	Cp	PORT1	PORT1-0	0.00	0.98	0.98
2021	Cp	PORT3a	PORT3a-12.5	0.00	0.39	0.39
2021	Cp	PORT3a	PORT3a-25	0.02	0.79	0.81
2021	Cp	PORT3a	PORT3a-37.5	0.00	0.26	0.26
2021	Cp	PORT3b	PORT3b-50	0.73	0.83	1.56
2021	Cp	PORT3b	PORT3b-62.5	1.41	1.00	2.41
2021	Cp	PORT3b	PORT3b-75	1.73	0.97	2.70
2021	Cp	RG_UCWER1	RG_UCWER1-25	0.00	0.00	0.00
2021	Cp	RG_UCWER1	RG_UCWER1-50	0.00	0.00	0.00
2021	Cp	RG_UCWER1	RG_UCWER1-75	0.00	0.00	0.00
2021	Cp	SAWM1	SAWM1-0	0.00	0.00	0.00
2021	Cp	SAWM1	SAWM1-50	0.00	0.01	0.01
2021	Cp	SAWM2	SAWM2-25	0.00	0.00	0.00
2021	Cp	SAWM2	SAWM2-50	0.00	0.00	0.00
2021	Cp	SITE	SITE-18	1.49	1.00	2.49
2021	Cp	SIXM1	SIXM1-25	0.10	0.84	0.94
2021	Cp	SIXM1	SIXM1-50	0.00	0.30	0.30
2021	Cp	SIXM1	SIXM1-75	0.06	0.67	0.73
2021	Cp	SPOU1	SPOU1-0	1.35	1.00	2.35
2021	Cp	SLINE2	SLINE2-25	0.00	0.34	0.34
2021	Cp	SLINE2	SLINE2-50	0.00	0.17	0.17
2021	Cp	SLINE2	SLINE2-75	0.00	0.03	0.03
2021	Cp	SPIT1	SPIT1-0	1.15	1.00	2.15
2021	Cp	WILS1	WILS1-25	0.00	0.00	0.00
2021	Cp	WILS1	WILS1-50	0.10	0.31	0.41
2021	Cp	SWOL1	SWOL1-25	1.63	0.99	2.62
2021	Cp	SWOL1	SWOL1-32.1	1.65	0.95	2.60
2021	Cp	SWOL1	SWOL1-7.5	1.18	0.76	1.94
2021	Cp	SPRI1	SPRI1-0	0.00	0.01	0.01
2021	Cp	STR02	STR02-50	0.00	0.00	0.00
2021	Cp	STR02	STR02-75	0.00	0.00	0.00
2021	Cp	STR14	STR14-25	0.00	0.46	0.46

Year	Cp_type	Reach	Site Code	Cc	Cp or Cp'	CI
2021	Cp	THOM2	THOM2-25	0.08	0.85	0.93
2021	Cp	THOM2	THOM2-50	0.24	0.95	1.19
2021	Cp	THOM2	THOM2-75	0.26	0.83	1.09
2021	Cp	THOM3	THOM3-25	1.03	0.90	1.93
2021	Cp	THOM3	THOM3-50	0.88	0.96	1.84
2021	Cp	THOM3	THOM3-75	1.02	0.92	1.94
2021	Cp	THOM4	THOM4-25	0.00	0.41	0.41
2021	Cp	THOM4	THOM4-50	0.00	0.14	0.14
2021	Cp	THOM4	THOM4-75	0.00	0.02	0.02
2021	Cp	TODH1	TODH1-25	0.00	0.11	0.11
2021	Cp	TODH1	TODH1-50	0.00	0.09	0.09
2021	Cp	TODH1	TODH1-75	0.00	0.11	0.11
2021	Cp	USOS1	USOS1-25	0.00	0.00	0.00
2021	Cp	USOS1	USOS1-50	0.00	0.00	0.00
2021	Cp	USOS1	USOS1-75	0.00	0.00	0.00
2021	Cp	UTHO1	UTHO1-25	0.56	0.79	1.35
2021	Cp	UTHO1	UTHO1-50	0.19	0.88	1.07
2021	Cp	UTHO1	UTHO1-75	1.12	0.99	2.11
2021	Cp	UTPO1	UTPO1-0	0.00	0.58	0.58
2021	Cp	WEIG1	WEIG1-25	0.00	0.04	0.04
2021	Cp	WEIG1	WEIG1-50	0.00	0.05	0.05
2021	Cp	WEIG1	WEIG1-75	0.00	0.00	0.00
2021	Cp	WOL1	WOL1-25	0.00	0.03	0.03
2021	Cp	WOL1	WOL1-50	0.00	0.12	0.12
2021	Cp	WOLF2	WOLF2-75	1.81	0.99	2.80
2021	Cp	WOLF3	WOLF3-25	1.98	1.00	2.98
2021	Cp	WOLF3	WOLF3-50	1.80	1.00	2.80
2021	Cp	WOLF3	WOLF3-75	1.95	1.00	2.95

Appendix 10. Calcite deposition multivariate analysis (Otto, M. 2022).

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Teck Coal Ltd – Sparwood Operations
Bag 2000
Sparwood, BC
V0B 2G0

April 14, 2022

Attn: Mike Pope, Lead, Aquatic Sciences

MEMORANDUM: Multivariate Assessment of Calcite Deposition and Water Chemistry

Introduction

The primary goal of this work was to conduct a multivariate assessment to explore and gain a better understanding of key water quality drivers of calcite formation in the Elk Valley downstream of Teck's coal mining operations. The results of this work may be used to inform the development of a predictive calcite model. This work stemmed from Environmental Monitoring Committee (EMC) advice and input into the regional calcite program to help inform early warning triggers, inform calcite management, and understand whether the results documented through the Regional Calcite Monitoring Program are consistent with expectations. This exploratory work links to the following calcite programs: data collected in the Regional Calcite Monitoring program, the Calcite Management Plan, Calcite Early Warning Triggers, Calcite Biological Effects, and BIC predictive modeling related to the Regional Aquatic Effects Monitoring Program (RAEMP). The analyses were completed by Mia Otto, PhD, RPBio with Lotic Environmental Ltd.

Methods

Data

To assess potential relationships between water chemistry and calcite occurrence in the Elk Valley, a multivariate analysis was conducted on chemical, calcite presence, and areal data. Chemical data were provided from Teck Water Quality data records, selecting for data that were collected monthly between June and September and overlapping spatially with calcite data from the Regional Calcite Monitoring Program (Zathey et al. 2021). Chemical data values were averaged for each of the 55 parameters (included in Appendix B) used in this assessment over the growth period for each calendar year to avoid the effects of freshet and winter drying. Data on the aerial extent of waste rock placement (percent of watershed covered) were taken from Teck waste rock layers by the year they were built out. Calcite data were taken from the Regional Calcite Program as the annual calcite data by reach and was used to classify chemical data set by Calcite Index (CI) bins. Raw data were not included in analyses. In total, 335 data points spanning from 2013 to 2020 were used in the analysis, covering 46% of the Regional Calcite Program area in an even distribution across the Calcite Monitoring Program study area (Figure 1).

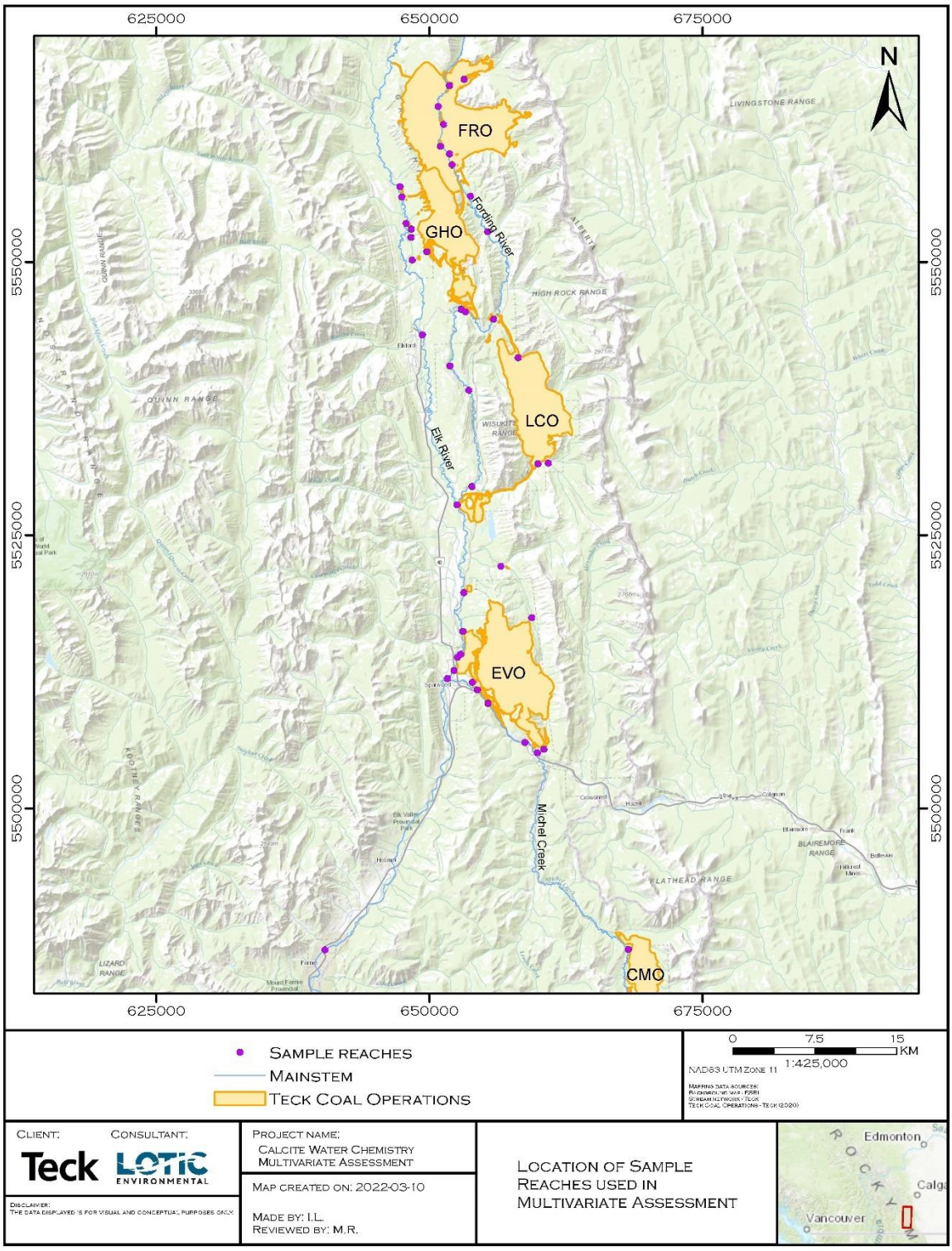

Figure 1. Calcite sampling reach locations in the Elk Valley used in the multivariate analysis.

Analysis

As part of the multivariate analysis, all data were assessed with six different statistical approaches using PRIMER v7 statistical software (Clarke and Gorley 2015). A Bray-Curtis Cluster analysis was completed first where observations were repeatedly grouped based on similarities in data to create a dendrogram illustrating relationships between samples. Non-metric multidimensional scaling (nMDS) was then completed to ordinate samples based on a distance of dissimilarity matrix and create a scaling plot based on similarities. A second nMDS was also produced to assess the relationship between parameters. A principal component analysis (PCA) was conducted where the variation between samples was assessed to identify the most influential variables. An Analysis of Similarities (ANOSIM) was conducted to compare the mean of ranked dissimilarities between groups to the mean of ranked dissimilarities within groups. The nature of the relationships between parameters and calcite was assessed calculating Pearson Correlation Coefficient (a univariate method) and a coherence assessment (a multivariate method to test for cohesion between different parameters' behavior across samples). A Similarity Percentage Breakdown (SIMPER) statistical analysis was performed to make pairwise comparisons of groups of samples and find the average contributions of each variable to the Bray-Curtis dissimilarity matrix (Clarke 1993). Finally, the BEST procedure was completed on the data to produces a subset of parameters that "best" explain the resemblance matrix in and between groups (Clarke and Gorley 2015).

Results

Water Chemistry and Calcite Relationship Exploration

Cluster Analysis

To test for relationships between water chemistry and calcite occurrence across reaches, a cluster analysis grouped samples based on similarities (Figure 2). The data clustered such that reaches with low to moderate calcite grouped together (represented by a green box) and reaches with moderate to high calcite grouped together (represented by a yellow box). A total of 25 data points were removed as outliers (represented by a red box) in order to analyze the relationships in of sites grouped in the yellow and green boxes, and the remaining 310 data points were carried forward to the other analyses.

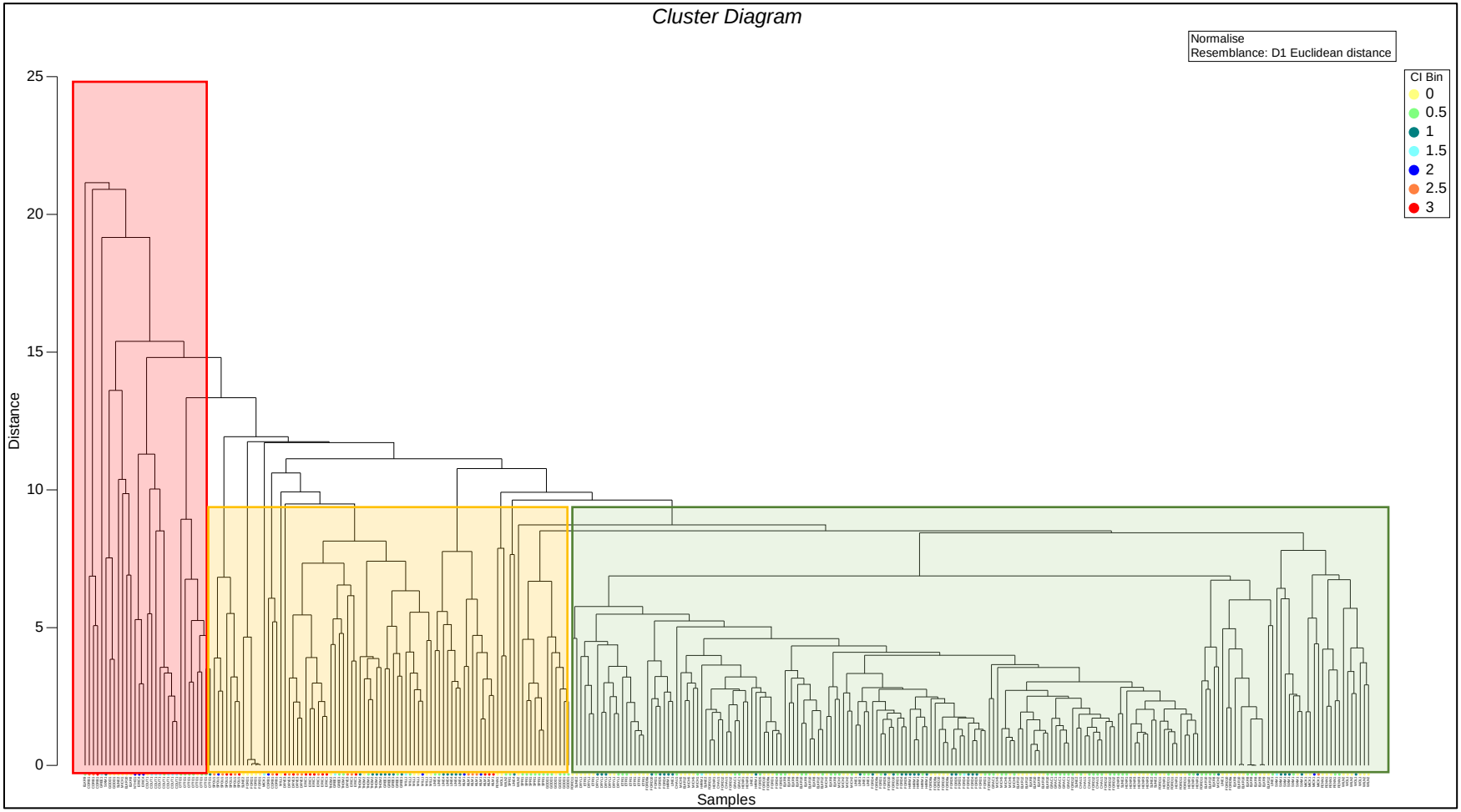

Figure 2. Results of the cluster analysis where reaches with low to moderate calcite grouped together (in green) and reaches with moderate to high calcite presence grouped together (in yellow); outliers (in red) were removed.

nMDS

The nMDS analysis spatially represented the relationship between samples based on water chemistry and classified them by calcite presence (i.e. CI Bins that are represented by colours in Figure 3). Samples with CI values of 2.5 and 3 grouped more closely together on the left while samples with CI 0 -1 grouped more closely together on the right side of the ordination; there is an apparent separation between samples based on water chemistry.

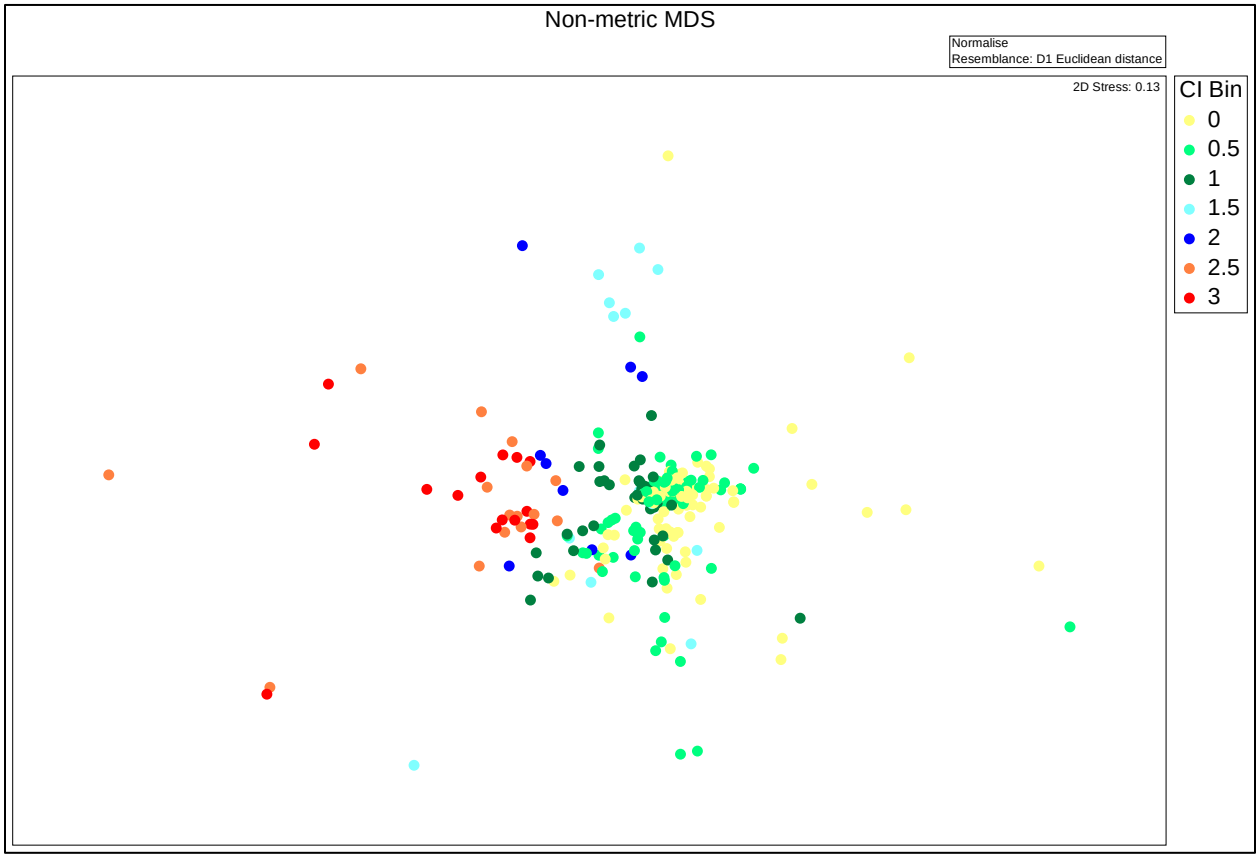

Figure 3. The ordination results of the nMDS analysis spatially representing relationships between water chemistry and CI bins (0 representing no calcite present and 3 representing high calcite presence).

PCA

The PCA results appear to show a strong relationship between higher calcite presence (as presented by CI Bins) and water chemistry parameters (Figure 4); strong grouping is evident between CI Bins with stronger grouping evident at CI > 1.5. The direction of each line associated with each parameter is an indication of the direction of the relationship between the parameter and the samples. For instance, Lithium is pulling in a South-East direction on the PCA ordination, and Aluminum and Iron are pulling in a North-West direction. The length of the line is the strength of the relationship and the direction it is pulling in is an indication of increase in value. Therefore, samples with higher calcite are associated with an increase in Lithium. The complete results of the PCA for each parameter is provided in Appendix A.

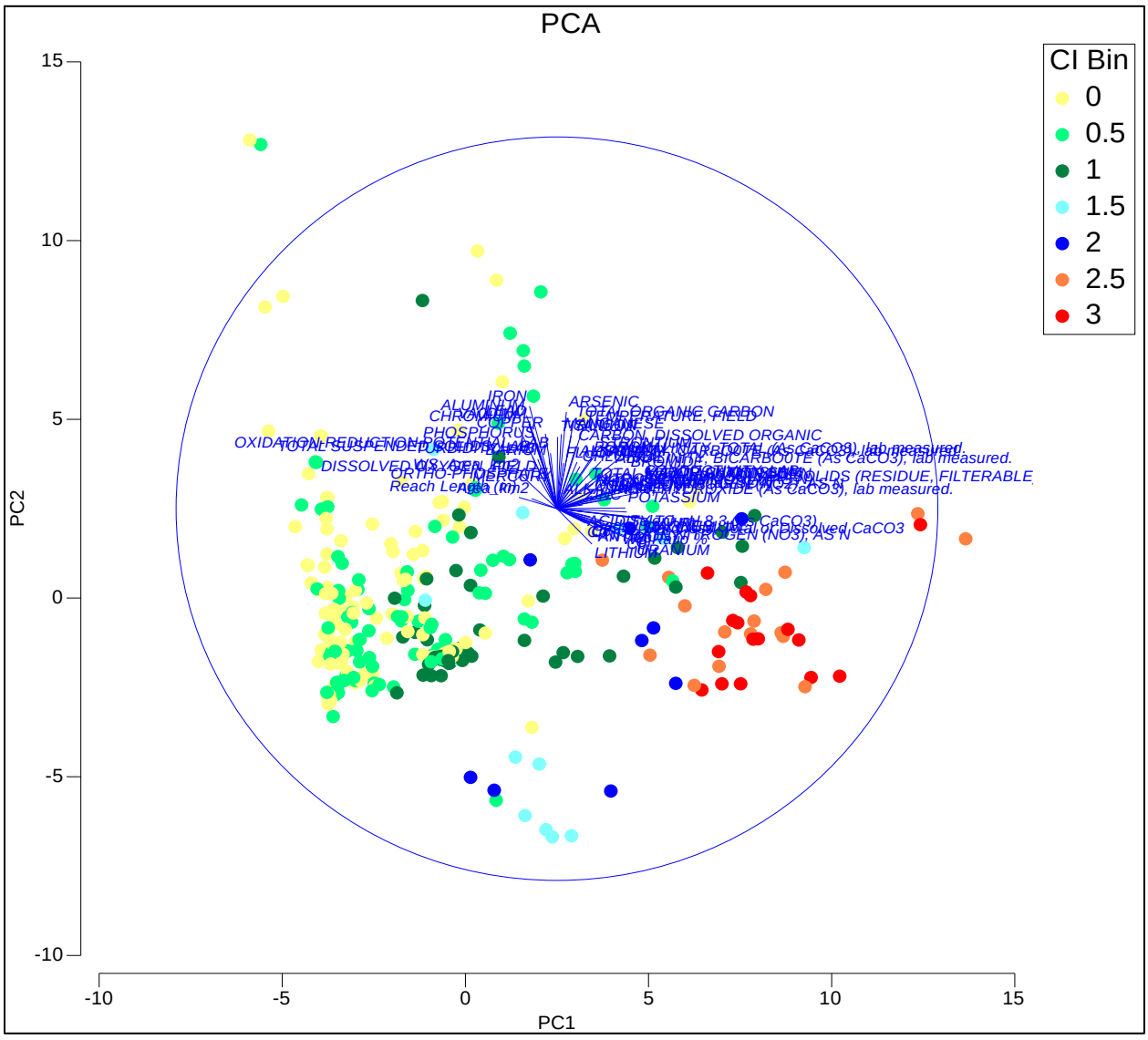

Figure 4. The PCA results spatially representing relationships between water chemistry parameters and CI bins (0 representing no calcite present and 3 representing high calcite presence) between PC 1 and PC2.

ANOSIM

The results of the ANOSIM analysis show that differences in water chemistry are greater the further apart two reaches are in calcite presence. For example, reaches in CI Bin 0 and reaches in CI Bin 3 have a more significant difference in water chemistry than reaches in CI Bin 0.5 and CI Bin 1 have from each other (Table 1; Figure 5) The global R value was 0.314 and the significance level of the test was 0.1%.

Table 1. Pairwise tests comparing chemistry values for data categorized into different reaches.

Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
0, 0.5	0.023	3.4	Very large	999	33
0, 1	0.134	0.3	Very large	999	2
0, 1.5	0.603	0.1	Very large	999	0
0, 2	0.64	0.1	Very large	999	0
0, 2.5	0.756	0.1	Very large	999	0
0, 3	**0.791**	0.1	Very large	999	0
0.5, 1	0.056	7.9	Very large	999	78
0.5, 1.5	0.593	0.2	Very large	999	1
0.5, 2	0.602	0.1	Very large	999	0
0.5, 2.5	0.738	0.1	Very large	999	0
0.5, 3	0.782	0.1	Very large	999	0
1, 1.5	0.588	0.1	Very large	999	0
1, 2	0.571	0.1	Very large	999	0
1, 2.5	0.651	0.1	Very large	999	0
1, 3	0.709	0.1	Very large	999	0
1.5, 2	0.02	32.2	497420	999	321
1.5, 2.5	0.296	0.1	67863915	999	0
1.5, 3	0.387	0.1	67863915	999	0
2, 2.5	0.069	20.7	2042975	999	206
2, 3	0.156	6.4	2042975	999	63
2.5, 3	-0.014	65.8	300540195	999	657

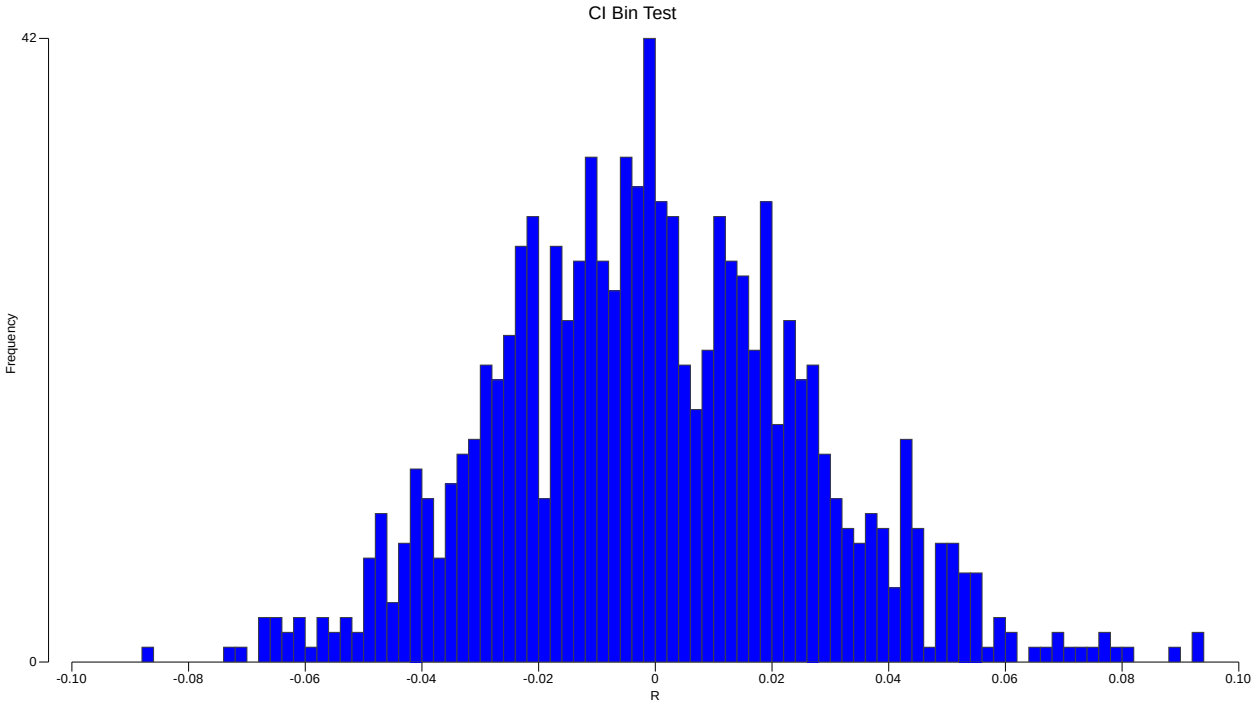

Figure 5. the distribution of randomized tests for the ANOSIM procedure.

Strongest Relationship Water Chemistry Parameters

The data were assessed for correlation for each parameter across sites in different CI Bins and it was found that CI had a moderate correlation with Mg, Ca, and $CaCO_3$ (Figure 6 and Figure 7; complete correlation scores are listed in Appendix B). Calcium and Magnesium had correlation above 0.5 (the highest scores of the 55 parameters) but the R^2 values were below 0.5 (though these R^2 values were higher than those of any other parameters). The high correlation above 0.5 but very low R^2 suggest that as stand-alone parameters are unable to fully account for calcite occurrence.

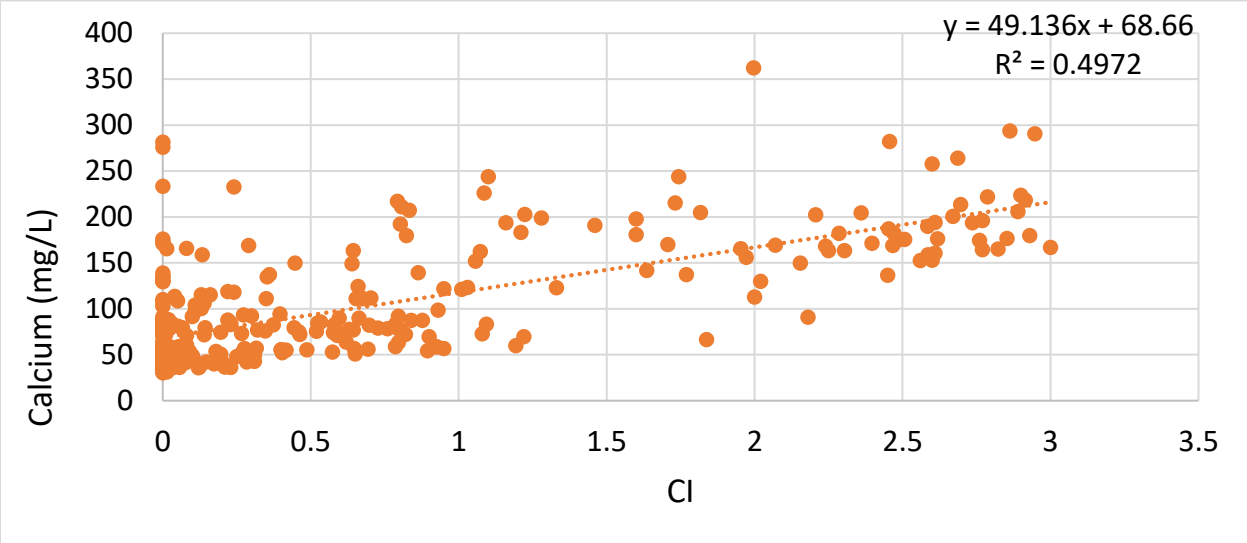

Figure 6. Correlation between Cl values and calcium illustrating a positive relationship.

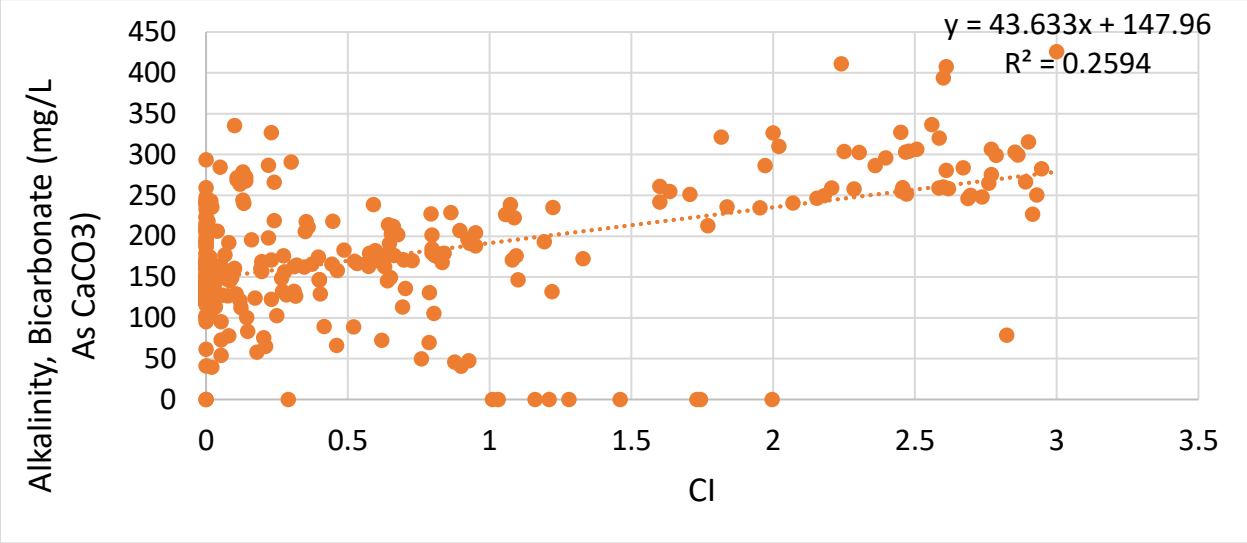

Figure 7. Correlation between Cl values and $CaCO_3$ illustrating a positive relationship. R^2 value is 0.2594.

The data were analyzed using a coherence assessment where parameters that showed coherence across samples were grouped together and plotted across Cl Bins. Waste rock extent %, SO_4, Mg, and $CaCO_3$ illustrated coherence with calcite occurrence in the Elk Valley. Good coherence was found between calcite occurrence and aerial extent waste rock % within a watershed as there is an overall increase in percent waste rock with an increase in Cl values (Figure 8). Similarly, good coherence is observed between magnesium and bicarbonate with calcite presence, as in they behave similarly across samples and exhibit a general increase as Cl values increase (Figure 9) as does sulphate (

CI Low ⟶ High

Figure 10).

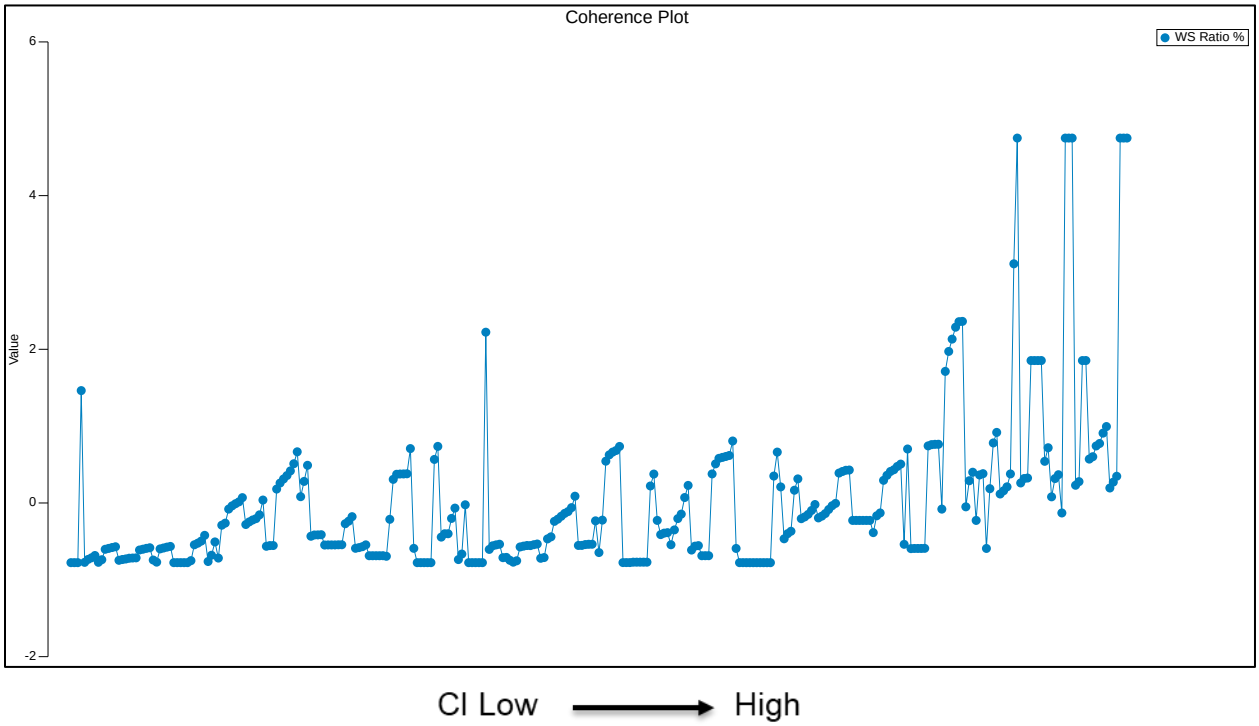

Figure 8. Coherence observed between waste rock (%) and CI values. Values are normalized and pre-treated as per the data standardization process in PRIMER therefor y-axis values are irrelevant.

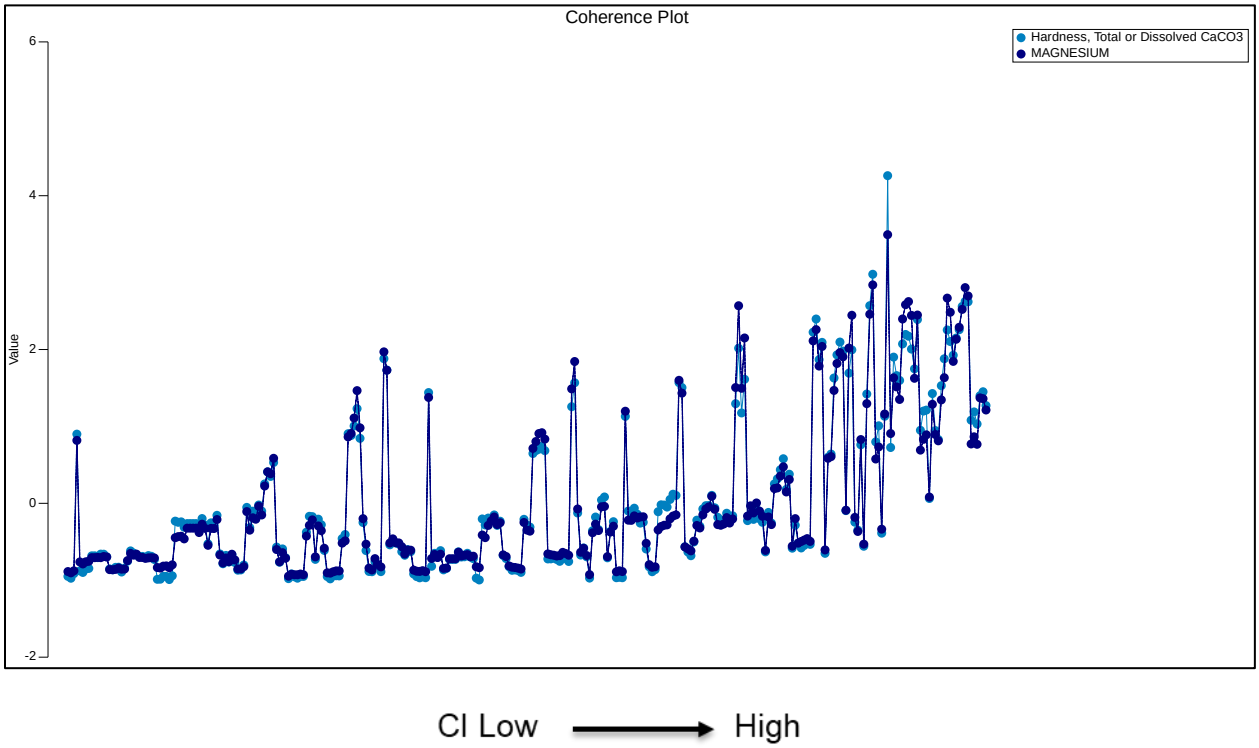

Figure 9. Coherence observed between magnesium and bicarbonate and Cl values. Values are normalized and pre-treated as per the data standardization process in PRIMER therefor y-axis values are irrelevant.

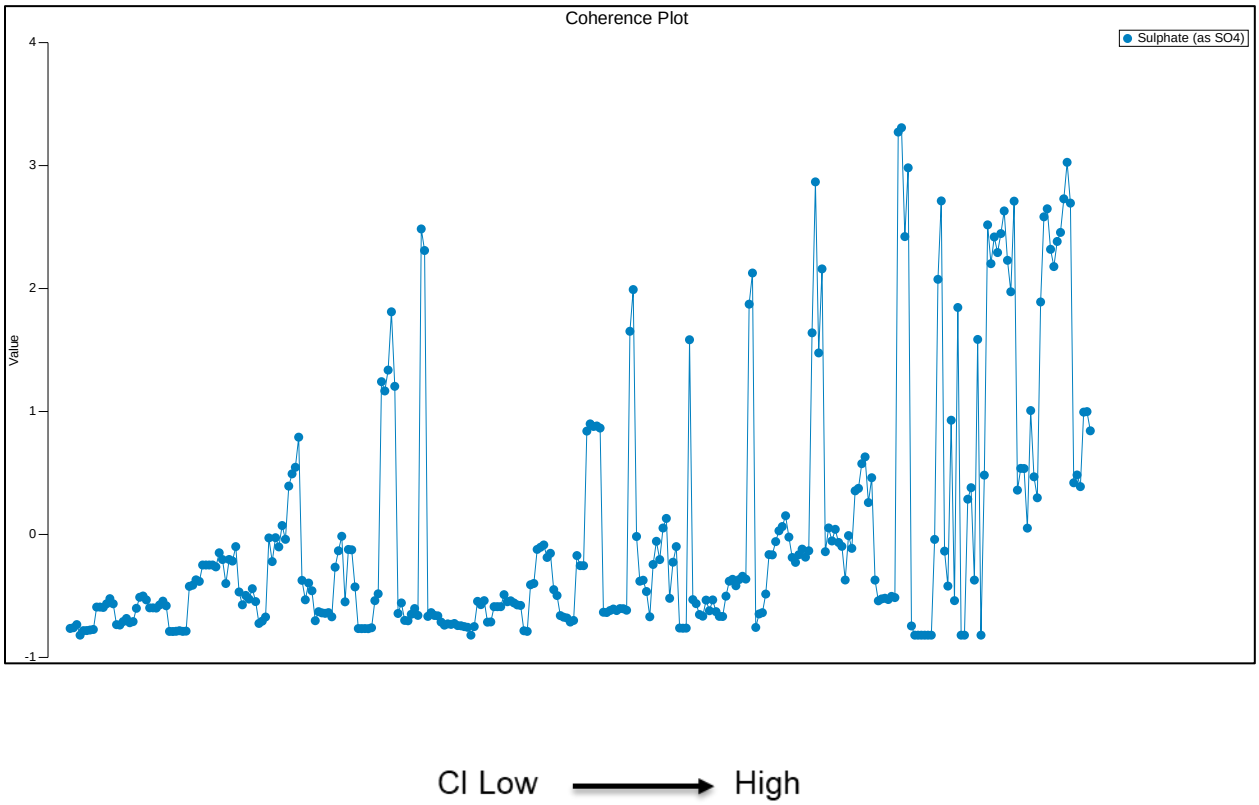

Figure 10. Coherence observed between sulphate and CI values. Values are normalized and pre-treated as per the data standardization process in PRIMER therefor y-axis values are irrelevant.

An nMDS analysis was produced for parameters to illustrate the relationship/dissimilarity between chemical parameters. The interpretation of results is that mining related constituents (e.g. lithium, cobalt, zinc, etc.) show separation from other parameters spatially (Figure 11). This is seen as a spatial disconnect between the upper right- and left-hand sides of the diagram. The space is indicative of dissimilarity between these parameters across sample reaches. This illustrates that one or two parameters are not sufficient in accounting for calcite occurrence, but instead calcite formation is more complex and more likely a group of parameters would be more adequately able to provide information regarding the chemical characteristics of samples with different calcite presence.

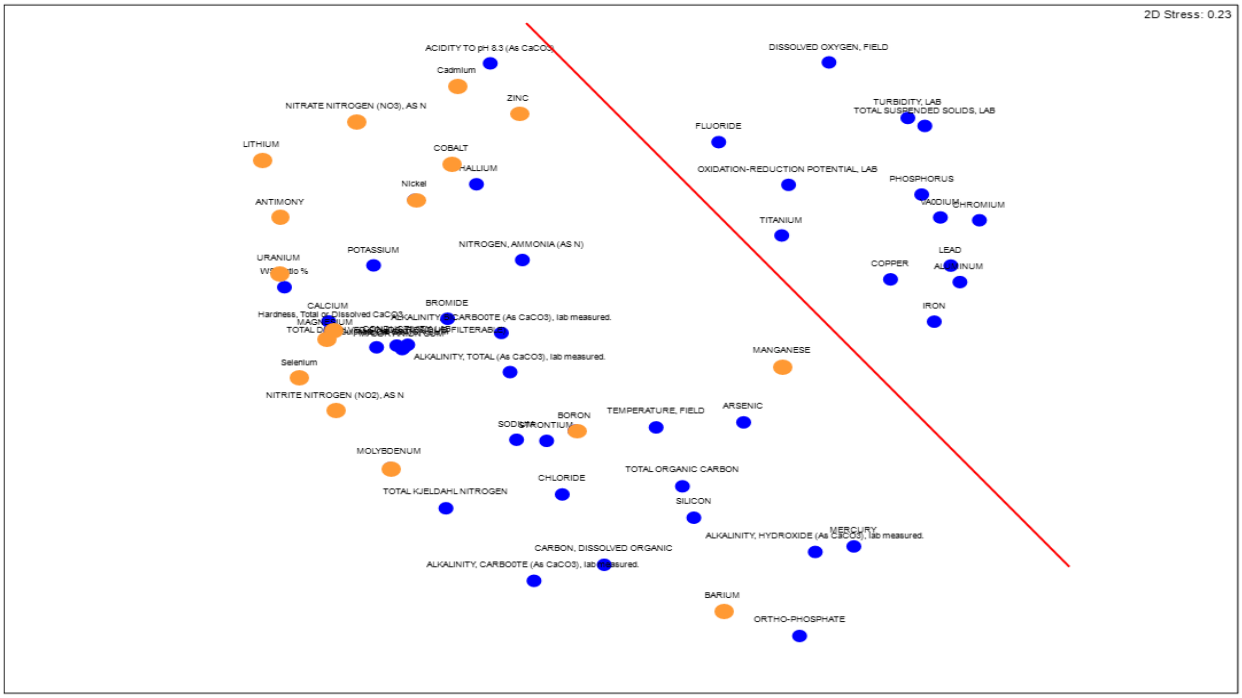

Figure 11. nMDS results illustrating the relationship/dissimilarity between chemical parameters. Mining related constituents (shown in orange) fall to the group on the left.

Characterization of Water Chemistry In and Between CI Bins

SIMPER

SIMPER analysis examining similarities within CI Bins and dissimilarities between CI Bins found that the aerial extent of waste rock (%) was likely a contributor to characteristics for all CI>1.5 groups, and was also a key contributor to the dissimilarity between CI = 0 vs CI = 3. Table 2 shows the top ten contributing parameters to the “identity” of each CI Bin which account for a large proportion of the CI Bin’s group identity. In the case of Group 0.5, the top ten parameters account for almost 50% of the chemical characteristics that define the group. The percentage of chemical characteristics that these parameters accounted for declined as calcite increased across Bins (left to right in Table 2) and thus there is an increase in complexity of characteristic/group description along the gradient of CI 0 to CI 3. Complete SIMPER results are available in Appendix C.

Groups 0 to 1 showed fairly low distance/variation between samples within the respective CI Bins, whereas Group 1.5 had the largest variability present within any of the CI Bins and Groups 2-3 had lower variability/dissimilarity present between samples within each CI Bin. There is great variation between groups with each being defined by a combination of parameters that are almost exclusively unique to each CI Bin. Similarly, when looking at the chemical parameters that are responsible for the dissimilarity between different CI Bins, it was found that the dissimilarity between adjoining CI Bins (0 and 0.5) is less than that of CI Bins that are further apart (for example Groups 0 and 3 or 1.5 and 2.5), which aligns with the results of the PCA and nMDS.

Table 2. The top ten contributing parameters to the "identity" of each Cl Bin from the SIMPER analysis. Parameters are ordered from largest contributor to smallest (from top to bottom). Mining related constituents (in orange) occur across all Cl Bins but more so on the higher Cl end of the scale. Aerial extent of waste rock (in yellow) was one of the top ten contributors in all groups with Cl higher than 1.5.

Group 0	Group 0.5	Group 1	Group 1.5	Group 2	Group 2.5	Group 3
Average squared distance = 40.36	Average squared distance = 41.15	Average squared distance = 34.97	Average squared distance = 104.95	Average squared distance = 79.34	Average squared distance = 77.95	Average squared distance = 62.24
Dissolved Oxygen	Alkalinity, Hydroxide (As Caco3)	Total Kjeldahl Nitrogen	Oxidation-reduction Potential	Cadmium	Nitrogen, Ammonia (As N)	Cobalt
Vanadium	Fluoride	Sulphate (As SO4)	Antimony	Sodium	Sodium	Nickel
Chromium	Chromium	Carbon, Dissolved Organic	Copper	Calcium	Nitrate Nitrogen (No3)	Cadmium
Phosphorus	Zinc	Temperature	Temperature	WS Ratio %	Cadmium	Nitrate Nitrogen (No3)
Iron	Lead	Total Organic Carbon	Potassium	Bromide	WS Ratio %	Thallium
Silicon	Silicon	Selenium	Total Kjeldahl Nitrogen	Temperature	Acidity To pH 8.3 (As Caco3)	WS Ratio %
Copper	Temperature	Dissolved Oxygen	Uranium	Carbon, Dissolved Organic	Alkalinity, Carbonate (As Caco3)	Alkalinity, Hydroxide (As Caco3)
Total Organic Carbon	Boron	Total Dissolved Solids	Molybdenum	Nickel	Selenium	Selenium
Molybdenum	Molybdenum	Major Anion Sum	Alkalinity, Total (As Caco3)	Acidity To pH 8.3 (As Caco3)	Boron	Total Kjeldahl Nitrogen
Antimony	Aluminum	Major Cation Sum	Thallium	Hardness, Total Or Dissolved Caco3	Thallium	Sodium
44.47%	49.38%	43.71%	40.65%	42.51%	30.45%	31.57%

BEST

Between one and five "BEST" parameters were pulled from the dataset to account for the difference in water chemistry between CI Bins (Table 3). If only one parameter is used to account for the differences between groups, alkalinity bicarbonate is the top parameter with a corr. value of 0.563. As more parameters are used to account for the chemical differences between groups the corr. values increase to 0.847 for Alkalinity ($CaCO_3$), Major Cation Sum, Manganese, Nitrite Nitrogen (NO_2), and Turbidity.

Table 3. Results of the BEST analysis showing the top parameters responsible for the differences in water chemistry between CI Bins.

Number of Parameters	Corr. Value	Parameters
1	0.563	Alkalinity, Total (As $CaCO_3$)
2	0.739	Major Cation Sum, Manganese
3	0.810	Alkalinity, Total (As $CaCO_3$), Manganese, TDS
4	0.834	Alkalinity (CaCO3), Conductivity, Iron, Nickel
5	0.847	Alkalinity (CaCO3), Major Cation Sum, Manganese, Nitrite Nitrogen (NO2), Turbidity

A BEST assessment also examines different potential variations of five parameters that would produce different high corr values. The top variation is the same combination of parameters that accounts for differences seen in water chemistry (Table 3). However, the second, third, fourth, and fifth best combinations of water chemistry parameters for explaining the differences in water chemistry between CI Bins have similarly high corr. values (Table 4). Further, the same parameters appear to be selected repeatedly just in different combinations to each other. In total, eleven parameters in different combinations with each other, best account for the differences in water chemistry between CI Bins. These parameters are Alkalinity, Total (As $CaCO_3$), Major Cation Sum, Manganese, Nitrite Nitrogen (NO_2), Turbidity, Alkalinity, Bicarbonate (As $CaCO_3$), Iron, Nickel, TDS, Conductivity, and Major Anion Sum.

Table 4. Results of the BEST analysis showing the top five parameter combinations with the highest corr. values responsible for the differences in water chemistry between CI Bins.

Number of Parameters	Corr. Value	Parameters
5	0.847	Alkalinity, Total (CaCO3), Major Cation Sum, Manganese, Nitrite Nitrogen (NO2), Turbidity
5	0.846	Alkalinity, Bicarbonate (As $CaCO_3$), Alkalinity, Total (As $CaCO_3$), Iron, Nickel, TDS
5	0.846	Alkalinity, Total (As $CaCO_3$), Conductivity, Iron, Nickel, Turbidity
5	0.845	Alkalinity, Bicarbonate (As $CaCO_3$), Alkalinity, Total (As $CaCO_3$), Iron, Major Anion Sum, Nickel
5	0.844	Alkalinity, Total (As $CaCO_3$), Manganese, Nitrite Nitrogen (NO_2), TDS, Turbidity

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Clarke. K. (1993) Non-parametric multivariate analyses of changes in community structure. Austral Ecology, 18:117–143.

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Appendix A – Principal Component Analysis

Sample	SCORE1	SCORE2	SCORE3	SCORE4	SCORE5	Sample	SCORE1	SCORE2	SCORE3	SCORE4	SCORE5
CHAU1	-3.81	-0.521	0.592	-0.842	0.24	FORD5	-1.69	-0.475	0.714	-1.6	-0.165
CHAU1	-4.15	-1.36	0.23	-1.19	0.564	GODD1	3.52	0.482	-0.636	1.05	-0.304
CHAU1	-3.69	-2.09	-0.481	-0.711	0.712	GODD1	3.6	0.19	-1.16	0.748	-0.725
COUT1	2.04	-4.09	7.65	12.3	-3.27	GODD1	3.34	0.493	-0.768	0.667	-0.686
DRYL1	-3	0.104	-1.2	0.0168	-0.256	GODD1	3.72	2.74	-0.323	0.702	-1.09
DRYL1	-3.64	0.454	-0.646	-0.399	-0.616	GODD1	3.3	0.185	-1.15	0.286	-0.708
DRYL1	-3.14	-0.102	-0.808	0.289	-0.354	GRAC1	-2.77	0.0623	0.138	-0.436	0.11
DRYL1	-2.95	-1.02	-1.63	0.584	-0.237	GRAC1	-3.18	-0.0342	0.239	-0.684	0.163
ELKR10	-3.06	2.69	2.59	-0.78	-0.318	GRAC1	-2.99	-1.18	-0.366	-0.0379	0.238
ELKR10	-3.05	2.69	2.59	-0.778	-0.321	GRAC1	-2.95	-1.5	-0.652	-0.104	0.312
ELKR10	-4.52	8.4	6.88	-2.01	-0.264	GRAC1	-2.86	-0.883	-0.829	0.131	0.104
ELKR10	-2.71	-0.463	-0.0135	-0.356	0.363	GRAC1	-2.65	-1.4	-1.14	0.0373	0.224
ELKR10	-2.55	-1.33	-0.565	-0.348	0.527	GRAC1	-2.65	-1.63	-0.89	0.128	0.335
ELKR10	-2.74	-0.0504	-0.136	-0.207	0.225	GRAC1	-3.11	-0.765	-0.598	-0.0124	0.515
ELKR12	-3.76	0.337	2.11	-0.569	-0.0785	GREE1	4.22	2.83	-0.435	-2.4	-2.8
ELKR12	-3.85	1.07	1.43	-1.09	0.131	GREE1	6.25	-0.375	-0.502	-0.225	-2.19
ELKR12	-3.47	-0.903	0.275	-0.587	0.659	HARM1	-0.787	-0.832	-0.765	-0.952	-0.516
ELKR12	-3.28	-1.25	0.0221	-0.327	0.707	HENR1	-2.61	-2.41	-0.451	-0.831	0.758
ELKR12	-3.52	0.316	0.166	-0.319	0.466	HENR1	-2.19	-2.27	-0.426	-0.58	1.17
ELKR12	-3.24	-1.21	-0.438	-0.086	0.439	HENR1	-2.68	-2.11	-0.459	-1.03	1.03
ELKR8	-4.14	4.53	3.53	-2.43	0.096	HENR3	-4.03	-2.23	-0.325	-1.22	1.42
ELKR8	-2.57	0.863	0.598	-0.549	0.0693	LINE1	-1.45	-0.00305	2.06	-1.53	0.5
ELKR8	-2.46	-0.937	-0.368	-0.275	0.527	LINE1	-0.422	-1.8	-0.146	-0.713	0.535
ELKR8	-2.63	-0.265	-0.327	0.0254	0.0399	LINE1	-1.06	-1.69	-0.378	-0.59	0.655
ELKR9	-3.26	4.42	3.75	-0.846	-0.729	LINE4	1.68	-0.835	3.74	-1.27	2.29
ELKR9	-3.27	4.42	3.75	-0.847	-0.727	LINE4	2.03	-1.01	3.07	-1.29	2.33
ELKR9	-3.51	3.4	3.2	-0.765	-0.509	MICH1	-2.85	0.761	0.351	-0.577	-0.15
ELKR9	-3.04	2.12	1.71	-0.462	-0.0571	MICH2	-1.33	-0.586	-0.802	0.362	-0.0172
ELKR9	-2.63	-1.08	-0.581	-0.325	0.494	MICH2	-0.416	-0.912	-1.09	0.0553	0.562
ELKR9	-2.97	1.78	0.787	-0.052	-0.112	MICH5	-3.59	-1.18	-0.862	0.249	0.14
ETRI1	-3.59	-0.298	-0.986	0.453	-0.344	MICH5	-3.52	-1.15	-1.09	0.0378	0.39
ETRI1	-3.87	0.0554	-0.605	0.193	-0.394	MICH5	-3.68	-1.26	-0.993	0.181	0.437
ETRI1	-3.48	-1.37	-1.64	0.881	-0.00442	MILL1	4.47	2.23	-3.11	0.768	-2.6

ETRI1	-3.45	-1.37	-1.74	0.903	0.0404	OTTO1	2.3	6.49	-1.92	3.74	2
ETRI1	-3.53	-1.15	-2.1	1.04	-0.247	OTTO1	2.01	7.42	-1.6	4	1.36
ETRI1	-3.39	-1.2	-1.98	1.16	-0.175	OTTO1	3.11	8.54	-3.92	5.7	2.64
FENN1	0.472	4.75	-2.76	2.32	-1.38	OTTO1	2.6	5.61	-3.93	4.67	2.41
FENN1	0.531	2.57	-4.34	2.4	-0.769	OTTO1	1.59	4.9	-3.38	4.4	1.41
FENN1	0.83	3.26	-5.18	2.73	-1.34	OTTO1	1.86	7.3	-3.27	6.42	3.13
FENN1	0.277	2.11	-3.02	3.05	0.743	SIXM1	-0.786	2.29	-1.63	2.18	0.761
FORD1	-2.01	1.36	2.07	-2.24	-0.397	SLINE2	-3.13	-1.94	-0.756	-0.399	0.898
FORD1	-1.99	1.36	2.08	-2.23	-0.403	SLINE2	-3.46	-1.97	-0.646	-0.887	1.02
FORD1	-1.96	1.34	2.09	-2.22	-0.415	SLINE2	-3.54	-1.98	-0.904	-0.643	0.947
FORD1	-2	1.36	2.08	-2.24	-0.401	SPRI1	-0.0393	1.78	-1.57	-0.906	1.55
FORD1	-1.63	-0.486	0.31	-1.42	0.0779	SPRI1	0.657	0.0982	-2.21	-0.187	1.62
FORD1	-0.737	-1.19	-0.502	-1.01	-0.0216	SPRI1	0.836	0.0618	-2.31	0.0423	1.6
FORD10	-1.3	3.29	3.44	-0.87	-0.625	SPRI1	0.758	0.745	-2.88	0.606	0.928
FORD10	-2.26	-0.424	0.714	-1.28	0.318	SPRI1	1.14	0.985	-3.18	0.678	0.77
FORD10	-0.741	-1.75	-0.31	-0.524	0.228	SPRI1	1.51	1.02	-2.79	0.157	1.45
FORD10	-0.977	-1.62	-0.238	-0.656	0.179	SPRI1	1.68	0.931	-3.24	0.843	1.31
FORD10	-0.309	-1.67	-0.696	-0.346	-0.0834	THOM2	6.06	1.72	-0.771	-0.589	-2.22
FORD11	-2.85	0.447	1.6	-1.17	-0.108	THOM2	5.94	1.18	-2.31	0.137	-1.92
FORD11	-3.36	-0.972	0.217	-1.56	0.528	WILN2	-1.33	1.03	-4.4	2.27	-0.0184
FORD11	-2.67	-2	-0.576	-0.828	0.447	DRYL1	-1.59	-0.678	-1.72	0.813	-0.284
FORD11	-3.06	-2.15	-0.31	-0.744	0.663	DRYL1	-2.03	-0.736	-1.41	0.711	-0.281
FORD11	-2.49	-1.95	-0.938	-0.607	0.205	DRYL1	-1.44	-0.808	-1.48	0.666	-0.0205
FORD11	-2.84	-2.01	-0.616	-0.778	0.621	FORD10	-0.633	-1.75	-0.727	-0.224	0.0196
FORD12	-3.5	0.0163	0.531	-0.593	-0.0289	FORD10	-0.901	-1.57	-0.324	-0.32	0.555
FORD12	-3.63	-0.886	-0.141	-0.794	0.103	FORD4	-0.493	-1.82	-0.537	-1.03	-0.0578
FORD12	-3.17	-1.8	-0.894	-0.505	0.381	FORD4	-0.125	-1.47	-0.217	-0.959	-0.136
FORD9a	-0.123	2.57	3.07	-1.41	-0.309	FORD4	-0.0228	-1.58	-1.04	-0.685	-0.542
FORD9a	-1.36	-0.514	0.898	-1.5	0.146	FORD4	0.39	-0.977	-0.379	-0.336	-0.499
FORD9a	0.0892	-1.63	-0.582	-0.606	-0.172	FORD4	-0.593	-1.52	-0.547	-0.324	0.42
FORD9a	-0.621	-1.76	-0.28	-0.686	-0.0211	FORD5	-0.982	-1.85	-0.316	-1.07	0.0343
FORD9a	0.401	-1.5	-0.822	-0.498	-0.58	FORD5	-1.2	-2.11	-0.444	-0.938	0.163
FORD9a	-0.0411	-1.82	-0.541	-0.656	0.344	FORD5	-0.739	-1.7	-0.835	-0.426	-0.477
FORD9a	0.957	-1.31	0.6	-0.693	-0.0146	FORD5	-0.645	-1.68	-0.952	-0.795	-0.266
GODD1	1.31	9.5	4.71	-0.444	-2.91	FORD5	-1.1	-2.09	-0.44	-0.951	0.156
GODD1	1.79	8.72	4.68	-0.0814	-3.27	FORD5	-0.866	-1.59	-0.487	-0.99	0.228
GODD1	2.22	-0.486	-0.939	-0.0152	-0.233	GREE1	5.45	0.494	-0.73	-0.302	-2.69

HENR1	-2.63	0.0527	1.54	-1.4	0.354	GREE1	8.12	-0.653	-0.153	-0.676	-3.03
HENR1	-3.41	-1.27	0.451	-1.67	0.73	GREE1	4.64	0.0593	-1.81	-0.974	-2.08
HENR1	-2.51	-2.29	-0.195	-1.07	0.907	GREE1	5.8	-0.226	-1.77	-1.13	-2.44
HENR1	-2.92	-2.09	-0.0749	-0.948	0.851	HARM1	-1.35	0.034	0.271	-1.15	-0.539
HENR3	-3.94	-1.13	1.13	-1.27	0.791	HARM1	-0.75	-1.39	-0.955	-1.01	-0.0419
HENR3	-3.76	-2.42	-0.198	-1.25	1.24	HARM1	-1.11	-1.49	-1.15	-0.842	-0.13
HENR3	-3.94	-2.4	0.00777	-0.984	1.09	HARM1	-0.74	-1.3	-1.24	-0.883	-0.188
HENR3	-3.92	-2.63	-0.263	-0.924	1.09	HARM1	-1.12	-1.38	-0.987	-0.908	0.0585
HENR3	-3.72	-2.6	-0.292	-0.708	1.03	HARM1	-1.67	-1.59	-1.12	-0.611	0.159
HENR3	-3.91	-2.34	-0.308	-1.29	1.23	HENR1	-2.65	-2.17	-0.357	-0.964	0.746
LINE1	-1.39	-0.903	0.72	-1.08	0.681	LINE1	0.089	-1.66	-0.297	-0.436	0.478
LINE1	-0.961	1.78	2.25	-1.16	-0.122	LINE1	-0.955	-1.48	-0.359	-0.204	0.811
LINE1	-0.136	-1.67	-0.611	-0.14	-0.0286	LINE4	2.35	-2.09	2.21	-1	2.1
MICH1	-5.1	13.2	9.68	-2.35	-1.97	LINE4	2.09	-0.13	3.03	-0.321	1.34
MICH2	-0.577	0.377	0.343	-0.163	0.0622	LINE4	3.04	-2.01	1.75	-0.232	1.33
MICH2	-0.753	-0.649	-0.366	0.0536	0.478	LINE4	3.76	-2.01	2.12	-0.59	1.56
MICH2	-1.9	-1.09	-0.96	-0.312	0.858	LINE4	1.29	-1.22	1.29	-1.38	2.64
MICH5	-3.51	0.484	0.555	0.00129	-0.267	LINE4	2.32	-1.62	1.09	-0.125	1.6
MICH5	-4.15	1.25	1.23	-0.588	-0.335	MICH2	-2.22	0.316	-0.278	-0.182	0.742
MICH5	-3.68	1.27	0.932	0.108	-0.156	OTTO1	1.21	4.1	-3.82	3.58	0.947
MICH5	-3.41	-1.51	-0.614	0.521	0.203	SIXM1	-1.06	8.81	2.76	1.4	-1.29
MICH5	-3.54	-0.958	-0.674	0.0851	0.327	SIXM1	-0.347	1.04	-2.75	2.67	1.26
MICK1	-0.227	2.79	-2.92	1.68	-0.699	SIXM1	-0.367	2.68	-2.4	3.07	0.729
MICK1	-0.154	2.28	-2.71	1.2	-0.169	SIXM1	-0.0313	2.14	-2.35	2.98	1.33
MILL1	4.26	4.46	-0.668	-0.283	-3.83	SIXM1	-0.716	1.04	-2.73	2.72	1.5
MILL1	4	2.26	-0.375	-0.463	-2.87	THOM2	8.55	1.32	-2.64	-0.0134	-3.25
MILL1	3.73	1.38	-0.497	0.0272	-2.65	THOM2	8.11	0.502	-2.17	-0.924	-2.92
MILL1	4.26	1.26	-2.1	0.529	-2.62	THOM2	6.18	0.749	-2.51	-0.563	-2.3
MILL1	3.46	1.16	-2.32	-0.0576	-2.32	THOM2	7.39	1.11	-2.4	-0.136	-2.31
OTTO1	1.89	6.05	-4.05	4.19	2.11	WOL1	-1.39	1.01	-4.07	1.18	-0.715
SIXM1	-0.764	0.728	-2.65	1.97	1.24	COUT1	0.734	-4.49	5.95	10.2	-2.89
SLINE2	-4.31	1.35	2.66	-2.38	-0.177	COUT1	1.4	-4.74	5.05	11.1	-2.73
SLINE2	-3.77	-1.49	0.0805	-0.927	0.501	COUT1	0.686	-6.09	5.75	7.69	-3.17
SLINE2	-4.55	8.74	8.4	-0.903	-0.789	COUT1	1.11	-6.52	6.01	7.77	-2.93
SLINE2	-3.04	-0.102	1.34	-0.213	0.846	COUT1	1.39	-6.78	6.06	7.94	-2.85
SLINE2	-3.26	-1.77	-1.21	-0.634	0.517	COUT1	1.48	-6.52	6.78	8.31	-2.58
THOM2	7.43	1.97	-0.00955	-1.93	-2.66	FORD4	-0.562	-1.6	-0.62	-0.96	0.0153
THOM2	7.25	1.69	-2.02	0.562	-2.2	GREE1	5.53	1.08	-0.326	-3.29	-2.95
WILN2	-1.72	1.56	-2.76	0.415	-1.02	GREE1	9.84	0.154	-0.631	-1.78	-2.1
WILN2	-3.3	2.09	-0.309	0.906	-0.726	HARM1	-1.67	0.312	0.515	-1.39	-0.785
WILN2	-1.45	0.724	-3.69	0.777	-0.637	MICK1	0.522	3.12	-1.46	2.95	0.162
WILN2	-0.72	1.45	-4.48	2.06	-1.19	MILL1	3.33	2.19	-2.6	0.843	-1.71

WILN2	-1.5	0.946	-4.08	1.03	-0.552	SIXM1	-1.23	4.68	0.497	1.6	-0.199
WOL1	-1.75	1.79	-2.76	0.793	-1.19	CORB1	7.35	1.62	3.39	-0.265	4.29
WOL1	-1.33	0.723	-3.69	1.5	-0.793	ERIC4	-1.13	-4.66	2.63	4.36	-3.26
WOL1	-1.08	1.46	-4	2.36	-0.169	ERIC4	-0.46	-5.12	2.32	4.68	-3.41
CHAU1	-3.73	-2.26	-0.545	-0.52	0.678	KILM1	4.61	-1.25	3.77	-3.87	1.12
CHAU1	-3.7	-1.98	-1.15	-0.757	0.653	KILM1	4.93	-2.78	2.63	-2.92	1.38
CHAU1	-3.79	-2.33	-0.633	-0.258	0.683	MICK1	1.04	1.43	-3.28	2.63	0.349
CHAU1	-3.8	-2.15	-0.648	-0.74	0.95	MILL1	4.13	1.81	-2.86	0.318	-2.59
CHAU1	-4	-2.86	-0.646	-0.137	0.728	NTHO1	1.41	-4.67	3.56	5.6	-3.62
COUT1	0.561	-5.89	5.61	7.47	-2.68	SPOU1	3.95	-1.32	-0.143	-1.61	0.773
DRYL1	-2.54	-0.649	-2.24	0.595	-0.494	CORB1	12.2	1.31	3.26	3.53	10.9
ELKR10	-2.46	-0.721	-0.7	-0.272	0.232	CORB1	8.03	0.208	1.66	1.28	5.9
ELKR10	-2.67	0.00899	0.159	-0.307	0.446	CORB1	11.7	1.52	3.16	4.83	12.6
ELKR10	-3.1	2.37	1.67	-0.0955	-0.0412	DRYE3	7.51	-0.363	1.43	-3.23	-2.75
ELKR12	-3.61	0.37	0.666	-0.481	0.489	DRYE3	7.84	-1.61	0.507	-2.63	-1.95
ELKR12	-3.96	2.75	2.09	-0.475	0.351	DRYE3	7.86	-1.72	0.766	-2.69	-1.93
ELKR8	-3.28	3.63	3.22	-0.869	-0.458	DRYE3	7.09	-1.58	0.17	-2.11	-1.63
ELKR8	-3.28	3.63	3.21	-0.871	-0.456	ERIC1	4.74	0.396	-0.381	-3.21	-2.06
ELKR8	-3.28	3.63	3.22	-0.87	-0.458	ERIC1	7.16	-1.2	-0.647	-3.4	-2.42
ELKR8	-2.13	-1.04	-0.777	-0.58	0.897	KILM1	5.18	-0.577	4.88	-3.27	1.92
ELKR8	-2.3	-0.427	0.0275	-0.55	0.997	KILM1	6.03	-2.36	2.7	-1.62	0.754
ELKR8	-2.79	2.28	1.51	-0.449	0.643	KILM1	6.69	-2.22	4.52	-2	2.26
ELKR9	-2.2	0.0108	-0.778	-0.16	0.787	MICK1	2.98	1.19	-2.88	2.56	-0.648
ELKR9	-2.74	0.976	0.62	-0.17	0.154	SPOU1	6.21	-1.33	1.06	-2.77	1.75
ELKR9	-4.41	12.9	8.84	0.277	-1.49	SPOU1	3.85	-1.62	0.43	-0.996	0.912
ETRI1	-3.18	-1.13	-1.61	1.43	-0.0623	SPOU1	3.98	-1.93	0.279	-1.46	1.22
ETRI1	-3.49	-1.21	-2.08	0.844	0.476	CORB1	6.88	-0.317	1.33	0.303	2.88
FENN1	0.894	3.13	-4.71	2.93	-0.971	CORB1	11.9	1.12	2.95	3.93	10.9
FENN1	0.876	3.05	-3.99	2.83	-0.273	DRYE3	8.1	-1.79	0.29	-2.43	-2.27
FORD1	-0.79	-1.67	-0.529	-0.909	0.106	DRYE3	6.41	-1.66	0.3	-1.64	-2.02
FORD1	-0.373	-1.27	-1.07	-0.339	-0.263	ERIC1	5.7	0.432	-0.069	-3.49	-2.99
FORD1	-0.468	-1.57	-0.76	-0.475	-0.196	ERIC1	6.4	-1.05	-1.02	-3.09	-2.56
FORD1	-1.13	-1.65	-0.56	-0.853	0.292	ERIC1	6.33	-0.992	-1.23	-2.8	-2.74
FORD1	-0.978	-0.721	-0.0842	-0.702	0.403	ERIC1	6.87	-1.55	-0.385	-2.94	-2.5
FORD11	-2.61	-2.15	-0.598	-0.773	0.801	ERIC1	7.76	-1.4	-0.536	-3.51	-2.47
FORD11	-3.35	1.35	1.44	-0.545	0.187	ERIC1	7.17	-1.71	-0.523	-3.01	-2.29
FORD12	-3.28	-2.03	-0.918	-0.468	0.52	KILM1	5.26	-2.87	2.51	-2.95	1.4
FORD12	-3.26	-1.85	-1.38	-0.188	0.172	KILM1	6.3	-2.81	3.01	-2.28	1.59
FORD12	-3.18	-1.98	-1.01	-0.326	0.661	KILM1	5.88	-2.78	3	-2.54	2.01
FORD12	-3.35	-1.82	-1.02	-0.818	0.799	SPOU1	6.62	-0.176	2.88	-3.24	2.2

FORD12	-3.82	-0.411	-0.357	-0.384	0.442	SPOU1	6.48	-1.4	1.54	-2.92	2.19
FORD4	-1.41	-0.682	0.421	-1.53	-0.19	SPOU1	5.74	-1.74	0.799	-2.47	1.96
FORD5	-1.52	0.0349	0.924	-1.47	-0.0886						

Appendix B – Correlation Test Results

Parameter	Correlation	R Square	Parameter	Correlation	R Square
ACIDITY TO pH 8.3 (As CaCO3)	0.343213	0.117795	NITRITE NITROGEN (NO2), AS N	0.156038	0.024348
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	0.50929	0.259376	NITROGEN, AMMONIA (AS N)	0.091825	0.008432
ALKALINITY, CARBO0TE (As CaCO3), lab measured.	-0.039	0.001521	ORTHO-PHOSPHATE	-0.13569	0.018412
ALKALINITY, HYDROXIDE (As CaCO3), lab measured.	0.026568	0.000706	OXIDATION-REDUCTION POTENTIAL, LAB	-0.0903	0.008154
ALKALINITY, TOTAL (As CaCO3), lab measured.	0.542475	0.294279	PHOSPHORUS	-0.16495	0.027209
ALUMINUM	-0.11165	0.012466	POTASSIUM	0.569306	0.324109
ANTIMONY	0.342	0.116964	Selenium	0.489966	0.240066
ARSENIC	0.027496	0.000756	SILICON	0.045623	0.002081
BARIUM	-0.21228	0.045063	SODIUM	0.390382	0.152398
BORON	0.247792	0.061401	STRONTIUM	0.300936	0.090562
BROMIDE	0.316138	0.099943	Sulphate (as SO4)	0.613396	0.376254
Cadmium	0.31194	0.097306	TEMPERATURE, FIELD	-0.04397	0.001933
CALCIUM	0.705098	0.497163	THALLIUM	0.45838	0.210112
CARBON, DISSOLVED ORGANIC	-0.01812	0.000328	TITANIUM	0.018253	0.000333
CHLORIDE	-0.03531	0.001247	TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	0.636366	0.404961
CHROMIUM	-0.17135	0.029359	TOTAL KJELDAHL NITROGEN	0.14193	0.020144
COBALT	0.30171	0.091029	TOTAL ORGANIC CARBON	0.073452	0.005395
CONDUCTIVITY, LAB	0.630268	0.397237	TOTAL SUSPENDED SOLIDS, LAB	-0.09552	0.009124
COPPER	0.076775	0.005894	TURBIDITY, LAB	-0.00738	5.45E-05
DISSOLVED OXYGEN, FIELD	-0.1219	0.01486	URANIUM	0.680642	0.463274
FLUORIDE	0.015716	0.000247	VA0DIUM	-0.11378	0.012945
Hardness, Total or Dissolved CaCO3	0.705527	0.497768	ZINC	0.190365	0.036239
IRON	-0.12635	0.015964	Cc	0.957192	0.916217
LEAD	-0.03485	0.001215	Cp	0.903578	0.816454
LITHIUM	0.395588	0.15649	CI	1	1
MAGNESIUM	0.69397	0.481594	Reach Length (m)	-0.2215	0.049062
MAJOR ANION SUM	0.640284	0.409964	Cc'	0.3534	0.124892
MAJOR CATION SUM	0.647079	0.418711	Cp'	0.323502	0.104653
MANGANESE	-0.03518	0.001238	CI'	0.3524	0.124186
MERCURY	0.046735	0.002184	WS_Area_km2	-0.23148	0.053584
MOLYBDENUM	0.295431	0.087279	Area_km2	-0.18271	0.033384
Nickel	0.520094	0.270498	WS Ratio %	0.632291	0.399792
NITRATE NITROGEN (NO3), AS N	0.448548	0.201195			

Appendix C – Complete SIMPER analysis results

Group 0

Average squared distance = 40.36

Species	Av.Value	Av.Sq.Dist	Sq.Dist/SD	Contrib%	Cum.%
COBALT	-0.116	0.013	0.12	0.03	0.03
Nickel	-0.23	0.0197	0.32	0.05	0.08
Cadmium	-0.221	0.066	0.34	0.16	0.24
ACIDITY TO pH 8.3 (As CaCO3)	-0.238	0.0979	0.12	0.24	0.49
NITRITE NITROGEN (NO2), AS N	-0.169	0.116	0.19	0.29	0.77
NITROGEN, AMMONIA (AS N)	-0.23	0.148	0.2	0.37	1.14
CHLORIDE	-0.249	0.184	0.22	0.45	1.6
URANIUM	-0.472	0.188	0.31	0.46	2.06
WS Ratio %	-0.372	0.197	0.39	0.49	2.55
NITRATE NITROGEN (NO3), AS N	-0.255	0.219	0.42	0.54	3.09
LITHIUM	-0.285	0.259	0.14	0.64	3.73
Selenium	-0.355	0.274	0.25	0.68	4.41
CALCIUM	-0.466	0.309	0.36	0.77	5.18
MAGNESIUM	-0.472	0.312	0.31	0.77	5.95
Hardness, Total or Dissolved CaCO3	-0.476	0.317	0.33	0.79	6.73
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.244	0.339	0.37	0.84	7.57
MAJOR ANION SUM	-0.409	0.352	0.32	0.87	8.45
MAJOR CATION SUM	-0.409	0.355	0.32	0.88	9.33
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	-0.405	0.355	0.3	0.88	10.21
MANGANESE	-0.0661	0.364	0.16	0.9	11.11
Sulphate (as SO4)	-0.364	0.366	0.28	0.91	12.01
CONDUCTIVITY, LAB	-0.404	0.376	0.33	0.93	12.94
ALKALINITY, TOTAL (As CaCO3), lab measured.	-0.33	0.38	0.39	0.94	13.88
SODIUM	-0.276	0.389	0.26	0.96	14.85
THALLIUM	-0.192	0.435	0.23	1.08	15.93
ZINC	-0.121	0.476	0.18	1.18	17.11
ALKALINITY, HYDROXIDE (As CaCO3), lab measured.	-0.189	0.505	0.15	1.25	18.36
BORON	-0.22	0.522	0.33	1.29	19.65
OXIDATION-REDUCTION POTENTIAL, LAB	0.15	0.522	0.25	1.29	20.94
POTASSIUM	-0.328	0.562	0.32	1.39	22.34
STRONTIUM	-0.248	0.593	0.33	1.47	23.81
TOTAL KJELDAHL NITROGEN	-0.272	0.612	0.31	1.52	25.32
BROMIDE	-0.283	0.626	0.25	1.55	26.87
TEMPERATURE, FIELD	-0.0187	0.645	0.39	1.6	28.47
FLUORIDE	0.0498	0.691	0.39	1.71	30.18
ARSENIC	0.0108	0.733	0.37	1.82	32
MERCURY	-0.26	0.822	0.38	2.04	34.03
BARIUM	0.0418	0.909	0.32	2.25	36.28

CARBON, DISSOLVED ORGANIC	0.0926	1.09	0.42	2.71	38.99
ALKALINITY, CARBO0TE (As CaCO3), lab measured.	0.0105	1.1	0.33	2.73	41.73
ANTIMONY	-0.141	1.11	0.11	2.74	44.47
MOLYBDENUM	-0.161	1.12	0.15	2.77	47.24
TOTAL ORGANIC CARBON	0.153	1.14	0.42	2.83	50.08
COPPER	0.261	1.2	0.3	2.98	53.05
SILICON	-0.0403	1.23	0.31	3.06	56.11
IRON	0.178	1.26	0.25	3.12	59.23
PHOSPHORUS	0.373	1.27	0.55	3.14	62.38
CHROMIUM	0.279	1.43	0.3	3.54	65.92
VA0DIUM	0.374	1.44	0.31	3.56	69.48
DISSOLVED OXYGEN, FIELD	0.141	1.45	0.18	3.59	73.07

Group 0.5

Average squared distance = 41.15

Species	Av.Value	Av.Sq.Dist	Sq.Dist/SD	Contrib%	Cum.%
COBALT	-0.131	0.00154	0.17	0	0
Nickel	-0.202	0.121	0.15	0.3	0.3
TURBIDITY, LAB	-0.0743	0.193	0.31	0.47	0.77
TITANIUM	-0.156	0.199	0.27	0.48	1.25
NITRITE NITROGEN (NO2), AS N	-0.149	0.201	0.15	0.49	1.74
NITRATE NITROGEN (NO3), AS N	-0.288	0.207	0.37	0.5	2.25
THALLIUM	-0.3	0.242	0.22	0.59	2.83
NITROGEN, AMMONIA (AS N)	-0.0141	0.268	0.29	0.65	3.48
WS Ratio %	-0.32	0.308	0.35	0.75	4.23
ANTIMONY	-0.201	0.33	0.21	0.8	5.04
Selenium	-0.288	0.34	0.34	0.83	5.86
TOTAL SUSPENDED SOLIDS, LAB	-0.0377	0.354	0.23	0.86	6.72
URANIUM	-0.368	0.374	0.27	0.91	7.63
LITHIUM	-0.191	0.397	0.16	0.96	8.6
Hardness, Total or Dissolved CaCO3	-0.348	0.399	0.38	0.97	9.56
CALCIUM	-0.342	0.4	0.41	0.97	10.54
MAGNESIUM	-0.347	0.402	0.36	0.98	11.51
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	-0.281	0.409	0.36	1	12.51
Sulphate (as SO4)	-0.301	0.413	0.32	1	13.51
MAJOR ANION SUM	-0.263	0.415	0.39	1.01	14.52
MAJOR CATION SUM	-0.267	0.425	0.39	1.03	15.55
CONDUCTIVITY, LAB	-0.256	0.471	0.41	1.15	16.7
DISSOLVED OXYGEN, FIELD	0.0278	0.476	0.15	1.16	17.86
Cadmium	-0.17	0.517	0.16	1.26	19.11
OXIDATION-REDUCTION POTENTIAL, LAB	0.0791	0.523	0.23	1.27	20.38
ACIDITY TO pH 8.3 (As CaCO3)	0.00437	0.556	0.3	1.35	21.74

COPPER	-0.141	0.586	0.22	1.42	23.16
POTASSIUM	-0.318	0.621	0.42	1.51	24.67
ALKALINITY, CARBO0TE (As CaCO3), lab measured.	-0.127	0.627	0.39	1.52	26.19
ALKALINITY, TOTAL (As CaCO3), lab measured.	-0.0889	0.672	0.42	1.63	27.82
BROMIDE	-0.096	0.723	0.36	1.76	29.58
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.101	0.743	0.43	1.8	31.39
ORTHO-PHOSPHATE	-0.0302	0.79	0.33	1.92	33.31
SODIUM	0.0272	0.797	0.39	1.94	35.24
STRONTIUM	0.00292	0.802	0.4	1.95	37.19
CARBON, DISSOLVED ORGANIC	-0.0748	0.804	0.35	1.95	39.15
TOTAL ORGANIC CARBON	-0.0512	0.814	0.39	1.98	41.12
VA0DIUM	-0.102	0.832	0.24	2.02	43.15
PHOSPHORUS	-0.0932	0.839	0.43	2.04	45.19
TOTAL KJELDAHL NITROGEN	-0.0449	0.845	0.39	2.05	47.24
ALUMINUM	0.0213	0.88	0.17	2.14	49.38
MOLYBDENUM	-0.00085	0.883	0.39	2.15	51.52
BORON	-0.0304	0.93	0.34	2.26	53.78
TEMPERATURE, FIELD	0.03	0.981	0.44	2.38	56.17
SILICON	0.117	1	0.34	2.43	58.6
LEAD	0.0304	1	0.15	2.44	61.03
ZINC	-0.113	1.02	0.2	2.48	63.51
CHROMIUM	0.091	1.07	0.2	2.59	66.1
FLUORIDE	0.0898	1.11	0.37	2.69	68.79
ALKALINITY, HYDROXIDE (As CaCO3), lab measured.	0.0761	1.13	0.22	2.75	71.54

Group 1

Average squared distance = 34.97

Species	Av.Value	Av.Sq.Dist	Sq.Dist/SD	Contrib%	Cum.%
COBALT	-0.141	0.000459	0.23	0	0
TOTAL SUSPENDED SOLIDS, LAB	-0.255	0.0145	0.29	0.04	0.04
TURBIDITY, LAB	-0.213	0.0374	0.19	0.11	0.15
ALKALINITY, TOTAL (As CaCO3), lab measured.	0.0798	0.116	0.43	0.33	0.48
MANGANESE	-0.146	0.131	0.21	0.37	0.86
THALLIUM	-0.357	0.136	0.25	0.39	1.25
LEAD	-0.231	0.14	0.25	0.4	1.64
CHROMIUM	-0.288	0.169	0.21	0.48	2.13
WS Ratio %	0.00453	0.172	0.5	0.49	2.62
LITHIUM	0.0201	0.174	0.46	0.5	3.12
POTASSIUM	-0.124	0.195	0.44	0.56	3.68
ACIDITY TO pH 8.3 (As CaCO3)	-0.16	0.205	0.21	0.59	4.26
IRON	-0.252	0.21	0.24	0.6	4.86
PHOSPHORUS	-0.505	0.236	0.21	0.67	5.53

ORTHO-PHOSPHATE	-0.238	0.238	0.28	0.68	6.21
OXIDATION-REDUCTION POTENTIAL, LAB	0.0366	0.239	0.51	0.68	6.9
NITROGEN, AMMONIA (AS N)	0.0841	0.246	0.43	0.7	7.6
NITRITE NITROGEN (NO2), AS N	0.0773	0.257	0.4	0.74	8.34
Nickel	0.0193	0.289	0.34	0.83	9.16
CHLORIDE	-0.0403	0.317	0.41	0.91	10.07
VA0DIUM	-0.403	0.343	0.24	0.98	11.05
FLUORIDE	-0.165	0.386	0.42	1.1	12.16
BROMIDE	-0.128	0.389	0.46	1.11	13.27
SILICON	-0.0791	0.416	0.38	1.19	14.46
ANTIMONY	-0.0395	0.438	0.28	1.25	15.71
NITRATE NITROGEN (NO3), AS N	0.339	0.458	0.52	1.31	17.02
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.103	0.46	0.44	1.32	18.33
ARSENIC	-0.169	0.461	0.22	1.32	19.65
MOLYBDENUM	-0.0321	0.465	0.33	1.33	20.98
MERCURY	0.331	0.524	0.37	1.5	22.48
SODIUM	0.0974	0.578	0.51	1.65	24.13
ALUMINUM	-0.197	0.581	0.16	1.66	25.79
BARIUM	0.0187	0.593	0.31	1.7	27.49
COPPER	-0.301	0.616	0.3	1.76	29.25
URANIUM	0.113	0.64	0.41	1.83	31.08
CALCIUM	0.108	0.642	0.4	1.84	32.91
Hardness, Total or Dissolved CaCO3	0.149	0.709	0.41	2.03	34.94
CONDUCTIVITY, LAB	0.325	0.748	0.42	2.14	37.08
ALKALINITY, CARBO0TE (As CaCO3), lab measured.	0.342	0.749	0.5	2.14	39.22
MAGNESIUM	0.172	0.779	0.41	2.23	41.45
MAJOR CATION SUM	0.295	0.793	0.41	2.27	43.71
MAJOR ANION SUM	0.301	0.844	0.41	2.41	46.13
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	0.306	0.882	0.41	2.52	48.65
DISSOLVED OXYGEN, FIELD	0.152	0.946	0.15	2.7	51.35
Selenium	0.424	0.985	0.41	2.82	54.17
TOTAL ORGANIC CARBON	0.116	1.04	0.46	2.99	57.15
TEMPERATURE, FIELD	0.326	1.13	0.51	3.23	60.38
CARBON, DISSOLVED ORGANIC	0.213	1.17	0.44	3.35	63.73
Sulphate (as SO4)	0.316	1.19	0.39	3.39	67.12
TOTAL KJELDAHL NITROGEN	0.519	1.26	0.42	3.59	70.72

Group 1.5

Average squared distance = 104.95

Species	Av.Value	Av.Sq.Dist	Sq.Dist/SD	Contrib%	Cum.%
MANGANESE	-0.246	0.0118	0.46	0.01	0.01
TOTAL SUSPENDED SOLIDS, LAB	-0.303	0.012	0.47	0.01	0.02
CHLORIDE	-0.386	0.0149	0.57	0.01	0.04

COBALT	-0.0595	0.021	0.41	0.02	0.06
Cadmium	-0.357	0.0297	0.49	0.03	0.09
TURBIDITY, LAB	-0.216	0.0382	0.36	0.04	0.12
ACIDITY TO pH 8.3 (As CaCO3)	-0.553	0.0696	0.61	0.07	0.19
LEAD	-0.163	0.185	0.36	0.18	0.36
NITRATE NITROGEN (NO3), AS N	-0.363	0.196	0.43	0.19	0.55
IRON	-0.298	0.217	0.31	0.21	0.76
ORTHO-PHOSPHATE	-0.397	0.257	0.52	0.24	1
BARIUM	-0.171	0.479	0.41	0.46	1.46
MERCURY	-0.509	0.488	0.48	0.46	1.92
CHROMIUM	-0.626	0.497	0.48	0.47	2.4
VA0DIUM	0.00665	0.724	0.49	0.69	3.09
ZINC	0.331	0.728	0.39	0.69	3.78
ALUMINUM	-0.137	0.731	0.31	0.7	4.48
DISSOLVED OXYGEN, FIELD	-1.2	0.779	0.58	0.74	5.22
STRONTIUM	0.29	0.795	0.37	0.76	5.98
TITANIUM	0.306	0.81	0.52	0.77	6.75
Nickel	-0.0144	0.836	0.29	0.8	7.54
ALKALINITY, HYDROXIDE (As CaCO3), lab measured.	0.0611	0.924	0.36	0.88	8.43
CALCIUM	0.876	0.995	0.56	0.95	9.37
Hardness, Total or Dissolved CaCO3	0.93	1.01	0.57	0.97	10.34
ARSENIC	0.0895	1.02	0.36	0.97	11.31
NITROGEN, AMMONIA (AS N)	-0.0806	1.05	0.39	1	12.31
PHOSPHORUS	-0.0859	1.05	0.49	1	13.32
MAGNESIUM	0.959	1.07	0.56	1.02	14.34
BROMIDE	-0.389	1.21	0.34	1.15	15.49
BORON	0.52	1.22	0.51	1.17	16.66
WS Ratio %	1.03	1.24	0.57	1.18	17.84
SODIUM	0.27	1.26	0.34	1.2	19.04
Sulphate (as SO4)	-0.0255	1.42	0.44	1.35	20.39
ALKALINITY, CARBO0TE (As CaCO3), lab measured.	-0.0461	1.46	0.56	1.39	21.79
SILICON	-0.281	1.54	0.49	1.46	23.25
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	-0.273	1.56	0.48	1.49	24.74
MAJOR CATION SUM	-0.325	1.64	0.5	1.57	26.3
CONDUCTIVITY, LAB	-0.416	1.7	0.51	1.62	27.93
MAJOR ANION SUM	-0.309	1.72	0.49	1.64	29.57
TOTAL ORGANIC CARBON	0.0356	1.74	0.54	1.66	31.22
Selenium	0.116	1.74	0.43	1.66	32.88
CARBON, DISSOLVED ORGANIC	-0.0145	1.82	0.53	1.73	34.62
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.912	1.83	0.58	1.74	36.36
FLUORIDE	-1.21	1.93	0.55	1.84	38.2
THALLIUM	1.05	2.57	0.57	2.45	40.65
ALKALINITY, TOTAL (As CaCO3), lab measured.	-0.93	2.72	0.59	2.59	43.24

MOLYBDENUM	1.4	2.84	0.46	2.71	45.95
URANIUM	1.53	2.9	0.56	2.76	48.71
TOTAL KJELDAHL NITROGEN	0.569	3.03	0.33	2.89	51.59
POTASSIUM	1.6	3.22	0.58	3.07	54.67
TEMPERATURE, FIELD	-0.577	3.81	0.58	3.63	58.3
COPPER	0.429	4.59	0.29	4.37	62.67
ANTIMONY	1.75	5.36	0.43	5.1	67.77
OXIDATION-REDUCTION POTENTIAL, LAB	-1.71	6.56	0.6	6.25	74.02

Group 2

Average squared distance = 79.34

Species	Av.Value	Av.Sq.Dist	Sq.Dist/SD	Contrib%	Cum.%
ALKALINITY, HYDROXIDE (As CaCO3), lab measured.	-0.311	0.000216	0.57	0	0
TURBIDITY, LAB	-0.305	0.00156	0.44	0	0
TOTAL SUSPENDED SOLIDS, LAB	-0.352	0.00209	0.45	0	0
IRON	-0.482	0.00269	0.52	0	0.01
ALUMINUM	-0.473	0.00531	0.36	0.01	0.01
CHLORIDE	-0.334	0.0225	0.53	0.03	0.04
LEAD	-0.34	0.0341	0.4	0.04	0.09
MANGANESE	-0.284	0.0615	0.39	0.08	0.16
BARIUM	-0.439	0.109	0.54	0.14	0.3
CHROMIUM	-0.796	0.132	0.54	0.17	0.47
LITHIUM	0.207	0.163	0.54	0.21	0.67
ANTIMONY	0.299	0.205	0.6	0.26	0.93
ORTHO-PHOSPHATE	-0.478	0.206	0.42	0.26	1.19
POTASSIUM	0.892	0.263	0.55	0.33	1.52
VA0DIUM	-0.163	0.391	0.57	0.49	2.02
MOLYBDENUM	0.164	0.441	0.51	0.56	2.57
COPPER	0.0893	0.473	0.4	0.6	3.17
MERCURY	-0.475	0.548	0.5	0.69	3.86
NITROGEN, AMMONIA (AS N)	-0.0681	0.646	0.49	0.81	4.67
TOTAL KJELDAHL NITROGEN	0.114	0.747	0.55	0.94	5.62
NITRITE NITROGEN (NO2), AS N	0.107	0.748	0.38	0.94	6.56
BORON	0.256	0.83	0.51	1.05	7.6
COBALT	0.195	0.961	0.35	1.21	8.82
PHOSPHORUS	-0.0726	0.969	0.49	1.22	10.04
Selenium	0.128	0.971	0.54	1.22	11.26
Sulphate (as SO4)	0.195	1.02	0.54	1.29	12.55
ARSENIC	0.151	1.05	0.42	1.32	13.87
DISSOLVED OXYGEN, FIELD	-0.556	1.05	0.57	1.33	15.2
URANIUM	1.24	1.14	0.52	1.44	16.64
STRONTIUM	0.254	1.16	0.47	1.46	18.1

TITANIUM	0.254	1.38	0.47	1.74	19.84
ZINC	0.315	1.44	0.49	1.81	21.65
SILICON	0.563	1.44	0.58	1.81	23.46
ALKALINITY, CARBO0TE (As CaCO3), lab measured.	-0.218	1.47	0.48	1.85	25.31
MAGNESIUM	1.46	1.5	0.53	1.89	27.2
THALLIUM	0.568	1.55	0.49	1.96	29.16
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	0.214	1.55	0.58	1.96	31.12
MAJOR ANION SUM	0.17	1.59	0.58	2	33.12
MAJOR CATION SUM	0.167	1.61	0.58	2.03	35.14
TOTAL ORGANIC CARBON	-0.316	1.93	0.5	2.43	37.58
CONDUCTIVITY, LAB	0.179	1.93	0.58	2.44	40.01
Hardness, Total or Dissolved CaCO3	1.61	1.98	0.5	2.5	42.51
ACIDITY TO pH 8.3 (As CaCO3)	0.303	2.04	0.46	2.57	45.09
Nickel	0.463	2.26	0.38	2.85	47.94
CARBON, DISSOLVED ORGANIC	-0.196	2.38	0.49	3	50.94
TEMPERATURE, FIELD	-0.618	2.49	0.56	3.14	54.08
BROMIDE	0.467	2.55	0.53	3.22	57.3
WS Ratio %	1.18	2.68	0.45	3.38	60.67
CALCIUM	1.76	2.89	0.46	3.64	64.31
SODIUM	0.566	2.92	0.44	3.68	67.99
Cadmium	0.738	3.15	0.5	3.96	71.96

Group 2.5

Average squared distance = 77.95

Species	Av.Value	Av.Sq.Dist	Sq.Dist/SD	Contrib%	Cum.%
TURBIDITY, LAB	-0.303	0.000673	0.39	0	0
TOTAL SUSPENDED SOLIDS, LAB	-0.328	0.00127	0.33	0	0
ALKALINITY, HYDROXIDE (As CaCO3), lab measured.	-0.28	0.00753	0.26	0.01	0.01
ALUMINUM	-0.462	0.0117	0.29	0.02	0.03
IRON	-0.442	0.0174	0.36	0.02	0.05
CHLORIDE	-0.0997	0.0306	0.53	0.04	0.09
LEAD	-0.311	0.0428	0.41	0.05	0.14
BARIUM	-0.644	0.0653	0.43	0.08	0.23
CHROMIUM	-0.397	0.0942	0.45	0.12	0.35
ARSENIC	-0.307	0.188	0.52	0.24	0.59
LITHIUM	0.504	0.267	0.54	0.34	0.93
TOTAL ORGANIC CARBON	-0.398	0.278	0.34	0.36	1.29
CARBON, DISSOLVED ORGANIC	-0.265	0.307	0.33	0.39	1.68
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	1.66	0.311	0.38	0.4	2.08
CALCIUM	1.51	0.311	0.42	0.4	2.48
ALKALINITY, TOTAL (As CaCO3), lab measured.	1.61	0.318	0.38	0.41	2.89
VA0DIUM	-0.361	0.318	0.44	0.41	3.3

POTASSIUM	1.48	0.359	0.53	0.46	3.76
OXIDATION-REDUCTION POTENTIAL, LAB	0.16	0.385	0.51	0.49	4.25
Hardness, Total or Dissolved CaCO3	1.52	0.391	0.47	0.5	4.75
SILICON	-0.362	0.41	0.46	0.53	5.28
MAJOR CATION SUM	1.76	0.422	0.5	0.54	5.82
TEMPERATURE, FIELD	0.0788	0.426	0.51	0.55	6.37
CONDUCTIVITY, LAB	1.68	0.435	0.51	0.56	6.92
ANTIMONY	0.483	0.442	0.55	0.57	7.49
TITANIUM	-0.0432	0.446	0.3	0.57	8.06
DISSOLVED OXYGEN, FIELD	-0.213	0.454	0.38	0.58	8.65
MOLYBDENUM	0.121	0.458	0.48	0.59	9.23
MERCURY	-0.048	0.474	0.5	0.61	9.84
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	1.76	0.498	0.5	0.64	10.48
URANIUM	1.62	0.515	0.52	0.66	11.14
MAJOR ANION SUM	1.72	0.52	0.52	0.67	11.81
COPPER	-0.169	0.528	0.41	0.68	12.49
MAGNESIUM	1.51	0.63	0.53	0.81	13.29
ORTHO-PHOSPHATE	-0.227	0.709	0.33	0.91	14.2
TOTAL KJELDAHL NITROGEN	0.0203	0.753	0.53	0.97	15.17
MANGANESE	0.0456	0.776	0.41	1	16.17
FLUORIDE	0.519	0.853	0.48	1.09	17.26
NITRITE NITROGEN (NO2), AS N	0.531	0.871	0.33	1.12	18.38
PHOSPHORUS	-0.224	0.887	0.44	1.14	19.52
Sulphate (as SO4)	1.54	1.03	0.57	1.32	20.83
BROMIDE	1.64	1.25	0.55	1.6	22.43
ZINC	0.529	2.03	0.47	2.61	25.04
STRONTIUM	0.448	2.05	0.42	2.63	27.67
THALLIUM	1.76	2.17	0.46	2.78	30.45
BORON	0.672	2.19	0.4	2.81	33.26
Selenium	1.1	2.51	0.58	3.22	36.48
ALKALINITY, CARBO0TE (As CaCO3), lab measured.	0.201	2.63	0.36	3.37	39.85
ACIDITY TO pH 8.3 (As CaCO3)	0.737	2.74	0.35	3.51	43.36
WS Ratio %	1.53	3.02	0.48	3.88	47.24
Cadmium	1.01	4.1	0.44	5.26	52.5
NITRATE NITROGEN (NO3), AS N	1.05	4.66	0.44	5.97	58.47
SODIUM	0.868	5.24	0.38	6.73	65.2
NITROGEN, AMMONIA (AS N)	1.17	6.71	0.38	8.61	73.8

Group 3

Average squared distance = 62.24

Species	Av.Value	Av.Sq.Dist	Sq.Dist/SD	Contrib%	Cum.%
TURBIDITY, LAB	-0.315	0.000333	0.32	0	0

ALUMINUM	-0.502	0.000677	0.32	0	0
TOTAL SUSPENDED SOLIDS, LAB	-0.334	0.000972	0.47	0	0
LEAD	-0.403	0.00204	0.39	0	0.01
IRON	-0.491	0.00378	0.28	0.01	0.01
CHLORIDE	-0.0736	0.0444	0.51	0.07	0.08
BARIUM	-0.612	0.0548	0.56	0.09	0.17
CARBON, DISSOLVED ORGANIC	-0.48	0.0623	0.51	0.1	0.27
TOTAL ORGANIC CARBON	-0.605	0.0697	0.46	0.11	0.38
CHROMIUM	-0.345	0.0953	0.52	0.15	0.54
COPPER	-0.425	0.101	0.39	0.16	0.7
URANIUM	1.65	0.184	0.51	0.29	0.99
MERCURY	-0.165	0.196	0.46	0.32	1.31
CALCIUM	1.82	0.205	0.52	0.33	1.64
CONDUCTIVITY, LAB	2	0.23	0.53	0.37	2.01
VA0DIUM	-0.497	0.23	0.36	0.37	2.38
OXIDATION-REDUCTION POTENTIAL, LAB	0.29	0.233	0.5	0.37	2.75
DISSOLVED OXYGEN, FIELD	-0.124	0.251	0.29	0.4	3.16
ARSENIC	-0.237	0.262	0.58	0.42	3.58
MOLYBDENUM	-0.0845	0.262	0.48	0.42	4
LITHIUM	0.379	0.27	0.56	0.43	4.43
MANGANESE	-0.218	0.278	0.27	0.45	4.88
Hardness, Total or Dissolved CaCO3	1.83	0.312	0.55	0.5	5.38
MAJOR CATION SUM	2.05	0.333	0.55	0.54	5.92
MAJOR ANION SUM	2.03	0.345	0.54	0.55	6.47
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	1.99	0.369	0.55	0.59	7.07
ANTIMONY	0.223	0.436	0.49	0.7	7.77
TEMPERATURE, FIELD	-0.256	0.441	0.56	0.71	8.48
POTASSIUM	1.29	0.451	0.54	0.72	9.2
MAGNESIUM	1.8	0.524	0.55	0.84	10.04
ALKALINITY, TOTAL (As CaCO3), lab measured.	1.86	0.555	0.47	0.89	10.93
PHOSPHORUS	-0.351	0.626	0.36	1.01	11.94
TITANIUM	-0.0154	0.654	0.34	1.05	12.99
BROMIDE	1.39	0.655	0.45	1.05	14.04
ALKALINITY, CARBO0TE (As CaCO3), lab measured.	-0.393	0.69	0.47	1.11	15.15
NITRITE NITROGEN (NO2), AS N	0.523	0.743	0.33	1.19	16.34
SILICON	0.126	0.798	0.56	1.28	17.63
ZINC	0.194	0.869	0.5	1.4	19.02
STRONTIUM	0.15	0.893	0.32	1.44	20.46
Sulphate (as SO4)	1.82	0.902	0.55	1.45	21.91
BORON	0.137	0.945	0.38	1.52	23.43
ORTHO-PHOSPHATE	0.198	1.18	0.51	1.9	25.32
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	1.69	1.21	0.41	1.95	27.27
FLUORIDE	0.155	1.25	0.45	2.01	29.28

SODIUM	0.155	1.42	0.34	2.29	31.57
TOTAL KJELDAHL NITROGEN	0.157	1.55	0.42	2.49	34.06
Selenium	1.72	2.43	0.54	3.9	37.95
ALKALINITY, HYDROXIDE (As CaCO3), lab measured.	0.25	2.82	0.29	4.53	42.49
WS Ratio %	1.49	2.86	0.46	4.6	47.09
THALLIUM	1.24	2.94	0.5	4.72	51.81
NITRATE NITROGEN (NO3), AS N	1.31	3.26	0.47	5.24	57.06
Cadmium	0.899	3.31	0.46	5.32	62.38
Nickel	0.866	3.92	0.33	6.3	68.68
COBALT	0.5	5.12	0.26	8.23	76.91

Groups 0 and 0.5

Average squared distance = 83.65

Variable	Grp 0 Av.Value	Gr 0.5 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
CHLORIDE	-0.249	0.451	3.3	0.43	3.94	3.94
MANGANESE	-0.0661	0.25	3.01	0.25	3.59	7.54
LEAD	0.213	0.0304	2.7	0.27	3.22	10.76
MERCURY	-0.26	0.314	2.68	0.36	3.2	13.96
IRON	0.178	0.156	2.68	0.32	3.2	17.16
TOTAL SUSPENDED SOLIDS, LAB	0.286	-0.0377	2.67	0.27	3.19	20.35
TURBIDITY, LAB	0.278	-0.0743	2.66	0.25	3.18	23.53
ARSENIC	0.0108	0.14	2.58	0.43	3.09	26.62
BARIUM	0.0418	0.223	2.54	0.45	3.04	29.66
CHROMIUM	0.279	0.091	2.51	0.37	3	32.66
VA0DIUM	0.374	-0.102	2.47	0.43	2.96	35.61
ALUMINUM	0.248	0.0213	2.42	0.33	2.89	38.51
ORTHO-PHOSPHATE	0.206	-0.0302	2.38	0.56	2.84	41.35
PHOSPHORUS	0.373	-0.0932	2.3	0.85	2.76	44.1
SILICON	-0.0403	0.117	2.24	0.49	2.67	46.78
MOLYBDENUM	-0.161	-0.00085	2.01	0.27	2.4	49.18
TOTAL ORGANIC CARBON	0.153	-0.0512	1.98	0.62	2.37	51.55
COPPER	0.261	-0.141	1.93	0.39	2.31	53.86
DISSOLVED OXYGEN, FIELD	0.141	0.0278	1.92	0.22	2.3	56.16
CARBON, DISSOLVED ORGANIC	0.0926	-0.0748	1.91	0.6	2.28	58.44
TITANIUM	0.131	-0.156	1.79	0.2	2.14	60.57
FLUORIDE	0.0498	0.0898	1.78	0.56	2.13	62.7
ALKALINITY, CARBO0TE (As CaCO3), lab measured.	0.0105	-0.127	1.73	0.49	2.07	64.77
ALKALINITY, HYDROXIDE (As CaCO3), lab measured.	-0.189	0.0761	1.69	0.27	2.02	66.8
TEMPERATURE, FIELD	-0.0187	0.03	1.61	0.65	1.93	68.72
TOTAL KJELDAHL NITROGEN	-0.272	-0.0449	1.49	0.54	1.79	70.51

Groups 0 and 1

Average squared distance = 85.78

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
TITANIUM	0.131	-0.13	3.08	0.24	3.59	3.59
STRONTIUM	-0.248	0.275	2.73	0.56	3.19	6.78
TURBIDITY, LAB	0.278	-0.213	2.62	0.24	3.06	9.84
TOTAL SUSPENDED SOLIDS, LAB	0.286	-0.255	2.52	0.24	2.94	12.77
ALKALINITY, HYDROXIDE (As CaCO3), lab measured.	-0.189	0.371	2.5	0.45	2.91	15.68
TOTAL KJELDAHL NITROGEN	-0.272	0.519	2.46	0.61	2.87	18.55
VA0DIUM	0.374	-0.403	2.37	0.43	2.76	21.31
DISSOLVED OXYGEN, FIELD	0.141	0.152	2.36	0.24	2.76	24.06
ZINC	-0.121	0.122	2.36	0.4	2.75	26.81
BORON	-0.22	0.134	2.28	0.48	2.65	29.47
ALUMINUM	0.248	-0.197	2.26	0.34	2.64	32.1
PHOSPHORUS	0.373	-0.505	2.26	0.8	2.63	34.73
CARBON, DISSOLVED ORGANIC	0.0926	0.213	2.24	0.67	2.62	37.35
TOTAL ORGANIC CARBON	0.153	0.116	2.16	0.67	2.52	39.87
COPPER	0.261	-0.301	2.11	0.43	2.46	42.33
LEAD	0.213	-0.231	2	0.24	2.34	44.66
Sulphate (as SO4)	-0.364	0.316	1.99	0.52	2.32	46.98
ORTHO-PHOSPHATE	0.206	-0.238	1.97	0.5	2.3	49.28
ALKALINITY, CARBO0TE (As CaCO3), lab measured.	0.0105	0.342	1.94	0.63	2.26	51.54
CHROMIUM	0.279	-0.288	1.9	0.36	2.22	53.76
TEMPERATURE, FIELD	-0.0187	0.326	1.86	0.69	2.17	55.93
Selenium	-0.355	0.424	1.84	0.57	2.15	58.08
Cadmium	-0.221	0.183	1.74	0.36	2.02	60.1
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	-0.405	0.306	1.72	0.57	2.01	62.11
MAJOR ANION SUM	-0.409	0.301	1.68	0.57	1.96	64.06
MERCURY	-0.26	0.331	1.68	0.7	1.95	66.02
IRON	0.178	-0.252	1.64	0.3	1.91	67.93
CONDUCTIVITY, LAB	-0.404	0.325	1.64	0.61	1.91	69.84
SILICON	-0.0403	-0.0791	1.63	0.43	1.9	71.74

Groups 0.5 and 1

Average squared distance = 81.45

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%

CHLORIDE	0.451	-0.0403	3.18	0.45	3.9	3.9
ZINC	-0.113	0.122	2.89	0.4	3.55	7.45
ALKALINITY, HYDROXIDE (As CaCO3), lab measured.	0.0761	0.371	2.89	0.45	3.55	11
MANGANESE	0.25	-0.146	2.83	0.24	3.47	14.47
STRONTIUM	0.00292	0.275	2.74	0.6	3.36	17.83
BORON	-0.0304	0.134	2.58	0.52	3.17	21
ARSENIC	0.14	-0.169	2.39	0.38	2.93	23.93
TOTAL KJELDAHL NITROGEN	-0.0449	0.519	2.38	0.62	2.93	26.86
BARIUM	0.223	0.0187	2.23	0.43	2.74	29.6
TEMPERATURE, FIELD	0.03	0.326	2.16	0.73	2.65	32.25
Cadmium	-0.17	0.183	2.14	0.38	2.63	34.88
MERCURY	0.314	0.331	2.05	0.33	2.51	37.4
CARBON, DISSOLVED ORGANIC	-0.0748	0.213	2.02	0.62	2.49	39.88
Sulphate (as SO4)	-0.301	0.316	1.95	0.52	2.4	42.28
TOTAL ORGANIC CARBON	-0.0512	0.116	1.85	0.67	2.28	44.56
Selenium	-0.288	0.424	1.81	0.58	2.22	46.78
IRON	0.156	-0.252	1.8	0.24	2.21	48.99
TITANIUM	-0.156	-0.13	1.7	0.17	2.09	51.07
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	-0.281	0.306	1.61	0.56	1.98	53.05
ALKALINITY, CARBO0TE (As CaCO3), lab measured.	-0.127	0.342	1.57	0.76	1.93	54.98
MAJOR ANION SUM	-0.263	0.301	1.55	0.57	1.91	56.89
FLUORIDE	0.0898	-0.165	1.54	0.51	1.89	58.78
CONDUCTIVITY, LAB	-0.256	0.325	1.54	0.61	1.89	60.67
MAJOR CATION SUM	-0.267	0.295	1.51	0.58	1.86	62.52
ALUMINUM	0.0213	-0.197	1.49	0.24	1.83	64.35
SILICON	0.117	-0.0791	1.43	0.47	1.76	66.11
MAGNESIUM	-0.347	0.172	1.43	0.58	1.76	67.86
DISSOLVED OXYGEN, FIELD	0.0278	0.152	1.41	0.2	1.73	69.6
CHROMIUM	0.091	-0.288	1.36	0.24	1.67	71.27

Groups 0 and 1.5

Average squared distance = 182.96

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
LITHIUM	-0.285	2.59	17.6	0.87	9.62	9.62
NITRITE NITROGEN (NO2), AS N	-0.169	0.91	17.4	0.29	9.48	19.1
OXIDATION-REDUCTION POTENTIAL, LAB	0.15	-1.71	10	0.93	5.48	24.58
ANTIMONY	-0.141	1.75	9.63	0.54	5.26	29.84
POTASSIUM	-0.328	1.6	7.26	0.92	3.97	33.81
URANIUM	-0.472	1.53	6.85	0.93	3.74	37.55
MOLYBDENUM	-0.161	1.4	6.17	0.63	3.37	40.93

COPPER	0.261	0.429	5.46	0.37	2.98	43.91
TEMPERATURE, FIELD	-0.0187	-0.577	4.47	1.09	2.44	46.35
THALLIUM	-0.192	1.05	4.34	0.82	2.37	48.72
TOTAL KJELDAHL NITROGEN	-0.272	0.569	4.11	0.4	2.25	50.97
FLUORIDE	0.0498	-1.21	4.05	0.87	2.21	53.18
DISSOLVED OXYGEN, FIELD	0.141	-1.2	3.96	0.36	2.17	55.35
MAGNESIUM	-0.472	0.959	3.35	1.05	1.83	57.18
WS Ratio %	-0.372	1.03	3.31	0.97	1.81	58.98
ALKALINITY, TOTAL (As CaCO3), lab measured.	-0.33	-0.93	3.25	1.03	1.77	60.76
Hardness, Total or Dissolved CaCO3	-0.476	0.93	3.23	1.07	1.76	62.52
CALCIUM	-0.466	0.876	3.03	1.01	1.65	64.18
CARBON, DISSOLVED ORGANIC	0.0926	-0.0145	2.77	0.77	1.52	65.69
TOTAL ORGANIC CARBON	0.153	0.0356	2.75	0.75	1.5	67.2
SILICON	-0.0403	-0.281	2.7	0.56	1.47	68.67
CHROMIUM	0.279	-0.626	2.69	0.43	1.47	70.14

Groups 0.5 and 1.5

Average squared distance = 181.34

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
NITRITE NITROGEN (NO2), AS N	-0.149	0.91	17.4	0.29	9.59	9.59
LITHIUM	-0.191	2.59	17.2	0.87	9.49	19.08
OXIDATION-REDUCTION POTENTIAL, LAB	0.0791	-1.71	9.76	0.94	5.38	24.46
ANTIMONY	-0.201	1.75	9.09	0.56	5.01	29.48
POTASSIUM	-0.318	1.6	7.28	0.92	4.01	33.49
URANIUM	-0.368	1.53	6.63	0.92	3.65	37.14
MOLYBDENUM	-0.00085	1.4	5.46	0.67	3.01	40.15
COPPER	-0.141	0.429	5.14	0.32	2.84	42.99
TEMPERATURE, FIELD	0.03	-0.577	4.86	0.99	2.68	45.67
FLUORIDE	0.0898	-1.21	4.56	0.74	2.51	48.18
THALLIUM	-0.3	1.05	4.43	0.83	2.44	50.62
TOTAL KJELDAHL NITROGEN	-0.0449	0.569	4.01	0.41	2.21	52.83
ALKALINITY, TOTAL (As CaCO3), lab measured.	-0.0889	-0.93	3.88	0.88	2.14	54.97
CHLORIDE	0.451	-0.386	3.34	0.42	1.84	56.81
WS Ratio %	-0.32	1.03	3.27	0.96	1.8	58.62
MAGNESIUM	-0.347	0.959	3.09	1.01	1.71	60.33
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.101	-0.912	3.08	0.82	1.7	62.02
Hardness, Total or Dissolved CaCO3	-0.348	0.93	2.96	1.03	1.63	63.66
MANGANESE	0.25	-0.246	2.8	0.23	1.55	65.2
CALCIUM	-0.342	0.876	2.8	0.97	1.54	66.75
ARSENIC	0.14	0.0895	2.78	0.45	1.53	68.28

DISSOLVED OXYGEN, FIELD	0.0278	-1.2	2.7	0.56	1.49	69.77
MERCURY	0.314	-0.509	2.66	0.34	1.47	71.24

Groups 1 and 1.5

Average squared distance = 167.54

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
NITRITE NITROGEN (NO2), AS N	0.0773	0.91	17	0.3	10.16	10.16
LITHIUM	0.0201	2.59	15.9	0.86	9.46	19.62
OXIDATION-REDUCTION POTENTIAL, LAB	0.0366	-1.71	9.33	0.95	5.57	25.19
ANTIMONY	-0.0395	1.75	8.58	0.54	5.12	30.31
POTASSIUM	-0.124	1.6	6.15	0.92	3.67	33.98
TEMPERATURE, FIELD	0.326	-0.577	5.44	0.93	3.25	37.23
COPPER	-0.301	0.429	5.37	0.33	3.21	40.44
URANIUM	0.113	1.53	5.29	0.86	3.16	43.6
MOLYBDENUM	-0.0321	1.4	5.13	0.64	3.06	46.66
THALLIUM	-0.357	1.05	4.48	0.83	2.67	49.33
TOTAL KJELDAHL NITROGEN	0.519	0.569	4.03	0.47	2.4	51.73
ALKALINITY, TOTAL (As CaCO3), lab measured.	0.0798	-0.93	3.64	1	2.18	53.91
DISSOLVED OXYGEN, FIELD	0.152	-1.2	3.48	0.39	2.08	55.98
FLUORIDE	-0.165	-1.21	3.24	0.93	1.94	57.92
BORON	0.134	0.52	2.91	0.7	1.74	59.66
CARBON, DISSOLVED ORGANIC	0.213	-0.0145	2.88	0.76	1.72	61.38
CONDUCTIVITY, LAB	0.325	-0.416	2.85	0.8	1.7	63.08
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.103	-0.912	2.79	0.96	1.67	64.75
MAJOR ANION SUM	0.301	-0.309	2.78	0.76	1.66	66.41
MAJOR CATION SUM	0.295	-0.325	2.68	0.77	1.6	68.01
Selenium	0.424	0.116	2.67	0.68	1.59	69.6
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	0.306	-0.273	2.64	0.73	1.58	71.18

Groups 0 and 2

Average squared distance = 146.88

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
CALCIUM	-0.466	1.76	7.83	0.75	5.33	5.33
OXIDATION-REDUCTION POTENTIAL, LAB	0.15	-1.27	7.42	0.73	5.05	10.38
NITRATE NITROGEN (NO3), AS N	-0.255	0.794	6.74	0.55	4.59	14.97
Hardness, Total or Dissolved CaCO3	-0.476	1.61	6.44	0.89	4.38	19.35
MAGNESIUM	-0.472	1.46	5.37	0.98	3.66	23.01

WS Ratio %	-0.372	1.18	4.98	0.58	3.39	26.4
URANIUM	-0.472	1.24	4.14	1	2.82	29.22
FLUORIDE	0.0498	-0.149	3.97	0.93	2.7	31.92
Cadmium	-0.221	0.738	3.78	0.57	2.57	34.5
ALKALINITY, TOTAL (As CaCO3), lab measured.	-0.33	-0.0861	3.76	1.26	2.56	37.06
SODIUM	-0.276	0.566	3.69	0.51	2.51	39.57
BROMIDE	-0.283	0.467	3.45	0.69	2.35	41.92
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.244	0.0776	3.35	1.27	2.28	44.2
CARBON, DISSOLVED ORGANIC	0.0926	-0.196	3.28	0.75	2.23	46.44
TEMPERATURE, FIELD	-0.0187	-0.618	3.21	0.82	2.19	48.63
TOTAL ORGANIC CARBON	0.153	-0.316	3.07	0.73	2.09	50.72
SILICON	-0.0403	0.563	2.87	0.75	1.95	52.67
DISSOLVED OXYGEN, FIELD	0.141	-0.556	2.86	0.3	1.95	54.61
TITANIUM	0.131	0.254	2.75	0.32	1.87	56.48
CHROMIUM	0.279	-0.796	2.69	0.42	1.83	58.32
TURBIDITY, LAB	0.278	-0.305	2.69	0.24	1.83	60.15
TOTAL SUSPENDED SOLIDS, LAB	0.286	-0.352	2.62	0.25	1.78	61.93
Nickel	-0.23	0.463	2.51	0.39	1.71	63.64
ALKALINITY, CARBO0TE (As CaCO3), lab measured.	0.0105	-0.218	2.45	0.59	1.67	65.31
CONDUCTIVITY, LAB	-0.404	0.179	2.43	1.16	1.65	66.96
THALLIUM	-0.192	0.568	2.39	0.63	1.63	68.59
PHOSPHORUS	0.373	-0.0726	2.32	0.86	1.58	70.17

Groups 0.5 and 2

Average squared distance = 142.37

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
CALCIUM	-0.342	1.76	7.38	0.72	5.18	5.18
OXIDATION-REDUCTION POTENTIAL, LAB	0.0791	-1.27	7.22	0.74	5.07	10.26
NITRATE NITROGEN (NO3), AS N	-0.288	0.794	6.8	0.55	4.77	15.03
Hardness, Total or Dissolved CaCO3	-0.348	1.61	6	0.86	4.22	19.24
MAGNESIUM	-0.347	1.46	4.99	0.94	3.51	22.75
WS Ratio %	-0.32	1.18	4.93	0.58	3.47	26.22
FLUORIDE	0.0898	-0.149	4.39	0.81	3.09	29.3
Cadmium	-0.17	0.738	4.13	0.59	2.9	32.2
ALKALINITY, TOTAL (As CaCO3), lab measured.	-0.0889	-0.0861	3.99	1	2.8	35.01
URANIUM	-0.368	1.24	3.98	0.97	2.8	37.8
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.101	0.0776	3.68	1.03	2.59	40.39
SODIUM	0.0272	0.566	3.67	0.55	2.58	42.97
TEMPERATURE, FIELD	0.03	-0.618	3.61	0.8	2.53	45.5

BROMIDE	-0.096	0.467	3.3	0.72	2.32	47.82
CHLORIDE	0.451	-0.334	3.26	0.42	2.29	50.11
CARBON, DISSOLVED ORGANIC	-0.0748	-0.196	2.92	0.71	2.05	52.17
MANGANESE	0.25	-0.284	2.88	0.24	2.03	54.19
ARSENIC	0.14	0.151	2.77	0.46	1.95	56.14
MERCURY	0.314	-0.475	2.64	0.34	1.86	58
TOTAL ORGANIC CARBON	-0.0512	-0.316	2.59	0.74	1.82	59.82
Nickel	-0.202	0.463	2.57	0.4	1.81	61.62
ZINC	-0.113	0.315	2.47	0.48	1.73	63.36
SILICON	0.117	0.563	2.47	0.78	1.73	65.09
ACIDITY TO pH 8.3 (As CaCO3)	0.00437	0.303	2.45	0.59	1.72	66.81
CONDUCTIVITY, LAB	-0.256	0.179	2.37	1.11	1.67	68.48
THALLIUM	-0.3	0.568	2.37	0.64	1.67	70.15

Groups 1 and 2

Average squared distance = 124.83

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
OXIDATION-REDUCTION POTENTIAL, LAB	0.0366	-1.27	6.82	0.73	5.47	5.47
NITRATE NITROGEN (NO3), AS N	0.339	0.794	6.08	0.62	4.87	10.33
CALCIUM	0.108	1.76	5.92	0.66	4.75	15.08
Cadmium	0.183	0.738	4.61	0.65	3.69	18.77
Hardness, Total or Dissolved CaCO3	0.149	1.61	4.6	0.77	3.69	22.46
TEMPERATURE, FIELD	0.326	-0.618	4.21	0.77	3.37	25.83
WS Ratio %	0.00453	1.18	3.93	0.53	3.15	28.98
MAGNESIUM	0.172	1.46	3.75	0.86	3	31.99
FLUORIDE	-0.165	-0.149	3.62	1.12	2.9	34.89
ALKALINITY, TOTAL (As CaCO3), lab measured.	0.0798	-0.0861	3.47	1.09	2.78	37.66
CARBON, DISSOLVED ORGANIC	0.213	-0.196	3.43	0.77	2.75	40.41
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.103	0.0776	3.4	1.13	2.72	43.13
SODIUM	0.0974	0.566	3.38	0.54	2.71	45.84
ZINC	0.122	0.315	3.14	0.57	2.51	48.35
BROMIDE	-0.128	0.467	3	0.72	2.41	50.76
TOTAL ORGANIC CARBON	0.116	-0.316	2.92	0.78	2.34	53.1
URANIUM	0.113	1.24	2.92	0.84	2.34	55.44
STRONTIUM	0.275	0.254	2.9	0.67	2.32	57.77
TITANIUM	-0.13	0.254	2.87	0.29	2.3	60.07
Nickel	0.0193	0.463	2.49	0.42	1.99	62.06
CONDUCTIVITY, LAB	0.325	0.179	2.47	0.82	1.98	64.04
BORON	0.134	0.256	2.39	0.6	1.91	65.96
THALLIUM	-0.357	0.568	2.37	0.63	1.9	67.85

DISSOLVED OXYGEN, FIELD	0.152	-0.556	2.36	0.3	1.89	69.74
ALKALINITY, CARBO0TE (As CaCO3), lab measured.	0.342	-0.218	2.35	0.9	1.89	71.63

Groups 1.5 and 2

Average squared distance = 190.36

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
NITRITE NITROGEN (NO2), AS N	0.91	0.107	17.4	0.3	9.13	9.13
LITHIUM	2.59	0.207	14.9	0.86	7.83	16.96
OXIDATION-REDUCTION POTENTIAL, LAB	-1.71	-1.27	11.1	0.96	5.84	22.8
ANTIMONY	1.75	0.299	7.24	0.51	3.8	26.6
NITRATE NITROGEN (NO3), AS N	-0.363	0.794	6.94	0.55	3.64	30.25
ALKALINITY, TOTAL (As CaCO3), lab measured.	-0.93	-0.0861	6.55	0.96	3.44	33.69
FLUORIDE	-1.21	-0.149	6.14	0.95	3.23	36.92
TEMPERATURE, FIELD	-0.577	-0.618	5.73	0.93	3.01	39.93
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.912	0.0776	5.58	0.98	2.93	42.86
COPPER	0.429	0.0893	4.77	0.32	2.51	45.37
MOLYBDENUM	1.4	0.164	4.54	0.61	2.39	47.75
CALCIUM	0.876	1.76	4.27	0.6	2.24	50
BROMIDE	-0.389	0.467	4.12	0.73	2.16	52.16
Cadmium	-0.357	0.738	4.02	0.57	2.11	54.27
THALLIUM	1.05	0.568	3.98	0.85	2.09	56.36
SODIUM	0.27	0.566	3.85	0.57	2.02	58.38
CARBON, DISSOLVED ORGANIC	-0.0145	-0.196	3.83	0.79	2.01	60.39
URANIUM	1.53	1.24	3.77	0.91	1.98	62.37
POTASSIUM	1.6	0.892	3.71	1.05	1.95	64.32
TOTAL KJELDAHL NITROGEN	0.569	0.114	3.67	0.4	1.93	66.25
CONDUCTIVITY, LAB	-0.416	0.179	3.65	0.96	1.91	68.16
WS Ratio %	1.03	1.18	3.55	0.65	1.86	70.03

Groups 0 and 2.5

Average squared distance = 197.20

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
COBALT	-0.116	1.45	13.7	0.43	6.94	6.94
Nickel	-0.23	1.66	11.5	0.49	5.83	12.77
NITROGEN, AMMONIA (AS N)	-0.23	1.17	8.39	0.41	4.25	17.02
WS Ratio %	-0.372	1.53	6.64	0.67	3.37	20.39
SODIUM	-0.276	0.868	6.61	0.43	3.35	23.74
NITRATE NITROGEN (NO3), AS N	-0.255	1.05	6.29	0.51	3.19	26.93
THALLIUM	-0.192	1.76	6.28	0.84	3.18	30.11

TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	-0.405	1.76	5.52	1.62	2.8	32.91
BROMIDE	-0.283	1.64	5.5	1.15	2.79	35.7
MAJOR CATION SUM	-0.409	1.76	5.44	1.66	2.76	38.46
Cadmium	-0.221	1.01	5.44	0.5	2.76	41.21
MAJOR ANION SUM	-0.409	1.72	5.38	1.55	2.73	43.94
CONDUCTIVITY, LAB	-0.404	1.68	5.14	1.57	2.61	46.55
URANIUM	-0.472	1.62	5.05	1.53	2.56	49.11
Sulphate (as SO4)	-0.364	1.54	4.96	1.25	2.52	51.63
MAGNESIUM	-0.472	1.51	4.82	1.34	2.44	54.07
Selenium	-0.355	1.1	4.74	0.87	2.4	56.47
Hardness, Total or Dissolved CaCO3	-0.476	1.52	4.68	1.63	2.37	58.85
CALCIUM	-0.466	1.51	4.5	1.71	2.28	61.13
ALKALINITY, TOTAL (As CaCO3), lab measured.	-0.33	1.61	4.45	1.26	2.26	63.38
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.244	1.66	4.26	1.22	2.16	65.55
POTASSIUM	-0.328	1.48	4.17	1.32	2.12	67.66
ACIDITY TO pH 8.3 (As CaCO3)	-0.238	0.737	3.61	0.4	1.83	69.49
ALKALINITY, CARBO0TE (As CaCO3), lab measured.	0.0105	0.201	3.6	0.48	1.82	71.32

Groups 0.5 and 2.5

Average squared distance = 187.17

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
COBALT	-0.131	1.45	13.7	0.43	7.33	7.33
Nickel	-0.202	1.66	11.5	0.49	6.14	13.47
NITROGEN, AMMONIA (AS N)	-0.0141	1.17	7.95	0.41	4.25	17.71
WS Ratio %	-0.32	1.53	6.56	0.67	3.5	21.22
THALLIUM	-0.3	1.76	6.52	0.86	3.48	24.7
SODIUM	0.0272	0.868	6.41	0.45	3.43	28.12
NITRATE NITROGEN (NO3), AS N	-0.288	1.05	6.36	0.51	3.4	31.52
Cadmium	-0.17	1.01	5.76	0.52	3.08	34.6
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	-0.281	1.76	5.05	1.51	2.7	37.3
BROMIDE	-0.096	1.64	4.91	1.05	2.62	39.92
MAJOR CATION SUM	-0.267	1.76	4.91	1.5	2.62	42.54
MAJOR ANION SUM	-0.263	1.72	4.84	1.42	2.59	45.13
URANIUM	-0.368	1.62	4.81	1.46	2.57	47.7
Sulphate (as SO4)	-0.301	1.54	4.77	1.22	2.55	50.25
CONDUCTIVITY, LAB	-0.256	1.68	4.64	1.41	2.48	52.72
Selenium	-0.288	1.1	4.61	0.87	2.46	55.19
MAGNESIUM	-0.347	1.51	4.42	1.26	2.36	57.55
Hardness, Total or Dissolved CaCO3	-0.348	1.52	4.27	1.49	2.28	59.83

POTASSIUM	-0.318	1.48	4.19	1.29	2.24	62.07
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.101	1.66	4.14	1.08	2.21	64.28
CALCIUM	-0.342	1.51	4.12	1.53	2.2	66.48
ALKALINITY, TOTAL (As CaCO3), lab measured.	-0.0889	1.61	3.86	1.09	2.06	68.54
ACIDITY TO pH 8.3 (As CaCO3)	0.00437	0.737	3.65	0.42	1.95	70.49

Groups 1 and 2.5

Average squared distance = 156.31

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
COBALT	-0.141	1.45	13.7	0.43	8.79	8.79
Nickel	0.0193	1.66	10.9	0.49	6.96	15.76
NITROGEN, AMMONIA (AS N)	0.0841	1.17	7.7	0.41	4.93	20.68
THALLIUM	-0.357	1.76	6.65	0.87	4.25	24.94
SODIUM	0.0974	0.868	6.08	0.44	3.89	28.82
Cadmium	0.183	1.01	6.04	0.57	3.87	32.69
WS Ratio %	0.00453	1.53	5.33	0.62	3.41	36.1
NITRATE NITROGEN (NO3), AS N	0.339	1.05	5.32	0.52	3.4	39.5
BROMIDE	-0.128	1.64	4.69	1.04	3	42.5
BORON	0.134	0.672	3.98	0.58	2.54	45.04
ZINC	0.122	0.529	3.9	0.62	2.49	47.54
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.103	1.66	3.86	1.01	2.47	50
STRONTIUM	0.275	0.448	3.82	0.64	2.44	52.45
Selenium	0.424	1.1	3.77	0.89	2.41	54.86
Sulphate (as SO4)	0.316	1.54	3.63	1.1	2.32	57.18
ACIDITY TO pH 8.3 (As CaCO3)	-0.16	0.737	3.57	0.4	2.28	59.47
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	0.306	1.76	3.45	1.28	2.21	61.67
URANIUM	0.113	1.62	3.38	1.12	2.16	63.84
MAJOR ANION SUM	0.301	1.72	3.34	1.25	2.13	65.97
MAJOR CATION SUM	0.295	1.76	3.31	1.3	2.12	68.09
ALKALINITY, CARBO0TE (As CaCO3), lab measured.	0.342	0.201	3.22	0.53	2.06	70.15

Groups 1.5 and 2.5

Average squared distance = 240.03

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
NITRITE NITROGEN (NO2), AS N	0.91	0.531	17	0.31	7.1	7.1
LITHIUM	2.59	0.504	13.7	0.87	5.7	12.8
COBALT	-0.0595	1.45	13.5	0.43	5.63	18.43
Nickel	-0.0144	1.66	11.5	0.5	4.78	23.21

OXIDATION-REDUCTION POTENTIAL, LAB	-1.71	0.16	9.9	0.93	4.13	27.34
ALKALINITY, TOTAL (As CaCO3), lab measured.	-0.93	1.61	9.27	1.03	3.86	31.2
NITROGEN, AMMONIA (AS N)	-0.0806	1.17	8.82	0.44	3.67	34.87
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.912	1.66	8.6	1.14	3.58	38.46
ANTIMONY	1.75	0.483	6.97	0.51	2.9	41.36
NITRATE NITROGEN (NO3), AS N	-0.363	1.05	6.54	0.51	2.73	44.09
SODIUM	0.27	0.868	6.44	0.47	2.68	46.77
BROMIDE	-0.389	1.64	6.41	1.18	2.67	49.44
CONDUCTIVITY, LAB	-0.416	1.68	6.39	1.2	2.66	52.1
MAJOR CATION SUM	-0.325	1.76	6.24	1.24	2.6	54.71
MAJOR ANION SUM	-0.309	1.72	6.2	1.23	2.58	57.29
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	-0.273	1.76	6.05	1.28	2.52	59.81
Cadmium	-0.357	1.01	5.75	0.51	2.4	62.21
FLUORIDE	-1.21	0.519	5.56	0.88	2.32	64.53
COPPER	0.429	-0.169	5.09	0.32	2.12	66.65
Selenium	0.116	1.1	4.92	0.89	2.05	68.7
THALLIUM	1.05	1.76	4.92	0.78	2.05	70.75

Groups 2 and 2.5

Average squared distance = 175.54

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
COBALT	0.195	1.45	13.6	0.44	7.77	7.77
Nickel	0.463	1.66	11.4	0.53	6.47	14.24
NITRATE NITROGEN (NO3), AS N	0.794	1.05	9.85	0.7	5.61	19.85
NITROGEN, AMMONIA (AS N)	-0.0681	1.17	8.39	0.42	4.78	24.63
SODIUM	0.566	0.868	7.6	0.54	4.33	28.96
OXIDATION-REDUCTION POTENTIAL, LAB	-1.27	0.16	7.29	0.73	4.15	33.11
Cadmium	0.738	1.01	6.72	0.67	3.83	36.94
ALKALINITY, TOTAL (As CaCO3), lab measured.	-0.0861	1.61	6.51	0.74	3.71	40.65
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	0.0776	1.66	5.72	0.75	3.26	43.9
WS Ratio %	1.18	1.53	5.34	0.7	3.04	46.95
THALLIUM	0.568	1.76	4.83	0.74	2.75	49.7
BROMIDE	0.467	1.64	4.82	0.96	2.75	52.45
ACIDITY TO pH 8.3 (As CaCO3)	0.303	0.737	4.57	0.52	2.6	55.05
FLUORIDE	-0.149	0.519	4.49	0.8	2.56	57.61
CONDUCTIVITY, LAB	0.179	1.68	4.39	0.83	2.5	60.11
MAJOR CATION SUM	0.167	1.76	4.35	0.87	2.48	62.59
MAJOR ANION SUM	0.17	1.72	4.31	0.86	2.46	65.04

TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	0.214	1.76	4.24	0.89	2.42	67.46
Selenium	0.128	1.1	4.16	0.86	2.37	69.83
ALKALINITY, CARBO0TE (As CaCO3), lab measured.	-0.218	0.201	3.95	0.51	2.25	72.08

Groups 0 and 3

Average squared distance = 188.22

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
ACIDITY TO pH 8.3 (As CaCO3)	-0.238	1.71	10.8	0.53	5.74	5.74
NITROGEN, AMMONIA (AS N)	-0.23	0.441	7.18	0.26	3.82	9.55
Selenium	-0.355	1.72	6.85	1.17	3.64	13.19
MAJOR CATION SUM	-0.409	2.05	6.7	1.84	3.56	16.75
MAJOR ANION SUM	-0.409	2.03	6.6	1.81	3.51	20.25
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	-0.405	1.99	6.44	1.78	3.42	23.67
WS Ratio %	-0.372	1.49	6.35	0.64	3.37	27.05
CONDUCTIVITY, LAB	-0.404	2	6.35	1.92	3.37	30.42
Sulphate (as SO4)	-0.364	1.82	5.96	1.41	3.17	33.59
MAGNESIUM	-0.472	1.8	5.95	1.58	3.16	36.75
Hardness, Total or Dissolved CaCO3	-0.476	1.83	5.94	1.82	3.16	39.91
NITRATE NITROGEN (NO3), AS N	-0.255	1.31	5.72	0.63	3.04	42.95
CALCIUM	-0.466	1.82	5.72	1.91	3.04	45.98
ALKALINITY, TOTAL (As CaCO3), lab measured.	-0.33	1.86	5.71	1.24	3.03	49.02
THALLIUM	-0.192	1.24	5.23	0.73	2.78	51.8
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.244	1.69	5.23	1.11	2.78	54.57
COBALT	-0.116	0.5	5.2	0.26	2.76	57.33
Nickel	-0.23	0.866	4.9	0.36	2.6	59.94
URANIUM	-0.472	1.65	4.86	2.08	2.58	62.52
Cadmium	-0.221	0.899	4.42	0.54	2.35	64.87
BROMIDE	-0.283	1.39	4.03	1.06	2.14	67.01
POTASSIUM	-0.328	1.29	3.6	1.13	1.91	68.92
ALKALINITY, HYDROXIDE (As CaCO3), lab measured.	-0.189	0.25	3.34	0.32	1.77	70.7

Groups 0.5 and 3

Average squared distance = 177.35

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
ACIDITY TO pH 8.3 (As CaCO3)	0.00437	1.71	10.4	0.53	5.84	5.84
NITROGEN, AMMONIA (AS N)	-0.0141	0.441	7.06	0.27	3.98	9.82

Selenium	-0.288	1.72	6.64	1.15	3.74	13.57
WS Ratio %	-0.32	1.49	6.27	0.64	3.54	17.1
MAJOR CATION SUM	-0.267	2.05	6.08	1.66	3.43	20.53
MAJOR ANION SUM	-0.263	2.03	5.97	1.64	3.37	23.9
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	-0.281	1.99	5.91	1.64	3.33	27.23
NITRATE NITROGEN (NO3), AS N	-0.288	1.31	5.81	0.63	3.28	30.51
CONDUCTIVITY, LAB	-0.256	2	5.75	1.68	3.24	33.75
Sulphate (as SO4)	-0.301	1.82	5.73	1.37	3.23	36.98
MAGNESIUM	-0.347	1.8	5.49	1.47	3.1	40.08
Hardness, Total or Dissolved CaCO3	-0.348	1.83	5.45	1.65	3.07	43.15
THALLIUM	-0.3	1.24	5.36	0.74	3.02	46.17
CALCIUM	-0.342	1.82	5.26	1.7	2.96	49.14
COBALT	-0.131	0.5	5.2	0.26	2.93	52.07
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.101	1.69	5.09	1.03	2.87	54.94
ALKALINITY, TOTAL (As CaCO3), lab measured.	-0.0889	1.86	5	1.1	2.82	57.76
Nickel	-0.202	0.866	4.94	0.37	2.78	60.54
Cadmium	-0.17	0.899	4.76	0.55	2.68	63.22
URANIUM	-0.368	1.65	4.61	1.92	2.6	65.82
ALKALINITY, HYDROXIDE (As CaCO3), lab measured.	0.0761	0.25	3.8	0.36	2.14	67.96
POTASSIUM	-0.318	1.29	3.63	1.12	2.05	70.01

Groups 1 and 3

Average squared distance = 144.47

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
ACIDITY TO pH 8.3 (As CaCO3)	-0.16	1.71	10.6	0.53	7.34	7.34
NITROGEN, AMMONIA (AS N)	0.0841	0.441	6.95	0.27	4.81	12.15
THALLIUM	-0.357	1.24	5.43	0.74	3.76	15.91
COBALT	-0.141	0.5	5.22	0.26	3.61	19.52
Cadmium	0.183	0.899	5.12	0.61	3.55	23.07
WS Ratio %	0.00453	1.49	5.06	0.58	3.51	26.57
Selenium	0.424	1.72	4.92	1.04	3.4	29.98
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.103	1.69	4.81	0.99	3.33	33.31
Nickel	0.0193	0.866	4.68	0.37	3.24	36.55
NITRATE NITROGEN (NO3), AS N	0.339	1.31	4.45	0.6	3.08	39.62
ALKALINITY, HYDROXIDE (As CaCO3), lab measured.	0.371	0.25	4.34	0.45	3.01	42.63
Sulphate (as SO4)	0.316	1.82	4.25	1.19	2.95	45.57
MAJOR CATION SUM	0.295	2.05	4.16	1.38	2.88	48.45
MAJOR ANION SUM	0.301	2.03	4.12	1.37	2.85	51.31

TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	0.306	1.99	4.05	1.34	2.8	54.11
MAGNESIUM	0.172	1.8	3.9	1.24	2.7	56.8
Hardness, Total or Dissolved CaCO3	0.149	1.83	3.83	1.37	2.65	59.45
ALKALINITY, TOTAL (As CaCO3), lab measured.	0.0798	1.86	3.81	1.14	2.64	62.09
CALCIUM	0.108	1.82	3.75	1.45	2.59	64.69
CONDUCTIVITY, LAB	0.325	2	3.74	1.39	2.59	67.27
BROMIDE	-0.128	1.39	3.3	0.91	2.28	69.56
URANIUM	0.113	1.65	3.16	1.32	2.19	71.74

Groups 1.5 and 3

Average squared distance = 234.93

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
NITRITE NITROGEN (NO2), AS N	0.91	0.523	16.9	0.31	7.2	7.2
LITHIUM	2.59	0.379	14.2	0.86	6.06	13.26
ACIDITY TO pH 8.3 (As CaCO3)	-0.553	1.71	12.1	0.55	5.15	18.4
ALKALINITY, TOTAL (As CaCO3), lab measured.	-0.93	1.86	10.8	1.05	4.61	23.02
OXIDATION-REDUCTION POTENTIAL, LAB	-1.71	0.29	10.3	0.93	4.37	27.38
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	-0.912	1.69	9.61	1.08	4.09	31.47
NITROGEN, AMMONIA (AS N)	-0.0806	0.441	7.83	0.29	3.33	34.81
ANTIMONY	1.75	0.223	7.69	0.52	3.27	38.08
CONDUCTIVITY, LAB	-0.416	2	7.61	1.32	3.24	41.32
MAJOR CATION SUM	-0.325	2.05	7.45	1.32	3.17	44.49
MAJOR ANION SUM	-0.309	2.03	7.36	1.33	3.13	47.62
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	-0.273	1.99	6.91	1.34	2.94	50.57
Selenium	0.116	1.72	6.45	1.08	2.75	53.31
NITRATE NITROGEN (NO3), AS N	-0.363	1.31	6.03	0.64	2.57	55.88
Sulphate (as SO4)	-0.0255	1.82	5.54	1.22	2.36	58.24
Nickel	-0.0144	0.866	5.22	0.39	2.22	60.46
THALLIUM	1.05	1.24	5.17	0.82	2.2	62.66
COBALT	-0.0595	0.5	5.14	0.26	2.19	64.85
MOLYBDENUM	1.4	-0.0845	5.07	0.63	2.16	67.01
COPPER	0.429	-0.425	5.06	0.3	2.15	69.16
BROMIDE	-0.389	1.39	4.89	1.14	2.08	71.25

Groups 2 and 3

Average squared distance = 164.13

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%

ACIDITY TO pH 8.3 (As CaCO3)	0.303	1.71	10.7	0.56	6.52	6.52
NITRATE NITROGEN (NO3), AS N	0.794	1.31	8.74	0.8	5.33	11.84
ALKALINITY, TOTAL (As CaCO3), lab measured.	-0.0861	1.86	7.65	0.76	4.66	16.5
OXIDATION-REDUCTION POTENTIAL, LAB	-1.27	0.29	7.54	0.73	4.59	21.1
NITROGEN, AMMONIA (AS N)	-0.0681	0.441	7.42	0.28	4.52	25.61
ALKALINITY, BICARBO0TE (As CaCO3), lab measured.	0.0776	1.69	6.66	0.76	4.06	29.67
Cadmium	0.738	0.899	5.93	0.71	3.61	33.28
Nickel	0.463	0.866	5.85	0.46	3.56	36.85
COBALT	0.195	0.5	5.75	0.3	3.5	40.35
Selenium	0.128	1.72	5.67	1.03	3.45	43.8
MAJOR CATION SUM	0.167	2.05	5.28	0.93	3.22	47.02
CONDUCTIVITY, LAB	0.179	2	5.24	0.88	3.19	50.21
MAJOR ANION SUM	0.17	2.03	5.17	0.92	3.15	53.36
WS Ratio %	1.18	1.49	5.16	0.68	3.15	56.51
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	0.214	1.99	4.88	0.93	2.97	59.48
THALLIUM	0.568	1.24	4.58	0.74	2.79	62.28
FLUORIDE	-0.149	0.155	4.51	0.82	2.75	65.02
Sulphate (as SO4)	0.195	1.82	4.38	1.04	2.67	67.69
SODIUM	0.566	0.155	4.1	0.57	2.5	70.19

Groups 2.5 and 3

Average squared distance = 138.77

Variable	Grp 0 Av.Value	Gr 1 Av.Sq.Dist	Sq.Dist/SD	Sq.Dist/SD	Contrib%	Cum.%
COBALT	1.45	0.5	16.9	0.49	12.2	12.2
NITROGEN, AMMONIA (AS N)	1.17	0.441	13.4	0.46	9.66	21.85
Nickel	1.66	0.866	12.2	0.56	8.81	30.66
ACIDITY TO pH 8.3 (As CaCO3)	0.737	1.71	10.4	0.58	7.5	38.16
NITRATE NITROGEN (NO3), AS N	1.05	1.31	7.49	0.7	5.4	43.56
Cadmium	1.01	0.899	6.96	0.67	5.02	48.58
SODIUM	0.868	0.155	6.76	0.47	4.87	53.44
WS Ratio %	1.53	1.49	5.52	0.72	3.98	57.42
THALLIUM	1.76	1.24	5.06	0.76	3.65	61.07
Selenium	1.1	1.72	5.01	0.96	3.61	64.68
ALKALINITY, CARBO0TE (As CaCO3), lab measured.	0.201	-0.393	3.47	0.45	2.5	67.18
BORON	0.672	0.137	3.23	0.53	2.32	69.5
ALKALINITY, HYDROXIDE (As CaCO3), lab measured.	-0.28	0.25	2.93	0.29	2.11	71.62

Appendix 11. 2022 Study Design.

Teck Coal Ltd.
Regional Calcite Monitoring Program

2022 Study Design

April 2022

Prepared by

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Appendix 2. Calcite Field Sampling Manual (Gordon and Robinson 2021).

1 Introduction

The Regional Calcite Monitoring Program has been successfully describing the degree and extent of calcite downstream of Teck's open-pit coal mine operations in the Elk Valley since 2013. This program has developed a comprehensive database of calcite in the Elk Valley and has been designed to satisfy the requirements for *Environmental Management Act* Permit 107517. Data and results generated by the regional program are used by Teck to monitor change, inform management decisions, describe efficacy of calcite treatment options, and report Teck's progress on calcite management to external agencies. This document provides the study design for 2022 and build from recommendations in the 2021 Regional Calcite Monitoring Program report (Robinson et al. 2022).

1.1 *Overview*

The Regional Calcite Monitoring Program uses a hierarchical approach to systematically break-down the large study areas, which essentially extends upstream from Fernie to the reference areas beyond each of Teck's five coal mining areas. Within the study area are Teck's five Management Units; distinct operational areas that loosely follow sub-watersheds. Within these, specific streams (mainstem versus tributary) are selected for monitoring and those are further differentiated into reaches. A stream reach is a relatively homogeneous section of stream in terms of channel morphology, riparian cover, and flow. Reaches are classified as exposed or reference relative to the presence or absence of upstream mining, respectively. The degree of calcite is primarily reported at a reach scale as it links most-closely with the scale at which Teck's management tools can be applied. Reaches also link well to biological assessments as these uses are often tied closely to habitat type.

Calcite is sampled at multiple points, or sites, within a reach to address the within-reach variability of calcite. A sample of 100 rocks is used to quantify the degree of calcification at each site. Data are recorded from the individual rock to the full study area to provide Teck with a robust dataset capable of discussing issues from local biological effects to watershed-scale trends in both exposed and reference areas. The program uses three key metrics to describe calcite:

$$Cp = Calcite\ Presence\ = \frac{Sum\ of\ stones\ presence\ scores}{Number\ of\ \text{stones}\ counted}$$

$$Cc = Calcite\ Concretion = \frac{Sum\ of\ stones\ concretion\ scores}{Number\ of\ stones\ counted}$$

$$CI = Calcite\ Index = Cp + Cc$$

1.2 *Program Objectives*

Key objectives of the Elk Valley Calcite Monitoring Program are to:

1. Document the extent and degree of calcite deposition in streams downstream of Teck's coal operations (e.g., streams influenced by mining, calcite treatment, water treatment, and in reference streams).
2. Satisfy the requirements for annual calcite monitoring in *Environmental Management Act* Permit 107517.
3. Provide data to support the re-evaluation of Management Question 4 ("*Is calcite being managed effectively to meet site performance objectives and protect aquatic ecosystem health?*") and Key Uncertainties in Permit 107517 as they relate to calcite.

2 Methods

2.1 *Study area and sample locations*

The Study Area proposed for 2022 will reflect that core area used from 2013-2020, with expansion to include more reference area. The core area remains the Elk River watershed upstream of Fernie, BC, including each of Teck's four mining operations in the Elk Valley, namely Fording River Operations (FRO), Greenhills Operations (GHO), Line Creek Operations (LCO), Elkview Operations (EVO), as well as Coal Mountain Mine (CMm). As recommended in the 2021 annual report for the Regional Calcite Monitoring Program, reference areas will be added to the upper Elk River, extending sampling into reference streams upstream of the Elk River/Fording River confluence.

The regional program began in 2013 using the reach-based approach. The program was reassessed in 2015 and proposed a stream segment approach. The stream segment combined reaches of similar calcification, trends, and mine exposure. The concept was that this would allow effort to be redistributed from streams with low spatial variability to more complex areas or areas requiring higher resolution. From 2019-2020, the annual programs used a hybrid approach where some areas continue to be monitored by segments and others require the more detailed reach-based approach. The number of areas monitored by the segment approach were few and the value of maintaining the full reach-based dataset become more evident. In 2021, the Program returned to reach-based sampling. This will be repeated for 2022. Sampling will follow the standardization of three sites per reach where reach length is >300 m. Sampling locations proposed for 2022 are provided in Appendix 1.

2.2 *Calcite training workshop*

A pre-field training workshop will be conducted to allow crews to meet in the field to review methods and field manual updates. Focus is given to potential sources of variability and the standardization of correctly identifying calcite. A list of attendees will be provided in the annual report.

2.3 *Field methods*

Field methods will follow those used in 2021. These methods are based on the 2021 updated field manual (Gordon and Robinson 2021), provided in Appendix 2. In summary, calcite is measured at each site using a modified Wolman Pebble Count (Wolman 1954). This uses a standard of 100 rocks per sample to derive the Cp, Cc, and CI metrics. The 2015 and 2020 programs assessed the effect of sample size (i.e., the number of rocks) on CI by calculating the percent difference from a CI score obtained from randomly selecting between 10-99 rocks relative to that obtained from the full 100 rock sample. This assessment found that reducing the number of rocks sampled has an immediate effect on accuracy (Figure 1). As such, the 2022 program will continue sampling 100 rocks per site.

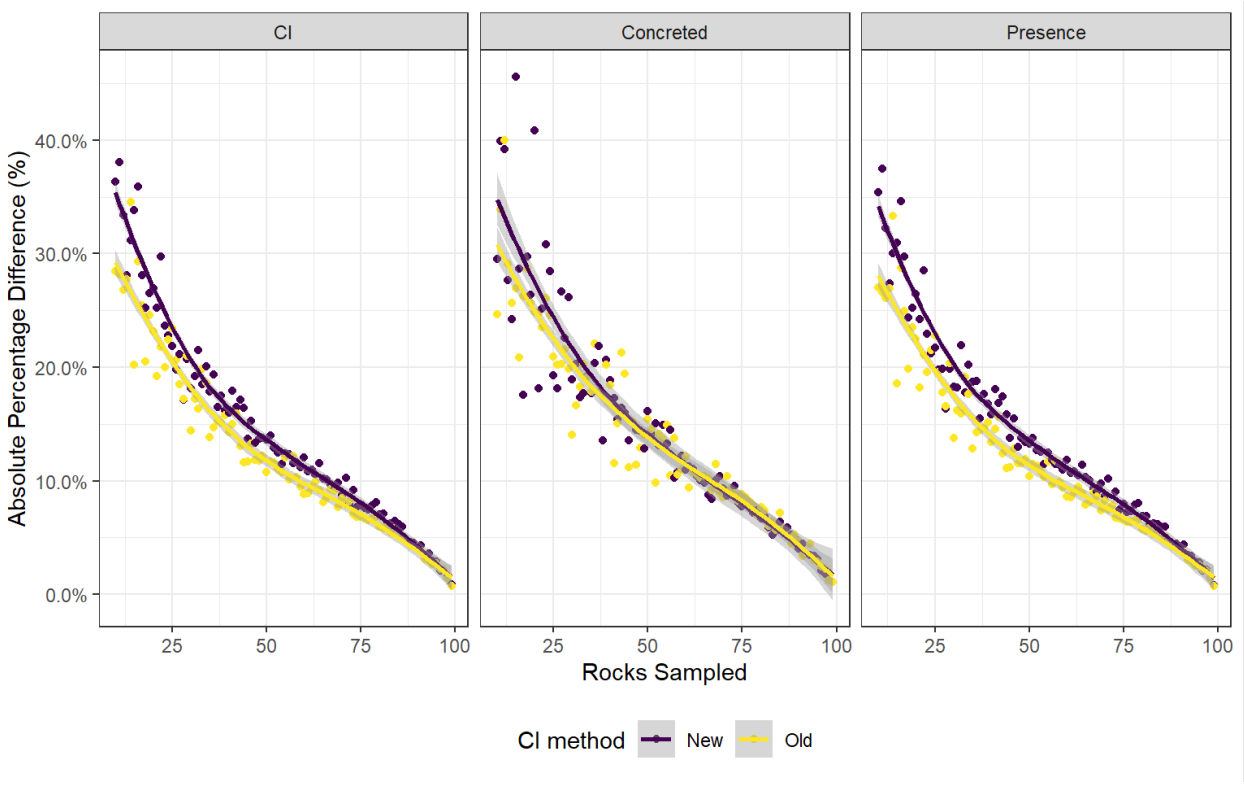

Figure 1. Absolute difference in calcite metrics between values randomly drawn from 10-99 rocks relative to the full 100 rock values.

Zathey et al. (2021) presented a proportional calcite presence (Cp') metric to record presence as a scalable score from 0 to 1 that increased by 0.1 increments where the increments equaled percentage cover of an individual particle. For example, a rock with 10% coverage would receive a Cp' score of 0.1, whereas it would have been scored Cp=1 with the binary Cp (Table 1). Cp' was recommended as a method to decrease inter-crew variability by increasing precision at a site level. It has secondarily been presented as a more accurate predictor of calcite concretion; the

component of CI related to potential biological effects (Minnow 2016). Cp' has been found effective at reducing inter-crew variability and is recommended for use as the primary calcite presence metric. The relationship between Cp and Cp' will also be assessed in 2022 in regard to trend analysis for historical data where Cp' does not exist.

Table 1. Cross-referencing between the old method of calcite presence (Cp) and the new method of calcite presence (Cp') scores.

Cp	Cp'	Percent of particle area covered
0	0	0%
1	0.1	10%
	0.2	20%
	0.3	30%
	0.4	40%
	0.5	50%
	0.6	60%
	0.7	70%
	0.8	80%
	0.9	90%
	1	100%

2.4 *Quality Assurance*

Data quality assurance procedures will follow those outlined in the 2021 field sampling manual. As per Gordon and Robinson (2021):

1. Crews will attend the annual calcite training course held at the beginning of the field season. At a minimum, all crew leads who will be conducting calcite sampling will attend the annual calcite training course. All crew members will be encouraged to attend the training course. This will ensure each crew is familiar with different types of calcite and sampling procedures. As well, a crew calibration day will occur at the start of the regional program. Attendance will be documented in the annual regional calcite monitoring report.
2. To assess inter-crew variability, 10% of sites will be randomly selected for duplicate sampling by second crew. Results were compared following 2020 methods.
3. Encourage communication between crew members completing different tasks (sampling versus recording) over the course of the entire project. Doing so is likely to reduce crew member variability, thereby resulting in improved data quality and consistency.
4. Data collection forms will be reviewed for completeness before leaving the sampling location and signed off at the end of each field day by the crew lead.
5. Data collection forms will be scanned and submitted to the Project Manager or designate daily. These data will be used to calculate a preliminary calcite index score and compare to previous records. Large deviations from previous years (>0.5 CI difference) will be investigated and potentially resampled by a second crew.

6. Following data entry into Lotic's digital form, values will be assessed for accuracy using a computer script developed from R Programming Language. This will check that cells contain acceptable values (e.g., calcite presence score can only be 0, 0.1, 0.2…. 1); concreted scores can only be 0, 1, or 2; concreted score must be 0 if calcite presence is 0); habitat unit type can only be R (riffle), P (pool), G (glide), C (cascade). Cells that had errors or were blank were flagged and corrected.

2.5 *Data analysis*

Data analyses will follow methods used in 2021 (Robinson et al 2022). Traditional analyses to be included are:

- General trend analysis including graphs presented in the KPI format (as done in 2021)
- Trend analysis by reach (linear and step-wise)
- Trends in reaches with water treatment
- Inter-program comparison
- Assessment of Cp versus Cp'

The effect of habitat unit has been assessed multiple times with weak relationships being reported. A specific assessment of the effect of habitat unit type will not be completed in 2022.

In addition to those listed above, the 2022 report will assess the roles of environmental (e.g., streamflow, geochemistry) and mine-related (level of disturbance, water treatment) variable on calcite deposition in regard to the flow hypothesis presented. Should the region experience a larger freshet, then monitoring will be used to directly determine if it results in reduction of calcite deposition. In absence of this, this Program should continue to try and explain the trends that are being observed through continued learning (e.g., multivariate analysis) and the potential/likelihood that calcite deposition may be returning to a post-2013 equilibrium.

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4 Appendices

Appendix 1. Sampling locations by reach and site.

Type	Stream	Reach	Site
Exposed	Aqueduct	AQUE1	AQUE1-0
Exposed	Aqueduct	AQUE2	AQUE2-0
Exposed	Aqueduct	AQUE2	AQUE2-50
Exposed	Aqueduct	AQUE3	AQUE3-25
Exposed	Aqueduct	AQUE3	AQUE3-50
Exposed	Aqueduct	AQUE3	AQUE3-75
Exposed	Balmer	BALM1	BALM1-25
Exposed	Balmer	BALM1	BALM1-50
Exposed	Balmer	BALM1	BALM1-75
Exposed	Bodie	BODI1	BODI1-25
Exposed	Bodie	BODI1	BODI1-50
Exposed	Bodie	BODI1	BODI1-75
Exposed	Bodie	BODI3	BODI3-25
Exposed	Bodie	BODI3	BODI3-50
Exposed	Bodie	BODI3	BODI3-75
Exposed	Clode Pond Outlet	COUT1	COUT1-0
Exposed	Clode West Infiltration	CLOW1	CLOW1-0
Exposed	Clode West Infiltration	CLOW1	CLOW1-50
Exposed	Corbin	CORB1	CORB1-25
Exposed	Corbin	CORB1	CORB1-50
Exposed	Corbin	CORB1	CORB1-75
Exposed	Corbin	CORB2	CORB2-25
Exposed	Corbin	CORB2	CORB2-50
Exposed	Corbin	CORB2	CORB2-75
Exposed	Dry (EVO)	DRYE1	DRYE1-0
Exposed	Dry (EVO)	DRYE3	DRYE3-25
Exposed	Dry (EVO)	DRYE3	DRYE3-50
Exposed	Dry (EVO)	DRYE3	DRYE3-75
Exposed	Dry (EVO)	DRYE4	DRYE4-25
Exposed	Dry (LCO)	DRYL1	DRYL1-25
Exposed	Dry (LCO)	DRYL1	DRYL1-50
Exposed	Dry (LCO)	DRYL1	DRYL1-75
Exposed	Dry (LCO)	DRYL2	DRYL2-25
Exposed	Dry (LCO)	DRYL2	DRYL2-50
Exposed	Dry (LCO)	DRYL2	DRYL2-75
Exposed	Dry (LCO)	DRYL3	DRYL3-25
Exposed	Dry (LCO)	DRYL3	DRYL3-50
Exposed	Dry (LCO)	DRYL3	DRYL3-75
Exposed	Dry (LCO)	DRYL4	DRYL4-25
Exposed	Dry (LCO)	DRYL4	DRYL4-50
Exposed	Dry (LCO)	DRYL4	DRYL4-75
Exposed	Elk	ELKR10	ELKR10-25
Exposed	Elk	ELKR10	ELKR10-50
Exposed	Elk	ELKR10	ELKR10-75
Exposed	Elk	ELKR11	ELKR11-25
Exposed	Elk	ELKR11	ELKR11-50
Exposed	Elk	ELKR11	ELKR11-75
Exposed	Elk	ELKR12	ELKR12-25

Type	Stream	Reach	Site
Exposed	Elk	ELKR12	ELKR12-50
Exposed	Elk	ELKR12	ELKR12-75
Exposed	Elk	ELKR8	ELKR8-25
Exposed	Elk	ELKR8	ELKR8-50
Exposed	Elk	ELKR8	ELKR8-75
Exposed	Elk	ELKR9	ELKR9-25
Exposed	Elk	ELKR9	ELKR9-50
Exposed	Elk	ELKR9	ELKR9-75
Exposed	Erickson	ERIC1	ERIC1-0
Exposed	Erickson	ERIC1	ERIC1-50
Exposed	Erickson	ERIC2	ERIC2-0
Exposed	Erickson	ERIC3	ERIC3-0
Exposed	Erickson	ERIC4	ERIC4-25
Exposed	Erickson	ERIC4	ERIC4-50
Exposed	Erickson	ERIC4	ERIC4-75
Exposed	Feltham	FELT1	FELT1-25
Exposed	Feltham	FELT1	FELT1-50
Exposed	Feltham	FELT1	FELT1-75
Exposed	Fennelon	FENN1	FENN1-50
Exposed	Fish Pond	FPON1	FPON1-25
Exposed	Fish Pond	FPON1	FPON1-50
Exposed	Fish Pond	FPON1	FPON1-75
Exposed	Fording River	FORD1	FORD1-25
Exposed	Fording River	FORD1	FORD1-50
Exposed	Fording River	FORD1	FORD1-75
Exposed	Fording River	FORD2	FORD2-25
Exposed	Fording River	FORD2	FORD2-50
Exposed	Fording River	FORD2	FORD2-75
Exposed	Fording River	FORD3	FORD3-25
Exposed	Fording River	FORD3	FORD3-50
Exposed	Fording River	FORD3	FORD3-75
Exposed	Fording River	FORD4	FORD4-25
Exposed	Fording River	FORD4	FORD4-50
Exposed	Fording River	FORD4	FORD4-75
Exposed	Fording River	FORD5	FORD5-12.5
Exposed	Fording River	FORD5	FORD5-25
Exposed	Fording River	FORD5	FORD5-50
Exposed	Fording River	FORD5	FORD5-75
Exposed	Fording River	FORD6	FORD6-25
Exposed	Fording River	FORD6	FORD6-50
Exposed	Fording River	FORD6	FORD6-75
Exposed	Fording River	FORD7	FORD7-25
Exposed	Fording River	FORD7	FORD7-50
Exposed	Fording River	FORD7	FORD7-75
Exposed	Fording River	FORD8	FORD8-25
Exposed	Fording River	FORD8	FORD8-50
Exposed	Fording River	FORD8	FORD8-75
Exposed	Fording River	FORD9a	FORD9a-12.5

Type	Stream	Reach	Site
Exposed	Fording River	FORD9a	FORD9a-25
Exposed	Fording River	FORD9a	FORD9a-37.5
Exposed	Fording River	FORD9a	FORD9a-50
Exposed	Fording River	FORD9b	FORD9b-62.5
Exposed	Fording River	FORD9b	FORD9b-75
Exposed	Fording River	FORD10	FORD10-25
Exposed	Fording River	FORD10	FORD10-50
Exposed	Fording River	FORD10	FORD10-75
Exposed	Fording River	FORD10	FORD10-86
Exposed	Fording River	FORD10	FORD10-89
Exposed	Fording River	FORD11	FORD11-25
Exposed	Fording River	FORD11	FORD11-50
Exposed	Fording River	FORD11	FORD11-75
Exposed	Gardine	GARD1	GARD1-25
Exposed	Gardine	GARD1	GARD1-50
Exposed	Gardine	GARD1	GARD1-75
Exposed	Gate	GATE2	GATE2-25
Exposed	Gate	GATE2	GATE2-50
Exposed	Gate	GATE2	GATE2-75
Exposed	Goddard	GODD1	GODD1-0
Exposed	Goddard	GODD3	GODD3-25
Exposed	Goddard	GODD3	GODD3-50
Exposed	Goddard	GODD3	GODD3-75
Exposed	Grassy	GRAS1	GRAS1-25
Exposed	Grassy	GRAS1	GRAS1-50
Exposed	Grassy	GRAS1	GRAS1-75
Exposed	Grave	GRAV1	GRAV1-25
Exposed	Grave	GRAV1	GRAV1-50
Exposed	Grave	GRAV1	GRAV1-75
Exposed	Grave	GRAV2	GRAV2-25
Exposed	Grave	GRAV2	GRAV2-50
Exposed	Grave	GRAV2	GRAV2-75
Exposed	Greenhills	GREE1	GREE1-25
Exposed	Greenhills	GREE1	GREE1-50
Exposed	Greenhills	GREE1	GREE1-75
Exposed	Greenhills	GREE3	GREE3-25
Exposed	Greenhills	GREE3	GREE3-50
Exposed	Greenhills	GREE3	GREE3-75
Exposed	Greenhills	GREE4	GREE4-25
Exposed	Greenhills	GREE4	GREE4-50
Exposed	Greenhills	GREE4	GREE4-75
Exposed	Greenhouse side channel	GSCH1	GSCH1-25
Exposed	Greenhouse side channel	GSCH1	GSCH1-50
Exposed	Greenhouse side channel	GSCH1	GSCH1-75
Exposed	Harmer	HARM1	HARM1-25
Exposed	Harmer	HARM1	HARM1-50
Exposed	Harmer	HARM1	HARM1-75
Exposed	Harmer	HARM3	HARM3-25

Type	Stream	Reach	Site
Exposed	Harmer	HARM3	HARM3-50
Exposed	Harmer	HARM3	HARM3-75
Exposed	Harmer	HARM4	HARM4-25
Exposed	Harmer	HARM4	HARM4-50
Exposed	Harmer	HARM4	HARM4-75
Exposed	Harmer	HARM5	HARM5-25
Exposed	Harmer	HARM5	HARM5-50
Exposed	Harmer	HARM5	HARM5-75
Exposed	Henretta	HENR1	HENR1-25
Exposed	Henretta	HENR1	HENR1-50
Exposed	Henretta	HENR1	HENR1-75
Exposed	Henretta	HENR2	HENR2-25
Exposed	Henretta	HENR2	HENR2-50
Exposed	Henretta	HENR2	HENR2-75
Exposed	Kilmamock	KILM1	KILM1-25
Exposed	Kilmamock	KILM1	KILM1-50
Exposed	Kilmamock	KILM1	KILM1-75
Exposed	Lake Mountain	LMOU1	LMOU1-0
Exposed	Leask	LEAS2	LEAS2-18.2
Exposed	Leask	LEAS2	LEAS2-25
Exposed	Leask	LEAS2	LEAS2-9.1
Exposed	Lindsay	LIND1	LIND1-25
Exposed	Lindsay	LIND1	LIND1-50
Exposed	Lindsay	LIND1	LIND1-75
Exposed	Line	LINE1	LINE1-25
Exposed	Line	LINE1	LINE1-50
Exposed	Line	LINE1	LINE1-75
Exposed	Line	LINE2	LINE2-25
Exposed	Line	LINE2	LINE2-50
Exposed	Line	LINE2	LINE2-75
Exposed	Line	LINE3	LINE3-25
Exposed	Line	LINE3	LINE3-50
Exposed	Line	LINE3	LINE3-75
Exposed	Line	LINE4	LINE4-25
Exposed	Line	LINE4	LINE4-50
Exposed	Line	LINE4	LINE4-75
Exposed	Line	LINE7	LINE7-50
Exposed	Line	LINE7	LINE7-75
Exposed	Michel	MICH1	MICH1-25
Exposed	Michel	MICH1	MICH1-50
Exposed	Michel	MICH1	MICH1-75
Exposed	Michel	MICH2	MICH2-25
Exposed	Michel	MICH2	MICH2-50
Exposed	Michel	MICH2	MICH2-75
Exposed	Michel	MICH3	MICH3-25
Exposed	Michel	MICH3	MICH3-50
Exposed	Michel	MICH3	MICH3-75
Exposed	Michel	MICH4	MICH4-25

Type	Stream	Reach	Site
Exposed	Michel	MICH4	MICH4-50
Exposed	Michel	MICH4	MICH4-75
Exposed	Mickelson	MICK2	MICK2-25
Exposed	Mickelson	MICK2	MICK2-50
Exposed	Mickelson	MICK2	MICK2-75
Exposed	Milligan	MILL2	MILL2-0
Exposed	North Thompson	NTHO1	NTHO1-25
Exposed	North Thompson	NTHO1	NTHO1-50
Exposed	North Thompson	NTHO1	NTHO1-75
Exposed	North Willow	WILN2	WILN2-25
Exposed	North Willow	WILN2	WILN2-50
Exposed	North Wolfram	NWOL1	NWOL1-25
Exposed	Otto	OTTO1	OTTO1-0
Exposed	Porter	PORT1	PORT1-0
Exposed	Porter	PORT3a	PORT3a-12.5
Exposed	Porter	PORT3a	PORT3a-25
Exposed	Porter	PORT3a	PORT3a-37.5
Exposed	Porter	PORT3b	PORT3b-50
Exposed	Porter	PORT3b	PORT3b-62.5
Exposed	Porter	PORT3b	PORT3b-75
Exposed	Sawmill	SAWM1	SAWM1-0
Exposed	Sawmill	SAWM1	SAWM1-50
Exposed	Sawmill	SAWM2	SAWM2-25
Exposed	Sawmill	SAWM2	SAWM2-50
Exposed	Site18	SITE	SITE-18
Exposed	Six Mile	SIXM1	SIXM1-25
Exposed	Six Mile	SIXM1	SIXM1-50
Exposed	Six Mile	SIXM1	SIXM1-75
Exposed	Smith Pond Outlet	SPOU1	SPOU1-0
Exposed	South Pit	SPIT1	SPIT1-0
Exposed	South Willow	WILS1	WILS1-25
Exposed	South Willow	WILS1	WILS1-50
Exposed	South Wolfram	SWOL1	SWOL1-25
Exposed	South Wolfram	SWOL1	SWOL1-32.1
Exposed	South Wolfram	SWOL1	SWOL1-7.5
Exposed	Spring	SPRI1	SPRI1-0
Exposed	Stream 02	STR02	STR02-50
Exposed	Stream 02	STR02	STR02-75
Exposed	Stream 14	STR14	STR14-25
Exposed	Thompson	THOM2	THOM2-25
Exposed	Thompson	THOM2	THOM2-50
Exposed	Thompson	THOM2	THOM2-75
Exposed	Thompson	THOM3	THOM3-25
Exposed	Thompson	THOM3	THOM3-50
Exposed	Thompson	THOM3	THOM3-75
Exposed	Thompson	THOM4	THOM4-25
Exposed	Thompson	THOM4	THOM4-50
Exposed	Thompson	THOM4	THOM4-75

Type	Stream	Reach	Site
Exposed	Unnamed Trib South of Sawmill	USOS1	USOS1-25
Exposed	Unnamed Trib South of Sawmill	USOS1	USOS1-50
Exposed	Unnamed Trib South of Sawmill	USOS1	USOS1-75
Exposed	Upper Thompson	UTHO1	UTHO1-25
Exposed	Upper Thompson	UTHO1	UTHO1-50
Exposed	Upper Thompson	UTHO1	UTHO1-75
Exposed	Upper Thompson Pond Outlet	UTPO1	UTPO1-0
Exposed	Wolf	WOL1	WOL1-25
Exposed	Wolf	WOL1	WOL1-50
Exposed	Wolfram	WOLF2	WOLF2-75
Exposed	Wolfram	WOLF3	WOLF3-25
Exposed	Wolfram	WOLF3	WOLF3-50
Exposed	Wolfram	WOLF3	WOLF3-75
Reference	Alexander	ALEX3	ALEX3-25
Reference	Alexander	ALEX3	ALEX3-50
Reference	Alexander	ALEX3	ALEX3-75
Reference	Andy Good	ANDY1	ANDY1-25
Reference	Andy Good	ANDY1	ANDY1-50
Reference	Andy Good	ANDY1	ANDY1-75
Reference	Bingay	BING1	BING1-25
Reference	Bingay	BING1	BING1-50
Reference	Bingay	BING1	BING1-75
Reference	Chauncey	CHAU1	CHAU1-25
Reference	Chauncey	CHAU1	CHAU1-50
Reference	Chauncey	CHAU1	CHAU1-75
Reference	East Dry	ETRI1	ETRI1-0
Reference	East Dry	ETRI1	ETRI1-50
Reference	Elk	ELKR15	ELKR15-25
Reference	Elk	ELKR15	ELKR15-50
Reference	Elk	ELKR15	ELKR15-75
Reference	Ewin	EWIN1	EWIN1-25
Reference	Ewin	EWIN1	EWIN1-50
Reference	Ewin	EWIN1	EWIN1-75
Reference	Fording	FORD12	FORD12-25
Reference	Fording	FORD12	FORD12-50
Reference	Fording	FORD12	FORD12-75
Reference	Forsythe	FORS1	FORS1-25
Reference	Forsythe	FORS1	FORS1-50
Reference	Forsythe	FORS1	FORS1-75
Reference	Grace	GRAC1	GRAC1-25
Reference	Grace	GRAC1	GRAC1-50
Reference	Grace	GRAC1	GRAC1-75
Reference	Grave	GRAV3	GRAV3-25
Reference	Grave	GRAV3	GRAV3-50
Reference	Grave	GRAV3	GRAV3-75
Reference	Henretta	HENR3	HENR3-25
Reference	Henretta	HENR3	HENR3-50
Reference	Henretta	HENR3	HENR3-75

Type	Stream	Reach	Site
Reference	Leach	RG_LE1	RG_LE1-25
Reference	Leach	RG_LE1	RG_LE1-50
Reference	Leach	RG_LE1	RG_LE1-75
Reference	Michel	MICH5	MICH5-25
Reference	Michel	MICH5	MICH5-50
Reference	Michel	MICH5	MICH5-75
Reference	RG_UCWER	RG_UCWER1	RG_UCWER1-25
Reference	RG_UCWER	RG_UCWER1	RG_UCWER1-50
Reference	RG_UCWER	RG_UCWER1	RG_UCWER1-75
Reference	South Line	SLINE2	SLINE2-25
Reference	South Line	SLINE2	SLINE2-50
Reference	South Line	SLINE2	SLINE2-75
Reference	Toddhunter	TODH1	TODH1-25
Reference	Toddhunter	TODH1	TODH1-50
Reference	Toddhunter	TODH1	TODH1-75
Reference	Weigert	WEIG1	WEIG1-25
Reference	Weigert	WEIG1	WEIG1-50
Reference	Weigert	WEIG1	WEIG1-75

Appendix 2. Calcite Field Sampling Manual (Gordon and Robinson 2021).