IN THE ENVIRONMENT COURT

CHRISTCHURCH REGISTRY

I MUA I TE KOOTI TAIAO O AOTEAROA

ENV-2017-CHC-090

Under	**the Resource Management Act 1991**
In the matter	**of an appeal pursuant to section 120 of the Act**
Between	**THE ROYAL FOREST AND BIRD PROTECTION SOCIETY OF NEW ZEALAND INCORPORATED** **Appellant**
And	**WEST COAST REGIONAL COUNCIL AND BULLER DISTRICT COUNCIL** **Respondents**
And	**STEVENSON MINING LIMITED** **Applicant**

STATEMENT OF EVIDENCE OF JAMES GORDON POPE FOR STEVENSON MINING

20 August 2021

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CONTENTS

QUALIFICATIONS AND EXPERIENCE

1 My full name is James Gordon Pope. I hold a BSc in Geology and PhD in Geochemistry.

2 I am the CEO of Verum Group.

3 I have approximately 20 years of experience in the minerals sector in Australia, Canada, Indonesia, Mexico and New Zealand. For the last 15 years I have supplied consultancy services through CRL Energy (now Verum Group) to the New Zealand minerals sector related to mine drainage geochemistry and management. For 14 years I have contributed to or led New Zealand's only government funded minerals sector environmental research programme. My research contributions to this programme are related to mine drainage geochemistry prediction, management and treatment and the research programme also covers other related disciplines including aquatic ecology, ecotoxicity, rehabilitation, and closure with expert input from other scientists.

4 Prior to working at Verum Group, I worked in a partnership in Australia for two years involved in resource definition in the Australian coal sector. Verum Group has a team of four Geologists that complete mineral exploration and geological consultancy. Our work has included geological modelling and coal quality assessment of the Te Kuha coal deposit and many other coal deposits in New Zealand. In addition, I supplied JORC (Joint Ore Reserves Committee) code compliant sign off for the Te Kuha coal resource.

5 I have prepared and presented evidence in Council Hearings and for the Environment Court on behalf of Bathurst Resources related to their Escarpment Mine development. I am the Waikato Regional Council appointed peer reviewer for geochemistry at the Oceana Gold Waihi mine site. I have co-authored two documents for use by Regional Councils and mining companies for managing minerals sector resource developments.

6 I am co-author of and contributed to the following reports that have been supplied to Stevenson Mining Ltd and as part of the data collection for resource consent application: Reports completed in 2018 are updates of environmental data and modelling.

(a) Dutton, A., Pope, J., and Christenson, H., 2018, Te Kuha Water Management Information (Update to Dec 17): CRL Energy 18-41213. 71p.

(b) Pope, J., & Dutton, A., 2016a, Te Kuha Mine - Water Management Plan – Information Report (Update to Dec 15): CRL Energy Ltd. 15-41213. 63p.

(c) Pope, J., & Dutton, A., 2016b, Te Kuha Mine Project GoldSim (TM) Drainage Model and Predicted Chemistry: CRL Energy Ltd. 15-41101. 63p

(d) Trumm, D., and Pope, J., 2017a, Te Kuha Mine - Waste rock management plan: CRL Energy Ltd. 16-41280. 39p

(e) Trumm, D., and Pope, J., 2017b, Te Kuha Mine - Mine Drainage Management and Treatment Contingency Report: CRL Energy Ltd, 16-41284. 21p

7 I have also authored or contributed to earlier reports on geology, coal quality, JORC code compliant coal resource, baseline environmental data and water management at the proposed Te Kuha mine site between 2011 and now.

8 I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note. This evidence has been prepared in accordance with it and I agree to comply with it. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

SCOPE OF EVIDENCE

9 My evidence summarises the reports by Verum Group (CRL Energy) listed above, and comments on the following matters:

(a) Coal geology and quality;

(b) Climate monitoring;

(c) Baseline water quality;

(d) Hydrology;

(e) Rock geochemistry;

(f) Mining impacts on water quality; and

(g) Comments related to Regional Land and Water Plan.

10 This statement of evidence has been updated from the statement I prepared and which was circulated in May 2020.

DESCRIPTION OF THE PROJECT

11 The project is described in Anne Brewster's evidence.

12 Verum Group has prepared a 'flyover' graphic of the project which I append as Attachment 1 to my evidence. This flyover shows the terrane, geology and the data set used to build the geological model of the Te Kuha coal deposit.

COAL GEOLOGY AND COAL QUALITY

Coal geology

13 The Te Kuha coal deposit is in the south western sector of the Buller Coalfield 12km south east of Westport. The Buller Coalfield extends north from Te Kuha and includes the Stockton and Denniston Plateaus where mining is active. At Te Kuha, the coal sits at an elevation of about 600m on the coastal range between Mt Rochfort (north) and the Buller River (south).

14 The Te Kuha coal deposit includes Brunner Coal Measures, that occur throughout the Buller Coalfield overlying Paparoa Coal Measures that have not been identified elsewhere in the Buller Coalfield, both dipping gently to the West. Major coal seams in both Brunner and Paparoa rocks at Te Kuha can be just over 10m thick and are commonly 4-8m thick with occasional thin coal seams. Brunner Coal Measures at Te Kuha are bound by outcrop on all sides and so the Te Kuha deposit is not continuous with the rest of the Buller Coalfield. Te Kuha is the only coal deposit in New Zealand where Brunner and Paparoa Coal Measures occur together and could be mined by open cast methods.

15 This unique feature is the underlying geological characteristic that allows confident prediction of weakly acidic to alkaline mine drainage chemistry rather than strongly acidic mine drainage

which is characteristic at mines in Brunner Coal Measures only. The Paparoa Coal Measures contain excess acid neutralising capacity and this can be managed to mitigate acid from the Brunner rocks.

Coal for Steel Making

16 Bituminous coal from the West Coast of the South Island is typically mined for export to be used in blast furnaces for steel manufacture around the world. Blast furnaces require that the coal is turned into coke, a hard porous residue that results from heating bituminous coal in the absence of oxygen. Coke is typically made of a blend of coals that have different characteristics and properties that are measured by a large suite of laboratory tests. Often a coke blend will include coal from several different parts of the world.

17 Within New Zealand, coal properties are variable and coal that is exported from New Zealand is often a blended product from two to four different deposits or mines. Blending of coals within New Zealand is a complex balance of providing sufficient favourable properties and diluting unfavourable properties so that the coal that is exported meets specifications required by the international market. In addition to meeting specification, coal that is exported does not exceed specifications for some properties because this would represent lost value.

Te Kuha coal deposit and its significance

18 Laboratory analyses indicate that the Te Kuha coal is high quality and will be valuable as a bulk export commodity for steel manufacture. The level of certainty regarding coal quality at Te Kuha is appropriate for the current level of resource development, 51% of this resource is classified as measured resource (high certainty), 31% is indicated (medium certainty) and 17% of the deposit is inferred (lower certainty). The next level of certainty prior to mining is to calculate a ‘proven or probable reserve’. This requires an additional phase of mining engineering studies to be completed.

19 Based on the data available the Te Kuha coal will be a valuable coal to blend into the other New Zealand coking coals. In this

situation Te Kuha coal could be used to improve the average properties for shipments of coal made up from other coals that have lower quality. This can be demonstrated by a comparison of selected coal analyses such as ash content, sulphur content, swell during coking, rank and fluidity during coking measured for the Te Kuha deposit to other coking coal mined in New Zealand.

Ash content of Te Kuha coal

20 The ash content values (Table 1) indicate that 62% of Te Kuha coal is low ash, < 4%, 28% is very low, < 2%, and the remainder is moderate to high ash. The < 4% ash coal would be some of the lowest ash coal on the market in NZ and internationally **(Figure 1)**. In general, New Zealand coking coal has a low ash content ~ 3-10% and this is a selling point for our coal on the international market which is typically 8-10 %. A mine at Te Kuha will have options to produce different coal products depending on offtake arrangements. It is likely a significant premium can be achieved for low ash coal and this might be selectively mined. Other coal could be blended at the mine to achieve higher ash value that enables production of increased total coal tonnes.

Table 1: Ash content in Te Kuha coal

Ash content		Percentage
Brunner < 2% Ash	28%	
Brunner < 4% Ash	(inc <2%)	39%
Paparoa < 4% Ash		23%
Brunner 4-15% Ash		10%
Paparoa 4-15% Ash		16%
Brunner > 15% Ash		8%
Paparoa > 15% Ash		4%
Total		100%

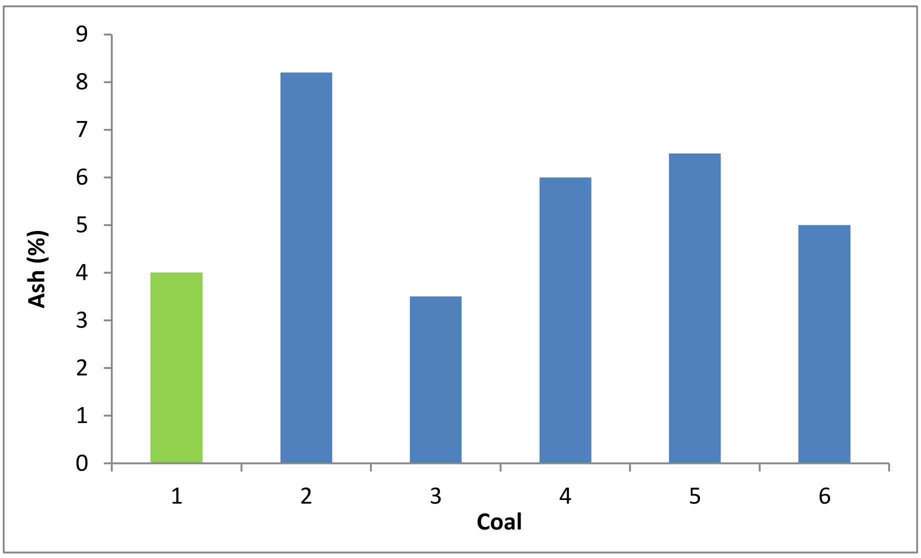

Figure 1: Ash content from currently producing coking coal mines in New Zealand (Te Kuha – green). Data from other mines is from run-of mine, whereas Te Kuha data is from drill holes. It is likely that the ash content could increase slightly during mining.

Sulphur Content of Te Kuha coal

21 In general, coal quality improves as the sulphur content decreases. The sulphur content values **(Table 2)** indicate that 94% of the Te Kuha coal has less than 1% sulphur and 65% of the Te Kuha coal has less than 0.7% sulphur. Less than 0.7% sulphur is low compared to most other available coking coal in New Zealand **(Figure 2)**. Commonly New Zealand coking coal is exported with a sulphur content of between 1.5 and 2.5%. Blending the low sulphur Te Kuha coal enables extraction of higher sulphur coal from other New Zealand deposits (some of which are not currently mined) to become viable for export.

Table 2: Sulphur content in Te Kuha coal

Sulphur content	Percentage
Brunner < 0.7% S	46%
Paparoa < 0.7% S	20%
Brunner 0.7-1% S	7%
Paparoa 0.7-1% S	21%
Brunner > 1% S	2%
Paparoa > 1% S	4%
Total	100%

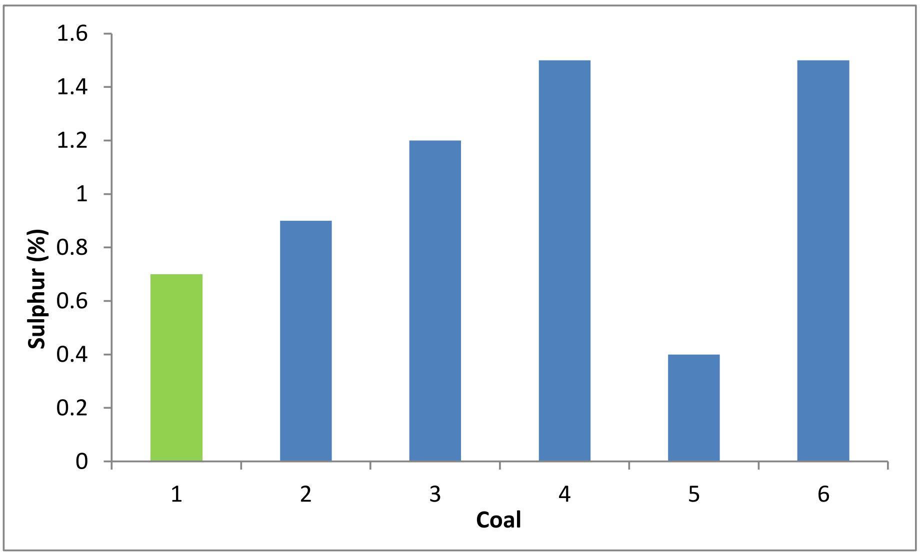

Figure 2: Sulphur content from currently producing coking coal mines in New Zealand (Te Kuha – green).

Swell during coking for Te Kuha coal

22 At Te Kuha, 60% of the coal has swell > 8 (csn) and much of this is in the range 9+ to 9+++ (csn) (average >9) which is at the top of the measured range for all coking coals traded internationally **(Figure 3)**. On the international market the swell of typical coals ranges between 2 and 7 and usually New Zealand coking coal is exported with a swell value of at least 7 (csn). This means that the Te Kuha coal can enable coking coal from other New Zealand deposits that have lower swell to be blended into coal exports.

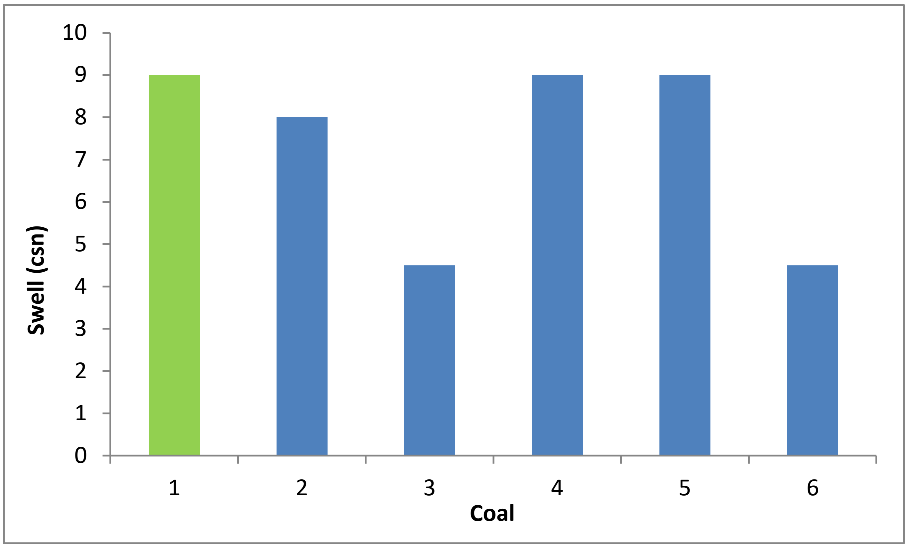

Figure 3: Swell values from currently producing coking coal mines in New Zealand (Te Kuha – green).

Rank of Te Kuha coal

23 The rank of coal can be assessed using a microscopic techniques and is defined by the maximum reflectance (Romax) of light from selected fossil plant material that makes up the coal. The reflectance measured at Te Kuha is between 1.31 and 1.39%

(Romax). Much of the available coking coal in New Zealand has a reflectance of 0.6 to 1.15%. In New Zealand, there is only one other high rank (high reflectance) coal that is available with a reflectance greater than 1.2% (Romax) and this is from Rajah mine near Blackball **(Figure 4)**.

24 Internationally traded coking coals have reflectance commonly ~1.1 to 1.5% for hard coking coals and ~0.8 to ~1.1% for semisoft coking coals, with hard coking coal commanding premium prices. Export specifications for New Zealand coals are most likely to be in the semisoft or bottom end of hard coking coal range. This means the coal from Te Kuha could be blended to with lower reflectance coal to provide an average reflectance that is in the premium rank range for the international coking coal market.

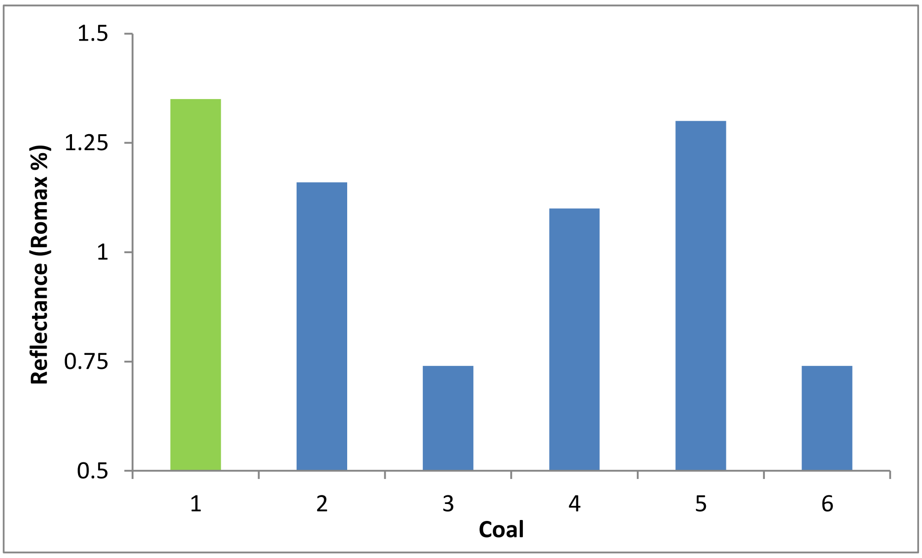

Figure 4: Reflectance values from currently producing coking coal mines in New Zealand (Te Kuha – green).

Fluidity during coking for Te Kuha coal

25 During the transition from coal to coke, the coal behaves as a viscous fluid with temperature dependant properties that are assessed for coke making. One of these properties is fluidity which controls how easily a coal blends with other coals during coke making. Coal at Te Kuha has high fluidity compared to other coking coal that is available in New Zealand **(Figure 5)** and

therefore can be used to upgrade other coal with lower fluidity into higher priced markets.

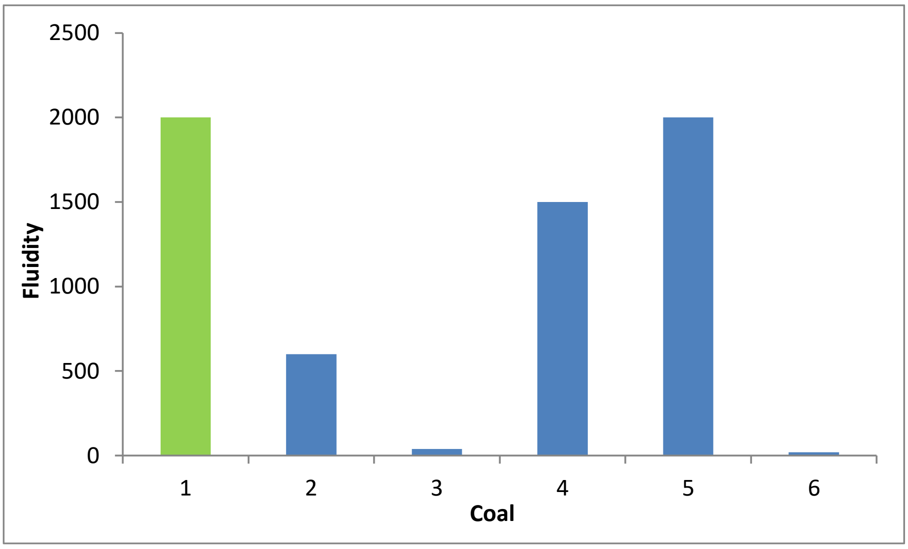

Figure 5: Fluidity values (ddpm) from currently producing coking coal mines in New Zealand (Te Kuha – green).

Other coal quality information and markets for Te Kuha coal

26 Coal that has been close to surface due to erosion of the cover rocks and has been exposed to air and rainwater often partially weathers so that the coking properties (swell and fluidity) are lost or diminished. At Te Kuha 15% of the coal has swell of 0 (csn) and 25% of the deposit has swell 0-8 (csn). This coal can find a place in the coking coal market where stamp charging is incorporated in the coke making process (eg India), however in general, demand is lower for low swell coal than for high swell coal. This coal could be blended with other coal at the Te Kuha mine to produce a product with acceptable specifications depending on client requirements. Coal of this type can sometimes find a place in specialist use markets such as activated carbon manufacture.

27 There are other potential uses for the Te Kuha coal, these include the specialist metallurgical market where coals with low ash and suitable ash chemistry are highly valued. Coal is also used as a feedstock for activated carbon, carbon fibre, carbon foam, electrodes and other niche products that are manufactured mostly in Europe, Asia or the USA. Much of the Te Kuha coal deposit has relatively promising characteristics for many of these applications

compared to other New Zealand coal or coal that is available internationally. Markets for these niche uses would need to be developed by Stevenson once product is available for sale. If manufacturing of these products is sought in New Zealand, then partnerships would need to be developed with manufacturers or a programme of research and development would be required by Stevenson.

Coal Quality Summary

28 Much of the coal from the Te Kuha could be exported as a stand alone product to the international coking coal market at premium hard coking coal prices because of favourable ash, sulphur, swell, reflectance and fluidity properties. There are many other coal properties that are measured for complete market assessment, and most of these tests have been completed with results supplied to Stevenson in several reports by Verum Group (CRL Energy) in 2012. In general, the Te Kuha coal has a favourable set of properties for the international coking coal market.

29 There is currently only one coal produced in New Zealand with similar hard coking coal properties to the Te Kuha coal. This coal is from Rajah mine near Blackball and it is blended to add value to coal mined at Stockton. The Te Kuha coal could also be used to add value to significant tonnages of coal from other mines on Stockton and Denniston Plateaus where properties such as reflectance, fluidity, ash, sulphur or swell can be less favourable.

CLIMATE MONITORING

30 Continuous climate data has been collected at the Te Kuha mine site from 25/10/12 to 21/12/15 and 4/6/16 to present (Pope and Dutton, 2016; Dutton, Pope & Christenson, 2018). Data collected includes rainfall, wind speed, wind direction, temperature, pressure, solar radiation, humidity and dew point. This data has been used to plan the management of environmental impacts related to the proposed Te Kuha coal mine.

31 The data provided by the weather station indicates climatic conditions typical of Bulller region coastal foothills. Temperatures

are most commonly between -2 and 30 degrees C; there are frequent high intensity rainfall events some of these lasting several days; prevailing winds are from the North-West and South-East. The level and intensity of rainfall is similar to rainfall that is recorded at other elevated coastal mine sites in the Buller region such as Stockton and Escarpment.

32 A long term (73 years) climate record for the Te Kuha mine site has been established by linking the data collected at Te Kuha over 5 years to monitoring data from the Westport Airport weather station. The environmental data collected at the Te Kuha weather station to date have been used as inputs for a site hydrology model using GoldSim^{TM} process flow software and have been utilised by WSP (Formerly Golder Associates) to plan water treatment and management infrastructure.

33 The data collected can be used to assess the number of rain days (0.1mm) wet days (>1mm) at Te Kuha which is important for planning rehabilitation **(Table 1 – Appendix 1)**. Additional data from Westport Airport can also be used to indicate visibility **(Table 2 – Appendix 1).**

BASELINE WATER QUALITY

34 Water samples have been collected from streams in catchments that intersect the mine footprint between 2012 and 2020. There are four sets of sampling sites, 1) upland sites West of the main drainage divide with manual monitoring, 2) lowland sites West of the main drainage divide, 3) upland sites East of the main drainage divide and 4) lowland sites with continuous monitoring and manual sampling (**Figure 6 – Appendix 1**). The data collected at these sites indicate that natural drainages have variable flow or are ephemeral within the mine footprint. In general the upland catchments are weakly acidic (pH 4.1 to 6.5) with low dissolved solids whereas lowland catchments are circum-neutral (pH 5.8-7.5) with slightly higher dissolved solids. Full chemical details with laboratory samples and continuous monitoring data are available for the sample sites (Dutton, Pope & Christenson, 2018). Additional data is available from 2018, 2019 and 2020, but

this has not been compiled into a formal report. Trends in the most recent data show continuity with reported data.

35 Baseline water quality demonstrates some variability between upland and lowland parts of the catchment that can be interpreted to relate to geology. Weakly acidic drainage with no alkalinity in areas that drain mostly Brunner Coal Measures is to be expected, and increasing alkalinity as streams drain Paparoa Coal Measures and underlying conglomerates is also to be expected. Overall these streams have chemistry that is relatively unimpacted by human activities compared to Denniston and Stockton areas and demonstrate natural variability spatially and temporally. The stream chemistry data has been utilised as inputs into water chemistry prediction for the mine site and its discharges and has been reviewed by Dr Boothroyd for assessment of aquatic ecology in the Te Kuha area.

HYDROLOGY

36 The Te Kuha mine site hydrology is a headwater area of six catchments, West Creek, Camp Creek, Landslide Creek, Coal Creek North, Little Cascade Creek and Buller River (**Figure 7 – Appendix 1**, Pope & Dutton 2016). Mining related disturbances occurs in all six catchments from year 1 to year 17 of operations. In year 18 the Buller Catchment is restored, in year 19 the Little Cascade Catchment is restored and the last disturbances in West Creek, Camp Creek, Landslide Creek, Coal Creek North are rehabilitated in year 20 (Rock, 2015).

37 Site hydrology has been studied through manual flow monitoring at water quality sites during water sampling and through continuous water depth monitoring of streams with pressure recording sensors. Continuous stream depth monitoring has been completed at one upland site (TKS 4) between August 2015 and May 2017 (excluding parts of November and December 2016 as well as January 2017).

38 The upland stream height logger was placed behind a V-notch weir so that direct correlations to stream flow can be completed. Analysis of the stream flow at the weir indicated that 95% of

rainfall is returned through the stream within 18 hours after the rainfall, with slightly elevated stream flow for 1-2 days following a rainfall event. The key interpretation from this dataset is that rainfall events at the mine site can be assumed to convert rapidly and almost completely to stream flow and that loss of surface water to groundwater, evapotranspiration, or soil profiles are negligible with respect to managing rainfall events.

39 The Te Kuha mine site hydrogeological relationships were modelled further with GoldSim™ software to allow estimation of flow rates from different parts of the mine site and assist with site water management and sizing of water management infrastructure. GoldSIM™ is software that can rapidly complete different input simulations for complex systems such as a mine site catchment and derive likely output parameters. We have applied it to model surface water flows seepages and chemistry at the Te Kuha mine as a method for dealing with uncertainty and variability in climate data, particularly with respect to rainfall. The GoldSim™ model has been run in a statistical manner rather than a probabilistic manner. This means all available climate data (73 years) has been run for each of the mining stages and surface water discharge parameters have been derived and treated statistically.

40 Despite this approach uncertainty remains and is related to assumptions in the modelling process. Key assumptions are listed below.

(a) Only surface water runoff and seepage from the disturbed areas is included in the model. Surface water from undisturbed areas is to be diverted before mixing with mine influenced water. A diversion drain concept plan is provided in (Pope 2014 a & b), and clean water diversion drains have been included in the mine plan.

(b) The 73 years of rainfall data are missing small parts of the rainfall dataset (particularly in 1944, 1982 & 1997). We used replacement data from a previous year of rainfall (Pope & Dutton, 2016) to get a continuous record.

(c) Modelling includes an assumption to scale the size of Westport rainfall events to what might be expected at Te Kuha. The scale factor adopted was 2.59 (Pope & Dutton, 2016), climate data to 2018 confirm this assumption and the scale factor has been refined to 2.6 (Dutton, Pope & Christenson 2018).

(d) Surface water from rehabilitated areas can be diverted to direct discharge after rehabilitation has been established for 1 year. This assumes that surface water chemistry and suspended sediment is acceptable for discharge. This has been discussed with rehabilitation expert, Dr Robyn Simcock.

(e) The probability that a rainfall event with a recurrence interval of greater than 73 years is captured in the data is less than 1. So the dataset is unlikely to capture very extreme events. In general, extreme events will be bypassed from mine infrastructure rather than managed within it.

41 As the Te Kuha mine is developed, surface water from disturbed areas will be directed out of four of the catchments, Coal Creek North, Landslide Creek, Buller River, Little Cascade Creek and into Camp Creek and West Creek (**Figure 6 and 7 – Appendix 1**) via water treatment infrastructure. Using the GoldSim^{TM} model, the daily volumes of water that is removed from the catchments during mining operations can be estimated (Pope and Dutton, 2016).

42 Initial modelling was conservative with respect to management of surface water flows and a runoff to infiltration ratio of 90:10 was used to derive flow volumes for treatment in the water treatment system. This means that during each rainfall event 90% of water at Te Kuha reports to surface water treatment after evapotranspiration, with 10% reporting to seepage. This assumption was used for initial design of water treatment infrastructure.

43 During development of waste rock management strategies and water treatment contingency plans (Trumm & Pope 2017a,b) data was provided by Bathurst Resources from the Barren Valley

Engineered Land Form (ELF) at Escarpment Mine related to infiltration and runoff. This dataset is the most relevant available dataset for prediction of flow from seeps at the Te Kuha site because, ELF construction methods will be similar and the underdrainage concept for Te Kuha is similar to the underdrainage system that is in place at the Barren Valley ELF.

44 Based on this data a runoff to infiltration ratio of 79:21 was measured for the Barren Velley ELF. This data was remodelled with GoldSim^{TM} and has the effect of decreasing the volumes of peak surface water flow and increasing the volumes of seepage that reports to the water treatment infrastructure. In addition, a conservative GoldSim^{TM} model was run with a runoff to infiltration ratio of 60:40 to ensure that any additional seepage that might occur at Te Kuha compared to Escarpment due to unforeseen circumstances would not deliver combined seepage and surface water flows that would exceed capability of the concept water treatment infrastructure. The conservative model has the effect of further decreasing peak surface water flows and increasing seepage volumes.

45 There are assumptions and unknowns in this modelling including:

(a) Loss of surface water and seepage to groundwater are assumed to be negligible based on measured surface flows at TK4. This assumption is conservative with respect to surface water flows as small (and relatively rapid) responses of aquifers below the coal seams to rainfall have been measured (Flintoft, 2013).

(b) The effect of long term evolution of ELF hydrogeology is unknown with the ELF construction method used. The Barren Valley ELF is the best analogy available with respect to runoff and infiltration, but it is a relatively young structure (~5 years) and is currently in care and maintenance. It is unclear if long term hydrological behaviour of these structures sees an increase or decrease in net percolation.

46 The infrastructure related to Westport water supply is located along the coastal range 3 km North-northwest of the Proposed Te Kuha mine footprint (**Figure 6 – Appendix 1**). There are two

stream valleys and two ridges between the Te Kuha mine site and the water management infrastructure. No surface water impact from the Te Kuha mine site on the quality of the Westport water supply is anticipated, and this will be demonstrated in routine water quality monitoring.

ROCK GEOCHEMISTRY

47 Brunner Coal Measures (BCM) rocks are typically strongly acid forming rocks with little neutralising capacity and when disturbed by mining form acid mine drainage with release of high concentrations of Al and Fe. Paparoa Coal Measures (PCM) are typically non-acid forming rocks that produce neutral drainage when disturbed by mining which can contain elevated concentrations of Fe (Pope et. al., 2010a). Both sets of rocks can release trace elements, most abundantly Mn, Zn and Ni. Other trace elements can be enriched in BCM acidic drainages including As, Cd, Co, Cu, Cr, Pb and rarely other metals. All these other trace elements are typically below detection in PCM neutral drainages (Pope et. al., 2010b).

48 At Te Kuha the Brunner Coal Measures rocks are atypical because they do not have as much potential to release acid as BCM that have been investigated and mined elsewhere on the West Coast (**Figure 8a and b – Appendix 1**). Based on 101 samples, Te Kuha BCM have an average maximum potential acid (MPA) value of 3.3 kg(H_2SO_4)/t and an average acid neutralising capacity (ANC) of 1.2 kg(H_2SO_4)/t. In other published data the average MPA for BCM is 22 kg(H_2SO_4)/t and the average ANC is similar to Te Kuha (Pope et. al., 2010a). So the acid forming potential for BCM at Te Kuha is less than one sixth of the average for BCM from other sites. PCM at Te Kuha have an average MPA of 1.8 kg(H_2SO_4)/t and ANC 19.8 kg(H_2SO_4)/t. In other published data for PCM the average ANC is 6 kg(H_2SO_4)/t and the MPA is similar to the Te Kuha average, however, there are only 25 published results for PCM analyses (Pope et. al., 2010a) (**Figure 9a and b – Appendix 1**).

49 At Te Kuha, the combination of low acid forming potential in BCM with concurrent mining of PCM that has strong acid neutralising capacity means that acid formation from overburden can be prevented through engineered landform design (details below). This management strategy relies on implementation of a suitable overburden classification and management scheme (Trumm & Pope 2017). The approach at Te Kuha is to add limestone to PAF and low PAF material. The PAF material is to be underlain by NAF, capped with NAF material and blended with NAF material.

MINING IMPACTS ON WATER QUALITY

50 Mining impacts on water quality have been assessed through free draining column leach tests on the rocks that will be disturbed by mining. These tests have been operated on 23 kg samples in the field at the foot of the Te Kuha range. This approach provides environmental conditions for rainfall frequency and temperature with near maximum availability of oxygen. Three columns of Brunner Coal Measures (BCM) were set up and two columns with Paparoa Coal Measures (PCM). Based on the suite of geochemical data collected for the site, the rock types included in the columns are appropriate to assess the leachate composition that can be expected from the rocks that will be disturbed by mining in conditions where oxygen is available.

51 Data from the BCM leach columns release lower acid volumes and trace element concentrations than BCM leach columns from other sites (**Figure 10 and 11 – Appendix 1**). Typically leachate from BCM columns has a pH between 1.5 and 3.5 and high release rates of Fe and Al, and this chemistry can continue for several years of monthly leach testing. Leachate analyses from BCM columns from Te Kuha have decreased pH and elevated concentrations of Fe and Al for the first 1-4 leach cycles. Subsequently pH stabilises between 4.3 and 6. In addition, Zn, Ni and other trace elements can be elevated in the initial 1-4 leachate samples from BCM, but in general, occur at lower concentrations in columns from Te Kuha than from columns from other BCM hosted mine sites.

52 Data from PCM leachate samples have pH in the range 7 to 9 and release alkalinity in the range of 9 to 78 mg(H_2SO_4)/kg. Fe and Al concentrations released by PCM are within the range that is measured in stream samples. Trace elements concentrations in leachate from PCM can be elevated above background stream concentrations but decrease rapidly over 2-7 leaching cycles.

53 In general, the leachate chemistry from column testing can be summarised as follows:

(a) The pH range of leachate is similar to or higher than the range measured in upland streams.

(b) With the exception of the most acid forming BCM column, acidity is low in the leachate data.

(c) Zn and Ni are elevated in the initial leachate samples in both BCM and PCM columns.

(d) Other trace elements including Cu, Cr, Co and As are enriched to concentrations less than 0.07 mg/L in leachate and typically much lower, less than 0.01 mg/L and the concentrations of these trace elements typically decreases over the first 2-7 leachate samples.

54 Interpretation of column leach data for prediction of water chemistry at a mine site is not straight forward and often a scale factor is applied for acid forming rocks based on comparison to analogous sites because leach rates in the column are usually faster per unit mass than within an operational ELF. In general, column leach testing is useful to identify which cations, anions or trace elements will be enriched in mine seeps but accurate prediction of concentrations that might occur at a water treatment plant is difficult and usually best and worst case scenarios are developed.

55 To summarise the approach taken at Te Kuha, average leachate chemistry over one year was used without a scale factor to derive a worst case scenario for leachate from disturbed areas, and this was blended with surface water assumed to have similar chemistry to upland streams to predict water chemistry at discharge in GoldSim™. In addition, a water treatment

contingency plan was developed should mine drainage chemistry prove to be worse than predicted by column leach testing.

56 An alternative approach with emerging test methodologies to enable prediction of mine water quality is to derive mine drainage seep chemistry based on geochemical reactions that are likely to take place in an ELF with input parameters of expected net percolation through overburden and likely ingress of oxygen into the ELF. The availability of water and oxygen are commonly limiting factors in chemical reactions that release acid and trace elements. This approach is adopted for assessment of the potential mine drainage types that could occur at Te Kuha and leads to a conservative worst case scenario for mine drainage seep chemistry.

57 Several combinations of parameters and assumptions have been used to calculate mine drainage chemistry including:

(a) Runoff to infiltration to ratios of between 90:10 and 60:40 (as described above).

(b) Saturation is assumed to limit ingress of oxygen.

(c) Saturation based on modelling with GoldSim™. The average value for saturation is 81% at Te Kuha based on all the climate data and this value drops to 70% in dry conditions (driest 95 percentile). Mine drainage chemistry calculations for both 81% and 70% have been completed.

(d) Oxygen concentration is 1 % at 2 m into the ELF similarly to data derived from the Barren Valley ELF at Escarpment mine (Pope et al., 2016).

58 Using this approach, and the parameters above, indicates that mine drainage chemistry at seeps at Te Kuha could have elevated concentrations of Fe and sulphate as well as trace element concentrations that are higher than those measured in the leachate testing and that any drainage acid would form within the dumps that is neutralised before it emerges at a seep (Trumm and Pope 2017a).

59 Overall the balance of acid neutralising capacity to potential acidity within the Te Kuha overburden with limestone additions will

have a ratio of 4.2:1 (Pope and Trumm 2017a). By calculating the maximum likely rates of acid production and alkalinity released by the overburden an overall balance for the overburden can be completed. At Te Kuha there is between 2 and 3.2 times as much ANC available after all acid is released indicating neutral drainage will come from engineered landforms.

60 Should water chemistry predicted by this approach eventuate, then treatment will be required before discharge to remove Fe and trace elements and this will be completed by dosing at the seep pumping sites or at the water treatment infrastructure (Trumm and Pope 2017b).

61 In the long term, once the disturbance related to mine pits, ELFs, ROM and top soil stockpiles has been rehabilitated, treatment of water for suspended sediment will not be required. It is anticipated water management related to roads and tracks that remain after mining can be managed with along with road maintenance. Treatment of seeps for water chemistry in the long term will depend on mine drainage quality and how this evolves with time. If active treatment of seeps is required during operations then it is likely that this will also be required during a period of aftercare. If possible treatment of seeps, if required, would switch to passive mechanisms until quality was suitable for direct discharge. Studies related to the evolution of mine drainage chemistry with time and the requirements for long term treatment will be completed as soon as practical, but cannot commence until the mine is operational and site monitoring data is able to be interpreted.

REGIONAL LAND AND WATER PLAN

62 The reports I have authored or contributed to demonstrate a response to two Regional Policies listed in the Regional Land and Water Plan.

63 Policy 4.3.2 To manage earthworks (for example mining) to avoid effects on the environment where the activity may produce any of the following geochemical processes above background levels:

a) Acid mine drainage

b) Precipitation of iron oxides

c) Release of heavy metals.

Policy 3.3.7: In the management of any activity involving water, to avoid, remedy, or mitigate adverse effects on:

a) Water quality;

b) Amenity values;

c) Indigenous biological diversity;

d) Intrinsic values of ecosystems;

e) The natural character of wetlands, and lakes and rivers and their margins, not described in 3.3.1(1)(d); and

f) Historic heritage not described in 3.3.1(1)(h).

64 A concept Overburden Management Plan has been developed (Trumm & Pope 2017a) and this will form the basis of the Overburden Management Plan as required in the consent conditions. This plan has been developed in line with international best practice and has the effect of limiting the potential for acidic, iron or heavy metal rich discharges (Trumm & Pope 2017a).

65 Overall, the geochemistry of the Te Kuha mine site is favourable compared to other Buller mine sites. At Te Kuha there is low potential for acid mine drainage formation and adequate rocks that contain excess acid neutralisation potential to prevent net acidic discharge from the mine. In addition to the favourable rock geochemistry, the Overburden Management Plan further mitigates the potential for acid, iron or heavy metal discharges. Key aspects in the overburden management plan include:

(a) Classification of rock prior to removal through geological and laboratory methods.

(b) Addition of limestone to Low PAF and PAF at 0.9 and 36 kg/t respectively.

(c) Selective placement of NAF rocks at the base, margins and cap of engineered landforms **(Figure 12 - Appendix 1** (Trumm and Pope, 2017)**)**.

(d) Engineered landforms to be built in 2 m lifts (which prevents grainsize segregation and oxygen ingress and reduces permeability and water ingress) of mixed rock types.

(e) Trafficking and wheel rolling of each lift (minimise ingress of water).

(f) Shaping of ELFs areas to have a durable landform and shed surface water.

66 Geochemical aspects of this engineered landform concept design including limestone addition and selective placement of NAF material have been used at other sites in New Zealand successfully. For example Waihi and Globe gold mines selectively places NAF and PAF material and, at Waihi, use limestone addition to deliver neutral surface drainage. The geochemical characteristics at these mine sites are not identical to Te Kuha, however, their success demonstrates proof of concept for prevention of acidification by robust geochemical interpretation and good management. With regard to Policy 4.3.2, it is my opinion that this indicates overburden management can be successfully implemented to prevent acid mine drainage and minimise release of Fe and heavy metals.

67 Physical aspects of this Overburden Management Plan including construction of short lifts, wheel rolling, shaping have been completed at Escarpment mine and partially at the Cypress Mine, Northern ELF. Information collected at these two sites indicate that this method of construction can exclude oxygen from all but the outer 2 meters of the ELF (Pope et al 2016) and limits permeability to water (Bathurst Resources, 2017). With regard to Policy 4.3.2, it is my opinion that this means that oxidation of sulphide minerals can be minimised and a substantial proportion of acid and trace elements will remain immobile with the ELF.

68 The Overburden Management Plan also includes concept design for segregation of surface drainage from underdrainage so that seeps from the ELF can be selectively treated if required and a

monitoring regime to ensure that adequate data is collected for decision making. This management plan includes conservative concept design with appropriate sensitivity analysis. It is anticipated the management and monitoring concepts put forward based on the data available to date are revisited and refined based on data that will be collected during the early years of mining.

69 In my opinion, the programme of overburden management proposed at Te Kuha is in line with best practise and is informed by analogy with sites in an appropriate manner. The conditions proposed are robust but have sufficient flexibility to allow the consent holder to optimise management as more is learned about the deposit when mining commences. In addition, the operation planned at Te Kuha is consistent with the Land and Water Plan policies listed above.

CONCLUSION

70 Coal quality information indicate that the Te Kuha deposit contains high quality coking coal that will command premium price as a stand alone product. As a product blended with other West Coast coking coal, the Te Kuha coal could be used to increase the value of significant tonnages of other coals particularly because of its high rank, high fluidity, high swell, low ash and low sulphur. As well as coking coal markets, it is likely that Stevenson would be able to develop other niche or specialist markets for Te Kuha coal if desired.

71 Climate data at Te Kuha have been measured since 2012 and have been combined with long term monitoring data from Westport to provide information on the hydrology for water management at the Te Kuha mine site.

72 Baseline stream chemistry monitoring has been completed since 2013 and results demonstrate the variability spatially and temporally throughout the catchment. This information provides a robust dataset to benchmark the site and it surrounds for any unexpected consequences related to development of the Te Kuha mine.

73 At Te Kuha the geochemistry of the rocks combined with a best practise Overburden Management Plan mean that acidic seeps from the overburden will be avoided. An effective classification scheme is critical to successful overburden management and this needs to be flexible as more information is learned about the deposit. The overall balance of acid neutralising capacity to potential acidity supported by calculations of annual acid production and alkalinity loss provides confidence that acid mine drainage from overburden will not occur.

74 Several scenarios have been run to consider the potential seep chemistry and flow rates. There is sufficient sensitivity analysis and conservatism in the approaches to seep chemistry and flow to indicate that the mine site will be able to mitigate challenges using adaptive management within the concept plans provided. Should seep chemistry arise that is similar to the worst case scenario then treatment with pH dosing will be deployed either at the seeps or with in the water treatment infrastructure. For the two most common trace elements (Zn and Ni) compliance limits are proposed, for other trace elements a monitoring and adaptive management regime is proposed.

Dr James Pope

20 August 2020

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APPENDIX 1

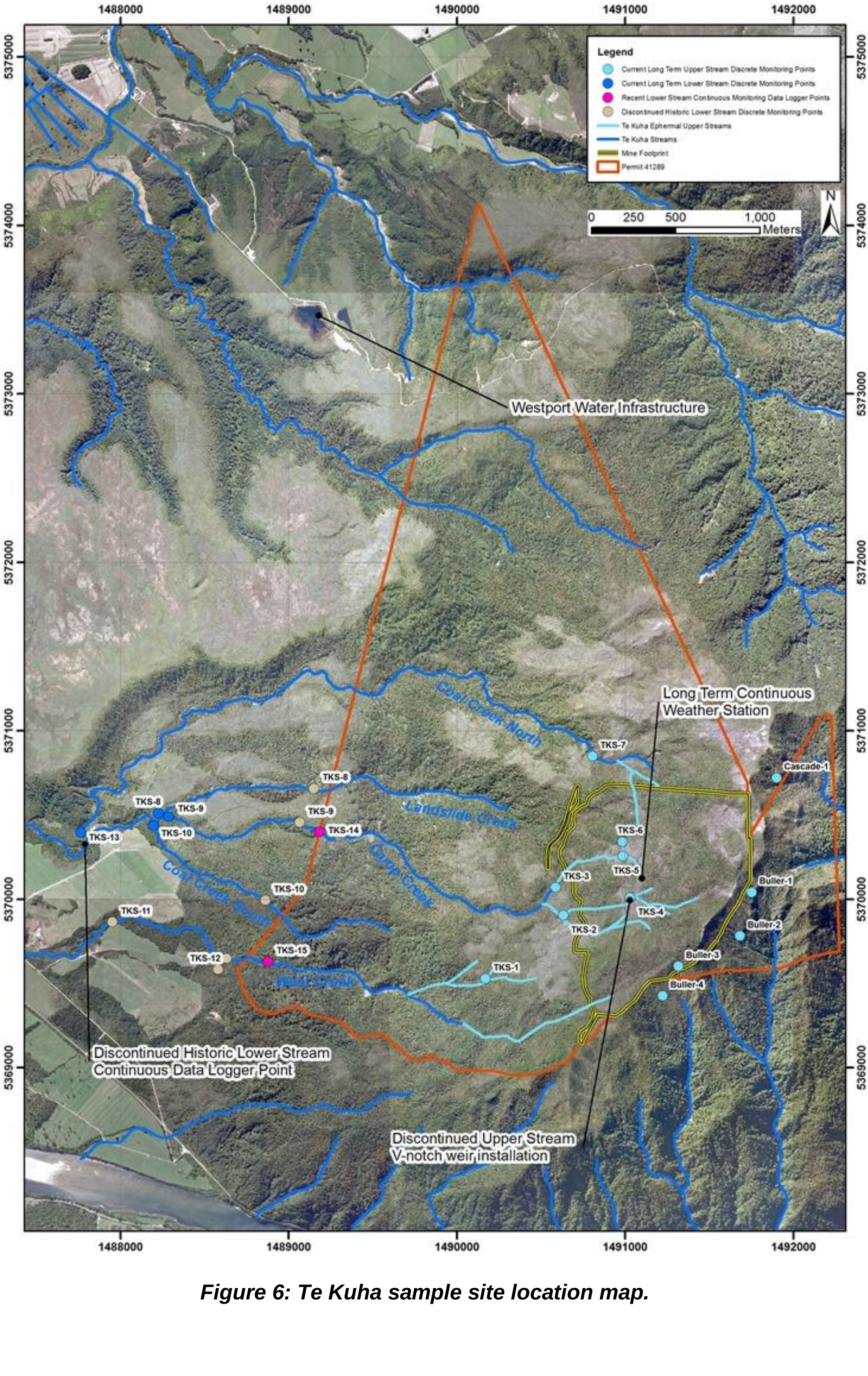


Figure 6: Te Kuha sample site location map.

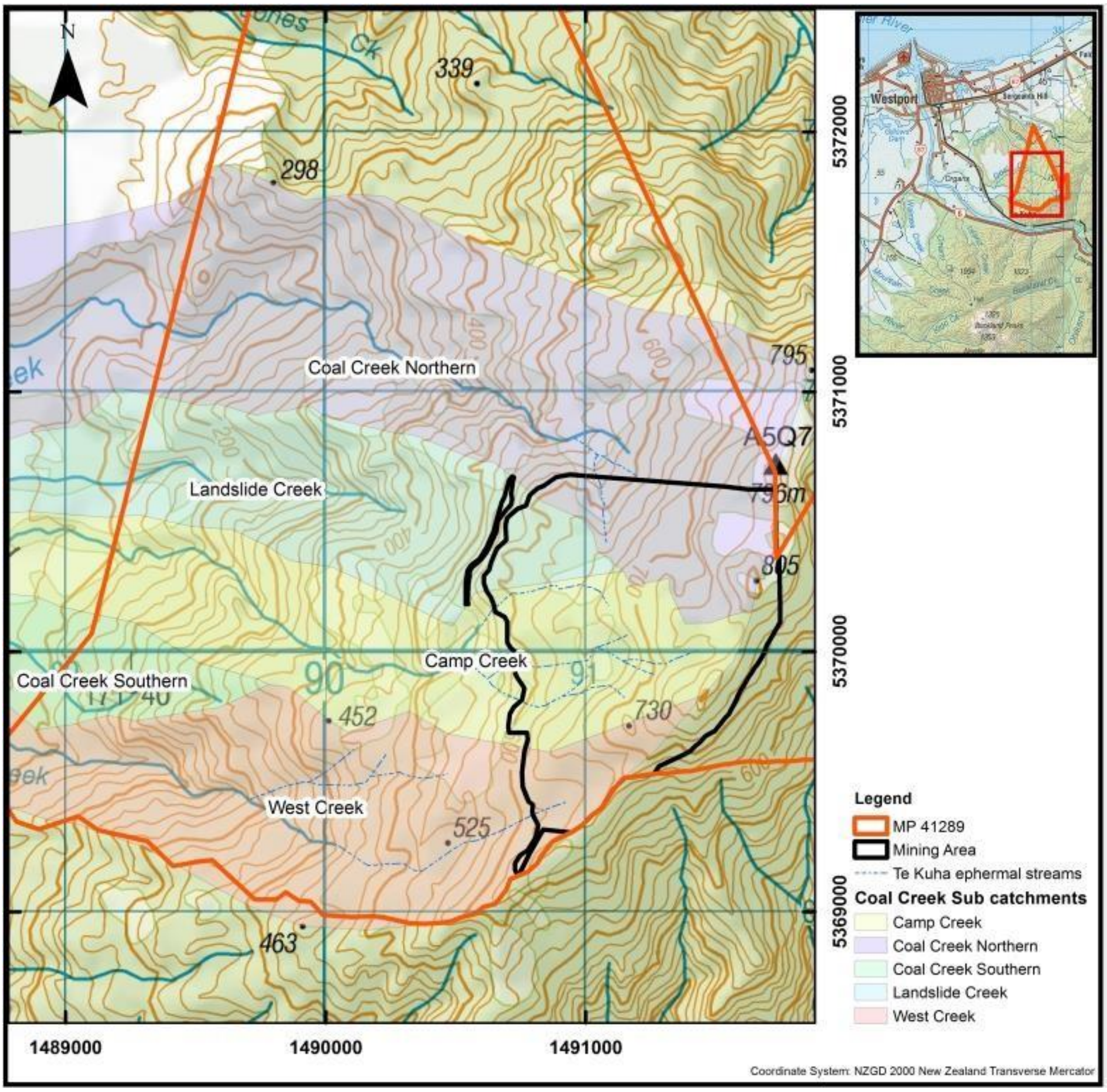
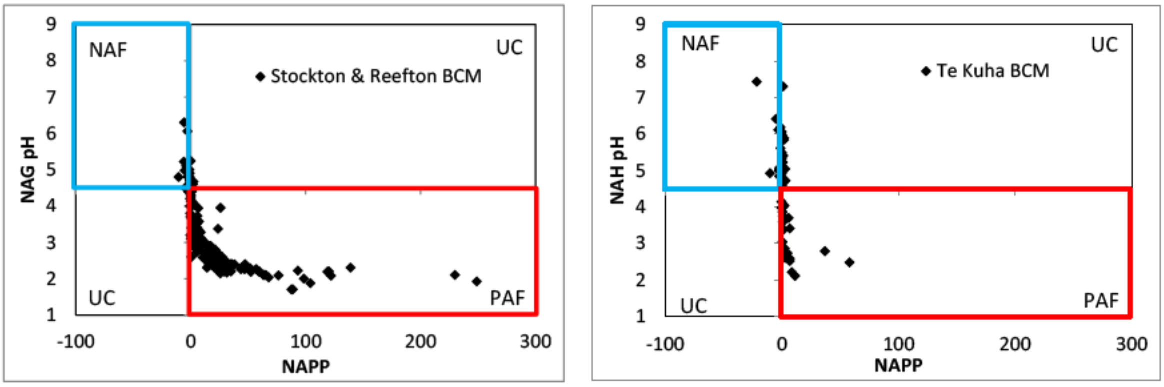
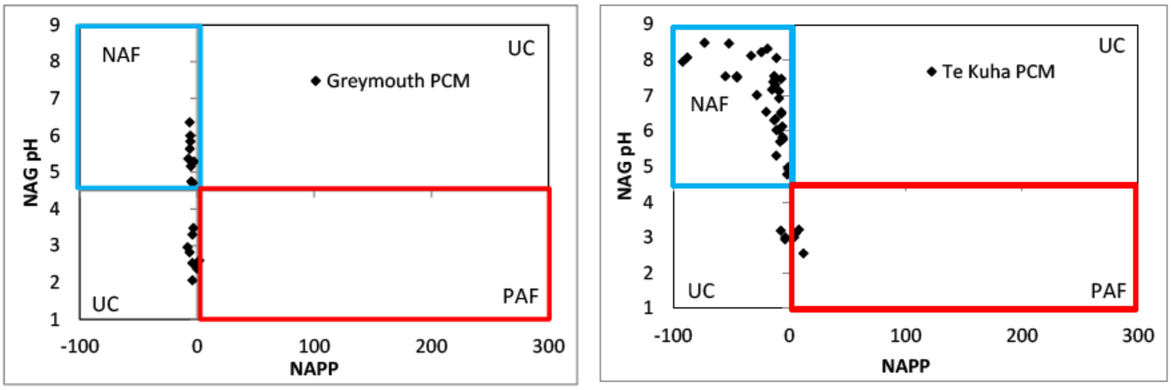


Figure 7: Te Kuha sub-catchments.



a b

Figure 8: Comparison of acid forming potential of typical Brunner Coal Measures (a) to Brunner Coal Measures at Te Kuha (b).



a b

Figure 9: Comparison of acid neutralising potential of typical Paparoa Coal Measures (a) to Paparoa Coal Measures at Te Kuha (b).

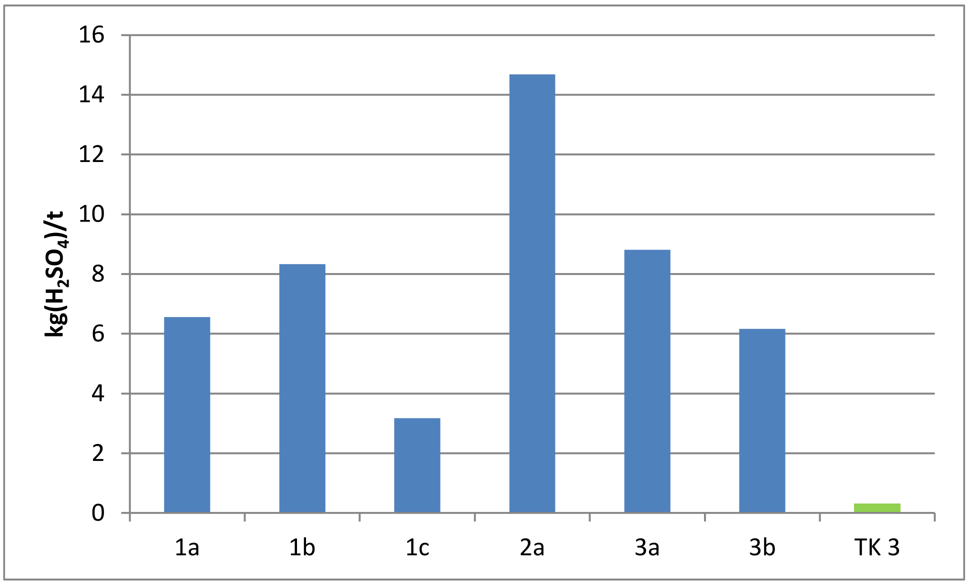


Figure 10: Acid release in column leach comparison of Te Kuha BCM to BCM from other sites.

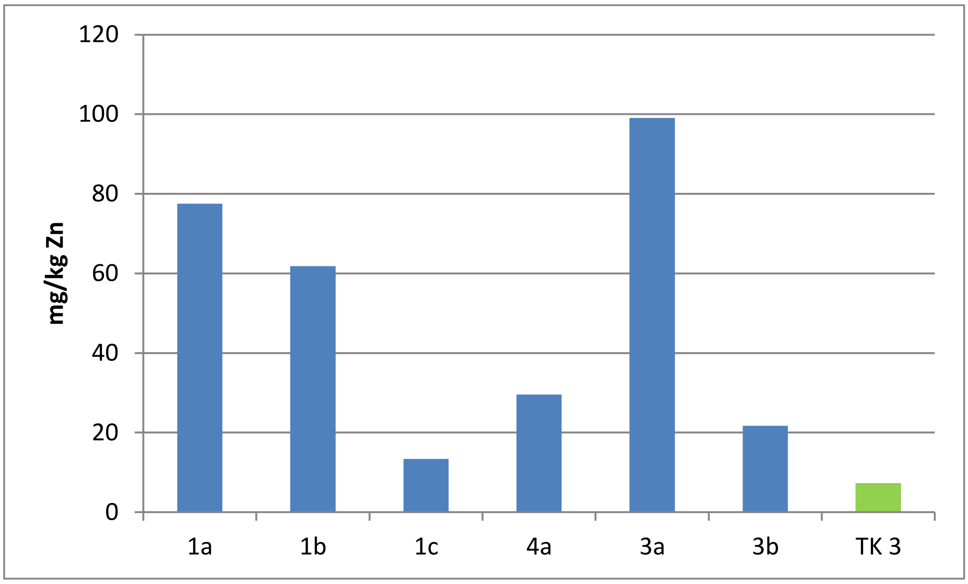


Figure 11: Zn release in column leach comparison of Te Kuha BCM to BCM from other sites.

Table 1: Wet and Rain day frequency distribution for Te Kuha – working on update to 2020

Year	2013	Expressed	2014	Expressed	2015	Expressed	2016	Expressed	2017	Expressed	2018	Expressed	2019	Expressed	2020	Expressed
Number of days with data	359	as %	364	as %	310	as %	211	as %	365	as %	359	as %	365	as %	366	as %
Days No Rain (less than 0.1mm)	112	31.2%	116	31.9%	83	26.8%	54	25.6%	101	27.7%	126	35.1%	98	26.8%	98	26.8%
Days between 0.1 and 1mm	56	15.6%	61	16.8%	56	18.1%	28	13.3%	62	17.0%	73	20.3%	56	15.3%	79	21.6%
Days between 1 and 10mm	108	30.1%	91	25.0%	91	29.4%	55	26.1%	89	24.4%	87	24.2%	82	22.5%	69	18.9%
Days between 10 and 20mm	39	10.9%	46	12.6%	29	9.4%	23	10.9%	31	8.5%	32	8.9%	37	10.1%	39	10.7%
Days between 20 and 50mm	32	8.9%	45	12.4%	33	10.6%	33	15.6%	48	13.2%	28	7.8%	61	16.7%	46	12.6%
Days between 50 and 100mm	11	3.1%	5	1.4%	14	4.5%	13	6.2%	26	7.1%	12	3.3%	26	7.1%	27	7.4%
Days between 100 and 150mm	1	0.3%	0	0.0%	4	1.3%	4	1.9%	8	2.2%	0	0.0%	3	0.8%	5	1.4%
Days Over 150mm	0	0.0%	0	0.0%	0	0.0%	1	0.5%	0	0.0%	1	0.3%	2	0.5%	3	0.8%
Total Rain days (more than 0.1mm per day	**247**	**68.8%**	**248**	**68.1%**	**227**	**73.2%**	**157**	**74.4%**	**264**	**72.3%**	**233**	**65%**	**267**	**73%**	**268**	**73%**
Total Wet days (more than 1mm per day)	**191**	**53.2%**	**187**	**51.4%**	**171**	**55.2%**	**129**	**61.1%**	**202**	**55.3%**	**160**	**45%**	**211**	**58%**	**189**	**52%**

Table 2: Visibility at Westport Airport

Visibility at Westport Airport at 9am	2013	2014	2015	2016	2017	2018	2019	2020
5km or less	36	37	31	48	38	28	40	32
10km or less	61	65	65	82	70	55	70	73
More than 10km	302	298	300	284	294	309	295	291
No data days	2	2	0	0	1	1	0	2